Calculations required to be provided by the Permittee on site for all Inspections



September 3, 2024





STRUCTURAL CALCULATIONS (Permit Submittal)

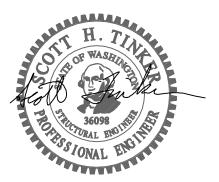
CENTERIS DATA CENTER VOLTAGE PARK FOUNDATIONS SOUTH YARD

1023 39th Avenue SE Puyallup, WA 98374

Quantum Job Number: 23444.01

Prepared for: CENTERIS DATA CENTERS 18300 Cascade Avenue S Seattle, WA 981188

Prepared by: QUANTUM CONSULTING ENGINEERS 1511 Third Avenue, Suite 323 Seattle, WA 98101 TEL 206.957.3900 FAX 206.957.3901





CENTERIS SOUTH YARD 1023 39TH AVE SE PUYALLUP, WA 38374

QUANTUM JOB NUMBER: 23444.01

INDEX

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Structural Design Criteria

Building Code:	2021 International Building Code
Building Department:	City of Puyallup

Seismic Criteria

S _s :	1.26		
S ₁ :	0.43	Seismic Soil Site Class:	D
S _{ds} :	1.01	Seismic Design Category:	D
S _{d1} :	0.50	Cs:	0.15

Wind Criteria

Wind Speed:	97
Risk Category:	- II
Wind Exposure:	В
Kzt:	1

<u>Geotechnical Criteria</u>	
Allowable Bearing Pressure	2500 PSF
Minimum Footing Width	Continuous: 18" min.
Frost Depth	18" min.
Soils Consultant	GeoEngineers
Soils Report Number	#4565-064-09
Soils Report Date	June 14, 2024
Active Soil Pressure (Restrained/Unrestrained)	55 PCF / 35 PCF
Seismic Surcharge Pressure	8H PSF
Passive Soil Pressure	300
Coefficient of Friction	0.4

Materials Criteria

Concrete (28 Day Strength): Foundation/Slab on Grade Walls and Columns	F'c= 3,000 PSI F'c= 3,000 PSI
Reinforcing Steel: Grade 60	Fy= 60,000 PSI
Structural Steel: Wide-Flange Sections: A-992 Miscellaneous Sections: A-36 Tube Sections: A-500 Pipe Sections: A-53 Welding	Fy= 50,000 PSI Fy= 36,000 PSI Fy= 46,000 PSI Fy= 35,000 PSI Fy= 70,000 PSI



Quantum Consulting Engineers LLC	Project: Centeris	Date:	9/3/24	Job No:	23444.01
1511 Third Avenue, Suite 323		Designer:	TVM	Sheet:	1
Seattle, WA 98101	Client: Centeris	Checked By:			

Building Loads

Snow Load

Roof

Assembly Loads

14" Water Pipe		
14" Pipe STD		54.6 plf
Water		60.8 plf
Fittings / Misc.		4.6 plf
	Total:	120.0 plf

8" Water Pipe		
8" Pipe STD		28.6 plf
Water		21.7 plf
Fittings / Misc.		9.7 plf
	Total:	60.0 plf

6" Water Pipe		
6" Pipe STD		19.0 plf
Water		12.5 plf
Fittings / Misc.		8.5 plf
	Total:	40.0 plf

Quantum Consulting Engineers LLC	Project: Centeris Chiller Pipe Frames	Date:	9/3/24	Job No:	23444.01
1511 Third Avenue, Suite 323		Designer:	TVM	Sheet:	1
Seattle, WA 98101	Client: Centeris	Checked By:			

25 psf

A This is a beta release of the new ATC Hazards by Location website. Please <u>contact us</u> with feedback
 The ATC Hazards by Location website will not be updated to support ASCE 7-22. <u>Find out why.</u>

ATC Hazards by Location

Search Information

Address:	1015 39th Ave SE Puyallup, WA 98374
Coordinates:	47.1590004, -122.2794422
Elevation:	489 ft
Timestamp:	2023-12-01T15:13:57.333Z
Hazard Type:	Wind



ASCE 7-16		ASCE 7-10		ASCE 7-05	
MRI 10-Year	67 mph	MRI 10-Year	72 mph	ASCE 7-05 Wind Speed	85 mph
MRI 25-Year	73 mph	MRI 25-Year	79 mph		
MRI 50-Year	78 mph	MRI 50-Year	85 mph		
MRI 100-Year	82 mph	MRI 100-Year	91 mph		
Risk Category I	92 mph	Risk Category I	100 mph		
Risk Category II	97 mph	Risk Category II	110 mph		
Risk Category III	104 mph	Risk Category III-IV	115 mph		
Risk Category IV	108 mph				

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 interpolated from data provided in ASCE 7 and rounded up to the nearest whole integer. Per ASCE 7, islands and coastal areas outside the last contour should use the last wind speed contour of the coastal area – in some cases, this website will extrapolate past the last wind speed contour and therefore, provide a wind speed that is slightly higher. NOTE: For queries near wind-borne debris region boundaries, the resulting determination is sensitive to rounding which may affect whether or not it is considered to be within a wind-borne debris region.

Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions.

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The ATC Hazards by Location website will not be updated to support ASCE 7-22. <u>Find out why.</u>

ATC Hazards by Location

Search Information

Address:	1015 39th Ave SE Puyallup, WA 98374
Coordinates:	47.1590004, -122.2794422
Elevation:	489 ft
Timestamp:	2023-12-01T15:14:56.409Z
Hazard Type:	Seismic
Reference Document:	ASCE7-16
Risk Category:	III
Site Class:	D-default



Basic Parameters

Name	Value	Description
SS	1.257	MCE _R ground motion (period=0.2s)
S ₁	0.433	MCE _R ground motion (period=1.0s)
S _{MS}	1.508	Site-modified spectral acceleration value
S _{M1}	* null	Site-modified spectral acceleration value
S _{DS}	1.005	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
Fa	1.2	Site amplification factor at 0.2s
Fv	* null	Site amplification factor at 1.0s
CRS	0.914	Coefficient of risk (0.2s)
CR ₁	0.898	Coefficient of risk (1.0s)
PGA	0.5	MCE _G peak ground acceleration
F _{PGA}	1.2	Site amplification factor at PGA
PGA _M	0.6	Site modified peak ground acceleration
ΤL	6	Long-period transition period (s)
SsRT	1.257	Probabilistic risk-targeted ground motion (0.2s)
SsUH	1.375	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
SsD	1.5	Factored deterministic acceleration value (0.2s)
S1RT	0.433	Probabilistic risk-targeted ground motion (1.0s)
S1UH	0.483	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
S1D	0.6	Factored deterministic acceleration value (1.0s)
PGAd	0.5	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.



CENTERIS SOUTH YARD 1023 39TH AVE SE PUYALLUP, WA 38374

QUANTUM JOB NUMBER: 23444.01

RETAINING WALL

LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 11' Retained - EQ QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

(c) ENERCALC INC 1983-2023

Code Reference

Calculations per IBC 2021 1807.3, ASCE 7-16

Criteria

Retained Height	=	11.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water table above		
bottom of footing	=	0.0 ft

Surcharge Loads

Surcharge Over Heel = 0.0 psf Used To Resist Sliding & Overturning Surcharge Over Toe = 0.0 psf Used for Sliding & Overturning				
Axial Load Applied to Stem				
Axial Dead Load Axial Live Load	=	0.0 lbs 0.0 lbs		

Earth Pressure Seismic Load

Method : Uniform Multiplier Used = 8.000 (Multiplier used on soil density)

Allow Soil Bearing Equivalent Fluid Pressure	= Meth	3,333.0 psf od
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	450.0 psf/ft
Soil Density, Heel	=	120.00 pcf
Soil Density, Toe	=	120.00 pcf
Footing Soil Friction	=	0.530
Soil height to ignore for passive pressure	=	0.00 in

Soil Data

Lateral Load Applied to Stem

Lateral Load Height to Top Height to Bottom	= = =	0.0 #/ft 0.00 ft 0.00 ft
Load Type	=	Seismic (E) (Strength Level)
Wind on Exposed Ster (Strength Level)	m _	0.0 psf

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
Footing Type Base Above/Below Soil at Back of Wall	=	Spread Footing 0.0 ft

Uniform Seismic Force = 97.333 Total Seismic Force = 1,184.222

LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 11' Retained - EQ

Design Summary

Wall Stability Ratios Overturning Sliding Global Stability	= =	1.98 1.53 1.86		-
Total Bearing Load resultant ecc. Eccentricity outsid			in	014
Soil Pressure @ Toe Soil Pressure @ Heel	=	3,303 0		OK
Allowable Soil Pressure Less		3,333 n Allowable	, psf	
ACI Factored @ Toe ACI Factored @ Heel	=	3,961 0	psr psf	
Footing Shear @ Toe	=	3.1	•	
Footing Shear @ Heel Allowable	=	31.3 82.2	•	OK
Sliding Calcs				
Lateral Sliding Force	=	3,419.4 l	bs	
less 100% Passive Force		625.0		
less 100% Friction Force	_	4,602.6 l 0.0		OK
Added Force Req'd for 1.5 Stability	=	0.0		

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	1.000
Seismic, E	1.000

Project File: Retaining Walls - Updated.ec6 (c) ENERCALC INC 1983-2023

Stem Construction		2nd	Bottom	
Design Height Above Ftg	ft =	Stem OK 3.00	Stem OK 0.00	
Wall Material Above "Ht"	=	Concrete	Concrete	
Design Method	=	SD	SD	SD SD
Thickness	=	8.00	8.00	
Rebar Size	=	# 4	# 6	
Rebar Spacing	=	6.00	6.00	
Rebar Placed at	=	Edge	Edge	
Design Data			0.074	
fb/FB + fa/Fa	=	0.748	0.971	
Total Force @ Section				
Service Level	lbs =			
Strength Level	lbs =	2,570.7	4,458.7	
MomentActual				
Service Level	ft-# =			
Strength Level	ft-# =	7,893.3	18,311.3	
MomentAllowable	ft-# =	10,542.0	18,848.3	
ShearActual				
Service Level	psi =			
Strength Level	psi =	34.3	66.1	
ShearAllowable	, psi =	57.4	77.3	
Anet (Masonry)	in2 =			
Wall Weight	psf =	100.0	100.0	
Rebar Depth 'd'	in=	6.25	5.63	
		0.20	0.00	
Masonry Data				
f'm	psi =			
es. Fs	psi =			
Solid Grouting	. =			
Modular Ratio 'n'	=			
Equiv. Solid Thick.	=			
Masonry Block Type	=			
Masonry Design Method	=	ASD		
Concrete Data				
f'c	psi =	3,000.0	3,000.0	
Fy	psi =	60,000.0	60,000.0	

LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 11' Retained - EQ

Concrete Stem Rebar Area Details

2nd Stem As (based on applied moment) :	<u>Vertical Reinforcing</u> 0.2957 in2/ft	Horizontal Reinforcing
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :
		One layer of : Two layers of :
Required Area :	0.2957 in2/ft	#4@ 13.89 in #4@ 27.78 in
Provided Area :	0.4 in2/ft	#5@ 21.53 in #5@ 43.06 in
Maximum Area :	1.016 in2/ft	#6@ 30.56 in #6@ 61.11 in
Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing
Bottom Stem As (based on applied moment) :	Vertical Reinforcing 0.7669 in2/ft	Horizontal Reinforcing
		Horizontal Reinforcing Horizontal Reinforcing Options :
As (based on applied moment) :	0.7669 in2/ft	-
As (based on applied moment) :	0.7669 in2/ft	Horizontal Reinforcing Options :
As (based on applied moment) : 0.0018bh : 0.0018(12)(8) :	0.7669 in2/ft 0.1728 in2/ft =======	Horizontal Reinforcing Options : One layer of : Two layers of :

Footing Data

Toe Width	=	1.00 ft
Heel Width	=	4.67
Total Footing Width	=	5.67
Footing Thickness	=	14.00 in

f'c = 3,00	0 psi	Fy =	60,000 psi
Footing Concret	te Density	′ =	150.00 pcf
Min. As %	2.00	=	0.0018
Cover @ Top		@ B	tm.= 3.00 in

Footing Design Results

QUANTUM CONSULTING ENGINEERS

		<u>Toe</u>	<u>Heel</u>	
Factored Pressure	=	3,961	0	psf
Mu' : Upward	=	1,855	5,813	ft-#
Mu' : Downward	=	141	22,366	ft-#
Mu: Design	=	1,714	16,553	ft-#
φ Mn	=	3,944	22,163	ft-#
Actual 1-Way Shear	=	3.13	31.31	psi
Allow 1-Way Shear	=	43.82	48.20	psi
Toe Reinforcing	=	None Spec'd		
Heel Reinforcing	=	#6 @ 12.00 in		
Key Reinforcing	=	None Spec'd		
Footing Torsion, Tu		=	0.00 ft-lb	os
Footing Allow. Torsion	ι, φ	Tn =	0.00 ft-lb	os

If torsion exceeds allowable, provide

supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: phiMn = phi*5*lambda*sqrt(fc)*Sm

Heel: #4@ 5.47 in, #5@ 8.48 in, #6@ 12.03 in, #7@ 16.41 in, #8@ 21.61 in, #9@ 27.35 in, #10@ 34.74 in

Key: No key defined

Min footing T&S reinf Area	1.71	in2
Min footing T&S reinf Area per foot	0.30	in2 /ft
If one layer of horizontal bars:	<u>lf two lay</u>	ers of horizontal bars:
#4@ 7.94 in	#4@ 1	5.87 in
#5@ 12.30 in	#5@ 2	4.60 in
#6@ 17.46 in	#6@ 3	4.92 in

Project File: Retaining Walls - Updated.ec6

(c) ENERCALC INC 1983-2023

LIC# : KW-06016450, Build:20.24.05.02

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

(c) ENERCALC INC 1983-2023

DESCRIPTION: 11' Retained - EQ

Summary of Overturning & Resisting Forces & Moments

		OV	ERTURNING			RE	ESISTING	
Item		Force lbs	Distance ft	Moment ft-#		Force Ibs	Distance ft	Moment ft-#
HL Act Pres (ab water t	bl)	2,590.5	4.06	10,505.9	Soil Over HL (ab. water tbl)	5,284.4	3.67	19,384.9
HL Act Pres (be water the Hydrostatic Force	'	,		-,	Soil Over HL (bel. water tbl Water Table)	3.67	19,384.9
Buoyant Force	=				Sloped Soil Over Heel =			
Surcharge over Heel	=				Surcharge Over Heel =			
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 So	- lic				Soil Over Toe =	60.0	0.50	30.0
Seismic Earth Load	=	829.0	6.08	5,042.8	Surcharge Over Toe =			
	=			,	Stem Weight(s) =	1,100.0	1.33	1,466.7
					Earth @ Stem Transitions =			
Total	=	3,419.4	O.T.M. =	15,548.7	Footing Weight =	992.3	2.84	2,813.0
					Key Weight =			
Resisting/Overturnin	•			1.98	Vert. Component =	1,247.4	5.67	7,073.0
Vertical Loads used	for So	il Pressure	= 8,684.1	lbs	Total =	8,684.1	bs R.M.=	30,767.6
If seismic is included, t	he OT	M and slidir	ng ratios		* Axial live load NOT included resistance, but is included for			r overturning

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

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 Modulus250.0pciHorizontal Defl @ Top of Wall (approximate only)0.178in

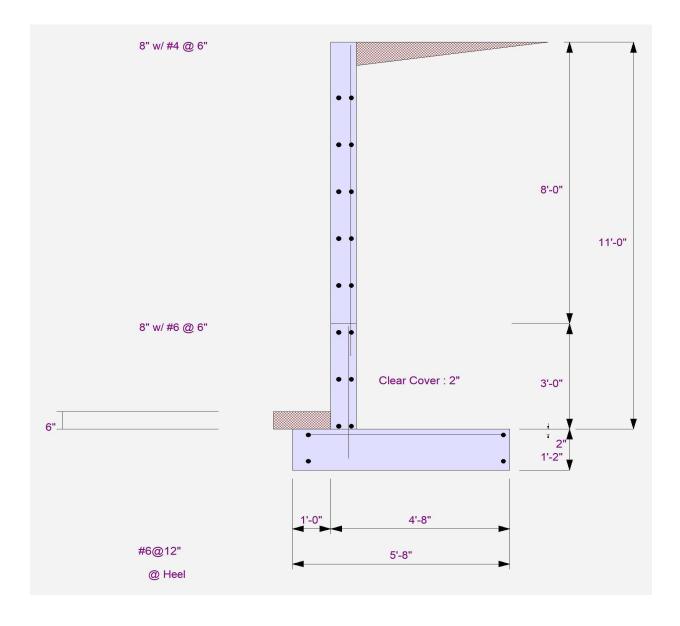
The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe.

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

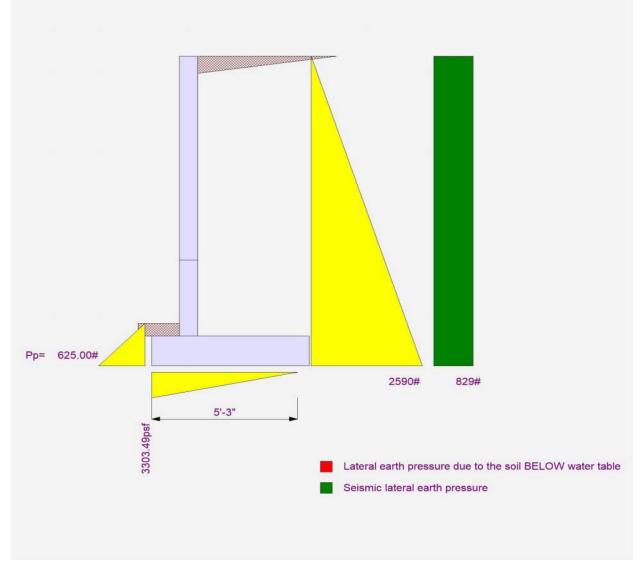
Cantilevered Retaining V	Vall	Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 11' Retained	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-202
Rebar Lap & Embedment Leng	gths Information	
Stem Design Segment: 2nd		
Stem Design Height: 3.00 ft above	top of footing	
Lap Splice length for #4 bar specified in	n this stem design segment (25.4.2.4a) =	17.09 in
Development length for #4 bar specifie	d in this stem design segment =	13.15 in
Stem Design Segment: Bottom		
Stem Design Height: 0.00 ft above	top of footing	
Lap Splice length for #6 bar specified in	n this stem design segment (25.4.2.4a) =	25.63 in
Development length for #6 bar specifie	d in this stem design segment =	19.72 in
Hooked embedment length into footing	for #6 bar specified in this stem design segment =	10.35 in
As Provided =		0.8800 in2/ft
As Required =		0.7669 in2/ft

Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023

DESCRIPTION: 11' Retained - EQ







LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 11' Retained QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

(c) ENERCALC INC 1983-2023

Code Reference

Calculations per IBC 2021 1807.3, ASCE 7-16

Criteria

Retained Height	=	11.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water table above		
bottom of footing	=	0.0 ft

Surcharge Loads

Surcharge Over Hee Used To Resist Slid Surcharge Over Toe Used for Sliding & C	ding & Ov =	0.0 psf
Axial Load App	lied to	Stem
Axial Dead Load Axial Live Load	=	0.0 lbs 0.0 lbs

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

Soil DataAllow Soil Bearing= 2,500.0 psfEquivalent Fluid Pressure MethodActive Heel Pressure= 35.0 psf/ft== 450.0 psf/ftSoil Density, Heel= 120.00 pcf

Soil Density, Toe=120.00 pcfFooting||Soil Friction=0.530Soil height to ignore
for passive pressure=0.00 in

Lateral Load Applied to Stem

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

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
Footing Type Base Above/Below Soil at Back of Wall	=	Spread Footing 0.0 ft

LIC# : KW-06016450, Build:20.24.05.02 **DESCRIPTION: 11' Retained**

Design Summary

Wall Stability Ratios Overturning Sliding Global Stability	= = =	2.93 2.02 1.86	OK OK
Total Bearing Load resultant ecc. Eccentricity withir	= = n mide		in
Soil Pressure @ Toe Soil Pressure @ Heel Allowable Soil Pressure Less ACI Factored @ Toe	= = Than =	718 2,500	e
ACI Factored @ Heel Footing Shear @ Toe Footing Shear @ Heel Allowable	= = =	861 2.2	psf psi OK psi OK
Sliding Calcs Lateral Sliding Force less 100% Passive Force less 100% Friction Force Added Force Req'd for 1.5 Stability		0.0	lbs

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	1.000
Seismic, E	1.000

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6 (c) ENERCALC INC 1983-2023

St	em Construction	_	2nd	Bottom		
	Design Height Above Ftg		Stem OK 3.00	Stem OK 0.00		
	Wall Material Above "Ht"	=	Concrete	Concrete		
	Design Method	_	SD	SD	SD SD	
	Thickness	=	8.00	8.00	66 66	
	Rebar Size	=	# 4	# 6		
	Rebar Spacing	=	6.00	6.00		
	Rebar Placed at	=	Edge	Edge		
	Design Data					
	fb/FB + fa/Fa	=	0.453	0.659		
	Total Force @ Section					
	Service Level	lbs =				
	Strength Level	lbs =	1,792.0	3,388.0		
	MomentActual					
	Service Level	ft-# =				
	Strength Level	ft-# =	4,778.7	12,422.7		
	MomentAllowable	ft-# =	10,542.0	18,848.3		
	ShearActual					
	Service Level	psi =				
	Strength Level	psi =	23.9	50.2		
	ShearAllowable	, psi =	57.4	77.3		
	Anet (Masonry)	in2 =				
	Wall Weight	psf =	100.0	100.0		
	Rebar Depth 'd'	in=	6.25	5.63		
			0.20	0.00		
	Masonry Data					
	f'm	psi =				
es.	Fs	psi =				
	Solid Grouting	. =				
	Modular Ratio 'n'	=				
	Equiv. Solid Thick.	=				
	Masonry Block Type	=				
	Masonry Design Method	=	ASD			
	Concrete Data					
	f'c	psi =	3,000.0	3,000.0		
	Fy	psi =	60,000.0	60,000.0		

LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 11' Retained

Concrete Stem Rebar Area Details

2nd Stem As (based on applied moment) :	<u>Vertical Reinforcing</u> 0.179 in2/ft	Horizontal Reinfo	orcing
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinfo	prcing Options :
	==========	One layer of :	Two layers of :
Required Area :	0.179 in2/ft	#4@ 13.89 in	#4@ 27.78 in
Provided Area :	0.4 in2/ft	#5@ 21.53 in	#5@ 43.06 in
Maximum Area :	1.016 in2/ft	#6@ 30.56 in	#6@ 61.11 in
Bottom Stem	Vertical Reinforcing	Horizontal Reinfo	orcing
As (based on applied moment) :	0.5203 in2/ft		
	0.0200 m2/m		
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinfo	orcing Options :
		Horizontal Reinfo	orcing Options : <u>Two layers of :</u>
	0.1728 in2/ft		0 1
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	One layer of :	Two layers of :

Footing Data

Toe Width	=	1.00 ft
Heel Width	=	4.67
Total Footing Width	=	5.67
Footing Thickness	=	14.00 in

f'c = 3,00	0 psi l	=y_=	60,000 psi
Footing Concret	e Density		150.00 pcf
Min. As % Cover @ Top	2.00		0.0018 m.= 3.00 in

Footing Design Results

QUANTUM CONSULTING ENGINEERS

		<u>Toe</u>	<u>Heel</u>	
Factored Pressure	=	2,811	861	psf
Mu' : Upward	=	1,348	10,579	ft-#
Mu' : Downward	=	141	22,366	ft-#
Mu: Design	=	1,207	11,788	ft-#
φ Mn	=	3,944	22,163	ft-#
Actual 1-Way Shear	=	2.16	21.55	psi
Allow 1-Way Shear	=	43.82	48.20	psi
Toe Reinforcing	=	None Spec'd		
Heel Reinforcing	=	#6@12.00 in		
Key Reinforcing	=	None Spec'd		
Footing Torsion, Tu		=	0.00 ft-lb	os
Footing Allow. Torsion	ι, φ	Tn =	0.00 ft-lk	os

If torsion exceeds allowable, provide

supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: phiMn = phi*5*lambda*sqrt(fc)*Sm

Heel: #4@ 7.68 in, #5@ 11.90 in, #6@ 16.90 in, #7@ 23.05 in, #8@ 30.34 in, #9@ 38.41 in, #10@ 48.78 in

Key: No key defined

Min footing T&S reinf Area	1.71	in2
Min footing T&S reinf Area per foot	0.30	in2 /ft
If one layer of horizontal bars:	If two laye	ers of horizontal bars:
#4@ 7.94 in	#4@ 1	5.87 in
#5@ 12.30 in	#5@ 24	4.60 in
#6@ 17.46 in	#6@ 34	4.92 in

Project File: Retaining Walls - Updated.ec6 (c) ENERCALC INC 1983-2023

LIC# : KW-06016450, Build:20.24.05.02

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

(c) ENERCALC INC 1983-2023

DESCRIPTION: 11' Retained

Summary of Overturning & Resisting Forces & Moments

	0V	ERTURNING			RE	SISTING	
Item	Force lbs	Distance ft	Moment ft-#		Force Ibs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl) HL Act Pres (be water tbl) Hydrostatic Force	2,590.5	4.06	10,505.9	Soil Over HL (ab. water tbl) Soil Over HL (bel. water tbl) Water Table	5,284.4	3.67 3.67	19,384.9 19,384.9
Buoyant Force = Surcharge over Heel = Surcharge Over Toe = Adjacent Footing Load =				Sloped Soil Over Heel = Surcharge Over Heel = Adjacent Footing Load = Axial Dead Load on Stem =			
Added Lateral Load = .oad @ Stem Above Soil =				* Axial Live Load on Stem = Soil Over Toe = Surcharge Over Toe =	60.0	0.50	30.0
=				Stem Weight(s) = Earth @ Stem Transitions =	1,100.0	1.33	1,466.7
Total =	2,590.5	0.T.M. =	10,505.9	Footing Weight = Key Weight =	992.3	2.84	2,813.0
Resisting/Overturning Ra Vertical Loads used for So		= = 8,684.1	2.93 1 lbs	Vert. Component _=	- /	5.67 bs R.M.=	7,073.0 30,767.6

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) 0.126 in

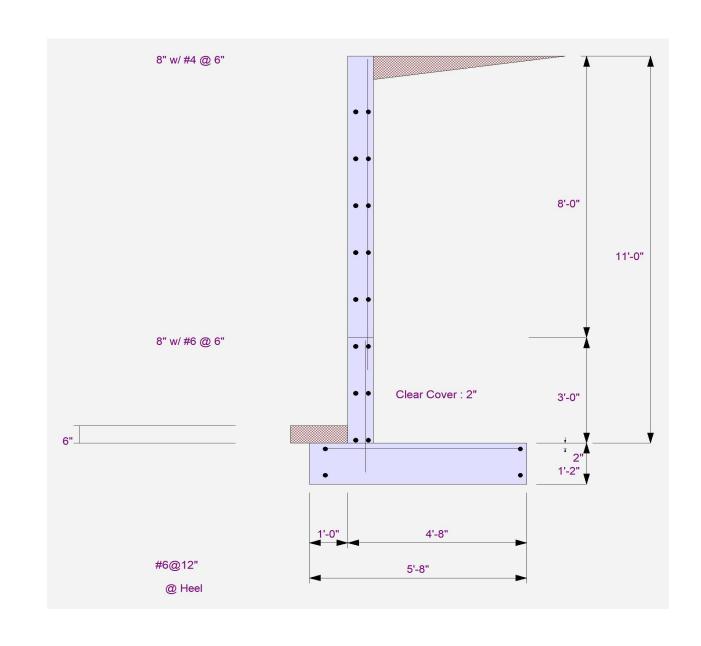
The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe,

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

Cantilevered F	Retaining Wall		Project File: Retaining Walls - Updated.ed
LIC# : KW-06016450, Bui		QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2
Rebar Lap & Emb	pedment Lengths I	nformation	
Stem Design Segmer	<u>nt: 2nd</u>		
Stem Design Height:	3.00 ft above top of	footing	
Lap Splice length for	#4 bar specified in this s	tem design segment (25.4.2.4a) =	17.09 in
Development length f	or #4 bar specified in thi	s stem design segment =	13.15 in
Stem Design Segmer	nt: Bottom		
Stem Design Height:	0.00 ft above top of	footing	
Lap Splice length for	#6 bar specified in this s	tem design segment (25.4.2.4a) =	25.63 in
	•	s stem design segment =	19.72 in
Hooked embedment I	ength into footing for #6	bar specified in this stem design segment =	10.35 in
As Provided =			0.8800 in2/ft
As Required =			0.5203 in2/ft

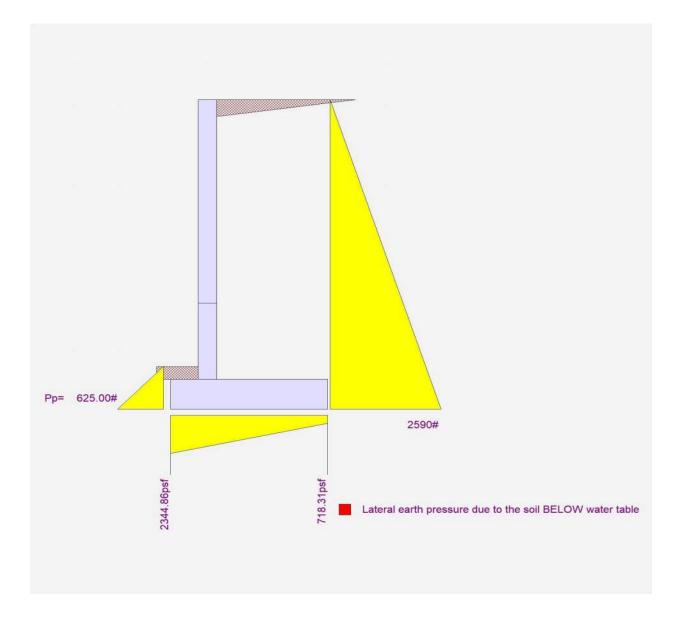
Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023

DESCRIPTION: 11' Retained



Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023

DESCRIPTION: 11' Retained



LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 10' Retained - EQ QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

(c) ENERCALC INC 1983-2023

Code Reference

Calculations per IBC 2021 1807.3, ASCE 7-16

Criteria

Retained Height	=	10.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water table above		
bottom of footing	=	0.0 ft

Surcharge Loads

Surcharge Over Heel Used To Resist Sliding Surcharge Over Toe Used for Sliding & Over	=	0.0 psf
Axial Load Applie	d to	Stem
Axial Dead Load Axial Live Load Axial Load Eccentricity	=	0.0 lbs 0.0 lbs

Earth Pressure Seismic Load

Method : Uniform Multiplier Used = 8.000 (Multiplier used on soil density)

Allow Soil Bearing Equivalent Fluid Pressure	= Meth	3,333.0 od	psf
Active Heel Pressure	=		psf/ft
	=		
Passive Pressure	=	450.0	psf/ft
Soil Density, Heel	=	120.00	pcf
Soil Density, Toe	=	120.00	pcf
Footing Soil Friction	=	0.530	
Soil height to ignore for passive pressure	=	0.00	in

Soil Data

Lateral Load Applied to Stem

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

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
r ooung rypo		opread r boung
Base Above/Below Soil at Back of Wall	=	0.0 ft

Uniform Seismic Force = 89.333 Total Seismic Force = 997.556

LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 10' Retained - EQ

Design Summary

Wall Stability Ratios Overturning	=	1.96		
Sliding	=	1.55	OK	
Global Stability	=	1.90		
Total Bearing Load	=	7,220 11.93		
	=		m	
Eccentricity outsid	=	3,026	nof	OK
Soil Pressure @ Heel	=		psf	
Allowable Soil Pressure Less	= Thor	3,333		
			-	
ACI Factored @ Toe ACI Factored @ Heel	=	3,619 0	psr psf	
Footing Shear @ Toe	=	2.8	psi	OK
Footing Shear @ Heel	=	27.6	psi	OK
Allowable	=	82.2	psi	
Sliding Calcs				
Lateral Sliding Force	=	2,880.4	lbs	
less 100% Passive Force	-	625.0		
less 100% Friction Force		3,826.4		
Added Force Reg'd	=	0.0	lbs	OK
for 1.5 Stability	=	0.0	lbs	ОК

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	1.000
Seismic, E	1.000

Project File: Retaining Walls - Updated.ec6 (c) ENERCALC INC 1983-2023

Stem Construction		2nd	Bottom	
Design Height Above Ftg	ft =	Stem OK 3.00	Stem OK 0.00	
Wall Material Above "Ht"	=	Concrete	Concrete	
Design Method	=	SD	SD	SD SD
Thickness	=	8.00	8.00	
Rebar Size	=	# 4	# 6	
Rebar Spacing	=	6.00	6.00	
Rebar Placed at	=	Edge	Edge	
Design Data				
fb/FB + fa/Fa	=	0.511	0.732	
Total Force @ Section				
Service Level	lbs =			
Strength Level	lbs =	1,997.3	3,693.3	
MomentActual				
Service Level	ft-# =			
Strength Level	ft-# =	5,390.0	13,800.0	
MomentAllowable	ft-# =	10,542.0	18,848.3	
ShearActual				
Service Level	psi =			
Strength Level	psi =	26.6	54.7	
ShearAllowable	psi =	57.4	77.3	
Anet (Masonry)	in2 =	0.1.1		
Wall Weight	psf =	100.0	100.0	
Rebar Depth 'd'	in =	6.25	5.63	
Rebai Deptiti u	111 =	0.20	5.05	
Masonry Data				
f'm	psi =			
es. Fs	psi =			
Solid Grouting	=			
Modular Ratio 'n'	=			
Equiv. Solid Thick.	=			
Masonry Block Type	=			
Masonry Design Method	=	ASD		
Concrete Data				
f'c	psi =	3,000.0	3,000.0	
Fy	psi =	60,000.0	60,000.0	

LIC# : KW-06016450, Build:20.24.05.02

DESCRIPTION: 10' Retained - EQ

Concrete Stem Rebar Area Details

2nd Stem As (based on applied moment) :	<u>Vertical Reinforcing</u> 0.2019 in2/ft	Horizontal Reinfo	rcing
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinfo	rcing Options :
		One layer of :	Two layers of :
Required Area :	0.2019 in2/ft	#4@ 13.89 in	#4@ 27.78 in
Provided Area :	0.4 in2/ft	#5@ 21.53 in	#5@ 43.06 in
Maximum Area :	1.016 in2/ft	#6@ 30.56 in	#6@ 61.11 in
Bottom Stem	Vertical Reinforcing	Horizontal Reinfo	rcing
As (based on applied moment) :	0.5779 in2/ft		
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinfo	rcing Options :
		One layer of :	Two layers of :
Required Area :	0.5779 in2/ft	#4@ 13.89 in	#4@ 27.78 in
Provided Area :	0.88 in2/ft	#5@ 21.53 in	#5@ 43.06 in
Maximum Area :	0.9144 in2/ft	#6@ 30.56 in	#6@ 61.11 in

Footing Data

Toe Width	=	1.00 ft
Heel Width	=	4.17
Total Footing Width	=	5.17
Footing Thickness	=	14.00 in

f'c = 3,00	0 psi l	=y_=	60,000 psi
Footing Concret	e Density		150.00 pcf
Min. As % Cover @ Top	2.00		0.0018 m.= 3.00 in

Footing Design Results

		<u>Toe</u>	<u>Heel</u>	
Factored Pressure	=	3,619	0	psf
Mu' : Upward	=	1,683	3,786	ft-#
Mu' : Downward	=	141	16,016	ft-#
Mu: Design	=	1,542	12,230	ft-#
φ Mn	=	3,944	22,163	ft-#
Actual 1-Way Shear	=	2.84	27.57	psi
Allow 1-Way Shear	=	43.82	48.20	psi
Toe Reinforcing	=	None Spec'd		
Heel Reinforcing	=	#6 @ 12.00 in		
Key Reinforcing	=	None Spec'd		
Footing Torsion, Tu		=	0.00 ft-lb	os
Footing Allow. Torsion	ι, φ	Tn =	0.00 ft-lk	os

If torsion exceeds allowable, provide

supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: phiMn = phi*5*lambda*sqrt(fc)*Sm

Heel: #4@ 7.40 in, #5@ 11.47 in, #6@ 16.29 in, #7@ 22.21 in, #8@ 29.25 in, #9@ 37.02 in, #10@ 47.02 in

Key: No key defined

Min footing T&S reinf Area	1.56	in2
Min footing T&S reinf Area per foot	0.30	in2 /ft
If one layer of horizontal bars:	<u>lf two lay</u>	ers of horizontal bars:
#4@ 7.94 in	#4@ 1	5.87 in
#5@ 12.30 in	#5@ 2	4.60 in
#6@ 17.46 in	#6@ 3	4.92 in

Project File: Retaining Walls - Updated.ec6 QUANTUM CONSULTING ENGINEERS

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LIC# : KW-06016450, Build:20.24.05.02

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

(c) ENERCALC INC 1983-2023

DESCRIPTION: 10' Retained - EQ

Summary of Overturning & Resisting Forces & Moments

		OV	ERTURNING			RE	SISTING	
Item		Force lbs	Distance ft	Moment ft-#		Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tb	1)	2,182.2	3.72	8,122.5	Soil Over HL (ab. water tbl)	4,204.0	3.42	14,370.7
HL Act Pres (be water tb Hydrostatic Force	,	_,		-,	Soil Over HL (bel. water tbl) Water Table		3.42	14,370.7
Buoyant Force	=				Sloped Soil Over Heel =			
Surcharge over Heel	=				Surcharge Over Heel =			
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 Soi	il =				Soil Over Toe =	60.0	0.50	30.0
Seismic Earth Load	=	698.3	5.58	3,898.8	Surcharge Over Toe =			
	=				Stem Weight(s) =	1,000.0	1.33	1,333.3
					Earth @ Stem Transitions =			
Total	=	2,880.4	O.T.M. =	12,021.2	Footing Weight =	904.8	2.59	2,338.8
					Key Weight =			
Resisting/Overturning	•		=	1.96	Vert. Component =	1,050.8	5.17	5,432.7
Vertical Loads used f	or So	il Pressure	= 7,219.0	6 lbs	Total =	7,219.6	bs R.M.=	23,505.5
If seismic is included, th	e OT	M and slidir	ng ratios		* Axial live load NOT included resistance, but is included fo			r overturning

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

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 Modulus250.0pciHorizontal Defl @ Top of Wall (approximate only)0.163in

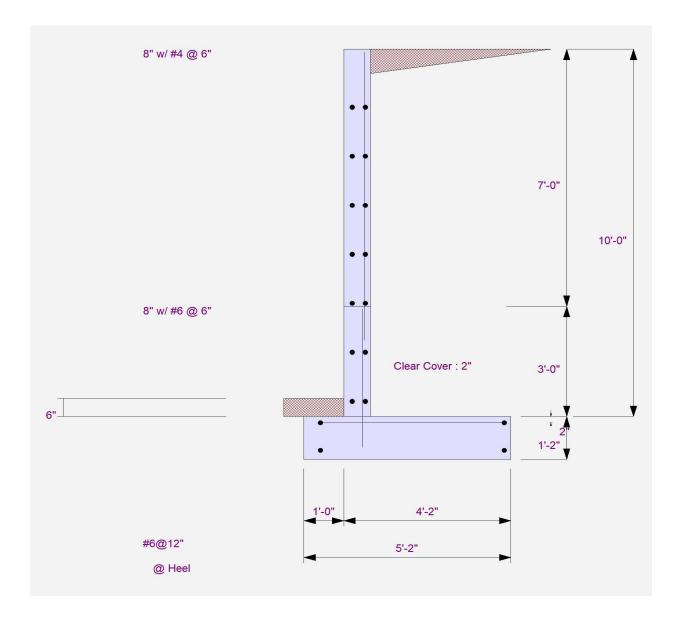
The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe,

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

Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 10' Retained - EQ	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-202
Rebar Lap & Embedment Lengths Info	ormation	
Stem Design Segment: 2ndStem Design Height:3.00 ft above top of foot	ing	
Lap Splice length for #4 bar specified in this stem Development length for #4 bar specified in this st		17.09 in 13.15 in
Stem Design Segment: Bottom Stem Design Height: 0.00 ft above top of foot	ing	
Lap Splice length for #6 bar specified in this stem		25.63 in 19.72 in
Development length for #6 bar specified in this st		
Development length for #6 bar specified in this st Hooked embedment length into footing for #6 bar		10.35 in

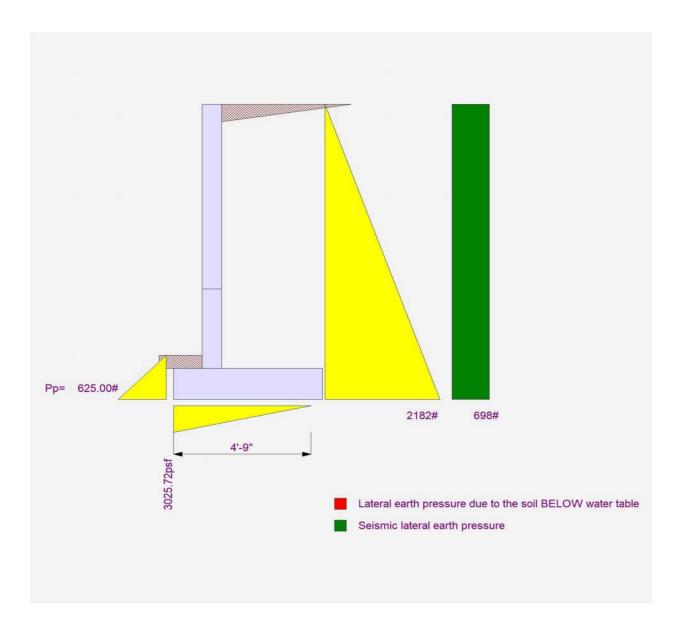
Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023

DESCRIPTION: 10' Retained - EQ





DESCRIPTION: 10' Retained - EQ



LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 10' Retained QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

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Code Reference

Calculations per IBC 2021 1807.3, ASCE 7-16

Criteria

Retained Height	=	10.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water table above		
bottom of footing	=	0.0 ft

Surcharge Loads

Surcharge Over Hee Used To Resist Slid Surcharge Over Toe Used for Sliding & C	ding & Ov =	0.0 psf	
Axial Load Applied to Stem			
Axial Dead Load Axial Live Load	=	0.0 lbs 0.0 lbs	

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

Soil Data Allow Soil Bearing = 2,500.0 psf Equivalent Fluid Pressure Method Active Heel Pressure = 35.0 psf/ft

	=		
Passive Pressure	=	450.0	psf/ft
Soil Density, Heel	=	120.00	pcf
Soil Density, Toe	=	120.00	pcf
Footing Soil Friction	=	0.530	
Soil height to ignore for passive pressure	=	0.00	in

Lateral Load Applied to Stem

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

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
Easting Trues		Concert Feetings
Footing Type		Spread Footing
Base Above/Below Soil at Back of Wall	=	0.0 ft

QUANTUM CONSULTING ENGINEERS

Fy

Cantilevered Retaining Wall

LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 10' Retained

Design Summary

Wall Stability Ratios Overturning Sliding Global Stability	= =	2.89 2.04 1.90	
Total Bearing Load resultant ecc. Eccentricity withir	= = n mide		in
Soil Pressure @ Toe Soil Pressure @ Heel Allowable Soil Pressure Less ACI Factored @ Toe	=	660 2,500 Allowable 2,551	e psf
ACI Factored @ Heel Footing Shear @ Toe Footing Shear @ Heel Allowable	= = =		psi OK psi OK
Sliding Calcs Lateral Sliding Force less 100% Passive Force less 100% Friction Force Added Force Req'd for 1.5 Stability		0.0	lbs

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	1.000
Seismic, E	1.000

St	em Construction		2nd	Bottom		
-	Design Usinht Above Etc	_,	Stem OK	Stem OK		
	Design Height Above Ftg Wall Material Above "Ht"		3.00	0.00		
			Concrete	Concrete	<u>CD</u>	00
	Design Method	=	SD	SD	SD	SD
	Thickness Rebar Size	=	8.00 # 4	8.00 # 6		
	Rebar Spacing	=	# 4 6.00	# 0 6.00		
	Rebar Placed at					
	Design Data	=	Edge	Edge		
	fb/FB + fa/Fa	=	0.303	0.495		
	Total Force @ Section					
	Service Level	lbs =				
	Strength Level	lbs =	1,372.0	2,800.0		
	MomentActual		,	,		
	Service Level	ft-# =				
	Strength Level	ft-# =	3,201.3	9,333.3		
	MomentAllowable	ft-# =	10,542.0	18,848.3		
	ShearActual					
	Service Level	psi =				
	Strength Level	psi =	18.3	41.5		
	ShearAllowable	, psi =	57.4	77.3		
	Anet (Masonry)	in2 =				
	Wall Weight	psf =	100.0	100.0		
	Rebar Depth 'd'	in =	6.25	5.63		
	Masonry Data					
3	f'm	psi =				
res.	Fs	psi =				
	Solid Grouting	=				
	Modular Ratio 'n'	=				
	Equiv. Solid Thick.	=				
	Masonry Block Type	=				
	Masonry Design Method	=	ASD			
	Concrete Data					
	f'c	psi =	3,000.0	3,000.0		

psi = 60,000.0

60,000.0

Project File: Retaining Walls - Updated.ec6

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LIC# : KW-06016450, Build:20.24.05.02 **DESCRIPTION: 10' Retained**

Concrete Stem Rebar Area Details

	Consiste Stein Result Area Details						
2nd Stem	Vertical Reinforcing	Horizontal Reinforcing					
As (based on applied moment) :	0.1199 in2/ft	-					
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :					
	===========	One layer of :	Two layers of :				
Required Area :	0.1728 in2/ft	#4@ 13.89 in	#4@ 27.78 in				
Provided Area :	0.4 in2/ft	#5@ 21.53 in	#5@ 43.06 in				
Maximum Area :	1.016 in2/ft	#6@ 30.56 in	#6@ 61.11 in				
		Horizontal Reinforcing					
Bottom Stem	Vertical Reinforcing	Horizontal Reinfor	rcing				
Bottom Stem As (based on applied moment) :	Vertical Reinforcing 0.3909 in2/ft	Horizontal Reinfor	rcing				
		Horizontal Reinfor Horizontal Reinfor	-				
As (based on applied moment) :	0.3909 in2/ft		-				
As (based on applied moment) :	0.3909 in2/ft	Horizontal Reinfor	rcing Options :				
As (based on applied moment) : 0.0018bh : 0.0018(12)(8) :	0.3909 in2/ft 0.1728 in2/ft =======	Horizontal Reinfor	rcing Options : Two layers of :				

Footing Data

Toe Width	=	1.00 ft
Heel Width	=	4.17
Total Footing Width	=	5.17
Footing Thickness	=	14.00 in

f'c = 3,00	10 psi l	=y_=	60,000 psi
Footing Concre	te Density		150.00 pcf
Min. As % Cover @ Top	2.00		0.0018 n.= 3.00 in

Footing Design Results

QUANTUM CONSULTING ENGINEERS

		Toe	Heel	
Factored Pressure	=	2,551	790	psf
Mu' : Upward	=	1,219	7,288	ft-#
Mu' : Downward	=	141	16,016	ft-#
Mu: Design	=	1,078	8,727	ft-#
φ Mn	=	3,944	22,163	ft-#
Actual 1-Way Shear	=	1.93	18.87	psi
Allow 1-Way Shear	=	43.82	48.20	psi
Toe Reinforcing	=	None Spec'd		
Heel Reinforcing	=	# 6 @ 12.00 in		
Key Reinforcing	=	None Spec'd		
Footing Torsion, Tu		=	0.00 ft-lb	s
Footing Allow. Torsion	η, φ	Tn =	0.00 ft-lb	s

If torsion exceeds allowable, provide

supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: phiMn = phi*5*lambda*sqrt(fc)*Sm

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 Min footing T&S reinf Area per foot	1.56 0.30	in2 in2 <i>/</i> ft
If one layer of horizontal bars:		ers of horizontal bars:
#4@ 7.94 in	#4@ 1	
#5@ 12.30 in	#5@ 2	4.60 in
#6@ 17.46 in	#6@ 3	4.92 in

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LIC# : KW-06016450, Build:20.24.05.02

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

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DESCRIPTION: 10' Retained

Summary of Overturning & Resisting Forces & Moments

	0\	ERTURNING			RE	SISTING	
Item	Force lbs	Distance ft	Moment ft-#		Force Ibs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl) HL Act Pres (be water tbl) Hydrostatic Force	2,182.2	3.72	8,122.5	Soil Over HL (ab. water tbl) Soil Over HL (bel. water tbl) Water Table	4,204.0	3.42 3.42	14,370.7 14,370.7
Buoyant Force = Surcharge over Heel = Surcharge Over Toe = Adjacent Footing Load =				Sloped Soil Over Heel = Surcharge Over Heel = Adjacent Footing Load = Axial Dead Load on Stem =			
Added Lateral Load = Load @ Stem Above Soil =				* Axial Live Load on Stem = Soil Over Toe = Surcharge Over Toe =	60.0	0.50	30.0
=				Stem Weight(s) = Earth @ Stem Transitions =	1,000.0	1.33	1,333.3
Total =	2,182.2	O.T.M. =	8,122.5	Footing Weight = Key Weight =	904.8	2.59	2,338.8
Resisting/Overturning Ra Vertical Loads used for So			2.89 5 lbs	Vert. Component = Total = * Axial live load NOT included in	,	5.17 bs R.M.=	5,432.7 23,505.5

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) 0.115 in

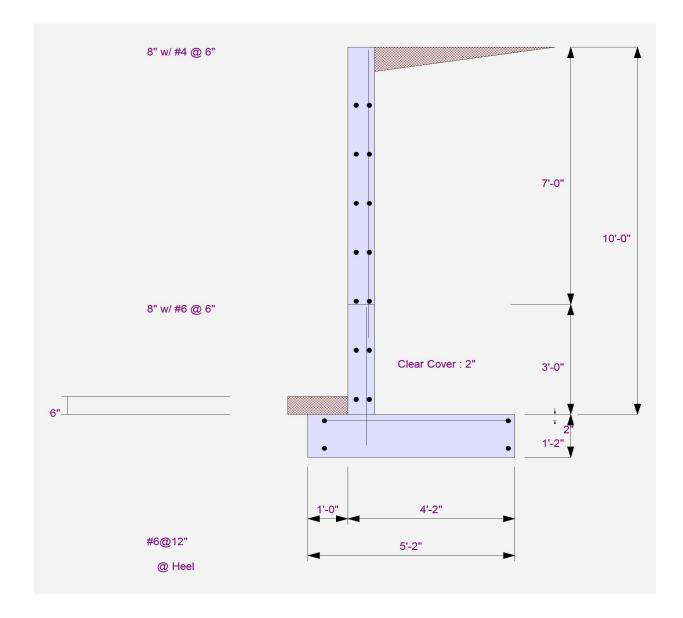
The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe,

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

Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 10' Retained	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-20
Rebar Lap & Embedment Lengths Inforr	nation	
Stem Design Segment: 2nd		
Stem Design Height: 3.00 ft above top of footing	I	
Lap Splice length for #4 bar specified in this stem de	esign segment (25.4.2.4a) =	17.09 in
Development length for #4 bar specified in this stem	i design segment =	13.15 in
Stem Design Segment: Bottom		
Stem Design Height: 0.00 ft above top of footing	1	
Lap Splice length for #6 bar specified in this stem do	esign segment (25.4.2.4a) =	25.63 in
Development length for #6 bar specified in this stem	design segment =	19.72 in
Hooked embedment length into footing for #6 bar sp	pecified in this stem design segment =	10.35 in
As Provided =		0.8800 in2/ft
As Required =		0.3909 in2/ft

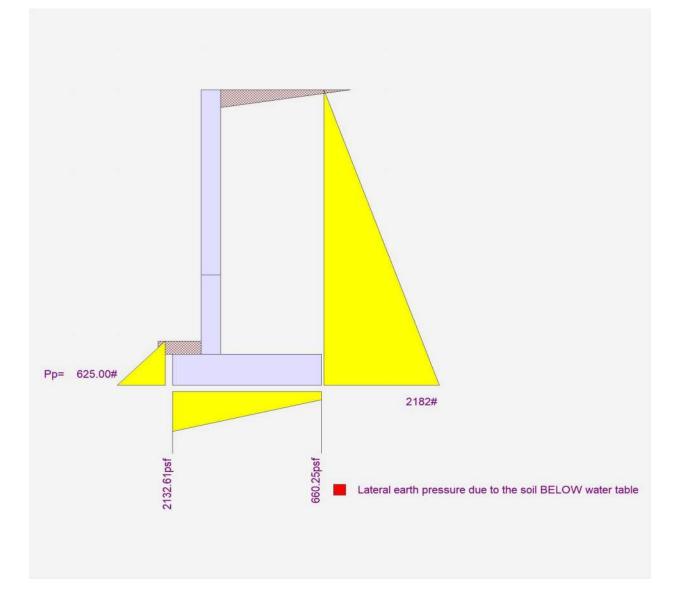
Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023

DESCRIPTION: 10' Retained



Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023

DESCRIPTION: 10' Retained



LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 9' Retained - EQ QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

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Code Reference

Calculations per IBC 2021 1807.3, ASCE 7-16

Criteria

Retained Height	=	9.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water table above		
bottom of footing	=	0.0 ft

Surcharge Loads

Surcharge Over Heel Used To Resist Sliding Surcharge Over Toe Used for Sliding & Ove Axial Load Applied	= rturning	0.0
Axial Dead Load	=	0.0 lbs
Axial Live Load	=	0.0 lbs
Axial Load Eccentricity	=	0.0 in

Earth Pressure Seismic Load

Method : Uniform Multiplier Used = 8.000 (Multiplier used on soil density)

Allow Soil Bearing Equivalent Fluid Pressure	= Meth	3,333.0 psf od
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	450.0 psf/ft
Soil Density, Heel	=	120.00 pcf
Soil Density, Toe	=	120.00 pcf
Footing Soil Friction	=	0.530
Soil height to ignore for passive pressure	=	0.00 in

Soil Data

Lateral Load Applied to Stem

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

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
Footing Type Base Above/Below Soil at Back of Wall	=	Spread Footing 0.0 ft

Uniform Seismic Force = 80.000 Total Seismic Force = 800.000

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LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 9' Retained - EQ

Design Summary

Wall Stability Ratios		
Overturning	=	1.88 OK
Sliding	=	1.57 OK
Global Stability	=	1.91
Total Bearing Load	=	5,874 lbs
resultant ecc.	=	11.55 in
Eccentricity outsid	de mic	Idle third
Soil Pressure @ Toe	=	3,041 psf OK
Soil Pressure @ Heel	=	0 psf OK
Allowable	=	3,333 psf
Soil Pressure Less	Than	Allowable
ACI Factored @ Toe	=	3,647 psf
ACI Factored @ Heel	=	0 psf
Footing Shear @ Toe	=	0.1 psi OK
Footing Shear @ Heel	=	26.4 psi OK
Allowable	=	82.2 psi
		02.2 por
Sliding Calcs		
Lateral Sliding Force	=	2,310.0 lbs
less 100% Passive Force	-	506.3 lbs
less 100% Friction Force	= -	3,113.4 lbs
Added Force Reg'd	_	0.0 lbs OK
for 1.5 Stability	_	0.0 lbs OK
or 1.0 Otability	-	0.0 103 010

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

				5
QUANTUM CONSULTING ENG	GINEEF	RS		(c) ENERCALC INC 1983-2023
Stom Construction		Bottom		
Stem Construction		Stem OK		
Design Height Above Ftg	ft =	0.00		
Wall Material Above "Ht"	=	Concrete		
Design Method	=	SD	SD	SD
Thickness	=	8.00		
Rebar Size	=	# 4		
Rebar Spacing	=	6.00		
Rebar Placed at	=	Edge		
Design Data fb/FB + fa/Fa	=	0.952		
Total Force @ Section	-	0.552		
Service Level	lbs =			
Strength Level	lbs =	2,988.0		
MomentActual	105 =	2,900.0		
Service Level	ft-# =			
Strength Level	ft-# =	10,044.0		
MomentAllowable		-		
	=	10,542.0		
ShearActual				
Service Level	psi =			
Strength Level	psi =	39.8		
ShearAllowable	psi =	57.4		
Anet (Masonry)	in2 =			
Wall Weight	psf =	100.0		
Rebar Depth 'd'	in =	6.25		
Maran Bata				
Masonry Data				
f'm es. Fs	psi =			
es. Fs Solid Grouting	psi =			
•	=			
Modular Ratio 'n'	=			
Equiv. Solid Thick.	=			
Masonry Block Type	=	ASD		
Masonry Design Method	=	ASD		
Concrete Data	psi =	3,000.0		
Fy	psi =	60,000.0		
· y	P31 -	00,000.0		

LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 9' Retained - EQ

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinfo	orcing
As (based on applied moment) :	0.3763 in2/ft		
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinfo	orcing Options :
		One layer of :	Two layers of :
Required Area :	0.3763 in2/ft	#4@ 13.89 in	#4@ 27.78 in
Provided Area :	0.4 in2/ft	#5@ 21.53 in	#5@ 43.06 in
Maximum Area :	1.016 in2/ft	#6@ 30.56 in	#6@ 61.11 in

Footing Data

Toe Width	=	0.67 ft
Heel Width	=	3.83
Total Footing Width	=	4.50
Footing Thickness	=	12.00 in

f'c = 3,00	0 psi	Fy =	60,0	000 psi
Footing Concret	e Density	/ =	150	.00 pcf
Min. As % Cover @ Top	2.00	= @ F	0.00)18 3.00 in

Footing Design Results

QUANTUM CONSULTING ENGINEERS

		Toe	<u>Heel</u>	
Factored Pressure	=	3,647	0	psf
Mu' : Upward	=	771	2,537	ft-#
Mu' : Downward	=	57	11,650	ft-#
Mu: Design	=	715	9,113	ft-#
φ Mn	=	2,739	16,844	ft-#
Actual 1-Way Shear	=	0.09	26.36	psi
Allow 1-Way Shear	=	43.82	49.51	psi
Toe Reinforcing	=	None Spec'd		
Heel Reinforcing	=	# 4 @ 6.00 in		
Key Reinforcing	=	None Spec'd		
Footing Torsion, Tu		=	0.00 ft-lb	os
Footing Allow. Torsion	n, գ	oTn =	0.00 ft-lb)S

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

Other Acceptable Sizes & Spacings

Toe: phiMn = phi*5*lambda*sqrt(fc)*Sm

Heel: #4@ 8.16 in, #5@ 12.64 in, #6@ 17.95 in, #7@ 24.48 in, #8@ 32.23 in, #9@ 40.80 in, #10@ 51.82 in

Key: No key defined

Min footing T&S reinf Area	1.17	in2
Min footing T&S reinf Area per foot	0.26	in2 /ft
If one layer of horizontal bars:	<u>lf two lay</u>	ers of horizontal bars:
#4@ 9.26 in	#4@1	8.52 in
#5@ 14.35 in	#5@ 2	8.70 in
#6@ 20.37 in	#6@4	0.74 in

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Project File: Retaining Walls - Updated.ec6

LIC# : KW-06016450, Build:20.24.05.02

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

(c) ENERCALC INC 1983-2023

DESCRIPTION: 9' Retained - EQ

Summary of Overturning & Resisting Forces & Moments

		OV	ERTURNING			RE	SISTING	
Item		Force lbs	Distance ft	Moment ft-#		Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	1,750.0	3.33	5,833.3	Soil Over HL (ab. water tbl)	3,416.4	2.92	9,970.2
HL Act Pres (be water tbl Hydrostatic Force	,	,		-,	Soil Over HL (bel. water tbl) Water Table		2.92	9,970.2
Buoyant Force	=				Sloped Soil Over Heel =			
Surcharge over Heel	=				Surcharge Over Heel =			
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 =	40.2	0.34	13.5
Seismic Earth Load	=	560.0	5.00	2,800.0	Surcharge Over Toe =			
	=				Stem Weight(s) =	900.0	1.00	903.0
Tetal		0.040.0	- отм -	0 622 2	Earth @ Stem Transitions =			
Total	=	2,310.0	O.T.M. =	8,633.3	Footing Weight =	675.0	2.25	1,518.8
					Key Weight =			
Resisting/Overturning			=	1.88	Vert. Component =	842.7	4.50	3,792.2
Vertical Loads used for	or Soi	Pressure =	= 5,874.3	3 lbs	Total =	5,874.3 lt	os R.M.=	16,197.6
If seismic is included, the	e OTN	A and slidin	ig ratios		* Axial live load NOT included in resistance, but is included for			r overturning

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

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

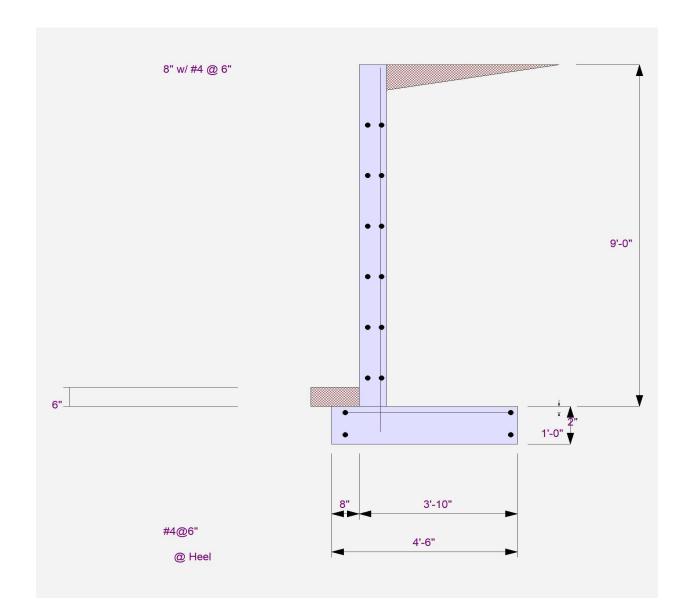
(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus 250.0 pci Horizontal Defl @ Top of Wall (approximate only) 0.169 in

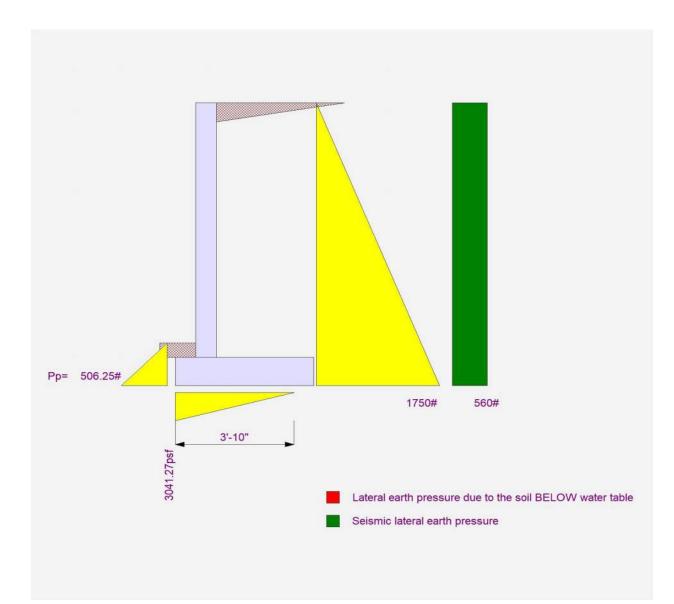
The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe,

Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2
DESCRIPTION: 9' Retained - EQ		
Rebar Lap & Embedment Lengths Info	ormation	
Stem Design Segment: Bottom		
Stem Design Height: 0.00 ft above top of foot	ing	
Lap Splice length for #4 bar specified in this stem	design segment (25.4.2.4a) =	17.09 in
Development length for #4 bar specified in this ste	em design segment =	13.15 in
Hooked embedment length into footing for #4 bar	specified in this stem design segment =	5.63 in
As Provided =		0.4000 in2/ft
As Required =		0.3763 in2/ft

Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023
DESCRIPTION: 9' Retained - EQ		







LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 9' Retained QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

(c) ENERCALC INC 1983-2023

Code Reference

Calculations per IBC 2021 1807.3, ASCE 7-16

Criteria

Retained Height	=	9.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water table above		
bottom of footing	=	0.0 ft

Surcharge Loads

Surcharge Over Heel = 0.0 psf Used To Resist Sliding & Overturning Surcharge Over Toe = 0.0 Used for Sliding & Overturning				
Axial Load Applied to Stem				
Axial Dead Load Axial Live Load	=	0.0 lbs 0.0 lbs		

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

	2,500.0 psf
e ivietr =	35.0 psf/ft
	= e Meth =

	=	
Passive Pressure	=	450.0 psf/ft
Soil Density, Heel	=	120.00 pcf
Soil Density, Toe	=	120.00 pcf
Footing Soil Friction	=	0.530
Soil height to ignore for passive pressure	=	0.00 in

Lateral Load Applied to Stem

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

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

LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 9' Retained

Design Summary

Wall Stability Ratios Overturning Sliding Global Stability	= = =	2.78 2.07 1.91	OK OK
Total Bearing Load resultant ecc. Eccentricity withir	= = n mide	5,874 5.83 dle third	
Soil Pressure @ Toe Soil Pressure @ Heel Allowable Soil Pressure Less ACI Factored @ Toe	= = =	2,151 460 2,500 Allowable 2,579	e psf
ACI Factored @ Heel Footing Shear @ Toe Footing Shear @ Heel Allowable	= = =		psi OK psi OK
Sliding Calcs Lateral Sliding Force less 100% Passive Force less 100% Friction Force Added Force Req'd for 1.5 Stability		0.0	lbs

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

1.200
1.600
1.600
1.000
1.000

QUANTUM CONSULTING EN	GINEEF	(5		(c) ENERCALC INC 1983-2023
Stem Construction		Bottom		
Design Height Above Ftg	ft =	Stem OK 0.00		
Wall Material Above "Ht"	=	Concrete		
Design Method	=	SD	SD	SD
Thickness	=	8.00		
Rebar Size	=	# 4		
Rebar Spacing	=	6.00		
Rebar Placed at	=	Edge		
Design Data		0.645		
fb/FB + fa/Fa	=	0.645		
Total Force @ Section				
Service Level	lbs =			
Strength Level	lbs =	2,268.0		
MomentActual	4 д			
Service Level	ft-# =	6 004 0		
Strength Level	ft-# =	6,804.0		
MomentAllowable	=	10,542.0		
ShearActual				
Service Level	psi =			
Strength Level	psi =	30.2		
ShearAllowable	psi =	57.4		
Anet (Masonry)	in2 =			
Wall Weight	psf =	100.0		
Rebar Depth 'd'	in =	6.25		
Masonry Data				
f'm	psi =			
es. Fs	psi – psi =			
Solid Grouting	- ieq			
 Modular Ratio 'n'	=			
Equiv. Solid Thick.	=			
Masonry Block Type	=			
Masonry Design Method	=	ASD		
Concrete Data				
f'c	psi =	3,000.0		
Fy	psi =	60,000.0		

LIC# : KW-06016450, Build:20.24.05.02

DESCRIPTION: 9' Retained

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.2549 in2/ft		
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :	
		One layer of :	Two layers of :
Required Area :	0.2549 in2/ft	#4@ 13.89 in	#4@ 27.78 in
Provided Area :	0.4 in2/ft	#5@ 21.53 in	#5@ 43.06 in
Maximum Area :	1.016 in2/ft	#6@ 30.56 in	#6@ 61.11 in
		_	

Footing Data

Toe Width	=	0.67 ft
Heel Width	=	3.83
Total Footing Width	=	4.50
Footing Thickness	=	12.00 in

f'c = 3 Footing Cone	,000 psi F crete Density	=y =	60,0 150	00 psi .00 pcf
Min. As %	0.00	=	0.00	
Cover @ Top	2.00	æ	Btm.=	3.00 in

Footing Design Results

QUANTUM CONSULTING ENGINEERS

		<u>Toe</u>	<u>Heel</u>	
Factored Pressure	=	2,579	552	psf
Mu' : Upward	=	556	5,137	ft-#
Mu' : Downward	=	57	11,650	ft-#
Mu: Design	=	500	6,513	ft-#
φ Mn	=	2,739	16,844	ft-#
Actual 1-Way Shear	=	0.09	17.70	psi
Allow 1-Way Shear	=	43.82	49.51	psi
Toe Reinforcing	=	None Spec'd		
Heel Reinforcing	=	# 4 @ 6.00 in		
Key Reinforcing	=	None Spec'd		
Footing Torsion, Tu		=	0.00 ft-lb	s
Footing Allow. Torsion	n, q	Tn =	0.00 ft-lb	s

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

Other Acceptable Sizes & Spacings

Toe: phiMn = phi*5*lambda*sqrt(fc)*Sm

Heel: #4@ 9.25 in, #5@ 14.35 in, #6@ 20.37 in, #7@ 27.77 in, #8@ 36.57 in, #9@ 46.29 in, #10@ 58.79 in

Key: No key defined

Min footing T&S reinf Area	1.17	in2
Min footing T&S reinf Area per foot	0.26	in2 /ft
If one layer of horizontal bars:	<u>lf two lay</u>	ers of horizontal bars:
#4@ 9.26 in	#4@1	8.52 in
#5@ 14.35 in	#5@ 2	8.70 in
#6@ 20.37 in	#6@4	0.74 in

Project File: Retaining Walls - Updated.ec6

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LIC# : KW-06016450, Build:20.24.05.02

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

QUANTUM CONSULTING ENGINEERS

(c) ENERCALC INC 1983-2023

DESCRIPTION: 9' Retained

Summary of Overturning & Resisting Forces & Moments

	0V	ERTURNING			RE	SISTING	
Item	Force lbs	Distance ft	Moment ft-#		Force Ibs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl) HL Act Pres (be water tbl) Hydrostatic Force	1,750.0	3.33	5,833.3	Soil Over HL (ab. water tbl) Soil Over HL (bel. water tbl) Water Table	3,416.4	2.92 2.92	9,970.2 9,970.2
Buoyant Force = Surcharge over Heel = Surcharge Over Toe = Adjacent Footing Load =				Sloped Soil Over Heel = Surcharge Over Heel = Adjacent Footing Load = Axial Dead Load on Stem =			
added Lateral Load = .oad @ Stem Above Soil =				* Axial Live Load on Stem = Soil Over Toe = Surcharge Over Toe =	40.2	0.34	13.5
=		_		Stem Weight(s) = Earth @ Stem Transitions =	900.0	1.00	903.0
Total =	1,750.0	O.T.M. =	5,833.3	Footing Weight = Key Weight =	675.0	2.25	1,518.8
Resisting/Overturning Ra Vertical Loads used for Se			2.78 3 lbs	Vert. Component = Total = * Axial live load NOT included in	842.7 5,874.3		3,792.2 16,197.6

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

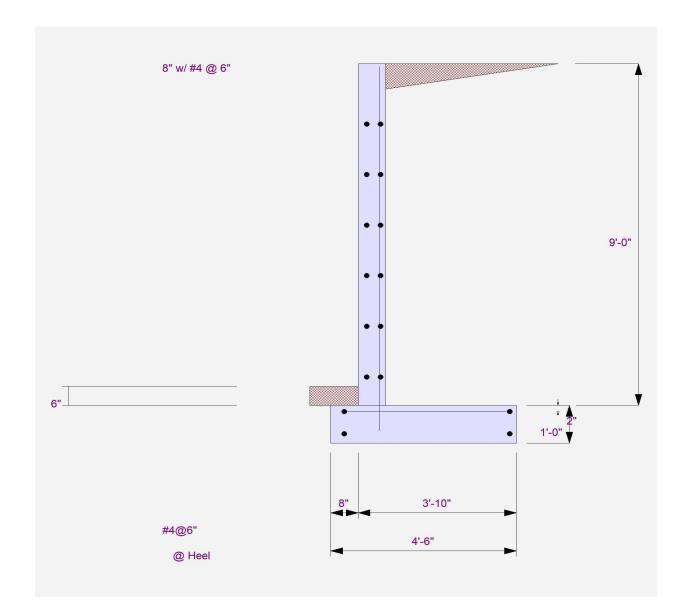
(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus250.0pciHorizontal Defl @ Top of Wall (approximate only)0.119in

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

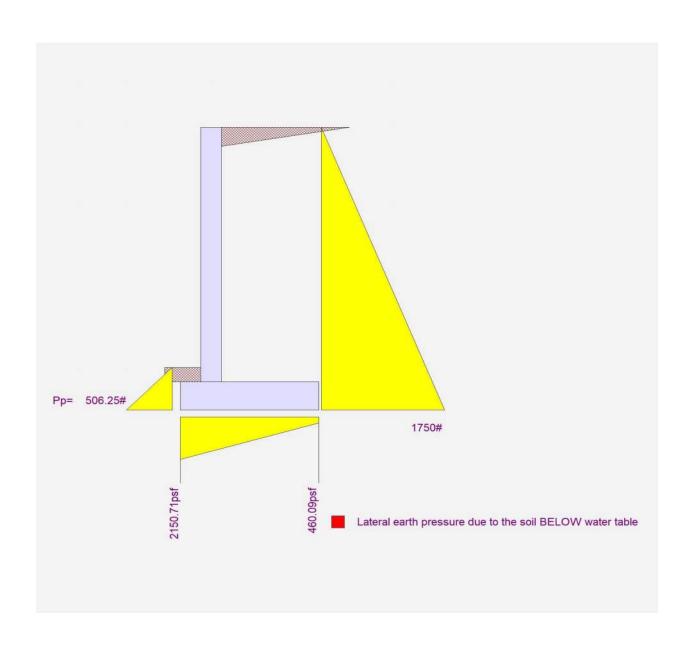
Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023
DESCRIPTION: 9' Retained		
Rebar Lap & Embedment Lengths In	formation	
Stem Design Segment: Bottom		
Stem Design Height: 0.00 ft above top of for	oting	
Lap Splice length for #4 bar specified in this ste	m design segment (25.4.2.4a) =	17.09 in
Development length for #4 bar specified in this	stem design segment =	13.15 in
Hooked embedment length into footing for #4 ba	ar specified in this stem design segment =	5.63 in
As Provided =		0.4000 in2/ft
As Required =		0.2549 in2/ft

Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023
DESCRIPTION: 9' Retained		



Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023

DESCRIPTION: 9' Retained



LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 8' Retained - EQ QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

(c) ENERCALC INC 1983-2023

Code Reference

Calculations per IBC 2021 1807.3, ASCE 7-16

Criteria

Retained Height	=	8.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water table above		
bottom of footing	=	0.0 ft

Surcharge Loads

Surcharge Over Heel Used To Resist Sliding Surcharge Over Toe Used for Sliding & Ove Axial Load Applied	= rturning	0.0
Axial Dead Load Axial Live Load Axial Load Eccentricity	= = = =	0.0 lbs 0.0 lbs 0.0 in

Earth Pressure Seismic Load

Method : Uniform Multiplier Used = 8.000 (Multiplier used on soil density)

Allow Soil Bearing Equivalent Fluid Pressure		3,333.0 od	psf
Active Heel Pressure	=		psf/ft
	=		
Passive Pressure	=	450.0	psf/ft
Soil Density, Heel	=	120.00	pcf
Soil Density, Toe	=	120.00	pcf
Footing Soil Friction	=	0.530	
Soil height to ignore for passive pressure	=	0.00	in

Soil Data

Lateral Load Applied to Stem

Lateral Load Height to Top Height to Bottom	= = =	0.0 #/ft 0.00 ft 0.00 ft
Load Type	=	Seismic (E) (Strength Level)
Wind on Exposed Ster (Strength Level)	n _	0.0 psf

•
•

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
Footing Type Base Above/Below Soil at Back of Wall	=	Spread Footing 0.0 ft

Uniform Seismic Force = 72.000 Total Seismic Force = 648.000

LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 8' Retained - EQ

Design Summary

Wall Stability Ratios Overturning Sliding Global Stability	= = =	1.84 OK 1.60 OK 1.97
Total Bearing Load resultant ecc. Eccentricity outsic Soil Pressure @ Toe	= = le mid =	4,680 lbs 10.47 in dle third 2,767 psf OK
Soil Pressure @ Heel Allowable Soil Pressure Less ACI Factored @ Toe ACI Factored @ Heel	= Than = =	0 psf OK 3,333 psf Allowable 3,309 psf 0 psf
Footing Shear @ Toe Footing Shear @ Heel Allowable	= = =	0.1 psi OK 22.7 psi OK 82.2 psi
Sliding Calcs Lateral Sliding Force less 100% Passive Force less 100% Friction Force Added Force Req'd for 1.5 Stability		1,871.1 lbs 506.3 lbs 2,480.2 lbs 0.0 lbs OK 0.0 lbs OK

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

1.200
1.600
1.600
1.000
1.000

				· · ·
QUANTUM CONSULTING EN	GINEEF	RS		(c) ENERCALC INC 1983-2023
Stem Construction		Bottom		
		Stem OK		
Design Height Above Ftg		0.00		
Wall Material Above "Ht" Design Method	=	Concrete	20	SD
Thickness	=	SD 8.00	SD	3D
Rebar Size	=	8.00 # 4		
Rebar Spacing	=	9.00		
Rebar Placed at	_	Edge		
Design Data		Luge		
fb/FB + fa/Fa	=	0.985		
Total Force @ Section				
Service Level	lbs =			
Strength Level	lbs =	2,368.0		
MomentActual		_,		
Service Level	ft-# =			
Strength Level	ft-# =	7,082.7		
MomentAllowable	=	7,185.3		
ShearActual		,		
Service Level	psi =			
Strength Level	, psi =	31.6		
ShearAllowable	psi =	50.2		
Anet (Masonry)	in2 =	00.2		
Wall Weight	psf =	100.0		
Rebar Depth 'd'	in =	6.25		
	=	0.25		
Masonry Data				
f'm	psi =			
es. Fs	psi =			
Solid Grouting	=			
Modular Ratio 'n'	=			
Equiv. Solid Thick.	=			
Masonry Block Type	=			
Masonry Design Method	=	ASD		
Concrete Data				
f'c	psi =	3,000.0		
Fy	psi =	60,000.0		

LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 8' Retained - EQ

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.2654 in2/ft	
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :
		One layer of : Two layers of :
Required Area :	0.2654 in2/ft	#4@ 13.89 in #4@ 27.78 in
Provided Area :	0.2667 in2/ft	#5@ 21.53 in #5@ 43.06 in
Maximum Area :	1.016 in2/ft	#6@ 30.56 in #6@ 61.11 in

Footing Data

Toe Width	=	0.67 ft
Heel Width	=	3.33
Total Footing Width	=	4.00
Footing Thickness	=	12.00 in

f'c = 3,00	0 psi	Fy =	60,0	000 psi
Footing Concret	e Density	/ =	150	.00 pcf
Min. As % Cover @ Top	2.00	= @ F	0.00)18 3.00 in

Footing Design Results

QUANTUM CONSULTING ENGINEERS

		<u>Toe</u>	<u>Heel</u>	
Factored Pressure	=	3,309	0	psf
Mu' : Upward	=	694	1,395	ft-#
Mu' : Downward	=	57	7,633	ft-#
Mu: Design	=	637	6,238	ft-#
φ Mn	=	2,739	11,388	ft-#
Actual 1-Way Shear	=	0.09	22.75	psi
Allow 1-Way Shear	=	43.82	43.25	psi
Toe Reinforcing	=	None Spec'd		
Heel Reinforcing	=	# 4 @ 9.00 in		
Key Reinforcing	=	None Spec'd		
Footing Torsion, Tu		=	0.00 ft-lb	s
Footing Allow. Torsion	n, q	Tn =	0.00 ft-lb	s

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

Other Acceptable Sizes & Spacings

Toe: phiMn = phi*5*lambda*sqrt(fc)*Sm

Heel: #4@ 9.25 in, #5@ 14.35 in, #6@ 20.37 in, #7@ 27.77 in, #8@ 36.57 in, #9@ 46.29 in, #10@ 58.79 in

Key: No key defined

Min footing T&S reinf Area	1.04	in2
Min footing T&S reinf Area per foot	0.26	in2 /ft
If one layer of horizontal bars:	<u>lf two lay</u>	ers of horizontal bars:
#4@ 9.26 in	#4@1	8.52 in
#5@ 14.35 in	#5@ 2	8.70 in
#6@ 20.37 in	#6@4	0.74 in

Project File: Retaining Walls - Updated.ec6

(c) ENERCALC INC 1983-2023

LIC# : KW-06016450, Build:20.24.05.02

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

(c) ENERCALC INC 1983-2023

DESCRIPTION: 8' Retained - EQ

Summary of Overturning & Resisting Forces & Moments

		OV	ERTURNING				SISTING	
Item		Force lbs	Distance ft	Moment ft-#		Force Ibs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	1,417.5	3.00	4,252.5	Soil Over HL (ab. water tbl)	2,556.8	2.67	6,822.4
HL Act Pres (be water tbl Hydrostatic Force	,	, -		,	Soil Over HL (bel. water tbl) Water Table		2.67	6,822.4
Buoyant Force	=				Sloped Soil Over Heel =			
Surcharge over Heel	=				Surcharge Over Heel =			
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 =	40.2	0.34	13.5
Seismic Earth Load	=	453.6	4.50	2,041.2	Surcharge Over Toe =			
	=				Stem Weight(s) =	800.0	1.00	802.7
		4 074 4			Earth @ Stem Transitions =			
Total	=	1,871.1	O.T.M. =	6,293.7	Footing Weight =	600.0	2.00	1,200.0
					Key Weight =			
Resisting/Overturning			=	1.84	Vert. Component =	682.6	4.00	2,730.4
Vertical Loads used for	or Soi	Pressure	= 4,679.6	6 lbs	Total =	4,679.6 I	bs R.M.=	11,568.9
If seismic is included, the		A and slidin	g ratios		* Axial live load NOT included resistance, but is included fo			r overturning

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

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

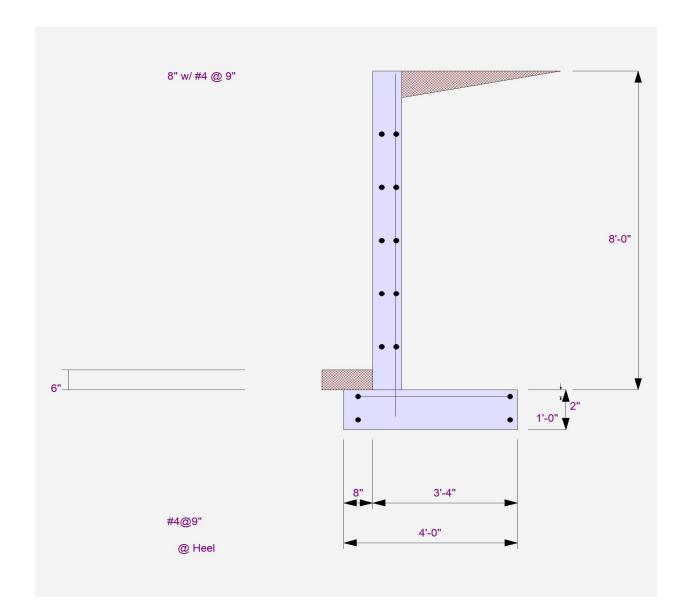
(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus 250.0 pci Horizontal Defl @ Top of Wall (approximate only) 0.154 in

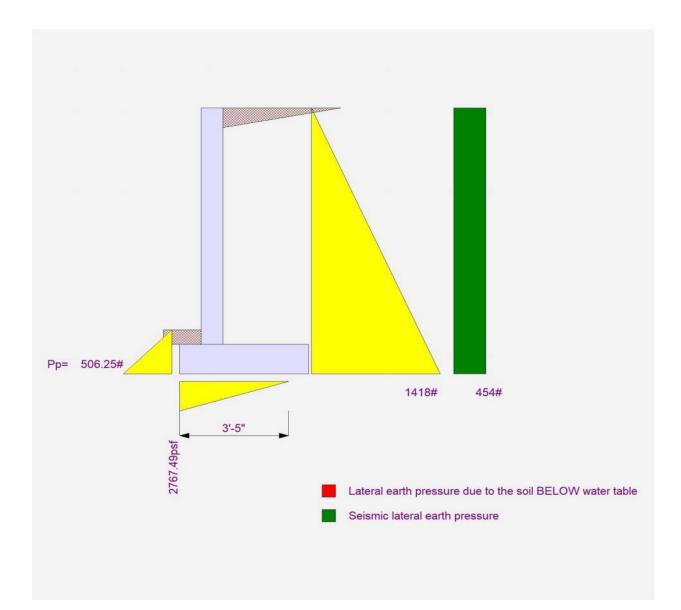
The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe,

Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023
DESCRIPTION: 8' Retained - EQ		
Rebar Lap & Embedment Lengths Inform	ation	
Stem Design Segment: Bottom		
Stem Design Height: 0.00 ft above top of footing		
Lap Splice length for #4 bar specified in this stem des	sign segment (25.4.2.4a) =	17.09 in
Development length for #4 bar specified in this stem	design segment =	13.15 in
Hooked embedment length into footing for #4 bar spe	5.63 in	
As Provided =	0.2667 in2/ft	
As Required =		0.2654 in2/ft

Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023
DESCRIPTION: 8' Retained - EQ		







LIC# : KW-06016450, Build:20.24.05.02

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

(c) ENERCALC INC 1983-2023

DESCRIPTION: 8' Retained - Rebar Centered

Code Reference

Calculations per IBC 2021 1807.3, ASCE 7-16

Criteria

Soil	Data

Retained Height	=	8.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water table above bottom of footing	=	0.0 ft

Surcharge Loads

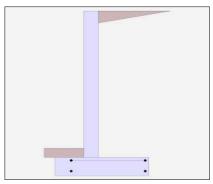
Surcharge Over Hee Used To Resist Slid Surcharge Over Toe Used for Sliding & (ding & Ov = =	0.0
Axial Load App	lied to	Stem
Axial Dead Load Axial Live Load	=	0.0 lbs 0.0 lbs

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

Allow Soil Bearing Equivalent Fluid Pressure		2,500.0 psf od
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	450.0 psf/ft
Soil Density, Heel	=	120.00 pcf
Soil Density, Toe	=	120.00 pcf
Footing Soil Friction	=	0.530
Soil height to ignore for passive pressure	=	0.00 in

Lateral Load Applied to Stem

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



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
Footing Type Base Above/Below Soil at Back of Wall	=	Spread Footing 0.0 ft

Cantilevered Retaining Wall LIC# : KW-06016450, Build:20.24.05.02

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6 (c) ENERCALC INC 1983-2023

DESCRIPTION: 8' Retained - Rebar Centered

Design Summary			Stem Construction		Bottom			
			Design Height Above Ftg	ft =	Stem OK 0.00			
Wall Stability Ratios			Wall Material Above "Ht"	=	Concrete			
Overturning	=	3.02 OK	Design Method	=	SD	SD	SD	
Sliding	=	2.02 OK	Thickness	=	8.00	02	02	
Global Stability	=	1.89	Rebar Size	=	# 4			
			Rebar Spacing	=	8.00			
Total Bearing Load	=	4,452 lbs	Rebar Placed at	=	Center			
resultant ecc.	=	2.86 in	Design Data					
Eccentricity withi	n mic		fb/FB + fa/Fa	=	0.955			
Soil Pressure @ Toe	=	1,367 psf OK	Total Force @ Section					
Soil Pressure @ Heel	=	689 psf OK	Service Level	lbs =				
Allowable	_	2,500 psf	Strength Level	lbs =	1,792.0			
Soil Pressure Less			MomentActual					
ACI Factored @ Toe	=	1,621 psf	Service Level	ft-# =				
ACI Factored @ Heel	=	817 psf	Strength Level	ft-# =	4,778.7			
Footing Shear @ Toe	=	6.7 psi OK	MomentAllowable	=	5,001.8			
Footing Shear @ Heel	=	15.7 psi OK	ShearActual		,			
Allowable	=	82.2 psi	Service Level	psi =				
			Strength Level	psi =	37.3			
Sliding Calcs			ShearAllowable		60.5			
Lateral Sliding Force	=	1,417.5 lbs		psi =	60.5			
less 100% Passive Force		00010 100	Anet (Masonry)	in2 =				
less 100% Friction Force	= -	,	Wall Weight	psf =	100.0			
Added Force Req'd	=	0.0 lbs OK	Rebar Depth 'd'	in =	4.00			
for 1.5 Stability	=	0.0 lbs OK	Maganini Data					
			Masonry Data f'm					
/ertical component of active considered in the calculation				psi =				
	1015	on bearing pressure:	Solid Grouting	psi =				
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	=	AGD			
Wind, W		1.000	f'c	psi =	3.000.0			
Seismic, E		1.000	Fy	psi =	60,000.0			
- /			- 7	1.0	_ ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,			

LIC# : KW-06016450, Build:20.24.05.02

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6 (c) ENERCALC INC 1983-2023

DESCRIPTION: 8' Retained - Rebar Centered

Concrete Stem Rebar Area Details

Required Area :	======================================	<u>One layer of : Two layers of :</u> #4@ 13.89 in #4@ 27.78 in		
Provided Area :	0.3 in2/ft	#5@ 21.53 in #5@ 43.06 in		
Maximum Area :	0.6503 in2/ft	#6@ 30.56 in #6@ 61.11 in		
Footing Data	Footing Design Results			

Toe Width	=	1.33 ft
Heel Width	=	3.00
Total Footing Width	= _	4.33
Footing Thickness	=	12.00 in

f'c = 3,00	0 psi l	Fy =	60,0	00 psi
Footing Concret	e Density	=	150	.00 pcf
Min. As %	2.00	=	0.00	18
Cover @ Top		@ E	8tm. =	3.00 in

T cotting Desig			_	
		Toe	<u>Heel</u>	
Factored Pressure	=	1,621	817	psf
Mu' : Upward	=	1,361	2,617	ft-#
Mu' : Downward	=	223	6,174	ft-#
Mu: Design	=	1,138	3,558	ft-#
φ Mn	=	2,739	11,388	ft-#
Actual 1-Way Shear	=	6.67	15.69	psi
Allow 1-Way Shear	=	43.82	43.25	psi
Toe Reinforcing	=	None Spec'd		
Heel Reinforcing	=	# 4 @ 9.00 in		
Key Reinforcing	=	None Spec'd		
Footing Torsion, Tu		=	0.00 ft-lb	os

Footing Allow. Torsion, ϕ Tn = 0.00 ft-lbs If torsion exceeds allowable, provide

supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: phiMn = phi*5*lambda*sqrt(fc)*Sm

Heel: #4@ 9.25 in, #5@ 14.35 in, #6@ 20.37 in, #7@ 27.77 in, #8@ 36.57 in, #9@ 46.29 in, #10@ 58.79 in

Key: No key defined

Min footing T&S reinf Area	1.12	in2
Min footing T&S reinf Area per foot	0.26	in2 /ft
If one layer of horizontal bars:	If two lay	ers of horizontal bars:
#4@ 9.26 in	#4@1	8.52 in
#5@ 14.35 in	#5@ 2	8.70 in
#6@ 20.37 in	#6@4	0.74 in

LIC# : KW-06016450, Build:20.24.05.02

Project File: Retaining Walls - Updated.ec6

(c) ENERCALC INC 1983-2023

DESCRIPTION: 8' Retained - Rebar Centered

Summary of Overturning & Resisting Forces & Moments

	OV	ERTURNING			RE	SISTING	
ltem	Force lbs	Distance ft	Moment ft-#		Force Ibs	Distance ft	Moment ft-#
L Act Pres (ab water tbl)	1,417.5	3.00	4,252.5	Soil Over HL (ab. water tbl)	2,240.0	3.16	7,085.9
L Act Pres (be water tbl)	,		,	Soil Over HL (bel. water tbl)		3.16	7,085.9
Hydrostatic Force				Water Table			
Buoyant Force =				Sloped Soil Over Heel =			
Surcharge over Heel =				Surcharge Over Heel =			
Surcharge Over Toe =				Adjacent Footing Load =			
Adjacent Footing Load =				Axial Dead Load on Stem =			
Added Lateral Load =				* Axial Live Load on Stem =			
_oad @ Stem Above Soil =				Soil Over Toe =	79.8	0.67	53.1
=				Surcharge Over Toe =			
_				Stem Weight(s) =	800.0	1.66	1,330.7
				Earth @ Stem Transitions =			
Total =	1,417.5	O.T.M. =	4,252.5	Footing Weight =	649.5	2.17	1,406.2
				Key Weight =			
Resisting/Overturning Rat		=	3.02	Vert. Component =	682.6	4.33	2,955.6
Vertical Loads used for So	il Pressure	= 4,451.9	9 lbs	Total =	4,451.9	bs R.M.=	12,831.4

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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)

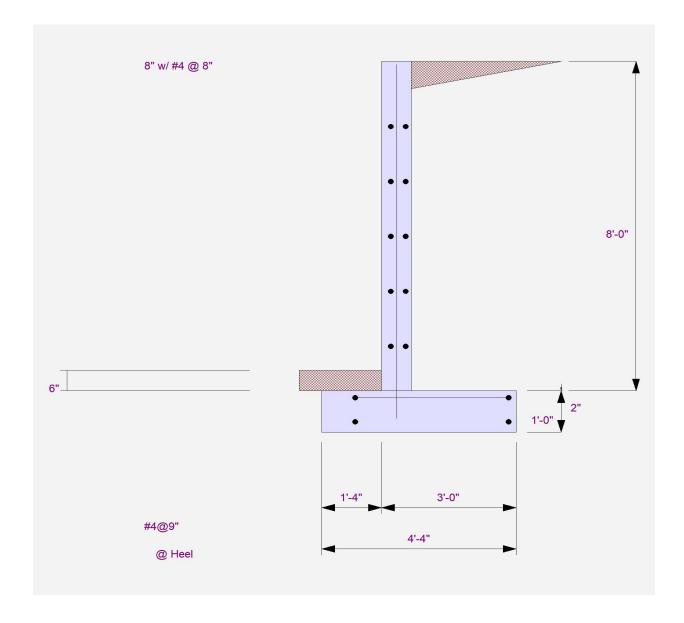
Soil Spring Reaction Modulus250.0pciHorizontal Defl @ Top of Wall (approximate only)0.070in

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

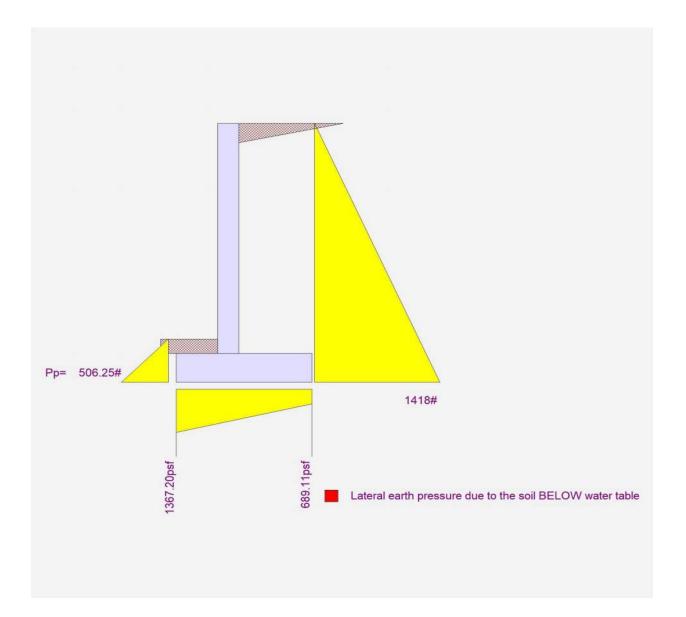
Cantilevered Retaining Wall	Project File: Retaining Walls - Updated.ec6 (c) ENERCALC INC 1983-2023		
LIC# : KW-06016450, Build:20.24.05.02			
DESCRIPTION: 8' Retained - Rebar Co	entered		
Rebar Lap & Embedment Lengths Info	rmation		
Stem Design Segment: Bottom			
Stem Design Height: 0.00 ft above top of footi	ng		
Lap Splice length for #4 bar specified in this stem	design segment (25.4.2.4a) =	17.09 in	
Development length for #4 bar specified in this ste	em design segment =	13.15 in	
Hooked embedment length into footing for #4 bar	specified in this stem design segment =	5.63 in	
As Provided =		0.3000 in2/ft	
As Required =		0.2885 in2/ft	

Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023

DESCRIPTION: 8' Retained - Rebar Centered



LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 8' Retained - Rebar Centered



LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 8' Retained

DESCRIPTION. 6 Retai

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

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Code Reference

Calculations per IBC 2021 1807.3, ASCE 7-16

Criteria

Retained Height	=	8.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water table above		
bottom of footing	=	0.0 ft

Surcharge Loads

Surcharge Over Heel = 0.0 psf Used To Resist Sliding & Overturning Surcharge Over Toe = 0.0 Used for Sliding & Overturning				
Axial Load Applied to Stem				
Axial Dead Load Axial Live Load	=	0.0 lbs 0.0 lbs		

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

Soil Data

Allow Soil Bearing Equivalent Fluid Pressure		2,500.0 psf od
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	450.0 psf/ft
Soil Density, Heel	=	120.00 pcf
Soil Density, Toe	=	120.00 pcf
Footing Soil Friction	=	0.530
Soil height to ignore for passive pressure	=	0.00 in

Lateral Load Applied to Stem

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

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

LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 8' Retained

Design Summary

Wall Stability Ratios Overturning Sliding Global Stability	= = =	2.72 2.11 1.97	•••	•
Total Bearing Load resultant ecc. Eccentricity withi	= = in mid	4,680 5.24 Idle third		
Soil Pressure @ Toe Soil Pressure @ Heel Allowable Soil Pressure Less	= = =	1,936 404 2,500	psf psf	
ACI Factored @ Toe ACI Factored @ Heel	= =	2,315 483		
Footing Shear @ Toe Footing Shear @ Heel Allowable	= = =	0.1 15.2 82.2	•	
Sliding Calcs Lateral Sliding Force less 100% Passive Force less 100% Friction Force Added Force Req'd for 1.5 Stability	•	0.0	lbs	-

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

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

QUANTUM CONSULTING EN		00	•	(c) ENERCALC INC 1983-2023
QUANTOW CONSULTING EN	10		(C) ENERGALG ING 1983-2023	
Stem Construction		Bottom		
Design Height Above Ftg	ft =	Stem OK 0.00		
Wall Material Above "Ht"	=	Concrete		
Design Method	=	SD	SD	SD
Thickness	=	8.00	-	
Rebar Size	=	# 4		
Rebar Spacing	=	10.00		
Rebar Placed at	=	Edge		
Design Data		0 705		
fb/FB + fa/Fa	=	0.735		
Total Force @ Section				
Service Level	lbs =	4 700 0		
Strength Level	lbs =	1,792.0		
MomentActual Service Level	ft-# =			
Strength Level	ft-# =	4,778.7		
0		,		
MomentAllowable	=	6,495.1		
ShearActual				
Service Level	psi =			
Strength Level	psi =	23.9		
ShearAllowable	psi =	48.4		
Anet (Masonry)	in2 =			
Wall Weight	psf =	100.0		
Rebar Depth 'd'	in =	6.25		
Masonry Data				
f'm	psi =			
es. Fs	psi =			
Solid Grouting	=			
Modular Ratio 'n'	=			
Equiv. Solid Thick.	=			
Masonry Block Type	=			
Masonry Design Method	=	ASD		
Concrete Data				
f'c	psi =	3,000.0		
Fy	psi =	60,000.0		

LIC# : KW-06016450, Build:20.24.05.02

DESCRIPTION: 8' Retained

Concrete Stem Rebar Area Details

Bottom Stem As (based on applied moment) :	Vertical Reinforcing 0.179 in2/ft	Horizontal Reinf	orcing
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinf	orcing Options :
		One layer of :	Two layers of :
Required Area :	0.179 in2/ft	#4@ 13.89 in	#4@ 27.78 in
Provided Area :	0.24 in2/ft	#5@ 21.53 in	#5@ 43.06 in
Maximum Area :	1.016 in2/ft	#6@ 30.56 in	#6@ 61.11 in
Exacting Data	E a strand		

Footing Data

Toe Width	=	0.67 ft
Heel Width	=	3.33
Total Footing Width	=	4.00
Footing Thickness	=	12.00 in

f'c = 3 Footing Cone	,000 psi F crete Density	=y =	60,0 150	00 psi .00 pcf
Min. As %	0.00	=	0.00	
Cover @ Top	2.00	æ	Btm.=	3.00 in

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

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Footing Design Results

		Toe	<u>Heel</u>	
Factored Pressure	=	2,315	483	psf
Mu' : Upward	=	497	3,155	ft-#
Mu': Downward	=	57	7,633	ft-#
Mu: Design	=	440	4,478	ft-#
φ Mn	=	2,739	11,388	ft-#
Actual 1-Way Shear	=	0.09	15.17	psi
Allow 1-Way Shear	=	43.82	43.25	psi
Toe Reinforcing	=	None Spec'd		
Heel Reinforcing	=	# 4 @ 9.00 in		
Key Reinforcing	=	None Spec'd		
Footing Torsion, Tu		=	0.00 ft-lb	s
Footing Allow. Torsio	n, q	vTn =	0.00 ft-lb	S

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

Other Acceptable Sizes & Spacings

Toe: phiMn = phi*5*lambda*sqrt(fc)*Sm

Heel: #4@ 9.25 in, #5@ 14.35 in, #6@ 20.37 in, #7@ 27.77 in, #8@ 36.57 in, #9@ 46.29 in, #10@ 58.79 in

Key: No key defined

Min footing T&S reinf Area	1.04	in2
Min footing T&S reinf Area per foot	0.26	in2 /ft
If one layer of horizontal bars:	If two lay	ers of horizontal bars:
#4@ 9.26 in	#4@1	8.52 in
#5@ 14.35 in	#5@ 2	8.70 in
#6@ 20.37 in	#6@4	0.74 in

LIC# : KW-06016450, Build:20.24.05.02

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6 (c) ENERCALC INC 1983-2023

DESCRIPTION: 8' Retained

Summary of Overturning & Resisting Forces & Moments

0\	ERTURNING	i		RE	SISTING	
Force lbs	Distance ft	ft-#		Force Ibs	Distance ft	Moment ft-#
1,417.5	3.00	4,252.5	Soil Over HL (ab. water tbl)	2,556.8	2.67	6,822.4
,		,	Soil Over HL (bel. water tbl)		2.67	6,822.4
			Water Table			
			Sloped Soil Over Heel =			
			Surcharge Over Heel =			
			Adjacent Footing Load =			
			Axial Dead Load on Stem =			
			* Axial Live Load on Stem =			
			Soil Over Toe =	40.2	0.34	13.5
			Surcharge Over Toe =			
			Stem Weight(s) =	800.0	1.00	802.7
			Earth @ Stem Transitions =			
1,417.5	O.T.M. =	4,252.5	Footing Weight =	600.0	2.00	1,200.0
			Key Weight =			
	=	2.72	Vert. Component =	682.6	4.00	2,730.4
oil Pressure	= 4,679.0	6 lbs	Total =	4.679.6	bs R.M.=	11.568.9
	Force lbs 1,417.5 1,417.5 tio	Force Distance lbs ft 1,417.5 3.00 1,417.5 O.T.M. = tio =	lbs ft ft-# 1,417.5 3.00 4,252.5 1,417.5 O.T.M. = 4,252.5 tio = 2.72	Force lbs Distance ft Moment ft-# 1,417.5 3.00 4,252.5 Soil Over HL (ab. water tbl) Soil Over HL (bel. water tbl) Water Table Sloped Soil Over Heel = Sloped Soil Over Heel = Adjacent Footing Load = Axial Dead Load on Stem = * Axial Live Load on Stem = * Axial Live Load on Stem = * Soil Over Toe 1,417.5 O.T.M. = 4,252.5 tio = 2.72 tio = 2.72 tio = 2.72 tio = 2.72 tio = 2.72	Force IbsDistance ftMoment ft-#Force Ibs1,417.53.004,252.5Soil Over HL (ab. water tbl) Soil Over HL (bel. water tbl) Water Table2,556.81,417.53.004,252.5Soil Over HL (bel. water tbl) Water Table2,556.8Sloped Soil Over Heel= Adjacent Footing Load= Axial Dead Load on Stem = * Axial Live Load on Stem = Soil Over Toe= 40.2 Surcharge Over Toe1,417.5O.T.M.= 4,252.54,252.5Soil Over Toe Earth @ Stem Transitions= Footing Weight= 600.0 Key Weighttio= 4,670.62.72Vert. Component= 682.6	Force lbsDistance ftMoment ft-#Force lbsDistance ft1,417.53.004,252.5Soil Over HL (ab. water tbl) Soil Over HL (bel. water tbl)2,556.82.671,417.53.004,252.5Soil Over HL (bel. water tbl) Water Table2,556.82.67Soil Over HL (bel. water tbl)2,556.82.67Water TableSloped Soil Over Heel = Adjacent Footing Load = Axial Dead Load on Stem = * Axial Live Load on Stem = Soil Over Toe = Stem Weight(s) =40.20.341,417.5O.T.M. =4,252.5Stem Transitions= Footing Weight = Vert. Component =600.02.00tio=2.72Vert. Component =682.64.00

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

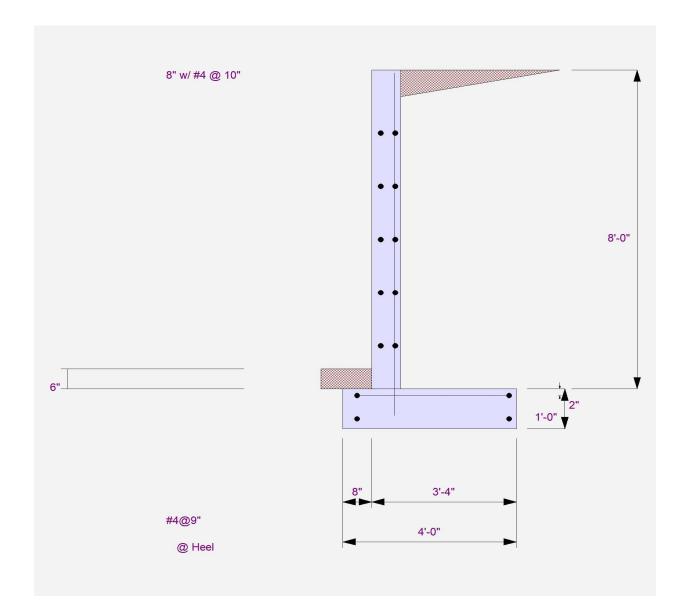
(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus 250.0 pci Horizontal Defl @ Top of Wall (approximate only) 0.108 in

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

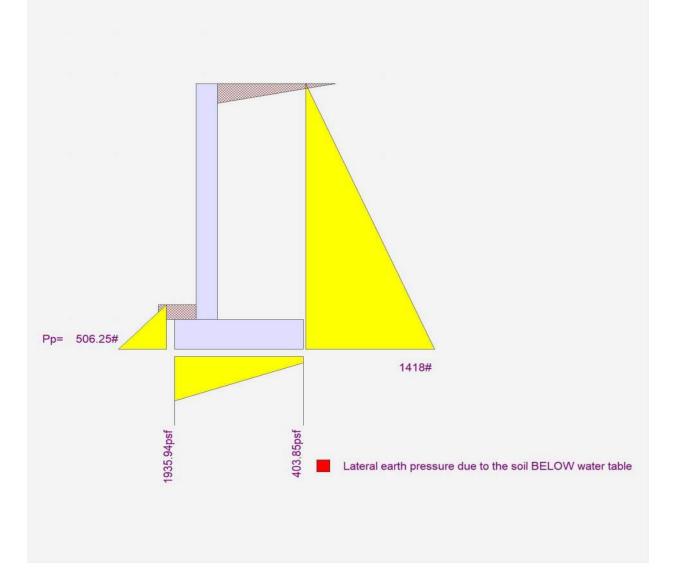
Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-202
DESCRIPTION: 8' Retained		
Rebar Lap & Embedment Lengths I	nformation	
Stem Design Segment: Bottom		
Stem Design Height: 0.00 ft above top of	footing	
Lap Splice length for #4 bar specified in this s	stem design segment (25.4.2.4a) =	17.09 in
Development length for #4 bar specified in thi	s stem design segment =	13.15 in
Hooked embedment length into footing for #4	bar specified in this stem design segment =	5.63 in
As Provided =		0.2400 in2/ft
As Required =		0.2387 in2/ft

Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023
DESCRIPTION: 8' Retained		



Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023

DESCRIPTION: 8' Retained



LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 7' Retained - EQ QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

(c) ENERCALC INC 1983-2023

Code Reference

Calculations per IBC 2021 1807.3, ASCE 7-16

Criteria

Retained Height	=	7.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water table above		
bottom of footing	=	0.0 ft

Surcharge Loads

Surcharge Over Heel = 0.0 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 Stepstrigity 0.0 p			
Axial Dead Load = 0.0 lbs Axial Live Load = 0.0 lbs	Used To Resist Sliding Surcharge Over Toe Used for Sliding & Ove	= rturning	turning 0.0
Axial Load Eccentricity $=$ 0.0 III	Axial Dead Load	=	0.0 lbs

Earth Pressure Seismic Load

Method : Uniform Multiplier Used = 8.000 (Multiplier used on soil density)

Allow Soil Bearing Equivalent Fluid Pressure	= Meth	3,333.0 Iod	psf
Active Heel Pressure	=		psf/ft
	=		
Passive Pressure	=	450.0	psf/ft
Soil Density, Heel	=	120.00	pcf
Soil Density, Toe	=	120.00	pcf
Footing Soil Friction	=	0.530	
Soil height to ignore for passive pressure	=	0.00	in

Soil Data

Lateral Load Applied to Stem

Lateral Load Height to Top Height to Bottom	= = =	0.0 #/ft 0.00 ft 0.00 ft
Load Type	=	Seismic (E) (Strength Level)
Wind on Exposed Sten (Strength Level)	n =	0.0 psf

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
Footing Type Base Above/Below Soil at Back of Wall	=	Spread Footing 0.0 ft

Uniform Seismic Force = 64.000 Total Seismic Force = 512.000

Cantilevered Retaining Wall

LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 7' Retained - EQ

Design Summary

Wall Stability Dation		
Wall Stability Ratios Overturning	=	1.79 OK
Sliding	_	1.64 OK
5	-	
Global Stability	=	2.04
Total Bearing Load	=	3,622 lbs
resultant ecc.	=	9.41 in
Eccentricity outsic Soil Pressure @ Toe		
Soil Pressure @ Heel	=	2,501 psf OK 0 psf OK
Allowable Soil Pressure Less	= Thon	3,333 psf
ACI Factored @ Toe ACI Factored @ Heel	=	2,980 psf
	=	0 psf
Footing Shear @ Toe	=	0.1 psi OK
Footing Shear @ Heel	=	19.1 psi OK
Allowable	=	82.2 psi
Sliding Calcs		
Lateral Sliding Force	=	1,478.4 lbs
less 100% Passive Force	-	506.3 lbs
less 100% Friction Force	≡ -	1,919.5 lbs
Added Force Reg'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.

Less I Frankright	
Load Factors	
Building Code	
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.000
Seismic, E	1.000

QUANTUM CONSULTING ENG	GINEEF	RS		(c) ENERCALC INC 1983-2023
		Dettem		
Stem Construction		Bottom		
Design Height Above Ftg	ft =	Stem OK 0.00		
Wall Material Above "Ht"	=	Concrete		
Design Method	=	SD	SD	SD
Thickness	=	8.00		
Rebar Size	=	# 4		
Rebar Spacing	=	9.00		
Rebar Placed at	=	Edge		
Design Data		0.663		
fb/FB + fa/Fa	=	0.003		
Total Force @ Section	lle e			
Service Level	lbs =	4 000 0		
Strength Level MomentActual	lbs =	1,820.0		
Service Level	ft-# =			
		4 760 2		
Strength Level	ft-# =	4,769.3		
MomentAllowable	=	7,185.3		
ShearActual				
Service Level	psi =			
Strength Level	psi =	24.3		
ShearAllowable	psi =	50.2		
Anet (Masonry)	in2 =			
Wall Weight	psf =	100.0		
Rebar Depth 'd'	in =	6.25		
Masonry Data				
f'm	psi =			
es. Fs	psi =			
Solid Grouting	=			
Modular Ratio 'n'	=			
Equiv. Solid Thick.	=			
Masonry Block Type	=			
Masonry Design Method	=	ASD		
Concrete Data	psi =	3,000.0		
Fy	psi = psi =	3,000.0 60,000.0		
i y	hai =	00,000.0		

LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 7' Retained - EQ

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinfo	orcing
As (based on applied moment) :	0.1787 in2/ft		
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinfo	orcing Options :
		One layer of :	Two layers of :
Required Area :	0.1787 in2/ft	#4@ 13.89 in	#4@ 27.78 in
Provided Area :	0.2667 in2/ft	#5@ 21.53 in	#5@ 43.06 in
Maximum Area :	1.016 in2/ft	#6@ 30.56 in	#6@ 61.11 in

Footing Data

Toe Width	=	0.67 ft
Heel Width	=	2.83
Total Footing Width	= -	3.50
Footing Thickness	=	12.00 in

f'c = 3,00	0 psi l	Fy =	60,0	00 psi
Footing Concret	e Density	=	150	.00 pcf
Min. As %	2.00	=	0.00	18
Cover @ Top		@ E	8tm. =	3.00 in

Footing Design Results

QUANTUM CONSULTING ENGINEERS

		Toe	Heel	
Factored Pressure	=	2,980	0	psf
Mu' : Upward	=	617	651	ft-#
Mu': Downward	=	57	4,647	ft-#
Mu: Design	=	561	3,996	ft-#
φ Mn	=	2,739	11,388	ft-#
Actual 1-Way Shear	=	0.09	19.14	psi
Allow 1-Way Shear	=	43.82	43.25	psi
Toe Reinforcing	=	None Spec'd		
Heel Reinforcing	=	# 4 @ 9.00 in		
Key Reinforcing	=	None Spec'd		
Footing Torsion, Tu		=	0.00 ft-lb	s
Footing Allow. Torsion	i, φ	Tn =	0.00 ft-lb	s

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

Other Acceptable Sizes & Spacings

Toe: phiMn = phi*5*lambda*sqrt(fc)*Sm

Heel: #4@ 9.25 in, #5@ 14.35 in, #6@ 20.37 in, #7@ 27.77 in, #8@ 36.57 in, #9@ 46.29 in, #10@ 58.79 in

Key: No key defined

Min footing T&S reinf Area	0.91	in2
Min footing T&S reinf Area per foot	0.26	in2 /ft
If one layer of horizontal bars:	If two lay	ers of horizontal bars:
#4@ 9.26 in	#4@1	8.52 in
#5@ 14.35 in	#5@ 2	8.70 in
#6@ 20.37 in	#6@4	0.74 in

Project File: Retaining Walls - Updated.ec6

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LIC# : KW-06016450, Build:20.24.05.02

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

(c) ENERCALC INC 1983-2023

DESCRIPTION: 7' Retained - EQ

Summary of Overturning & Resisting Forces & Moments

		OV	ERTURNING				SISTING	
Item		Force lbs	Distance ft	Moment ft-#		Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water th	bl)	1,120.0	2.67	2,986.7	Soil Over HL (ab. water tbl)	1,817.2	2.42	4,394.6
HL Act Pres (be water the Hydrostatic Force	,	,	-	,	Soil Over HL (bel. water tbl) Water Table		2.42	4,394.6
Buoyant Force	=				Sloped Soil Over Heel =			
Surcharge over Heel	=				Surcharge Over Heel =			
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 So	oil =				Soil Over Toe =	40.2	0.34	13.5
Seismic Earth Load	=	358.4	4.00	1,433.6	Surcharge Over Toe =			
	=				Stem Weight(s) =	700.0	1.00	702.3
T = 4 = 1		4 470 4	- o T M -	4 400 0	Earth @ Stem Transitions =			
Total	=	1,478.4	O.T.M. =	4,420.3	Footing Weight =	525.0	1.75	918.8
					Key Weight =			
Resisting/Overturnir	•		=	1.79	Vert. Component _=	539.3	3.50	1,887.7
Vertical Loads used	for So	il Pressure	= 3,621.7	7 lbs	Total =	3,621.7 I	bs R.M.=	7,916.8
If seismic is included, tl	he OT	M and slidir	ng ratios		* Axial live load NOT included resistance, but is included for			r overturning

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

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)

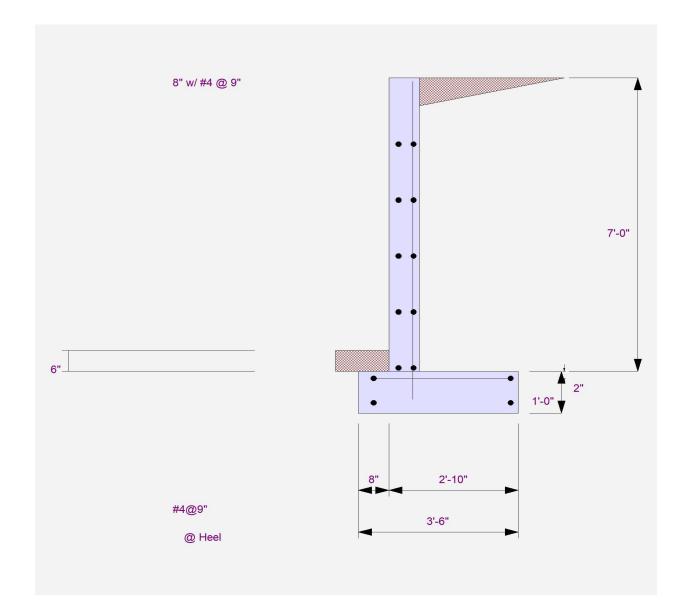
Soil Spring Reaction Modulus 250.0 pci Horizontal Defl @ Top of Wall (approximate only) 0.139 in

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

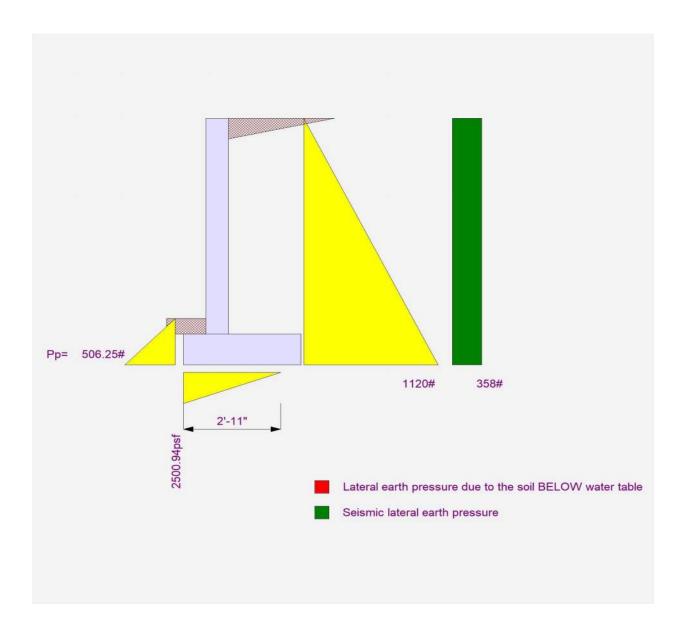
because the wall would then tend to rotate into the retained soil.

Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023
DESCRIPTION: 7' Retained - EQ		
Rebar Lap & Embedment Lengths Info	rmation	
Stem Design Segment: Bottom		
Stem Design Height: 0.00 ft above top of footi	ng	
Lap Splice length for #4 bar specified in this stem	design segment (25.4.2.4a) =	17.09 in
Development length for #4 bar specified in this ste	m design segment =	13.15 in
Hooked embedment length into footing for #4 bar	specified in this stem design segment =	5.63 in
As Provided =		0.2667 in2/ft
As Required =		0.2383 in2/ft

Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023
DESCRIPTION: 7' Retained - EQ		







LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 7' Retained QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

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Code Reference

Calculations per IBC 2021 1807.3, ASCE 7-16

Criteria

Retained Height	=	7.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water table above		
bottom of footing	=	0.0 ft

Surcharge Loads

Surcharge Over Hee Used To Resist Slid Surcharge Over Toe Used for Sliding & 0	ding & Ov	0.0	
Axial Load Applied to Stem			
Axial Dead Load Axial Live Load	=	0.0 lbs 0.0 lbs	

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

10		
Soil Data		
Allow Soil Bearing	=	2,500.0 psf
Equivalent Fluid Pressure	Meth	nod
Active Heel Pressure	=	35.0 psf/ft

=	
=	450.0 psf/ft
=	120.00 pcf
=	120.00 pcf
=	0.600
=	0.00 in
	= =

Lateral Load Applied to Stem

Lateral Load Height to Top Height to Bottom	= = =	0.0 #/ft 0.00 ft 0.00 ft
Load Type	=	Seismic (E) (Strength Level)
Wind on Exposed Sten (Strength Level)	י –	0.0 psf

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

LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 7' Retained

Design Summary

Wall Stability Ratios		
Overturning	=	2.65 OK
Sliding	=	2.39 OK
Global Stability	=	2.04
Total Bearing Load	=	3,622 lbs 4.66 in
Eccentricity with	in mic	Idle third
Soil Pressure @ Toe	=	1,724 psf OK
Soil Pressure @ Heel	=	345 psf OK
Allowable	=	2,500 psf
Soil Pressure Less	s Thar	n Allowable
ACI Factored @ Toe	=	2,055 psf
ACI Factored @ Heel	=	411 psf
Footing Shear @ Toe	=	0.1 psi OK
Footing Shear @ Heel	=	12.7 psi OK
Allowable	=	82.2 psi
Sliding Calcs		
Lateral Sliding Force	=	1,120.0 lbs
less 100% Passive Forc	•	506.3 lbs
less 100% Friction Force	∋≡ -	,
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	1.000
Seismic, E	1.000

				g traile op date alooe
QUANTUM CONSULTING ENG	QUANTUM CONSULTING ENGINEERS			(c) ENERCALC INC 1983-2023
Stom Construction		Bottom		
Stem Construction		Stem OK		
Design Height Above Ftg	ft =	0.00		
Wall Material Above "Ht"	=	Concrete		
Design Method	=	SD	SD	SD
Thickness	=	8.00		
Rebar Size	=	# 4		
Rebar Spacing	=	9.00		
Rebar Placed at	=	5.75 i		
Design Data fb/FB + fa/Fa		0.486		
Total Force @ Section	=	0.400		
Service Level	lbs =			
		4 070 0		
Strength Level MomentActual	lbs =	1,372.0		
Service Level	ft-# =			
Strength Level	ft-# =	3,201.3		
U U		-		
MomentAllowable	=	6,585.3		
ShearActual				
Service Level	psi =			
Strength Level	psi =	19.9		
ShearAllowable	psi =	51.6		
Anet (Masonry)	in2 =			
Wall Weight	psf =	100.0		
Rebar Depth 'd'	in =	5.75		
Masonry Data				
f'm es. Fs	psi =			
es. Fs Solid Grouting	psi =			
•	=			
Modular Ratio 'n'				
Equiv. Solid Thick. Masonry Block Type	=			
Masonry Design Method	=	ASD		
Concrete Data	=	ASD		
f'c	psi =	3,000.0		
Fy	psi =	60,000.0		
· J	- 10 H	20,000.0		

Project File: Retaining Walls - Updated.ec6

LIC# : KW-06016450, Build:20.24.05.02 **DESCRIPTION:** 7' Retained

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinfo	orcing
As (based on applied moment) :	0.131 in2/ft		
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinfo	orcing Options :
		One layer of :	Two layers of :
Required Area :	0.1728 in2/ft	#4@ 13.89 in	#4@ 27.78 in
Provided Area :	0.2667 in2/ft	#5@ 21.53 in	#5@ 43.06 in
Maximum Area :	0.9347 in2/ft	#6@ 30.56 in	#6@ 61.11 in
Footing Data	Footing	Design Results	

Footing Data

Toe Width	=	0.67 ft
Heel Width	=	2.83
Total Footing Width	=	3.50
Footing Thickness	=	12.00 in

f'c = 3,00	0 psi l	Fy =	60,0	000 psi
Footing Concret	te Density		150	.00 pcf
Min. As %	2.00	=	0.00)18
Cover @ Top		@ E	8tm.=	3.00 in

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

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	·			
		Toe	<u>Heel</u>	
Factored Pressure	=	2,055	411	psf
Mu' : Upward	=	438	1,755	ft-#
Mu': Downward	=	57	4,647	ft-#
Mu: Design	=	381	2,892	ft-#
φ Mn	=	2,739	11,388	ft-#
Actual 1-Way Shear	=	0.09	12.67	psi
Allow 1-Way Shear	=	43.82	43.25	psi
Toe Reinforcing	=	None Spec'd		
Heel Reinforcing	=	# 4 @ 9.00 in		
Key Reinforcing	=	None Spec'd		
Footing Torsion, Tu		=	0.00 ft-lb	os
Footing Allow. Torsio	n, q	pTn =	0.00 ft-lb	os

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

Other Acceptable Sizes & Spacings

Toe: phiMn = phi*5*lambda*sqrt(fc)*Sm

Heel: #4@ 9.25 in, #5@ 14.35 in, #6@ 20.37 in, #7@ 27.77 in, #8@ 36.57 in, #9@ 46.29 in, #10@ 58.79 in

Key: No key defined

Min footing T&S reinf Area	0.91 i	n2
Min footing T&S reinf Area per foot	0.26 i	n2 <i>/</i> ft
If one layer of horizontal bars:	<u>If two layer</u>	s of horizontal bars:
#4@ 9.26 in	#4@ 18.	52 in
#5@ 14.35 in	#5@ 28.	70 in
#6@ 20.37 in	#6@ 40.	74 in

LIC# : KW-06016450, Build:20.24.05.02

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6 (c) ENERCALC INC 1983-2023

DESCRIPTION: 7' Retained

Summary of Overturning & Resisting Forces & Moments

Force Ibs	Distance ft	Moment		Faraa		
		ft-#		Force Ibs	Distance ft	Moment ft-#
1.120.0	2.67	2.986.7	Soil Over HL (ab. water tbl)	1,817.2	2.42	4,394.6
,		,	Soil Over HL (bel. water tbl)		2.42	4,394.6
			Water Table			
			Sloped Soil Over Heel =			
			Surcharge Over Heel =			
			Adjacent Footing Load =			
			Axial Dead Load on Stem =			
			* Axial Live Load on Stem =			
			Soil Over Toe =	40.2	0.34	13.5
			Surcharge Over Toe =			
			Stem Weight(s) =	700.0	1.00	702.3
			Earth @ Stem Transitions =			
1,120.0	O.T.M. =	2,986.7	Footing Weight =	525.0	1.75	918.8
			Key Weight =			
io	=	2.65	Vert. Component =	539.3	3.50	1,887.7
il Pressure	= 3,621.7	7 lbs	Total =	3.621.7	bs R.M.=	7.916.8
	tio	1,120.0 O.T.M. =	1,120.0 O.T.M. = 2,986.7 tio = 2.65	Soil Over HL (bel. water tbl) Water Table Sloped Soil Over Heel = Surcharge Over Heel = Adjacent Footing Load = Axial Dead Load on Stem = * Axial Live Load on Stem = Soil Over Toe = Surcharge Over Toe = Surcharge Over Toe = Stem Weight(s) = Earth @ Stem Transitions= Footing Weight = Key Weight = Vert. Component = Total =	Soil Over HL (bel. water tbl) Water Table Sloped Soil Over Heel = Surcharge Over Heel = Adjacent Footing Load = Axial Dead Load on Stem = * Axial Live Load on Stem = Soil Over Toe = Stem Weight(s) = 700.0 Earth @ Stem Transitions= Footing Weight = 525.0 Key Weight = Vert. Component = 539.3 Total = 3,621.7	Soil Over HL (bel. water tbl) 2.42 Water Table Sloped Soil Over Heel = Surcharge Over Heel = Adjacent Footing Load = Axial Dead Load on Stem = * Axial Live Load on Stem = Soil Over Toe = 40.2 0.34 Surcharge Over Toe = Stem Weight(s) = 700.0 1.00 Earth @ Stem Transitions = Footing Weight = 525.0 1.75 Key Weight = Vert. Component = 539.3 3.50

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) 0.096 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.

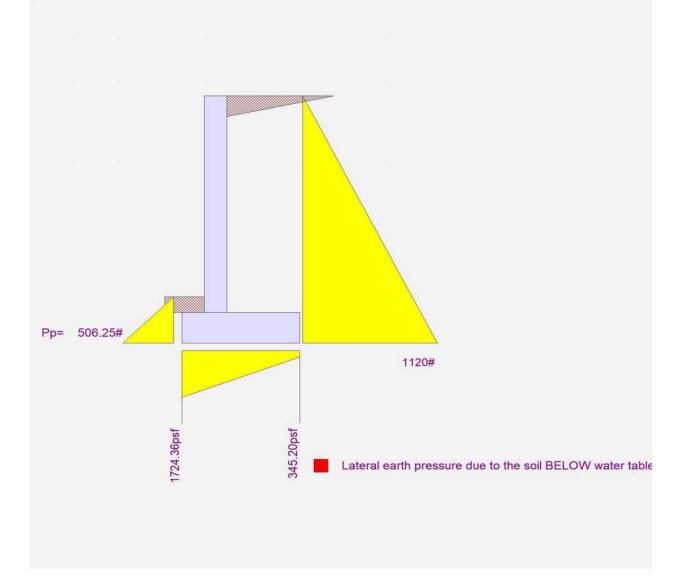
Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-202
DESCRIPTION: 7' Retained		
Rebar Lap & Embedment Lengths I	nformation	
Stem Design Segment: Bottom		
Stem Design Height: 0.00 ft above top of	footing	
Lap Splice length for #4 bar specified in this s	tem design segment (25.4.2.4a) =	17.09 in
Development length for #4 bar specified in thi	13.15 in	
Hooked embedment length into footing for #4	bar specified in this stem design segment =	5.63 in
As Provided =		0.2667 in2/ft
As Required =		0.1746 in2/ft

Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023
DESCRIPTION: 7' Retained		

8" w/ #4 @ 9" • ٠ 7'-0" • • 6"_ V • . 2" • 1'-0" • 8" 2'-10" #4@9" 3'-6" @ Heel

Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023

DESCRIPTION: 7' Retained



LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 6' Retained - EQ QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

(c) ENERCALC INC 1983-2023

Code Reference

Calculations per IBC 2021 1807.3, ASCE 7-16

Criteria

Retained Height	=	6.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water table above		
bottom of footing	=	0.0 ft

Surcharge Loads

Surcharge Over Heel = 0.0 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	

Earth Pressure Seismic Load

Method : Uniform Multiplier Used = 8.000 (Multiplier used on soil density)

Allow Soil Bearing Equivalent Fluid Pressure	= Meth	3,333.0 od	psf
Active Heel Pressure	=		psf/ft
	=		
Passive Pressure	=	450.0	psf/ft
Soil Density, Heel	=	120.00	pcf
Soil Density, Toe	=	120.00	pcf
Footing Soil Friction	=	0.530	
Soil height to ignore for passive pressure	=	0.00	in

Soil Data

Lateral Load Applied to Stem

Lateral Load Height to Top Height to Bottom	= = =	0.0 #/ft 0.00 ft 0.00 ft
Load Type	=	Seismic (E) (Strength Level)
Wind on Exposed Sten (Strength Level)	^ר =	0.0 psf

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
Footing Type Base Above/Below Soil at Back of Wall	=	Spread Footing 0.0 ft

Uniform Seismic Force = 56.000 Total Seismic Force = 392.000

LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 6' Retained - EQ

Design Summary

Wall Stability Ratios Overturning Sliding Global Stability	= = =	1.73 OK 1.71 OK 2.14
Total Bearing Load resultant ecc. Eccentricity outsic Soil Pressure @ Toe Soil Pressure @ Heel	= = le mid = =	2,701 lbs 8.38 in Idle third 2,246 psf OK 0 psf OK
Allowable Soil Pressure Less ACI Factored @ Toe ACI Factored @ Heel	= Than = =	3,333 psf Allowable 2,664 psf 0 psf
Footing Shear @ Toe Footing Shear @ Heel Allowable Sliding Calcs	= =	0.1 psi OK 14.7 psi OK 82.2 psi
Lateral Sliding Force less 100% Passive Force less 100% Friction Force Added Force Req'd for 1.5 Stability		1,131.9 lbs 506.3 lbs 1,431.4 lbs 0.0 lbs OK 0.0 lbs OK

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

		20	•	
QUANTUM CONSULTING EN	GINEEF	(5		(c) ENERCALC INC 1983-2023
Stem Construction		Bottom		
Design Height Above Ftg	ft =	Stem OK 0.00		
Wall Material Above "Ht"	=	Concrete		
Design Method	=	SD	SD	SD
Thickness	=	8.00		
Rebar Size	=	# 4		
Rebar Spacing	=	12.00		
Rebar Placed at	=	5.75 i		
Design Data		0.005		
fb/FB + fa/Fa	=	0.605		
Total Force @ Section				
Service Level	lbs =			
Strength Level	lbs =	1,344.0		
MomentActual	•• ••			
Service Level	ft-# =	0.004.0		
Strength Level	ft-# =	3,024.0		
MomentAllowable	=	4,998.0		
ShearActual				
Service Level	psi =			
Strength Level	psi =	19.5		
ShearAllowable	psi =	46.9		
Anet (Masonry)	in2 =			
Wall Weight	psf =	100.0		
Rebar Depth 'd'	in =	5.75		
·				
Masonry Data				
f'm	psi =			
es. Fs	psi =			
Solid Grouting	=			
Modular Ratio 'n'	=			
Equiv. Solid Thick.	=			
Masonry Block Type	=	4.0.0		
Masonry Design Method	=	ASD		
Concrete Data	psi =	3,000.0		
Fy	psi = psi =	3,000.0 60,000.0		
· y	P31 -	00,000.0		

Project File: Retaining Walls - Updated.ec6

LIC# : KW-06016450, Build:20.24.05.02

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6 (c) ENERCALC INC 1983-2023

DESCRIPTION: 6' Retained - EQ

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.1237 in2/ft	
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :
		One layer of : Two layers of :
Required Area :	0.1728 in2/ft	#4@ 13.89 in #4@ 27.78 in
Provided Area :	0.2 in2/ft	#5@ 21.53 in #5@ 43.06 in
Maximum Area :	0.9347 in2/ft	#6@ 30.56 in #6@ 61.11 in
Footing Data	Footing Des	ign Results

Footing Data

Toe Width	=	0.67 ft
Heel Width	=	2.33
Total Footing Width	=	3.00
Footing Thickness	=	12.00 in

f'c = 3,000) psi	Fy =	60,0	000 psi
Footing Concrete	e Densit	y =	150	.00 pcf
Min. As %	2.00	=	0.00)18
Cover @ Top		@.B	stm =	3.00 in

<u> </u>			
	Toe	<u>Heel</u>	
=	2,664	0	psf
=	542	225	ft-#
=	57	2,543	ft-#
=	486	2,318	ft-#
=	2,739	2,739	ft-#
=	0.09	14.71	psi
=	43.82	43.82	psi
=	None Spec'd		
=	None Spec'd		
=	None Spec'd		
	=	0.00 ft-lb	s
n, գ	Tn =	0.00 ft-lb	S
		= 2,664 = 542 = 57 = 486 = 2,739 = 0.09 = 43.82 = None Spec'd = None Spec'd	= 2,664 0 = 542 225 = 57 2,543 = 486 2,318 = 2,739 2,739 = 0.09 14.71 = 43.82 43.82 = None Spec'd = None Spec'd = 0.00 ft-lb

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

Other Acceptable Sizes & Spacings

Toe: phiMn = phi*5*lambda*sqrt(fc)*Sm

Heel: phiMn = phi*5*lambda*sqrt(fc)*Sm

Key: No key defined

0.78	in2
0.26	in2 /ft
If two lay	ers of horizontal bars:
#4@ 1	8.52 in
#5@ 2	8.70 in
#6@4	0.74 in
	0.26 <u>If two lay</u> #4@ 1 #5@ 2

LIC# : KW-06016450, Build:20.24.05.02

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

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DESCRIPTION: 6' Retained - EQ

Summary of Overturning & Resisting Forces & Moments

		OV	ERTURNING.			RE	SISTING	
Item		Force lbs	Distance ft	Moment ft-#		Force Ibs	Distance ft	Moment ft-#
HL Act Pres (ab water tb	D	857.5	2.33	2,000.8	Soil Over HL (ab. water tbl)	1,197.6	2.17	2,596.8
HL Act Pres (be water tb Hydrostatic Force	'			_,	Soil Over HL (bel. water tbl) Water Table		2.17	2,596.8
Buoyant Force	=				Sloped Soil Over Heel =			
Surcharge over Heel	=				Surcharge Over Heel =			
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 Soi	=				Soil Over Toe =	40.2	0.34	13.5
Seismic Earth Load	=	274.4	3.50	960.4	Surcharge Over Toe =			
	=				Stem Weight(s) =	600.0	1.00	602.0
					Earth @ Stem Transitions =			
Total	=	1,131.9	O.T.M. =	2,961.2	Footing Weight =	450.0	1.50	675.0
					Key Weight =			
Resisting/Overturning	•			1.73	Vert. Component =	412.9	3.00	1,238.8
Vertical Loads used for	or Soi	Pressure	= 2,700.7	lbs	Total =	2,700.7	bs R.M.=	5,126.0
If seismic is included, th	e OTN	/I and slidin	g ratios		* Axial live load NOT included resistance, but is included fo			r overturning

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

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)

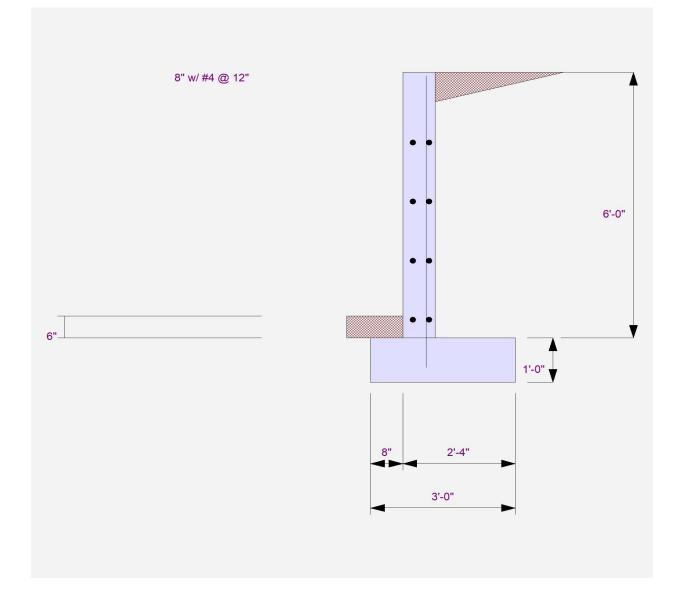
Soil Spring Reaction Modulus 250.0 pci Horizontal Defl @ Top of Wall (approximate only) 0.125 in

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: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023
DESCRIPTION: 6' Retained - EQ		
Rebar Lap & Embedment Lengths Info	ormation	
Stem Design Segment: Bottom		
Stem Design Height: 0.00 ft above top of foot	ing	
Lap Splice length for #4 bar specified in this stem	design segment (25.4.2.4a) =	17.09 in
Development length for #4 bar specified in this st	em design segment =	13.15 in
Hooked embedment length into footing for #4 bar	specified in this stem design segment =	5.63 in
As Provided =		0.2000 in2/ft
As Required =		0.1728 in2/ft

Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023
DESCRIPTION: 6' Retained - EQ		





Pp= 506.25# 858# 274# 2'-5" 2246.21psf Lateral earth pressure due to the soil BELOW water table Seismic lateral earth pressure

LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 6' Retained

DESCRIPTION. 6 Retain

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Project File: Retaining Walls - Updated.ec6

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Code Reference.

Calculations per IBC 2021 1807.3, ASCE 7-16

Criteria

Retained Height	=	6.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	12.00 in
Water table above		
bottom of footing	=	0.0 ft

Surcharge Loads

Surcharge Over Hee Used To Resist Slid Surcharge Over Toe Used for Sliding & C	ling & Ov =	0.0		
Axial Load Applied to Stem				
Axial Dead Load	=	0.0 lbs		

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

6 Soil Data

Allow Soil Bearing Equivalent Fluid Pressure		2,500.0 od	psf
Active Heel Pressure	=		psf/ft
	=		
Passive Pressure	=	450.0	psf/ft
Soil Density, Heel	=	120.00	pcf
Soil Density, Toe	=	120.00	pcf
Footing Soil Friction	=	0.530	
Soil height to ignore for passive pressure	=	0.00	in

Lateral Load Applied to Stem

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

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
Footing Type Base Above/Below Soil at Back of Wall	=	Spread Footing 0.0 ft

LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 6' Retained

Design Summary

Wall Stability Ratios Overturning Sliding Global Stability	= = =	2.57 2.74 2.42	
Total Bearing Load	=	2,741	
resultant ecc. Eccentricity within	= n mide	4.26 i	in
Soil Pressure @ Toe	=		psf OK
Soil Pressure @ Heel	=		psf OK
Allowable	=	2,500	
Soil Pressure Less	Than		
ACI Factored @ Toe ACI Factored @ Heel	=	1,857 315	
	_		
Footing Shear @ Toe Footing Shear @ Heel	=		psi OK
Allowable	=	9.7 82.2	psi OK
Allowable	-	02.2	231
Sliding Calcs			
Lateral Sliding Force	=	857.5 l	bs
less 100% Passive Force	-	900.0 l	bs
less 100% Friction Force	≡ -	1,452.7 l	bs
Added Force Req'd	=	0.0	bs 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	1.000
Seismic, E	1.000

QUANTUM CONSULTING EN	GINEEF	RS		(c) ENERCALC INC 1983-2023
Cham Construction		Bottom		
Stem Construction		Stem OK		
Design Height Above Ftg	ft =	0.00		
Wall Material Above "Ht"	=	Concrete		
Design Method	=	SD	SD	SD
Thickness	=	8.00		
Rebar Size	=	# 4		
Rebar Spacing	=	12.00		
Rebar Placed at	=	5.75 i		
Design Data		0.403		
fb/FB + fa/Fa	=	0.403		
Total Force @ Section				
Service Level	lbs =			
Strength Level	lbs =	1,008.0		
MomentActual	6 11			
Service Level	ft-# =			
Strength Level	ft-# =	2,016.0		
MomentAllowable	=	4,998.0		
ShearActual				
Service Level	psi =			
Strength Level	psi =	14.6		
ShearAllowable	psi =	46.9		
Anet (Masonry)	in2 =			
Wall Weight	psf =	100.0		
Rebar Depth 'd'	in=	5.75		
		00		
Masonry Data				
f'm	psi =			
es. Fs	psi =			
Solid Grouting	- =			
Modular Ratio 'n'	=			
Equiv. Solid Thick.	=			
Masonry Block Type	=			
Masonry Design Method	=	ASD		
Concrete Data		0.000.0		
f'c	psi =	3,000.0		
Fy	psi =	60,000.0		

Project File: Retaining Walls - Updated.ec6

LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 6' Retained

Concrete Stem Rebar Area Details					
Bottom Stem	Vertical Reinforcing	Horizontal Reinf	orcing		
As (based on applied moment) :	0.0825 in2/ft				
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinf	orcing Options :		
		One layer of :	Two layers of :		
Required Area :	0.1728 in2/ft	#4@ 13.89 in	#4@ 27.78 in		
Provided Area :	0.2 in2/ft	#5@ 21.53 in	#5@ 43.06 in		
Maximum Area :	0.9347 in2/ft	#6@ 30.56 in	#6@ 61.11 in		
Footing Data	Footing [Design Results			

Toe Width	=	0.67 ft
Heel Width	=	2.33
Total Footing Width	= -	3.00
Footing Thickness	=	12.00 in

f'c = 3	,000 psi I	=y_=	60,0	000 psi
Footing Cone	crete Density		150	.00 pcf
Min. As % Cover @ Tor	2.00	= @	0.00)18 3.00 in

QUANTUM CONSULTING ENGINEERS

		Toe	<u>Heel</u>	
Factored Pressure	=	1,857	315	psf
Mu' : Upward	=	391	830	ft-#
Mu': Downward	=	73	2,543	ft-#
Mu: Design	=	318	1,713	ft-#
φ Mn	=	2,739	2,739	ft-#
Actual 1-Way Shear	=	0.12	9.68	psi
Allow 1-Way Shear	=	43.82	43.82	psi
Toe Reinforcing	=	None Spec'd		
Heel Reinforcing	=	None Spec'd		
Key Reinforcing	=	None Spec'd		
Footing Torsion, Tu		=	0.00 ft-lb	S
Footing Allow. Torsio	n, գ	Tn =	0.00 ft-lb	S

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

Other Acceptable Sizes & Spacings

Toe: phiMn = phi*5*lambda*sqrt(fc)*Sm

Heel: phiMn = phi*5*lambda*sqrt(fc)*Sm

Key: No key defined

Min footing T&S reinf Area	0.78	in2
Min footing T&S reinf Area per foot	0.26	in2 /ft
If one layer of horizontal bars:	If two lay	ers of horizontal bars:
#4@ 9.26 in	#4@1	8.52 in
#5@ 14.35 in	#5@2	8.70 in
#6@ 20.37 in	#6@4	0.74 in

Project File: Retaining Walls - Updated.ec6

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LIC# : KW-06016450, Build:20.24.05.02

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

(c) ENERCALC INC 1983-2023

DESCRIPTION: 6' Retained

Summary of Overturning & Resisting Forces & Moments

	OV	ERTURNING			RE	SISTING	
Item	Force lbs	Distance ft	Moment ft-#		Force Ibs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	857.5	2.33	2,000.8	Soil Over HL (ab. water tbl)	1,197.6	2.17	2,596.8
HL Act Pres (be water tbl) Hydrostatic Force				Soil Over HL (bel. water tbl) Water Table		2.17	2,596.8
Buoyant Force =				Sloped Soil Over Heel =			
Surcharge over Heel =				Surcharge Over Heel =			
Surcharge Over Toe =				Adjacent Footing Load =			
Adjacent Footing Load =				Axial Dead Load on Stem =			
Added Lateral Load =				* Axial Live Load on Stem =			
_oad @ Stem Above Soil =				Soil Over Toe =	80.4	0.34	26.9
= =				Surcharge Over Toe =		0.0.1	
-				Stem Weight(s) =	600.0	1.00	602.0
				Earth @ Stem Transitions =			
Total =	857.5	O.T.M. =	2,000.8	Footing Weight =	450.0	1.50	675.0
				Key Weight =			
Resisting/Overturning Rat	io	=	2.57	Vert. Component =	412.9	3.00	1,238.8
Vertical Loads used for So	il Pressure	= 2,740.9	9 lbs	Total =	2.740.9	os R.M.=	5,139.5

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)

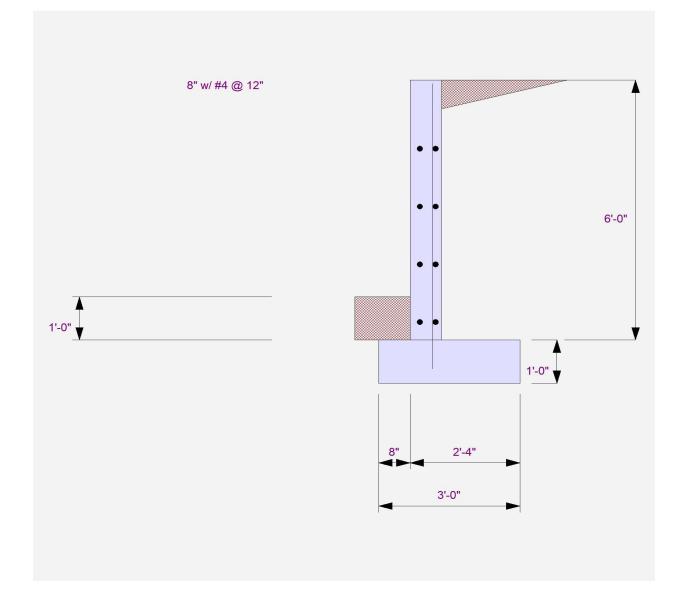
Soil Spring Reaction Modulus250.0pciHorizontal Defl @ Top of Wall (approximate only)0.087in

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: Retaining Walls - Updated.ece
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-20
DESCRIPTION: 6' Retained		
Rebar Lap & Embedment Lengths	Information	
Stem Design Segment: Bottom		
Stem Design Height: 0.00 ft above top c	f footing	
Lap Splice length for #4 bar specified in this	stem design segment (25.4.2.4a) =	17.09 in
Development length for #4 bar specified in t	his stem design segment =	13.15 in
Hooked embedment length into footing for #	4 bar specified in this stem design segment =	5.63 in
As Provided =		0.2000 in2/ft
As Required =		0.1728 in2/ft

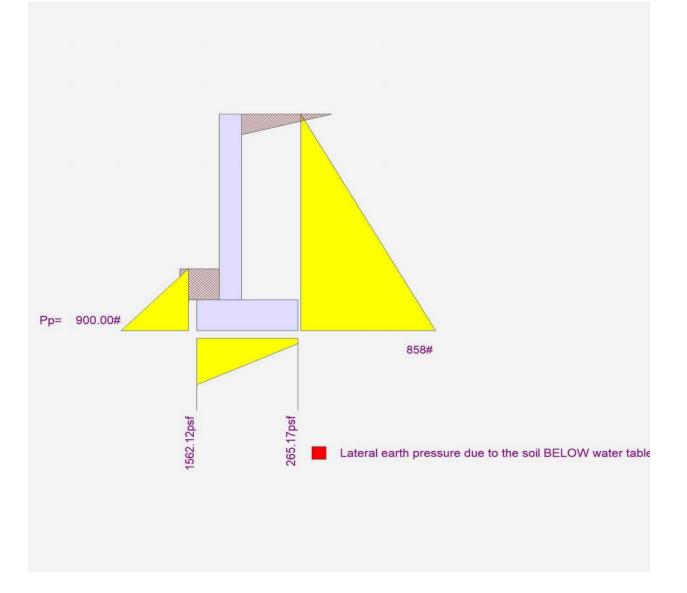
Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023
DESCRIPTION: 6' Retained		



DESCRIPTION: 6' Retained

QUANTUM CONSULTING ENGINEERS

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LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 5' Retained - EQ QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

(c) ENERCALC INC 1983-2023

Code Reference

Calculations per IBC 2021 1807.3, ASCE 7-16

Criteria

Retained Height	=	5.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water table above		
bottom of footing	=	0.0 ft

Surcharge Loads

Surcharge Over Heel Used To Resist Sliding Surcharge Over Toe Used for Sliding & Ove	=	0.0
Axial Load Applie	d to St	tem
Axial Dead Load Axial Live Load Axial Load Eccentricity	= = =	0.0 lbs 0.0 lbs 0.0 in

Earth Pressure Seismic Load

Method : Uniform Multiplier Used = 8.000 (Multiplier used on soil density)

Allow Soil Bearing Equivalent Fluid Pressure	= Meth	3,333.0 od	psf
Active Heel Pressure	=		psf/ft
	=		
Passive Pressure	=	450.0	psf/ft
Soil Density, Heel	=	120.00	pcf
Soil Density, Toe	=	120.00	pcf
Footing Soil Friction	=	0.530	
Soil height to ignore for passive pressure	=	0.00	in

Soil Data

Lateral Load Applied to Stem

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

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

Uniform Seismic Force = 48.000 Total Seismic Force = 288.000

LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 5' Retained - EQ

Design Summary

Wall Stability Ratios Overturning Sliding Global Stability	=	1.64 OK 1.81 OK 2.29
Total Bearing Load resultant ecc. Eccentricity outsid Soil Pressure @ Toe	= = de m	1,892 lbs 7.48 in iddle third 2,013 psf OK
Soil Pressure @ Heel	=	0 psf OK
Allowable Soil Pressure Less	= Tha	3,333 _{psf} n Allowable
ACI Factored @ Toe ACI Factored @ Heel	=	2,366 psf 0 psf
Footing Shear @ Toe	=	0.1 psi OK
Footing Shear @ Heel Allowable	=	11.4 psi OK 82.2 psi
Sliding Calcs		
Lateral Sliding Force	=	831.6 lbs
less 100% Passive Force	-	- 506.3 lbs
less 100% Friction Force	= -	,
Added Force Req'd for 1.5 Stability	=	0.0 lbs OK 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	1.000
Seismic, E	1.000

		20	•	
QUANTUM CONSULTING ENGINEERS				(c) ENERCALC INC 1983-2023
Stem Construction		Bottom		
Design Height Above Ftg	ft =	Stem OK 0.00		
Wall Material Above "Ht"		Concrete		
Design Method	=	SD	SD	SD
Thickness	=	6.00		
Rebar Size	=	# 4		
Rebar Spacing	=	16.00		
Rebar Placed at	=	3.75 i		
Design Data fb/FB + fa/Fa		0.726		
Total Force @ Section	=	0.720		
Service Level	lbs =			
Strength Level	lbs =	940.0		
MomentActual	105 =	940.0		
Service Level	ft-# =			
Strength Level	ft-# =	1,766.7		
MomentAllowable	= "	2,431.7		
ShearAllowable	=	2,431.7		
SnearActual Service Level	noi.			
	psi =			
Strength Level	psi =	20.9		
ShearAllowable	psi =	49.1		
Anet (Masonry)	in2 =			
Wall Weight	psf =	75.0		
Rebar Depth 'd'	in =	3.75		
Masonry Data				
f'm	psi =			
es. Fs	psi =			
Solid Grouting	- icq			
Modular Ratio 'n'	=			
Equiv. Solid Thick.	=			
Masonry Block Type	=			
Masonry Design Method	=	ASD		
Concrete Data				
f'c	psi =	3,000.0		
Fy	psi =	60,000.0		

Project File: Retaining Walls - Updated.ec6

LIC# : KW-06016450, Build:20.24.05.02

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

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DESCRIPTION: 5' Retained - EQ

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing Horizontal Reinforcing			
As (based on applied moment) :	0.1144 in2/ft			
0.0018bh : 0.0018(12)(6) :	0.1296 in2/ft	Horizontal Reinforcing Options :		
		One layer of : Two layers of :		
Required Area :	0.1296 in2/ft	#4@ 18.52 in #4@ 37.04 in		
Provided Area :	0.15 in2/ft	#5@ 28.70 in #5@ 57.41 in		
Maximum Area :	0.6096 in2/ft	#6@ 40.74 in #6@ 81.48 in		
Footing Data	Footing Design Results			

Footing Data

Toe Width	=	0.67 ft
Heel Width	=	1.83
Total Footing Width	=	2.50
Footing Thickness	=	12.00 in

f'c = 3,00	0 psi	Fy =	60,0	000 psi
Footing Concret	e Density	y =	150	.00 pcf
Min. As %	2.00	=	0.00)18
Cover @ Top		@ E	3tm.=	3.00 in

		Toe	Heel	
Factored Pressure	=	2,366	0	psf
Mu': Upward	=	468	75	ft-#
Mu' : Downward	=	57	1,442	ft-#
Mu: Design	=	411	1,367	ft-#
φ Mn	=	2,739	2,739	ft-#
Actual 1-Way Shear	=	0.09	11.38	psi
Allow 1-Way Shear	=	43.82	43.82	psi
Toe Reinforcing	=	None Spec'd		
Heel Reinforcing	=	None Spec'd		
Key Reinforcing	=	None Spec'd		

Footing Torsion, Tu 0.00 ft-lbs = Footing Allow. Torsion, ϕ Tn = 0.00 ft-lbs

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

Other Acceptable Sizes & Spacings

Toe: phiMn = phi*5*lambda*sqrt(fc)*Sm

Heel: phiMn = phi*5*lambda*sqrt(fc)*Sm

Key: No key defined

0.65	in2
0.26	in2 /ft
If two lay	ers of horizontal bars:
#4@ 1	8.52 in
#5@ 2	8.70 in
#6@4	0.74 in
	0.26 <u>If two lay</u> #4@ 1 #5@ 2

LIC# : KW-06016450, Build:20.24.05.02

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

(c) ENERCALC INC 1983-2023

DESCRIPTION: 5' Retained - EQ

Summary of Overturning & Resisting Forces & Moments

		OV	ERTURNING	i		RE	SISTING	
Item		Force lbs	Distance ft	Moment ft-#		Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water th	ol)	630.0	2.00	1,260.0	Soil Over HL (ab. water tbl)	798.0	1.84	1,464.3
HL Act Pres (be water the Hydrostatic Force	,			,	Soil Over HL (bel. water tbl Water Table)	1.84	1,464.3
Buoyant Force	=				Sloped Soil Over Heel =			
Surcharge over Heel	=				Surcharge Over Heel =			
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 So	il =				Soil Over Toe =	40.2	0.34	13.5
Seismic Earth Load	=	201.6	3.00	604.8	Surcharge Over Toe =			
	=				Stem Weight(s) =	375.0	0.92	345.0
					Earth @ Stem Transitions =			
Total	=	831.6	O.T.M. =	1,864.8	Footing Weight =	375.0	1.25	468.8
					Key Weight =			
Resisting/Overturnin	•		=	1.64	Vert. Component =	303.4	2.50	758.4
Vertical Loads used	for So	il Pressure	= 1,891.	6 lbs	Total =	1,891.6	bs R.M.=	3,050.0
If seismic is included, th	ne OT	M and slidir	ng ratios		* Axial live load NOT included resistance, but is included for			r overturning

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

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

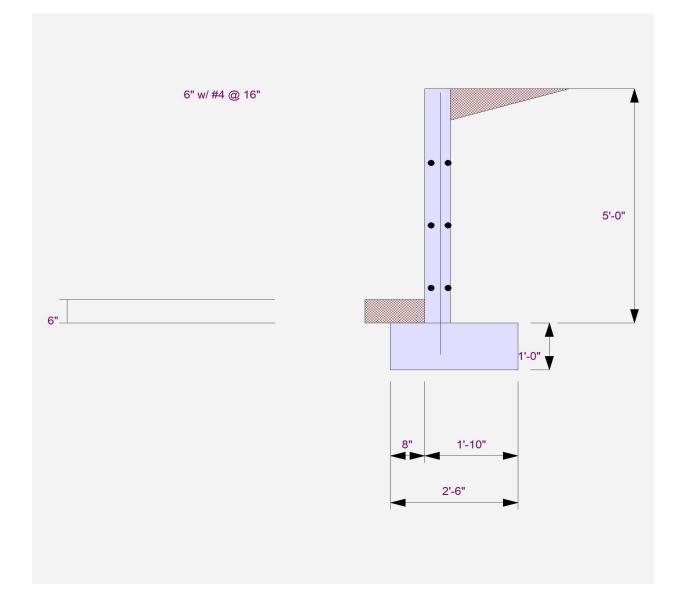
(Deflection due to wall bending not considered)

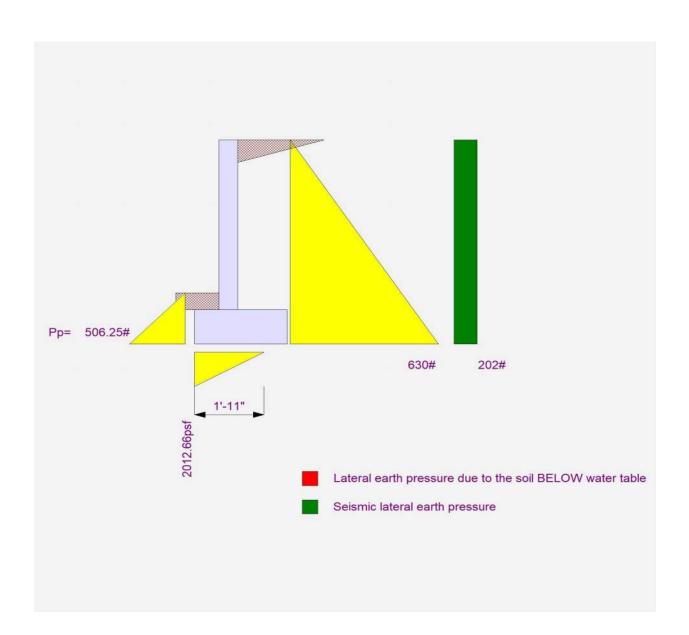
Soil Spring Reaction Modulus	250.0	pci
Horizontal Defl @ Top of Wall (approximate only)	0.112	in

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: Retaining Walls - Updated.e
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-
DESCRIPTION: 5' Retained - EQ		
Rebar Lap & Embedment Lengths Info	rmation	
Stem Design Segment: Bottom		
Stem Design Height: 0.00 ft above top of footin	ng	
Lap Splice length for #4 bar specified in this stem	design segment (25.4.2.4a) =	17.09 in
Development length for #4 bar specified in this ste	m design segment =	13.15 in
Hooked embedment length into footing for #4 bars	specified in this stem design segment =	5.63 in
As Provided =		0.1500 in2/ft
As Required =		0.1500 in2/ft





LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 5' Retained

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

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Code Reference

Calculations per IBC 2021 1807.3, ASCE 7-16

Criteria

Retained Height	=	5.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water table above		
bottom of footing	=	0.0 ft

Surcharge Loads

Surcharge Over Heel Used To Resist Slid Surcharge Over Toe Used for Sliding & C	ing & Ov =	0.0		
Axial Load Applied to Stem				
Axial Dead Load Axial Live Load	= =	0.0 lbs 0.0 lbs		

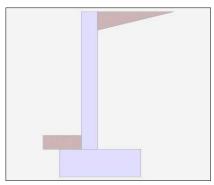
Axial Live Load	=	0.0 lbs
Axial Load Eccentricity	=	0.0 in

16		
Soil Data		

Allow Soil Bearing Equivalent Fluid Pressure		2,500.0 psf od
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	450.0 psf/ft
Soil Density, Heel	=	120.00 pcf
Soil Density, Toe	=	120.00 pcf
Footing Soil Friction	=	0.530
Soil height to ignore for passive pressure	=	0.00 in

Lateral Load Applied to Stem

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



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
Footing Type Base Above/Below Soil at Back of Wall	=	Spread Footing 0.0 ft

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Cantilevered Retaining Wall LIC# : KW-06016450, Build:20.24.05.02

DESCRIPTION: 5' Retained

Design Summary

Wall Stability Ratios			
Overturning	=	2.42 OK	
Sliding	=	2.39 OK	
Global Stability	=	2.29	
Total Bearing Load	=	1,892 lbs	
resultant ecc.	=	3.64 in	
Eccentricity withir Soil Pressure @ Toe		1,308 psf Ol	ĸ
Soil Pressure @ Heel	_	205 psf Ol	
Allowable		2,500 psf	
Soil Pressure Less			
ACI Factored @ Toe	=	1,538 psf	
ACI Factored @ Heel	=	241 psf	
Footing Shear @ Toe	=	0.1 psi Ol	K
Footing Shear @ Heel	=	7.5 psi Ol	K
Allowable	=	82.2 psi	
Sliding Calcs			
Lateral Sliding Force	=	630.0 lbs	
less 100% Passive Force		506.3 lbs	
less 100% Friction Force	≡ - 1,	002.5 lbs	
Added Force Req'd	=	0.0 lbs Ol	<
for 1.5 Stability	=	0.0 lbs O	K
			_

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	1.000
Seismic, E	1.000

em Construction		Bottom			
Design Height Above Ftg		Stem OK 0.00			
Wall Material Above "Ht"	=	Concrete			
Design Method	=	SD	SD	SD	
Thickness	=	6.00			
	=	# 4			
	=	16.00			
	=	3.75 i			
		0 470			
	=	0.479			
· · · · · · · · · · · · · · · · · · ·					
	lbs =	700.0			
0	ft-# =	1,166.7			
MomentAllowable	=	2,431.7			
ShearActual					
Service Level	psi =				
Strength Level	psi =	15.6			
ShearAllowable	psi =	49.1			
Anet (Masonry)	in2 =				
Wall Weight	psf =	75.0			
Rebar Depth 'd'	in =	3.75			
·					
	psi =				
	psi =				
U	=				
	=				
	=				
, , ,	=				
	=	ASD			
Concrete Data					
Fy	psi =	60,000.0			
	Wall Material Above "Ht" Design Method Thickness Rebar Size Rebar Spacing Rebar Placed at Design Data fb/FB + fa/Fa Total Force @ Section Service Level Strength Level MomentActual Service Level Strength Level MomentAllowable ShearAllowable ShearAllowable Anet (Masonry) Wall Weight Rebar Depth 'd' Masonry Data f'm Fs Solid Grouting Modular Ratio 'n' Equiv. Solid Thick. Masonry Block Type Masonry Design Method	Design Height Above Ftgft =Wall Material Above "Ht"=Design Method=Thickness=Rebar Size=Rebar Size=Rebar Spacing=Rebar Placed at=Design Data=fb/FB + fa/Fa=Total Force @ SectionService LevelService Levellbs =MomentActualService LevelService Levelft-# =MomentAllowable=ShearAllowablepsi =ShearAllowablepsi =Anet (Masonry)in2 =Wall Weightpsf =Rebar Depth 'd'in =Masonry Data=fmpsi =Fspsi =Solid Grouting=Masonry Block Type=Masonry Design Method=Concrete Datapsi =f'cpsi =	Stem OK 0.00Stem OK 0.00Wall Material Above "Ht"=Concrete 0.00Design Method=SD Thickness=6.00 Rebar Size=#4Rebar Size=#44Rebar Size=#4Rebar Spacing=16.00 Rebar Placed at=3.75 i00Design DataTotal Force @ Section Service LevelIbs =700.0MomentActual Service Levelft-# =1,166.7MomentAllowable=2,431.7ShearActual Service Levelpsi =15.6ShearAllowablepsi =49.1Anet (Masonry)in2 =Wall Weightpsf =75.0Rebar Depth 'd'in =3.75Masonry Data fmpsi =Fspsi =Solid Grouting=Masonry Block Type=Masonry Design Method=ASDConcrete Dataf'cpsi =3,000.0	Stem OKDesign Height Above Ftgft = 0.00 Wall Material Above "Ht"=ConcreteDesign Method=SDSDThickness= 6.00 Rebar Size=#4Rebar Spacing=16.00Rebar Placed at=200Rebar Placed at=3.75 iDesign Datafb/FB + fa/Fa=0.479Total Force @ SectionService LevelService Levellbs =Strength Levellbs =Strength Levelft-# =Strength Levelft-# =Strength Levelpsi =Strength Levelpsi =Strength Levelpsi =Strength Levelpsi =Strength Levelpsi =Strength Levelpsi =Anet (Masonry)in2 =Wall Weightpsf =Fspsi =Solid Grouting=Masonry Datafmfmpsi =Fspsi =Solid Grouting=Masonry Block Type=Masonry Design Method=ASDConcrete Dataf'cpsi =forpsi =for <t< td=""></t<>	

Project File: Retaining Walls - Updated.ec6

(c) ENERCALC INC 1983-2023

<u>Heel</u>

Cantilevered Retaining Wall

LIC# : KW-06016450, Build:20.24.05.02

DESCRIPTION: 5' Retained

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinf	orcing	
As (based on applied moment) :	0.0756 in2/ft			
0.0018bh : 0.0018(12)(6) :	0.1296 in2/ft	Horizontal Reinforcing Options :		
		One layer of :	Two layers of :	
Required Area :	0.1296 in2/ft	#4@ 18.52 in	#4@ 37.04 in	
Provided Area :	0.15 in2/ft	#5@ 28.70 in	#5@ 57.41 in	
Maximum Area :	0.6096 in2/ft	#6@ 40.74 in	#6@ 81.48 in	
Footing Data	Footing Design Results			

Toe Width	=	0.67 ft
Heel Width	=	1.83
Total Footing Width	= _	2.50
Footing Thickness	=	12.00 in

f'c = 3,00 Footing Concret	0 psi e Density	Fy =	60,0 150	000 psi .00 pcf
Min. As % Cover @ Top	2.00	= @ F	0.00)18 3.00 in
Cover @ Top	2.00	w i	3tm.=	3.00 I

rooting	Design	Nesuits	
		Тое	

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Factored Pressure	=	1,538	241	psf
Mu' : Upward	=	319	417	ft-#
Mu': Downward	=	57	1,442	ft-#
Mu: Design	=	263	1,025	ft-#
φ Mn	=	2,739	2,739	ft-#
Actual 1-Way Shear	=	0.09	7.53	psi
Allow 1-Way Shear	=	43.82	43.82	psi
Toe Reinforcing	=	None Spec'd		
Heel Reinforcing	=	None Spec'd		
Key Reinforcing	=	None Spec'd		
Footing Torsion, Tu		=	0.00 ft-lb	S
Footing Allow. Torsio	n, գ	Tn =	0.00 ft-lb	S

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

Other Acceptable Sizes & Spacings

Toe: phiMn = phi*5*lambda*sqrt(fc)*Sm

Heel: phiMn = phi*5*lambda*sqrt(fc)*Sm

Key: No key defined

Min footing T&S reinf Area	0.65	in2
Min footing T&S reinf Area per foot	0.26	in2 <i>I</i> ft
If one layer of horizontal bars:	If two lay	ers of horizontal bars:
#4@ 9.26 in	#4@ 1	8.52 in
#5@ 14.35 in	#5@ 2	8.70 in
#6@ 20.37 in	#6@4	0.74 in

Project File: Retaining Walls - Updated.ec6

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LIC# : KW-06016450, Build:20.24.05.02

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

(c) ENERCALC INC 1983-2023

DESCRIPTION: 5' Retained

Summary of Overturning & Resisting Forces & Moments

		ERTURNING				SISTING	
Item	Force lbs	Distance ft	Moment ft-#		Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	630.0	2.00	1,260.0	Soil Over HL (ab. water tbl)	798.0	1.84	1,464.3
HL Act Pres (be water tbl)			,	Soil Over HL (bel. water tbl) Water Table		1.84	1,464.3
Hydrostatic Force							
Buoyant Force = Surcharge over Heel =				Sloped Soil Over Heel = Surcharge Over Heel =			
Surcharge Over Toe =				Adjacent Footing Load =			
Adjacent Footing Load =				Axial Dead Load on Stem =			
Added Lateral Load =				* Axial Live Load on Stem =			
_oad @ Stem Above Soil =				Soil Over Toe =	40.2	0.34	13.5
				Surcharge Over Toe =			
_				Stem Weight(s) =	375.0	0.92	345.0
				Earth @ Stem Transitions =			
Total =	630.0	O.T.M. =	1,260.0	Footing Weight =	375.0	1.25	468.8
				Key Weight =			
Resisting/Overturning Rat	io	=	2.42	Vert. Component =	303.4	2.50	758.4
Vertical Loads used for So	il Pressure	= 1,891.6	6 lbs	Total =	1.891.6	bs R.M.=	3,050.0

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

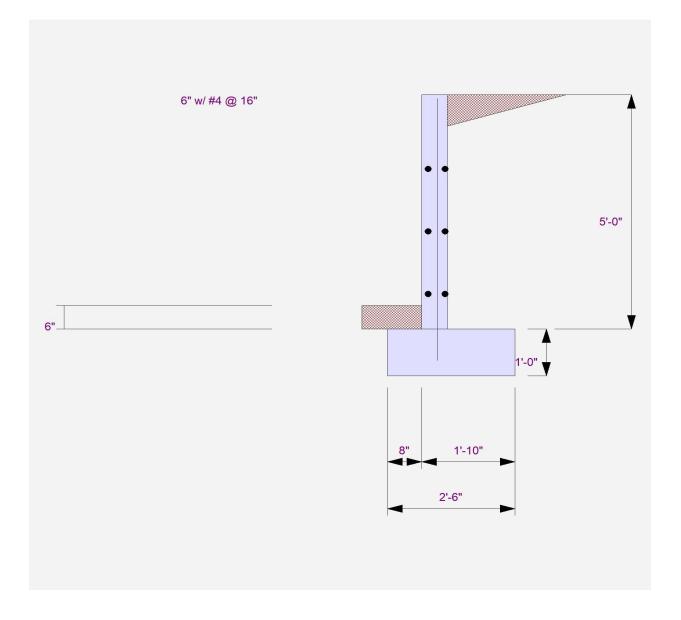
Horizontal Deflection at Top of Wall due to settlement of soil

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus250.0pciHorizontal Defl @ Top of Wall (approximate only)0.073in

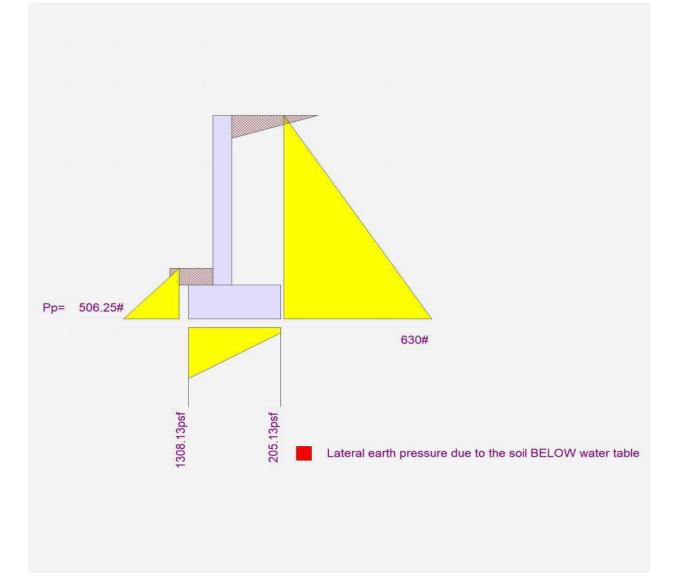
The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe.

Cantilevered Retaining Wall	Project File: Retaining Walls - Updated.ec6	
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023
DESCRIPTION: 5' Retained		
Rebar Lap & Embedment Lengths	Information	
Stem Design Segment: Bottom		
Stem Design Height: 0.00 ft above top of	footing	
Lap Splice length for #4 bar specified in this	stem design segment (25.4.2.4a) =	17.09 in
Development length for #4 bar specified in th	is stem design segment =	13.15 in
Hooked embedment length into footing for #4	bar specified in this stem design segment =	5.63 in
As Provided =		0.1500 in2/ft
As Required =		0.1296 in2/ft



Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023

DESCRIPTION: 5' Retained



LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 4' Retained - EQ QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

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Code Reference

Calculations per IBC 2021 1807.3, ASCE 7-16

Criteria

Retained Height	=	4.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water table above		
bottom of footing	=	0.0 ft

Surcharge Loads

Surcharge Over Heel Used To Resist Sliding Surcharge Over Toe Used for Sliding & Ove Axial Load Applied	= rturning	0.0
Axial Dead Load Axial Live Load Axial Load Eccentricity	= = =	0.0 lbs 0.0 lbs 0.0 in

Earth Pressure Seismic Load

Method : Uniform Multiplier Used = 8.000 (Multiplier used on soil density)

Allow Soil Bearing Equivalent Fluid Pressure	= Meth	3,333.0 Iod	psf
Active Heel Pressure	=		psf/ft
	=		
Passive Pressure	=	450.0	psf/ft
Soil Density, Heel	=	120.00	pcf
Soil Density, Toe	=	120.00	pcf
Footing Soil Friction	=	0.530	
Soil height to ignore for passive pressure	=	0.00	in

Soil Data

Lateral Load Applied to Stem

Lateral Load Height to Top Height to Bottom	= = =	0.0 #/ft 0.00 ft 0.00 ft
Load Type	=	Seismic (E) (Strength Level)
Wind on Exposed Ster (Strength Level)	m _	0.0 psf

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
r ooung rype		Spread I boung
Base Above/Below Soil at Back of Wall	=	0.0 ft

Uniform Seismic Force = 40.000 Total Seismic Force = 200.000

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Cantilevered Retaining Wall

LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 4' Retained - EQ

Design Summary

Wall Stability Ratios Overturning Sliding Global Stability	= = =	1.59 OK 2.17 OK 2.69	
Total Bearing Load resultant ecc. Eccentricity outsid Soil Pressure @ Toe Soil Pressure @ Heel Allowable	= = =	2,102 psf 0 psf 3,333 psf	
Soil Pressure Less ACI Factored @ Toe ACI Factored @ Heel Footing Shear @ Toe Footing Shear @ Heel Allowable	I han A = = = = =	10wable 2,504 psf 0 psf 0.9 psi 8.2 psi 82.2 psi	
Sliding Calcs Lateral Sliding Force less 100% Passive Force less 100% Friction Force Added Force Req'd for 1.5 Stability		577.5 lbs 506.3 lbs 748.4 lbs 0.0 lbs 0.0 lbs	-

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

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

				(-)
Stem Construction		Bottom		
Design Height Above Ftg		Stem OK 0.00		
Wall Material Above "Ht"	ft =	Concrete		
	=	SD	SD	SD
Design Method Thickness	=	8.00	5D	50
Rebar Size	=	8.00 # 4		
Rebar Spacing	_	# 4 12.00		
Rebar Placed at	_	Edge		
Design Data		Luge		
fb/FB + fa/Fa	=	0.168		
Total Force @ Section				
Service Level	lbs =			
Strength Level	lbs =	608.0		
MomentActual				
Service Level	ft-# =			
Strength Level	ft-# =	917.3		
MomentAllowable	=	5,448.0		
ShearActual				
Service Level	psi =			
Strength Level	, psi =	8.1		
ShearAllowable	psi =	45.6		
Anet (Masonry)	in2 =			
Wall Weight	psf =	100.0		
Rebar Depth 'd'	in =	6.25		
		0.20		
Masonry Data				
f'm	psi =			
es. Fs	psi =			
Solid Grouting	=			
Modular Ratio 'n'	=			
Equiv. Solid Thick.	=			
Masonry Block Type	=			
Masonry Design Method	=	ASD		
Concrete Data				
f'c	psi =	3,000.0		
Fy	psi =	60,000.0		

Project File: Retaining Walls - Updated.ec6

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psf

. ft-#

ft-#

ft-#

Cantilevered Retaining Wall

LIC# : KW-06016450, Build:20.24.05.02 **DESCRIPTION:** 4' Retained - EQ

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinford	bing
As (based on applied moment) :	0.0344 in2/ft		
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinford	cing Options :
		One layer of :	Two layers of :
Required Area :	0.1728 in2/ft	#4@ 13.89 in	#4@ 27.78 in
Provided Area :	0.2 in2/ft	#5@ 21.53 in	#5@ 43.06 in
Maximum Area :	1.016 in2/ft	#6@ 30.56 in	#6@ 61.11 in
Footing Data	Footing Des	ign Results	

Footing Data

Toe Width	=	0.33 ft
Heel Width	=	1.67
Total Footing Width	= -	2.00
Footing Thickness	=	12.00 in

f'c = 3,00	0 psi	Fy =	60,0	000 psi
Footing Concret	e Density	y =	150	.00 pcf
Min. As %	2.00	=	0.00)18
Cover @ Top		@ E	3tm.=	3.00 in

		<u>Toe</u>	<u>Heel</u>
Factored Pressure	=	2,504	0
Mu' : Upward	=	125	13
Mu': Downward	=	14	719
Mu: Design	=	111	706

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φ Mn	=	2,739	2,739	ft-#
Actual 1-Way Shear	=	0.87	8.20	psi
Allow 1-Way Shear	=	43.82	43.82	psi
Toe Reinforcing	=	None Spec'd		
Heel Reinforcing		None Spec'd		
Key Reinforcing	=	None Spec'd		
Footing Torsion, Tu		=	0.00 ft-lb	s
Footing Allow. Torsion	η, φ	Tn =	0.00 ft-lb	s

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

Other Acceptable Sizes & Spacings

Toe: phiMn = phi*5*lambda*sqrt(fc)*Sm

Heel: phiMn = phi*5*lambda*sqrt(fc)*Sm

Key: No key defined

0.52 in2 0.26 in2 /ft
If two layers of horizontal bars:
#4@ 18.52 in
#5@ 28.70 in
#6@ 40.74 in

Project File: Retaining Walls - Updated.ec6

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LIC# : KW-06016450, Build:20.24.05.02

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

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DESCRIPTION: 4' Retained - EQ

Summary of Overturning & Resisting Forces & Moments

		OV	ERTURNING			RE	ESISTING	
Item		Force Ibs	Distance ft	Moment ft-#		Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tb	I)	437.5	1.67	729.2	Soil Over HL (ab. water tbl)	481.6	1.50	721.6
HL Act Pres (be water tb Hydrostatic Force	,				Soil Over HL (bel. water tbl) Water Table)	1.50	721.6
Buoyant Force	=				Sloped Soil Over Heel =			
Surcharge over Heel	=				Surcharge Over Heel =			
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 Soi	=				Soil Over Toe =	19.8	0.17	3.3
Seismic Earth Load	=	140.0	2.50	350.0	Surcharge Over Toe =			
	=				Stem Weight(s) =	400.0	0.66	265.3
					Earth @ Stem Transitions =			
Total	=	577.5	O.T.M. =	1,079.2	Footing Weight =	300.0	1.00	300.0
					Key Weight =			
Resisting/Overturning	•		=	1.59	Vert. Component =	210.7	2.00	421.4
Vertical Loads used for	or So	il Pressure	= 1,412.	1 lbs	Total =	1,412.1	bs R.M.=	1,711.6
If seismic is included, th	e OT	M and slidir	ig ratios		* Axial live load NOT included resistance, but is included for			r overturning

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

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

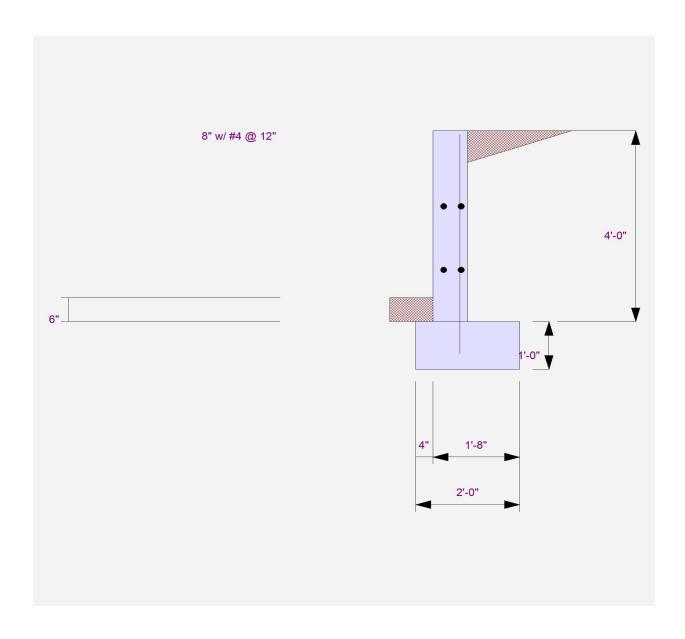
(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus	250.0	pci
Horizontal Defl @ Top of Wall (approximate only)	0.117	in

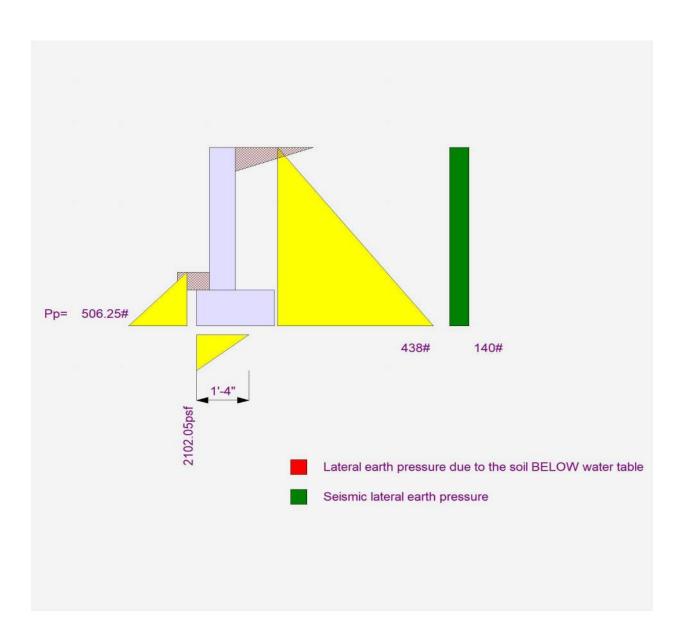
The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe,

Cantilevered Retaining Wall	Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02 QUANTUM CONSULTIN	IG ENGINEERS (c) ENERCALC INC 1983-2023
DESCRIPTION: 4' Retained - EQ	
Rebar Lap & Embedment Lengths Information	
Stem Design Segment: Bottom	
Stem Design Height: 0.00 ft above top of footing	
Lap Splice length for #4 bar specified in this stem design segment (25.4.2.4a)	= 17.09 in
Development length for #4 bar specified in this stem design segment =	13.15 in
Hooked embedment length into footing for #4 bar specified in this stem design	n segment = 5.63 in
As Provided =	0.2000 in2/ft
As Required =	0.1728 in2/ft

Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023
DESCRIPTION: 4' Retained - EQ		







LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 4' Retained QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

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Code Reference

Calculations per IBC 2021 1807.3, ASCE 7-16

Criteria

Retained Height	=	4.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water table above		
bottom of footing	=	0.0 ft

Surcharge Loads

Surcharge Over Hee Used To Resist Slic Surcharge Over Toe Used for Sliding & C	ling & Ov =	0.0	
Axial Load Applied to Stem			
Axial Dead Load Axial Live Load	=	0.0 lbs 0.0 lbs	

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

Soil Data		
Allow Soil Bearing		2,500.0 psf
Equivalent Fluid Pressure	e Meth	
Active neer Plessure	=	35.0 psf/ft

	=	
Passive Pressure	=	450.0 psf/ft
Soil Density, Heel	=	120.00 pcf
Soil Density, Toe	=	120.00 pcf
Footing Soil Friction	=	0.530
Soil height to ignore for passive pressure	=	0.00 in

Lateral Load Applied to Stem

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

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 LIC# : KW-06016450, Build:20.24.05.02

DESCRIPTION: 4' Retained

Design Summary

Wall Stability Ratios Overturning Sliding Global Stability	= = =	2.35 2.87 2.69	
Total Bearing Load resultant ecc. Eccentricity within Soil Pressure @ Toe Soil Pressure @ Heel Allowable Soil Pressure Less	= = =	1,346 65 2,500 Allowable	in psf OK psf OK psf e
ACI Factored @ Toe ACI Factored @ Heel Footing Shear @ Toe Footing Shear @ Heel Allowable	= = = =	0.9	psf psi OK psi OK
Sliding Calcs Lateral Sliding Force less 100% Passive Force less 100% Friction Force Added Force Req'd for 1.5 Stability		0.0	lbs

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

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

QUANTUM CONSULTING EN	GINEEF	RS		(c) ENERCALC INC 1983-2023
Stem Construction		Bottom		
Design Height Above Ftg	ft =	Stem OK 0.00		
Wall Material Above "Ht"	=	Concrete		
Design Method	=	SD	SD	SD
Thickness	=	8.00		
Rebar Size	=	# 4		
Rebar Spacing	=	12.00		
Rebar Placed at	=	Edge		
Design Data		0.109		
fb/FB + fa/Fa Total Force @ Section	=	0.109		
	llea			
Service Level	lbs =	440.0		
Strength Level MomentActual	lbs =	448.0		
Service Level	ft-# =			
	ft-# =	597.3		
Strength Level				
MomentAllowable	=	5,448.0		
ShearActual				
Service Level	psi =			
Strength Level	psi =	6.0		
ShearAllowable	psi =	45.6		
Anet (Masonry)	in2 =			
Wall Weight	psf =	100.0		
Rebar Depth 'd'	in =	6.25		
Masonry Data				
f'm	psi =			
es. Fs	psi =			
Solid Grouting	=			
Modular Ratio 'n'	=			
Equiv. Solid Thick.	=			
Masonry Block Type	=			
Masonry Design Method	=	ASD		
Concrete Data				
f'c	psi =	3,000.0		
Fy	psi =	60,000.0		

Project File: Retaining Walls - Updated.ec6

LIC# : KW-06016450, Build:20.24.05.02

DESCRIPTION: 4' Retained

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinfor	cing	
As (based on applied moment) :	0.0224 in2/ft			
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinfor	cing Options :	
		One layer of :	Two layers of :	
Required Area :	0.1728 in2/ft	#4@ 13.89 in	#4@ 27.78 in	
Provided Area :	0.2 in2/ft	#5@ 21.53 in	#5@ 43.06 in	
Maximum Area :	1.016 in2/ft	#6@ 30.56 in	#6@ 61.11 in	
Footing Data	Footing Design Results			

Footing Data

Toe Width	=	0.33 ft
Heel Width	=	1.67
Total Footing Width	=	2.00
Footing Thickness	=	12.00 in

f'c = 3,00 Footing Concret	0 psi e Density	Fy =	60,0 150	000 psi .00 pcf
Min. As % Cover @ Top	2.00	=	0.00)18 3.00 in
Cover @ rop	2.00	<i>w</i> b	sum.=	3.00 m

Toe

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		<u>Toe</u>	Heel	
Factored Pressure	=	1,603	77	psf
Mu' : Upward	=	84	167	ft-#
Mu' : Downward	=	14	719	ft-#
Mu: Design	=	70	552	ft-#
φ Mn	=	2,739	2,739	ft-#
Actual 1-Way Shear	=	0.86	5.29	psi
Allow 1-Way Shear	=	43.82	43.82	psi
Toe Reinforcing	=	None Spec'd		
Heel Reinforcing	=	None Spec'd		
Key Reinforcing	=	None Spec'd		
Footing Torsion, Tu		=	0.00 ft-lb	s
Footing Allow. Torsion	n, q	Tn =	0.00 ft-lb	S

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

Other Acceptable Sizes & Spacings

Toe: phiMn = phi*5*lambda*sqrt(fc)*Sm

Heel: phiMn = phi*5*lambda*sqrt(fc)*Sm

Key: No key defined

Min footing T&S reinf Area	0.52	in2
Min footing T&S reinf Area per foot	0.26	in2 /ft
If one layer of horizontal bars:	If two lay	ers of horizontal bars:
#4@ 9.26 in	#4@1	8.52 in
#5@ 14.35 in	#5@ 2	8.70 in
#6@ 20.37 in	#6@4	0.74 in

Project File: Retaining Walls - Updated.ec6

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LIC# : KW-06016450, Build:20.24.05.02

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Project File: Retaining Walls - Updated.ec6

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DESCRIPTION: 4' Retained

Summary of Overturning & Resisting Forces & Moments

		ERTURNING				SISTING	
Item	Force lbs	Distance ft	ft-#		Force Ibs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	437.5	1.67	729.2	Soil Over HL (ab. water tbl)	481.6	1.50	723.0
HL Act Pres (be water tbl) Hydrostatic Force				Soil Over HL (bel. water tbl) Water Table		1.50	723.0
Buoyant Force =				Sloped Soil Over Heel =			
Surcharge over Heel =				Surcharge Over Heel =			
Surcharge Over Toe =				Adjacent Footing Load =			
Adjacent Footing Load =				Axial Dead Load on Stem =			
Added Lateral Load =				* Axial Live Load on Stem =			
_oad @ Stem Above Soil =				Soil Over Toe =	20.0	0.17	3.3
=				Surcharge Over Toe =			
-				Stem Weight(s) =	400.0	0.67	266.5
				Earth @ Stem Transitions =			
Total =	437.5	O.T.M. =	729.2	Footing Weight =	300.5	1.00	300.9
				Key Weight =			
Resisting/Overturning Rat	io	=	2.35	Vert. Component =	210.7	2.00	422.0
Vertical Loads used for So	il Pressure	= 1,412.7	7 lbs	Total =	1,412.7	bs R.M.=	1,715.8

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

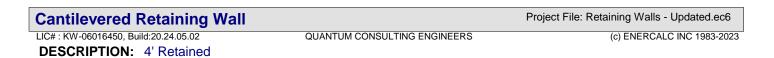
Horizontal Deflection at Top of Wall due to settlement of soil

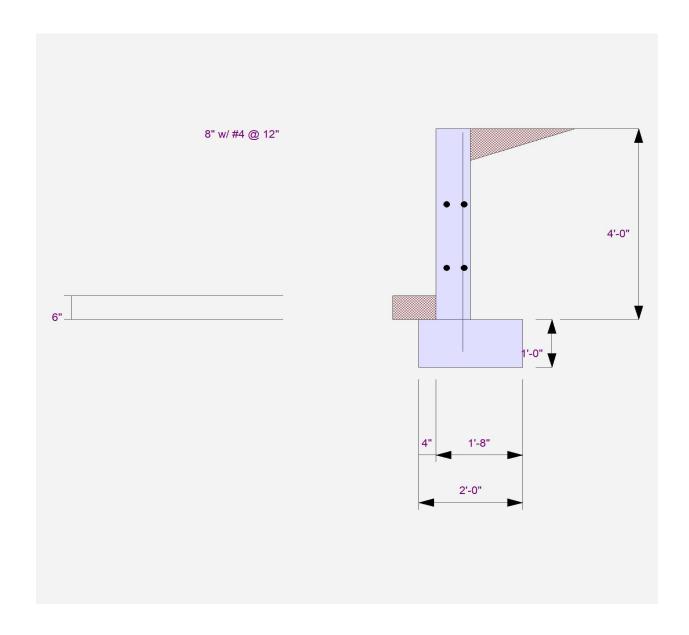
(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus250.0pciHorizontal Defl @ Top of Wall (approximate only)0.075in

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

Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-202
DESCRIPTION: 4' Retained		
Rebar Lap & Embedment Lengths Inf	ormation	
Stem Design Segment: Bottom		
Stem Design Height: 0.00 ft above top of foc	ting	
Lap Splice length for #4 bar specified in this ster	n design segment (25.4.2.4a) =	17.09 in
Development length for #4 bar specified in this s	tem design segment =	13.15 in
Hooked embedment length into footing for #4 ba	r specified in this stem design segment =	5.63 in
As Provided =		0.2000 in2/ft
As Required =		0.1728 in2/ft

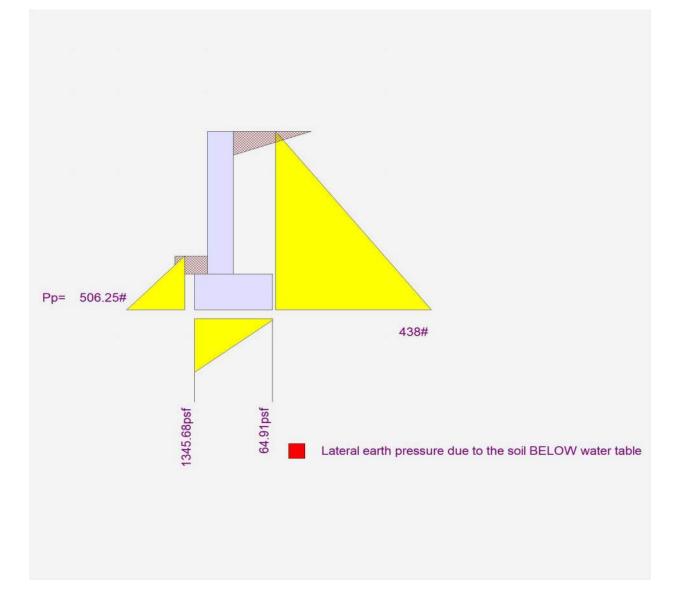




DESCRIPTION: 4' Retained

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LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 11' Retained -EQ (P_Line)

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

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Code Reference

Calculations per IBC 2021 1807.3, ASCE 7-16

Criteria

Retained Height	=	11.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water table above		
bottom of footing	=	0.0 ft

Surcharge Loads

Surcharge Over Heel Used To Resist Sliding Surcharge Over Toe Used for Sliding & Over	=	0.0 psf			
Axial Load Applied to Stem					
Axial Dead Load Axial Live Load Axial Load Eccentricity	=	0.0 lbs 0.0 lbs 0.0 in			

Earth Pressure Seismic Load

Method : Uniform Multiplier Used = 8.000 (Multiplier used on soil density)

Allow Soil Bearing Equivalent Fluid Pressure	= Moth	3,333.0 psf
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	450.0 psf/ft
Soil Density, Heel	=	120.00 pcf
Soil Density, Toe	=	120.00 pcf
Footing Soil Friction	=	0.530
Soil height to ignore for passive pressure	=	0.00 in

Soil Data

Lateral Load Applied to Stem

Lateral Load Height to Top Height to Bottom	= = =	0.0 #/ft 0.00 ft 0.00 ft
Load Type	=	Seismic (E) (Strength Level)
Wind on Exposed Ster (Strength Level)	n _	0.0 psf

Period Residence in the second s

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
Easting Trues		Concert Festing
Footing Type		Spread Footing
Base Above/Below Soil at Back of Wall	=	0.0 ft

Uniform Seismic Force = 97.333 Total Seismic Force = 1,184.222

Cantilevered Retaining Wall LIC# : KW-06016450, Build:20.24.05.02

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6 (c) ENERCALC INC 1983-2023

DESCRIPTION: 11' Retained -EQ (P_Line)

Design Summary			Stem Construction		2nd	Bottom			
			Design Height Above F	g ft=	Stem OK 3.00	Stem OK 0.00			
Wall Stability Ratios			Wall Material Above "H	-	Concrete	Concrete			
Overturning	=	1.30 Ratio < 1	.5! Design Method	=	SD	SD	SD	SD	
Slab Resis	ts All	Sliding !	Thickness	=	8.00	8.00			
Global Stability	=	1.06	Rebar Size	=	# 4	# 6			
,			Rebar Spacing	=	6.00	6.00			
Total Bearing Load	=	4,573 lbs	Rebar Placed at	=	Edge	Edge			
resultant ecc.	=	21.57 in	Design Data						
Eccentricity outsi			fb/FB + fa/Fa	=	0.748	0.971			
Soil Pressure @ Toe	=	2,953 psf OK	Total Force @ Section						
Soil Pressure @ Heel	=	0 psf OK	Service Level	lbs =					
Allowable	=	3,333 psf	Strength Level	lbs =	2,570.7	4,458.7			
Soil Pressure Less ACI Factored @ Toe			MomentActual						
ACI Factored @ Heel	=	3,006 psf 0 psf	Service Level	ft-# =					
		•	Strength Level	ft-# =	7,893.3	18,311.3			
Footing Shear @ Toe	=	28.6 psi OK	MomentAllowable	ft-# =	10,542.0	18,848.3			
Footing Shear @ Heel	=	22.1 psi OK	ShearActual						
Allowable	=	82.2 psi	Service Level	psi =					
Sliding Calcs			Strength Level	psi =	34.3	66.1			
Lateral Sliding Force		3,419.4 lbs	ShearAllowable	psi =	57.4	77.3			
Eateral Glaing Force	=	3,419.4 105	Anet (Masonry)	in2 =	01.1	11.0			
			Wall Weight	psf =	100.0	100.0			
			0			5.63			
			Rebar Depth 'd'	in =	6.25	5.63			
			Masonry Data						
ertical component of activ	e later	ral soil pressure IS	f'm	psi =					
onsidered in the calculatio			s. Fs	psi =					
		01	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 Metho	= b	ASD				
Earth, H		1.600	Concrete Data						
Wind, W		1.000	f'c	psi =	3,000.0	3,000.0			
Seismic, E		1.000	Fy	psi =	60,000.0	60,000.0			

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6 (c) ENERCALC INC 1983-2023

LIC# : KW-06016450, Build:20.24.05.02 **DESCRIPTION:** 11' Retained -EQ (P_Line)

Concrete Stem Rebar Area Details

2nd Stem As (based on applied moment) :	Vertical Reinforcing 0.2957 in2/ft	Horizontal Reinforcing		
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinf	orcing Options :	
		One layer of :	Two layers of :	
Required Area :	0.2957 in2/ft	#4@ 13.89 in	#4@ 27.78 in	
Provided Area :	0.4 in2/ft	#5@ 21.53 in	#5@ 43.06 in	
Maximum Area :	1.016 in2/ft	#6@ 30.56 in	#6@ 61.11 in	
Bottom Stem	Vertical Reinforcing	Horizontal Reinf	orcing	
As (based on applied moment) :	0.7669 in2/ft			
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinf	orcing Options :	
		One layer of :	Two layers of :	
Required Area :	0.7669 in2/ft	#4@ 13.89 in	#4@ 27.78 in	
Provided Area :	0.88 in2/ft	#5@ 21.53 in	#5@ 43.06 in	

Footing Data

Toe Width Heel Width Total Footing Width	= 4.33 ft = 1.33 = 5.66
Footing Thickness	= 14.00 in
Key Width Key Depth Key Distance from Toe	= 12.00 in = 8.00 in = 0.00 ft
f'c = 3,000 psi Footing Concrete Dens Min. As % Cover @ Top 2.00	= 0.0018

Footing Design Results

		Toe	<u>Heel</u>	Key	
Factored Pressure	=	3,006	0		psf
Mu' : Upward	=	15,353	0		ft-#
Mu' : Downward	=	2,644	1,719		ft-#
Mu: Design	=	12,710	1,719	777	ft-#
φ Mn	=	18,644	3,944	2,739	ft-#
Actual 1-Way Shear	=	28.56	22.12	13.71	psi
Allow 1-Way Shear	=	47.92	43.82	43.82	psi
Toe Reinforcing	=	# 4 @ 6.00 in			
Heel Reinforcing	=	None Spec'd			
Key Reinforcing	=	None Spec'd			
Footing Torsion, Tu		=	0.00 ft-lbs		
Footing Allow. Torsion	n, φ	Tn =	0.00 ft-lbs		

If torsion exceeds allowable, provide

supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: #4@ 6.48 in, #5@ 10.05 in, #6@ 14.27 in, #7@ 19.46 in, #8@ 25.62 in, #9@ 32.44 in, #10@ 41.20 in

Heel: phiMn = phi*5*lambda*sqrt(fc)*Sm

Key: Slab Resists Sliding - No Force on Key

Min footing T&S reinf Area	1.71	in2
Min footing T&S reinf Area per foot	0.30	in2 /ft
If one layer of horizontal bars:	<u>lf two lay</u>	ers of horizontal bars:
#4@ 7.94 in	#4@1	5.87 in
#5@ 12.30 in	#5@ 2	4.60 in
#6@ 17.46 in	#6@ 3	4.92 in

LIC# : KW-06016450, Build:20.24.05.02

Project File: Retaining Walls - Updated.ec6

DESCRIPTION: 11' Retained -EQ (P_Line)

QUANTUM CONSULTING ENGINEERS

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Summary of Overturning & Resisting Forces & Moments

		OV	ERTURNING			RE	SISTING	
Item		Force lbs	Distance ft	ft-#		Force Ibs	Distance ft	Moment ft-#
HL Act Pres (ab water th	ol)	2,590.5	4.06	10,505.9	Soil Over HL (ab. water tbl)	875.6	5.33	4,665.5
HL Act Pres (be water the Hydrostatic Force	,	,		-,	Soil Over HL (bel. water tbl) Water Table		5.33	4,665.5
Buoyant Force	=				Sloped Soil Over Heel =			
Surcharge over Heel	=				Surcharge Over Heel =			
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 So	oil =				Soil Over Toe =	259.8	2.17	562.5
Seismic Earth Load	=	829.0	6.08	5,042.8	Surcharge Over Toe =			
	=				Stem Weight(s) =	1,100.0	4.66	5,129.7
				15 5 40 7	Earth @ Stem Transitions =			
Total	=	3,419.4	O.T.M. =	15,548.7	Footing Weight =	990.5	2.83	2,803.1
					Key Weight =	100.0	0.50	50.0
Resisting/Overturning Ratio = 1.30			Vert. Component =	1,247.4	5.66	7,060.5		
Vertical Loads used	for So	il Pressure	= 4,573.3	B lbs	Total =	4,573.3	bs R.M.=	20,271.3
If seismic is included, th	ne OT	M and slidin	g ratios		* Axial live load NOT included resistance, but is included fo			r overturning

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

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)

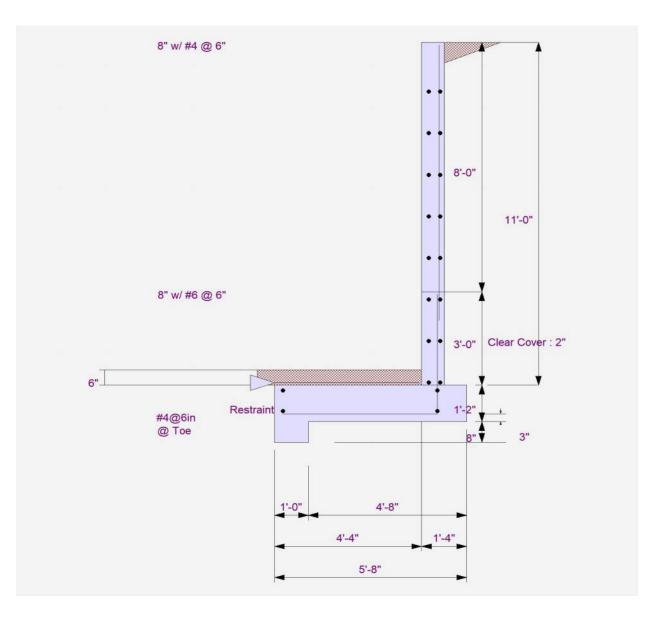
Soil Spring Reaction Modulus 250.0 pci Horizontal Defl @ Top of Wall (approximate only) 0.159 in

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

Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 11' Retained -EQ (P_Line)	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023
Rebar Lap & Embedment Lengths Informati	on	
Stem Design Segment: 2nd		
Stem Design Height: 3.00 ft above top of footing		
Lap Splice length for #4 bar specified in this stem design	segment (25.4.2.4a) =	17.09 in
Development length for #4 bar specified in this stem desi	13.15 in	
Stem Design Segment: Bottom		
Stem Design Height: 0.00 ft above top of footing		
Lap Splice length for #6 bar specified in this stem design	segment (25.4.2.4a) =	25.63 in
Development length for #6 bar specified in this stem desi	gn segment =	19.72 in
Hooked embedment length into footing for #6 bar specifie	ed in this stem design segment =	10.35 in
As Provided =		0.8800 in2/ft
As Required =	0.7669 in2/ft	

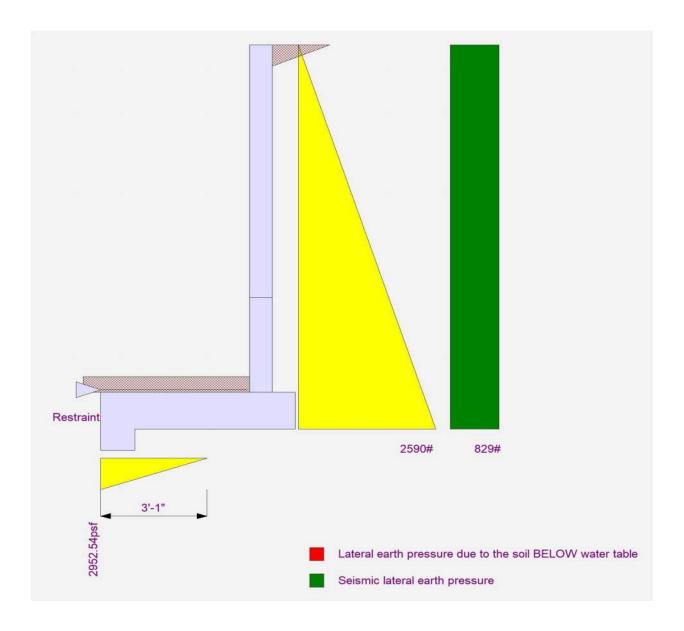
Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023

DESCRIPTION: 11' Retained -EQ (P_Line)





DESCRIPTION: 11' Retained -EQ (P_Line)



LIC# : KW-06016450, Build:20.24.05.02 **DESCRIPTION:** 11' Retained -EQ QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

(c) ENERCALC INC 1983-2023

Code Reference

Calculations per IBC 2021 1807.3, ASCE 7-16

Criteria

Retained Height	=	11.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water table above		
bottom of footing	=	0.0 ft

Surcharge Loads

Surcharge Over Heel = 0.0 psf Used To Resist Sliding & Overturning Surcharge Over Toe = 0.0 psf Used for Sliding & Overturning				
Axial Load Applied to Stem				
Axial Dead Load Axial Live Load	=	0.0 lbs 0.0 lbs		

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

Soil Data Allow Soil Bearing = 2,5 Equivalent Fluid Pressure Method = 2,500.0 psf Active Heel Pressure 35.0 psf/ft = = Passive Pressure = 450.0 psf/ft Soil Density, Heel 120.00 pcf

Soil Density, Toe 120.00 pcf = Footing||Soil Friction 0.530 = Soil height to ignore for passive pressure = 0.00 in

=

Lateral Load Applied to Stem

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

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	_	0.0 ft
at Back of Wall	-	0.010

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QUANTUM CONSULTING ENGINEERS

Cantilevered Retaining Wall

LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 11' Retained -EQ

Design Summary

Wall Stability Ratios Overturning Slab Resis	= sts All	1.93 OK Sliding !
Global Stability	=	1.06
Total Bearing Load resultant ecc. Eccentricity with	= = nin mic	
Soil Pressure @ Toe Soil Pressure @ Heel	= =	1,403 psf OK 213 psf OK
Allowable Soil Pressure Les ACI Factored @ Toe ACI Factored @ Heel	s Thar = =	2,500 psf Allowable 1,429 psf 217 psf
Footing Shear @ Toe Footing Shear @ Heel Allowable	= = =	20.6 psi OK 20.8 psi OK 82.2 psi
Sliding Calcs Lateral Sliding Force	=	2,590.5 lbs

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	1.000
Seismic, E	1.000

Stem Construction		2nd	Bottom		
Design Height Above Ftg	ft =	Stem OK 3.00	Stem OK 0.00		
Wall Material Above "Ht"		Concrete	Concrete		
Design Method	_	SD	SD	SD	SD
Thickness	_	8.00	8.00	50	50
Rebar Size	_	# 4	# 6		
Rebar Spacing	=	6.00	6.00		
Rebar Placed at	=	Edge	Edge		
Design Data		Eago	Lago		
fb/FB + fa/Fa	=	0.453	0.659		
Total Force @ Section					
Service Level	lbs =				
Strength Level	lbs =	1,792.0	3,388.0		
MomentActual		,			
Service Level	ft-# =				
Strength Level	ft-# =	4,778.7	12,422.7		
MomentAllowable	ft-# =	10,542.0	18,848.3		
ShearActual					
Service Level	psi =				
Strength Level	psi =	23.9	50.2		
ShearAllowable	psi =	57.4	77.3		
Anet (Masonry)	in2 =				
Wall Weight	psf =	100.0	100.0		
Rebar Depth 'd'	in =	6.25	5.63		
Masonry Data					
f'm -	psi =				
es. Fs	psi =				
Solid Grouting	=				
Modular Ratio 'n'	=				
Equiv. Solid Thick.	=				
Masonry Block Type	=				
Masonry Design Method	=	ASD			
Concrete Data		2 000 0	2 000 0		

psi =

f'c Fy 3,000.0

psi = 60,000.0

3,000.0

60,000.0

Project File: Retaining Walls - Updated.ec6

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LIC# : KW-06016450, Build:20.24.05.02

QUANTUM CONSULTING ENGINEERS

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Project File: Retaining Walls - Updated.ec6

DESCRIPTION: 11' Retained -EQ

Concrete Stem Rebar Area Details

Footing Date		Design Desults
Maximum Area :	0.9144 in2/ft	#6@ 30.56 in #6@ 61.11 in
Provided Area :	0.88 in2/ft	#5@ 21.53 in #5@ 43.06 in
Required Area :	0.5203 in2/ft	#4@ 13.89 in #4@ 27.78 in
		One layer of : Two layers of :
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :
As (based on applied moment) :	0.5203 in2/ft	
Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing
Maximum Area :	1.016 in2/ft	#6@ 30.56 in #6@ 61.11 in
Provided Area :	0.4 in2/ft	#5@ 21.53 in #5@ 43.06 in
Required Area :	0.179 in2/ft	#4@ 13.89 in #4@ 27.78 in
		One layer of : Two layers of :
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :
As (based on applied moment) :	0.179 in2/ft	- · · ·
2nd Stem	Vertical Reinforcing	Horizontal Reinforcing

Footing Data

Toe Width	=	4.33 ft
Heel Width	=	1.33
Total Footing Width	=	5.66
Footing Thickness	=	14.00 in
Key Width	=	12.00 in
Key Depth	=	8.00 in
Key Distance from Toe	=	0.00 ft
f'c = 3,000 psi Footing Concrete Densi Min. As % Cover @ Top 2.00	=	60,000 psi 150.00 pcf 0.0018 3tm.= 3.00 in

Footing Design Results

		Toe	<u>Heel</u>	<u>Key</u>	
Factored Pressure	=	1,429	217		psf
Mu' : Upward	=	10,495	58		ft-#
Mu' : Downward	=	2,644	1,719		ft-#
Mu: Design	=	7,851	1,661	777	ft-#
φ Mn	=	18,644	3,944	2,739	ft-#
Actual 1-Way Shear	=	20.64	20.80	13.71	psi
Allow 1-Way Shear	=	47.92	43.82	43.82	psi
Toe Reinforcing	=	# 4 @ 6.00 in			
Heel Reinforcing	=	None Spec'd			
Key Reinforcing	=	None Spec'd			
Footing Torsion, Tu		=	0.00 ft-lbs		
Footing Allow. Torsion	n, φ	Tn =	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: phiMn = phi*5*lambda*sqrt(fc)*Sm

Key: Slab Resists Sliding - No Force on Key

Min footing T&S reinf Area	1.71	in2
Min footing T&S reinf Area per foot	0.30	in2 /ft
If one layer of horizontal bars:	<u>lf two lay</u>	ers of horizontal bars:
#4@ 7.94 in	#4@1	5.87 in
#5@ 12.30 in	#5@ 2	4.60 in
#6@ 17.46 in	#6@ 3	4.92 in

LIC# : KW-06016450, Build:20.24.05.02

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

(c) ENERCALC INC 1983-2023

DESCRIPTION: 11' Retained -EQ

Summary of Overturning & Resisting Forces & Moments

	OV	ERTURNING			RE	SISTING	
Item	Force lbs	Distance ft	Moment ft-#		Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	2,590.5	4.06	10,505.9	Soil Over HL (ab. water tbl)	875.6	5.33	4,665.5
HL Act Pres (be water tbl) Hydrostatic Force				Soil Over HL (bel. water tbl) Water Table		5.33	4,665.5
Buoyant Force =				Sloped Soil Over Heel =			
Surcharge over Heel =				Surcharge Over Heel =			
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 =	259.8	2.17	562.5
=				Surcharge Over Toe =			
-				Stem Weight(s) =	1,100.0	4.66	5,129.7
				Earth @ Stem Transitions =			
Total =	2,590.5	O.T.M. =	10,505.9	Footing Weight =	990.5	2.83	2,803.1
				Key Weight =	100.0	0.50	50.0
Resisting/Overturning Rat	tio	=	1.93	Vert. Component =	1,247.4	5.66	7,060.5
Vertical Loads used for So	il Pressure	= 4,573.3	3 lbs	Total =	4,573.3 I	bs R.M.=	20,271.3

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)

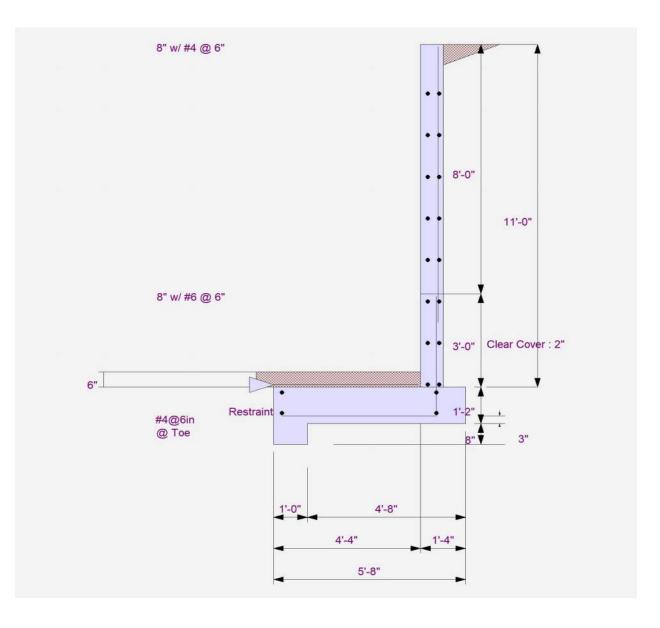
Soil Spring Reaction Modulus250.0pciHorizontal Defl @ Top of Wall (approximate only)0.076in

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

Cantilevered Retaining W	all	Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 11' Retained -	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-202
Rebar Lap & Embedment Leng	ths Information	
Stem Design Segment: 2nd		
Stem Design Height: 3.00 ft above t	op of footing	
Lap Splice length for #4 bar specified in	this stem design segment (25.4.2.4a) =	17.09 in
Development length for #4 bar specified	I in this stem design segment =	13.15 in
Stem Design Segment: Bottom		
Stem Design Height: 0.00 ft above t	op of footing	
Lap Splice length for #6 bar specified in	this stem design segment (25.4.2.4a) =	25.63 in
Development length for #6 bar specified		19.72 in
Hooked embedment length into footing	for #6 bar specified in this stem design segment =	10.35 in
As Provided =		0.8800 in2/ft
As Required =		0.5203 in2/ft

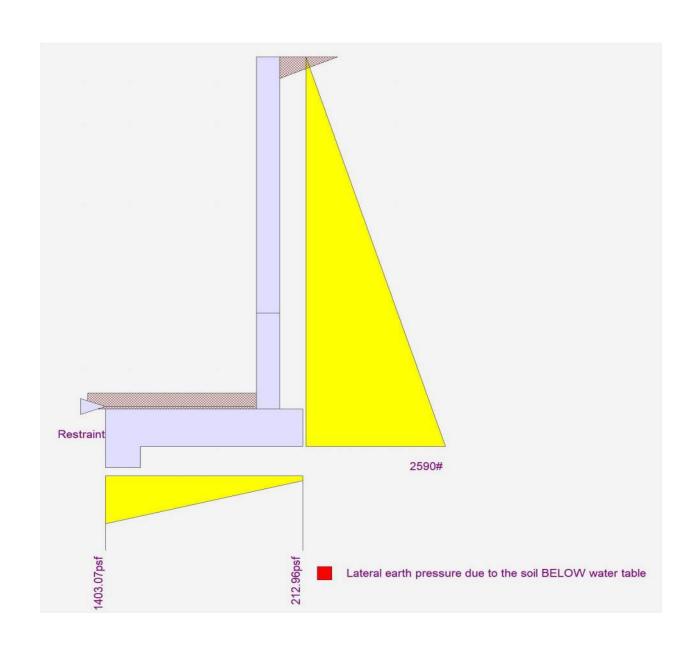
Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023

DESCRIPTION: 11' Retained -EQ



Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023

DESCRIPTION: 11' Retained -EQ



LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 10' Retained -EQ (P_Line)

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

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Code Reference

Calculations per IBC 2021 1807.3, ASCE 7-16

Criteria

Retained Height	=	10.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water table above		
bottom of footing	=	0.0 ft

Surcharge Loads

Surcharge Over Heel Used To Resist Sliding Surcharge Over Toe Used for Sliding & Ove	=	0.0 psf
Axial Load Applie	d to S	Stem
Axial Dead Load Axial Live Load Axial Load Eccentricity	=	0.0 lbs 0.0 lbs 0.0 in

Earth Pressure Seismic Load

Method : Uniform Multiplier Used = 8.000 (Multiplier used on soil density)

		psf
=	35.0	psf/ft
=		
=	450.0	psf/ft
=	120.00	pcf
=	120.00	pcf
=	0.530	
=	0.00	in
	Meth = = = =	= = 450.0 = 120.00 = 120.00

Soil Data

Lateral Load Applied to Stem

Lateral Load Height to Top Height to Bottom	= = =	0.0 #/ft 0.00 ft 0.00 ft
Load Type	=	Seismic (E) (Strength Level)
Wind on Exposed Stem (Strength Level)	^ר =	0.0 psf

Refired a

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

Uniform Seismic Force = 89.333 Total Seismic Force = 997.556

Cantilevered Retaining Wall LIC# : KW-06016450, Build:20.24.05.02

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6 (c) ENERCALC INC 1983-2023

DESCRIPTION: 10' Retained -EQ (P_Line)

Design Summary			Stem Construction		2nd	Bottom		
			Design Height Above Ftg	ft =	Stem OK 3.00	Stem OK 0.00		
Wall Stability Ratios			Wall Material Above "Ht"	=	Concrete	Concrete		
Overturning	=	1.35 Ratio < 1.		_	SD	SD	SD	SD
Slab Resis	ts All	Sliding !	Thickness	=	8.00	8.00	00	00
Global Stability	=	1.16	Rebar Size	=	# 4	# 6		
Clobal Clability	_		Rebar Spacing	=	6.00	6.00		
Total Bearing Load	=	4.080 lbs	Rebar Placed at	=	Edge	Edge		
resultant ecc.	_	18.53 in	Design Data		0	-		
Eccentricity outs	ide mi		fb/FB + fa/Fa	=	0.511	0.732		
Soil Pressure @ Toe	=	2,625 psf OK	Total Force @ Section					
Soil Pressure @ Heel	=	0 psf OK	Service Level	lbs =				
Allowable	=	3,333 psf	Strength Level	lbs =	1,997.3	3,693.3		
Soil Pressure Les			MomentActual					
ACI Factored @ Toe	=	2,728 psf	Service Level	ft-# =				
ACI Factored @ Heel	=	0 psf	Strength Level	ft-# =	5,390.0	13,800.0		
Footing Shear @ Toe	=	26.4 psi OK	MomentAllowable	ft-# =	10,542.0	18,848.3		
Footing Shear @ Heel	=	19.3 psi OK	ShearActual		-,	-,		
Allowable	=	82.2 psi	Service Level	psi =				
o			Strength Level	psi =	26.6	54.7		
Sliding Calcs		0.000 / 11	ShearAllowable		20.0 57.4	54.7 77.3		
Lateral Sliding Force	=	2,880.4 lbs		psi =	57.4	11.5		
			Anet (Masonry)	in2 =				
			Wall Weight	psf =	100.0	100.0		
			Rebar Depth 'd'	in =	6.25	5.63		
			Masonry Data					
ertical component of activ	e late	ral soil pressure IS	f'm	psi =				
onsidered in the calculation	on of se	oil bearing pressures		psi =				
			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		1.000	f'c	psi =	3,000.0	3,000.0		
Seismic, E		1.000	Fy	psi =	60,000.0	60,000.0		

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Cantilevered Retaining Wall LIC# : KW-06016450, Build:20.24.05.02

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6 (c) ENERCALC INC 1983-2023

DESCRIPTION: 10' Retained -EQ (P_Line)

Concrete Stem Rebar Area Details

2nd Stem As (based on applied moment) :	Vertical Reinforcing 0.2019 in2/ft	Horizontal Reinforcing
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :
		One layer of : Two layers of :
Required Area :	0.2019 in2/ft	#4@ 13.89 in #4@ 27.78 in
Provided Area :	0.4 in2/ft	#5@ 21.53 in #5@ 43.06 in
Maximum Area :	1.016 in2/ft	#6@ 30.56 in #6@ 61.11 in
Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.5779 in2/ft	
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :
		One layer of : Two layers of :
Required Area :	0.5779 in2/ft	#4@ 13.89 in #4@ 27.78 in
Provided Area :	0.88 in2/ft	#5@ 21.53 in #5@ 43.06 in
Maximum Area :	0.9144 in2/ft	#6@ 30.56 in #6@ 61.11 in

Footing Data

Toe Width	=	3.83 ft
Heel Width	= _	<u>1.33</u>
Total Footing Width	=	5.16
Footing Thickness	=	14.00 in
Key Width	=	12.00 in
Key Depth	=	8.00 in
Key Distance from Toe	=	0.00 ft
f'c = 3,000 psi Footing Concrete Densi Min. As % Cover @ Top 2.00	=	60,000 psi 150.00 pcf 0.0018 3tm.= 3.00 in

Footing Design Results

		<u>Toe</u>	<u>Heel</u>	<u>Key</u>	
Factored Pressure	=	2,728	0		psf
Mu' : Upward	=	11,846	0		ft-#
Mu' : Downward	=	2,068	1,478		ft-#
Mu: Design	=	9,778	1,478	767	ft-#
φ Mn	=	18,644	3,944	2,739	ft-#
Actual 1-Way Shear	=	26.39	19.28	13.59	psi
Allow 1-Way Shear	=	47.92	43.82	43.82	psi
Toe Reinforcing	=	# 4 @ 6.00 in			
Heel Reinforcing	=	None Spec'd			
Key Reinforcing	=	None Spec'd			
Footing Torsion, Tu		=	0.00 ft-lbs		
Footing Allow. Torsion	n, φ	Tn =	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: phiMn = phi*5*lambda*sqrt(fc)*Sm

Key: Slab Resists Sliding - No Force on Key

Min footing T&S reinf Area	1.56	in2
Min footing T&S reinf Area per foot	0.30	in2 <i>l</i> ft
If one layer of horizontal bars:	<u>lf two lay</u>	ers of horizontal bars:
#4@ 7.94 in	#4@1	5.87 in
#5@ 12.30 in	#5@ 2	4.60 in
#6@ 17.46 in	#6@ 3	4.92 in

LIC# : KW-06016450, Build:20.24.05.02

Project File: Retaining Walls - Updated.ec6

(c) ENERCALC INC 1983-2023

DESCRIPTION: 10' Retained -EQ (P_Line)

QUANTUM CONSULTING ENGINEERS

Summary of Overturning & Resisting Forces & Moments

OVERTURNING						RESISTING			
Item		Force lbs	Distance ft	Moment ft-#			Force Ibs	Distance ft	Moment ft-#
HL Act Pres (ab water tb	I)	2,182.2	3.72	8,122.5	Soil Over HL (ab. water	tbl)	796.0	4.83	3,843.4
HL Act Pres (be water tb Hydrostatic Force	,	, -	-	-, -	Soil Over HL (bel. water Water Table	tbl)		4.83	3,843.4
Buoyant Force	=				Sloped Soil Over Heel	=			
Surcharge over Heel	=				Surcharge Over Heel	=			
Surcharge Over Toe	=				Adjacent Footing Load	=			
Adjacent Footing Load	=				Axial Dead Load on Ster	n =			
Added Lateral Load	=				* Axial Live Load on Stem	=			
Load @ Stem Above Soi	=				Soil Over Toe	=	229.8	1.92	440.1
Seismic Earth Load	=	698.3	5.58	3,898.8	Surcharge Over Toe	=			
	=				Stem Weight(s)	=	1,000.0	4.16	4,163.3
T = 4 = 1		0.000.4	- o T M -	40.004.0	Earth @ Stem Transition	IS =			
Total	=	2,880.4	O.T.M. =	12,021.2	Footing Weight	=	903.0	2.58	2,329.7
					Key Weight	=	100.0	0.50	50.0
Resisting/Overturning	•		=	1.35	Vert. Component	=	1,050.8	5.16	5,422.2
Vertical Loads used f	or So	il Pressure	= 4,079.6	6 lbs	Tota	al =	4,079.6 II	os R.M.=	16,248.7
If seismic is included, th			ng ratios		* Axial live load NOT inclu resistance, but is include				r overturning

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

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)

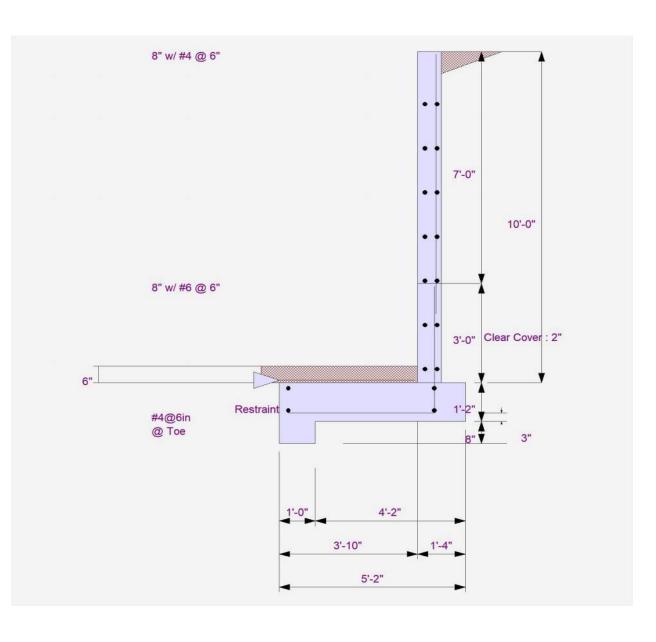
Soil Spring Reaction Modulus 250.0 pci Horizontal Defl @ Top of Wall (approximate only) 0.141 in

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

Cantilevered R	etaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build	d:20.24.05.02 10' Retained -EQ (P	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-202
Rebar Lap & Embe	edment Lengths In	formation	
Stem Design Segment	<u>: 2nd</u>		
Stem Design Height:	3.00 ft above top of for	pting	
Lap Splice length for #	4 bar specified in this ste	m design segment (25.4.2.4a) =	17.09 in
Development length fo	r #4 bar specified in this s	stem design segment =	13.15 in
Stem Design Segment	: Bottom		
Stem Design Height:	0.00 ft above top of for	oting	
Lap Splice length for #	6 bar specified in this ste	m design segment (25.4.2.4a) =	25.63 in
Development length fo	r #6 bar specified in this s	stem design segment =	19.72 in
Hooked embedment le	ngth into footing for #6 ba	ar specified in this stem design segment =	10.35 in
As Provided =			0.8800 in2/ft
As Required =			0.5779 in2/ft

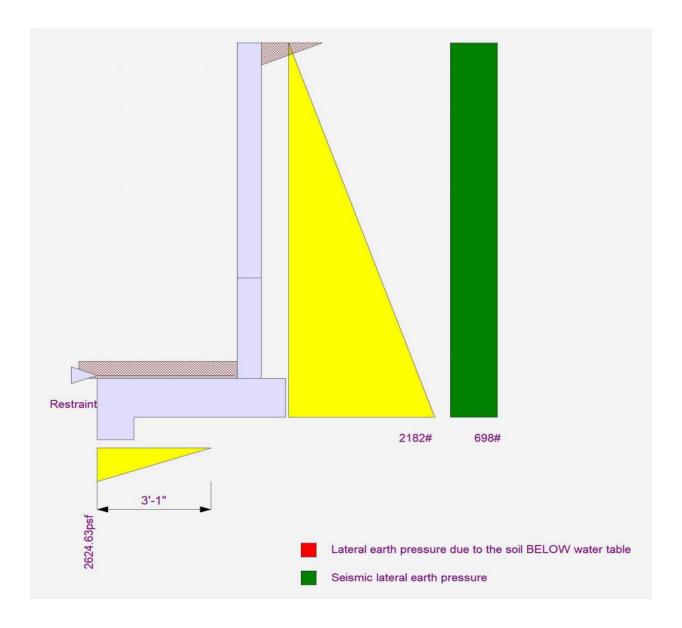
Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023

DESCRIPTION: 10' Retained -EQ (P_Line)





DESCRIPTION: 10' Retained -EQ (P_Line)



35.0 psf/ft

Cantilevered Retaining Wall

LIC# : KW-06016450, Build:20.24.05.02 **DESCRIPTION:** 10' Retained (P_Line) QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

(c) ENERCALC INC 1983-2023

Code Reference

Calculations per IBC 2021 1807.3, ASCE 7-16

Criteria

Retained Height	=	10.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water table above		
bottom of footing	=	0.0 ft

Surcharge Loads

Surcharge Over Heel = 0.0 psf Used To Resist Sliding & Overturning Surcharge Over Toe = 0.0 psf Used for Sliding & Overturning				
Axial Load Applied to Stem				
Axial Dead Load Axial Live Load	=	0.0 lbs 0.0 lbs		

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

Soil Data			
Allow Soil Bearing		2,500.0	psf
Equivalent Fluid Pressu Active Heel Pressure	re ivietn =	od 35.0	psf/f
	=	450.0	

Passive Pressure	=	450.0 psf/ft
Soil Density, Heel	=	120.00 pcf
Soil Density, Toe	=	120.00 pcf
Footing Soil Friction	=	0.530
Soil height to ignore for passive pressure	=	0.00 in

Lateral Load Applied to Stem

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

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
Footing Type Base Above/Below Soil at Back of Wall	=	Spread Footing 0.0 ft

Design Summary

Lateral Sliding Force

LIC# : KW-06016450, Build:20.24.05.02

DESCRIPTION: 10' Retained (P_Line)

	Stem Construction		2nd	Bottom		
_	Design Height Above Ftg	ft =	Stem OK 3.00	Stem OK 0.00		
	Wall Material Above "Ht"	=	Concrete	Concrete		
<	Design Method	=	SD	SD	SD	SD
	Thickness	=	8.00	8.00		
	Rebar Size	=	# 4	# 6		
	Rebar Spacing	=	6.00	6.00		
	Rebar Placed at	=	Edge	Edge		
	Design Data					
	fb/FB + fa/Fa	=	0.303	0.495		
OK	Total Force @ Section					
OK	Service Level	lbs =				
	Strength Level	lbs =	1,372.0	2,800.0		
	MomentActual					
	Service Level	ft-# =				
<u></u>	Strength Level	ft-# =	3,201.3	9,333.3		
OK	MomentAllowable	ft-# =	10,542.0	18,848.3		
OK	ShearActual		,	,		
	Service Level	psi =				
	Strength Level	psi =	18.3	41.5		
	ShearAllowable	psi =	57.4	77.3		
	Anet (Masonry)	in2 =				
	Wall Weight	psf =	100.0	100.0		
	Rebar Depth 'd'	in =	6.25	5.63		
	Rebai Deptiti u	111 =	0.20	5.05		
	Masonry Data					
re IS	f'm	psi =				
ssure		psi =				
	Solid Grouting	. =				
	Modular Ratio 'n'	=				
	Equiv. Solid Thick.	=				
	Masonry Block Type	=				
	Masonry Design Method	=	ASD			
	Concrete Data					
	f'c	psi =	3,000.0	3,000.0		
	Fy	psi =	60,000.0	60,000.0		

Wall Stability Ratios Overturning = 2.00 OK Slab Resists All Sliding ! **Global Stability** 1.16 = Total Bearing Load ...resultant ecc. 4,080 lbs 7.06 in = = Eccentricity within middle third Soil Pressure @ Toe 1,331 psf = Soil Pressure @ Heel 250 psf = 2,500 psf Allowable = So ACI Facto

Soil Pressure Less	s Tha	n Allowable	м
ACI Factored @ Toe	=	1,384 psf	IVI
ACI Factored @ Heel	=	260 psf	
Footing Shear @ Toe	=	17.7 psi OK	M
Footing Shear @ Heel	=	17.7 psi OK	
Allowable	=	82.2 psi	SI
Sliding Calcs			

2,182.2 lbs

Vertical component of active lateral soil pressure considered in the calculation of soil bearing pres

=

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

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6 (c) ENERCALC INC 1983-2023

LIC# : KW-06016450, Build:20.24.05.02

QUANTUM CONSULTING ENGINEERS

(c) ENERCALC INC 1983-2023

Project File: Retaining Walls - Updated.ec6

DESCRIPTION: 10' Retained (P_Line)

Concrete Stem Rebar Area Details

2nd Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.1199 in2/ft	
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :
		One layer of : Two layers of :
Required Area :	0.1728 in2/ft	#4@ 13.89 in #4@ 27.78 in
Provided Area :	0.4 in2/ft	#5@ 21.53 in #5@ 43.06 in
Maximum Area :	1.016 in2/ft	#6@ 30.56 in #6@ 61.11 in
Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.3909 in2/ft	
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :
		One layer of : Two layers of :
Required Area :	0.3909 in2/ft	#4@ 13.89 in #4@ 27.78 in
Provided Area :	0.88 in2/ft	#5@ 21.53 in #5@ 43.06 in
Maximum Area :	0.9144 in2/ft	#6@ 30.56 in #6@ 61.11 in

Footing Data

Toe Width Heel Width Total Footing Width	= 3.83 ft = 1.33 = 5.16
Footing Thickness	= 14.00 in
Key Width	= 12.00 in
Key Depth	= 8.00 in
Key Distance from Toe	e = 0.00 ft
f'c = 3,000 psi Footing Concrete Dens Min. As % Cover @ Top 2.00	= 0.0018

Footing Design Results

		<u>Toe</u>	<u>Heel</u>	<u>Key</u>	
Factored Pressure	=	1,384	260		psf
Mu' : Upward	=	8,109	68		ft-#
Mu' : Downward	=	2,068	1,478		ft-#
Mu: Design	=	6,041	1,411	767	ft-#
φ Mn	=	18,644	3,944	2,739	ft-#
Actual 1-Way Shear	=	17.73	17.75	13.59	psi
Allow 1-Way Shear	=	47.92	43.82	43.82	psi
Toe Reinforcing	=	# 4 @ 6.00 in			
Heel Reinforcing	=	None Spec'd			
Key Reinforcing	=	None Spec'd			
Footing Torsion, Tu		=	0.00 ft-lbs		
Footing Allow. Torsion	n, φ	Tn =	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: phiMn = phi*5*lambda*sqrt(fc)*Sm

Key: Slab Resists Sliding - No Force on Key

Min footing T&S reinf Area	1.56	in2
Min footing T&S reinf Area per foot	0.30	in2 <i>l</i> ft
If one layer of horizontal bars:	<u>lf two lay</u>	ers of horizontal bars:
#4@ 7.94 in	#4@1	5.87 in
#5@ 12.30 in	#5@ 2	4.60 in
#6@ 17.46 in	#6@ 3	4.92 in

LIC# : KW-06016450, Build:20.24.05.02

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

(c) ENERCALC INC 1983-2023

DESCRIPTION: 10' Retained (P_Line)

Summary of Overturning & Resisting Forces & Moments

	0\	ERTURNING			RE	SISTING	
Item	Force lbs	Distance ft	Moment ft-#		Force Ibs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl) HL Act Pres (be water tbl) Hydrostatic Force	2,182.2	3.72	8,122.5	Soil Over HL (ab. water tbl) Soil Over HL (bel. water tbl) Water Table	796.0	4.83 4.83	3,843.4 3,843.4
Buoyant Force = Surcharge over Heel = Surcharge Over Toe = Adjacent Footing Load =				Sloped Soil Over Heel = Surcharge Over Heel = Adjacent Footing Load = Axial Dead Load on Stem =			
Added Lateral Load = Load @ Stem Above Soil =				* Axial Live Load on Stem = Soil Over Toe = Surcharge Over Toe =	229.8	1.92	440.1
=				Stem Weight(s) = Earth @ Stem Transitions =	1,000.0	4.16	4,163.3
Total =	2,182.2	O.T.M. =	8,122.5	Footing Weight = Key Weight =	903.0 100.0	2.58 0.50	2,329.7 50.0
Resisting/Overturning Ra Vertical Loads used for S			2.00 5 lbs	Vert. Component Total = * Axial live load NOT included in	1,050.8 4,079.6	5.16 	5,422.2 16,248.7

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 Modulus250.0pciHorizontal Defl @ Top of Wall (approximate only)0.072in

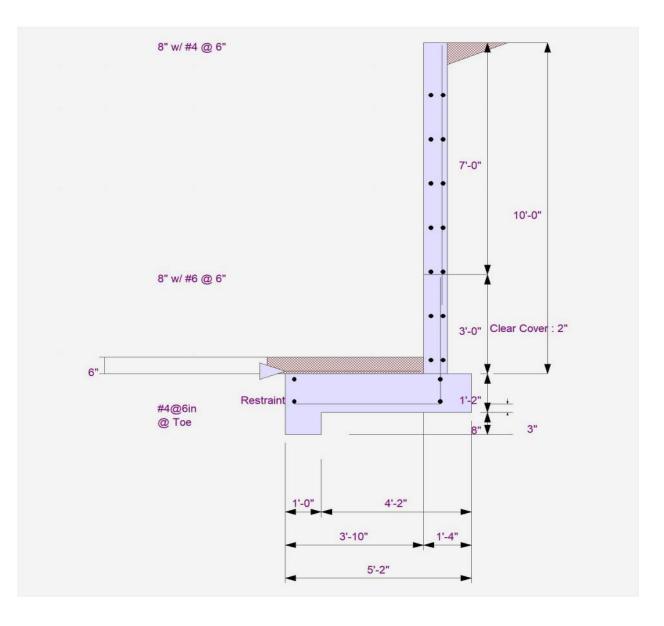
The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe,

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

Cantilevered Retaini	ng Wall	Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05. DESCRIPTION: 10' Reta		(c) ENERCALC INC 1983-2023
Rebar Lap & Embedment	Lengths Information	
Stem Design Segment: 2nd		
Stem Design Height: 3.00 ft	above top of footing	
Lap Splice length for #4 bar spe	cified in this stem design segment (25.4.2.4a) =	17.09 in
Development length for #4 bar s	specified in this stem design segment =	13.15 in
Stem Design Segment: Bottom		
Stem Design Height: 0.00 ft	above top of footing	
Lap Splice length for #6 bar spe	cified in this stem design segment (25.4.2.4a) =	25.63 in
Development length for #6 bar s	pecified in this stem design segment =	19.72 in
Hooked embedment length into	footing for #6 bar specified in this stem design segment =	10.35 in
As Provided =		0.8800 in2/ft
As Required =		0.3909 in2/ft

Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023

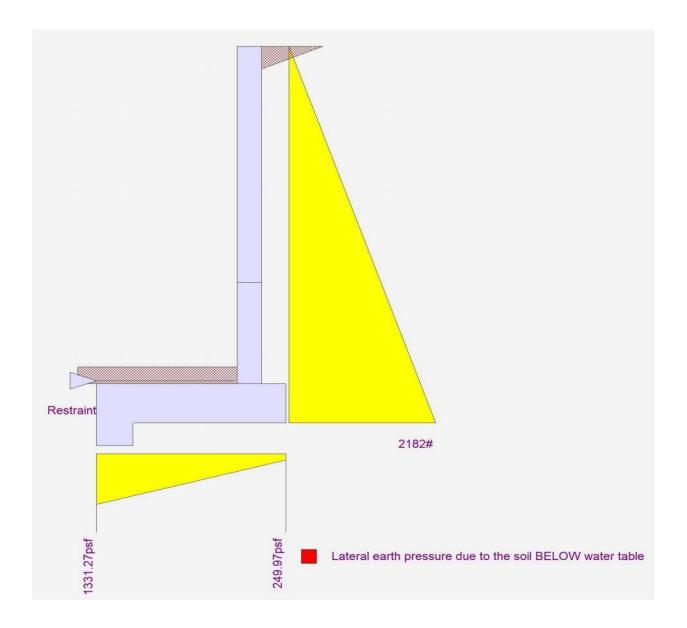
DESCRIPTION: 10' Retained (P_Line)



Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023

DESCRIPTION: 10' Retained (P_Line)

QUANTUM CONSULTING ENGINEERS



LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 9' Retained -EQ (P_Line) QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

(c) ENERCALC INC 1983-2023

Code Reference

Calculations per IBC 2021 1807.3, ASCE 7-16

Criteria

Retained Height	=	9.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water table above		
bottom of footing	=	0.0 ft

Surcharge Loads

Surcharge Over Heel Used To Resist Sliding Surcharge Over Toe Used for Sliding & Ove Axial Load Applied	= rturning	0.0
Axial Dead Load Axial Live Load Axial Load Eccentricity	= = =	0.0 lbs 0.0 lbs 0.0 in

Earth Pressure Seismic Load

Method : Uniform Multiplier Used = 8.000 (Multiplier used on soil density)

Allow Soil Bearing Equivalent Fluid Pressure	= Meth	3,333.0 od	psf
Active Heel Pressure	=		psf/ft
	=		
Passive Pressure	=	450.0	psf/ft
Soil Density, Heel	=	120.00	pcf
Soil Density, Toe	=	120.00	pcf
Footing Soil Friction	=	0.530	
Soil height to ignore for passive pressure	=	0.00	in

Soil Data

Lateral Load Applied to Stem

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

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
Footing Type Base Above/Below Soil at Back of Wall	=	Spread Footing 0.0 ft

Uniform Seismic Force = 80.000 Total Seismic Force = 800.000

LIC# : KW-06016450, Build:20.24.05.02 **DESCRIPTION:** 9' Retained -EQ (P_Line)

Design SummaryStem ConstructionWall Stability Ratios Overturning=1.37 Ratio < 1.5!Design Height Above FtgSliding=1.37 Ratio < 1.5!Wall Material Above "Ht" Design Method Thickness Rebar Size Rebar Size Rebar SpacingTotal Bearing Load=3,424 lbs micresultant ecc.Total Bearing Load=3,424 lbs Rebar Size Rebar SpacingTotal Bearing Load=3,424 lbs micresultant ecc.Total Bearing Load=1.590 in thicknessTotal Bearing Load=3,424 lbs micresultant ecc.Total Force @ Section Soil Pressure @ ToePesign DataSoil Pressure @ Toe=2,467 psf OK Soil Pressure Less Than Allowable ACI Factored @ Toe=2,604 psf ACI Factored @ ToeTotal Force @ Section Service Level Strength LevelAllowable=9 psfStrength LevelFooting Shear @ Toe=2,310.0 lbs less 100% Passive ForceShearAllowable Anet (Masonry)Lateral Sliding Force=1,056.3 lbs less 100% Friction Force =-100% Friction Force =-1,056.3 lbs lessAnet (Masonry) Wall Weight	= = = = lbs = ft-# = ft-# = =	Stem OK 0.00 Concrete SD 8.00 # 4 6.00 Edge 0.952 2,988.0 10,044.0 10,542.0	SD	SD	
Wall Stability Ratios OverturningWall Material Above "Ht" Design Method Thickness Rebar Size Rebar Size Rebar SpacingGlobal Stability= 1.24 Ratio < 1.5! Design Method Thickness Rebar Size Rebar SpacingTotal Bearing Load= $3,424$ lbs resultant ecc.Rebar Size Rebar SpacingTotal Bearing Load= $3,424$ lbs resultant ecc.Rebar Placed at Design Data fb/FB + fa/FaSoil Pressure @ Toe= $2,467$ psf OK Soil Pressure @ Heel0 psf OK Service LevelAcl Factored @ Toe= $2,604$ psf ACl Factored @ Toe=Acl Factored @ Toe= $2,604$ psf Acl Factored @ Toe=Footing Shear @ Toe= 28.3 psi OK AllowableService Level Strength LevelSliding Calcs Lateral Sliding Force= $2,310.0$ lbs less 100% Passive ForceShearAllowable Anet (Masonry)Just 100% Priction Force= $1,814.9$ lbsWall Weight	= = = = lbs = ft-# = ft-# = =	Concrete SD 8.00 # 4 6.00 Edge 0.952 2,988.0 10,044.0	SD	SD	
Overturning=1.37 Ratio < 1.5!Design MethodSliding=1.24 Ratio < 1.5!	= = = lbs = ft-# = ft-# = =	SD 8.00 # 4 6.00 Edge 0.952 2,988.0 10,044.0	SD	SD	
Sliding=1.24 Ratio < 1.5!Design MiellouGlobal Stability=1.23Rebar SizeGlobal Stability=1.23Rebar SizeTotal Bearing Load=3,424 lbsRebar Placed atresultant ecc.=15.90 inEccentricity outside middle thirdSoil Pressure @ Toe=2,467 psf OKService LevelSoil Pressure @ Heel=0 psf OKService LevelAllowable=3,333 psfStrength LevelACI Factored @ Toe=2,604 psfService LevelACI Factored @ Heel=0 psfStrength LevelFooting Shear @ Toe=28.3 psi OKMomentActualFooting Shear @ Heel=19.4 psi OKAllowable=82.2 psiShearAllowableSliding CalcsStrength LevelStrength LevelLateral Sliding Force=2,310.0 lbsShearAllowableless 100% Passive Force-1,056.3 lbsAnet (Masonry)less 100% Friction Force=1,814.9 lbsWall Weight	= = = lbs = ft-# = ft-# = =	8.00 # 4 6.00 Edge 0.952 2,988.0 10,044.0			
Global Stability=1.23Rebar Size Rebar Size Service Level Strength Level ShearAllowable Anet (Masonry) Wall Weight	= = lbs = ft-# = ft-# = =	# 4 6.00 Edge 0.952 2,988.0 10,044.0			
Choose of the strengthChoose of the strengthRebar SpacingTotal Bearing Load=3,424 lbsRebar Spacingresultant ecc.=15.90 inEccentricity outside middle thirdSoil Pressure @ Toe=2,467 psf OKDesign DataSoil Pressure @ Heel=0 psf OKService LevelAllowable=3,333 psfStrength LevelACI Factored @ Toe=2,604 psfService LevelACI Factored @ Toe=2,83 psi OKService LevelFooting Shear @ Toe=28.3 psi OKMomentAllowableFooting Shear @ Heel=19.4 psi OKShearAllowableAllowable=82.2 psiStrength LevelSliding CalcsStrength LevelStrength LevelLateral Sliding Force=1,056.3 lbsAnet (Masonry)less 100% Passive Force-1,056.3 lbsWall Weight	= = lbs = ft-# = ft-# = =	6.00 Edge 0.952 2,988.0 10,044.0			
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International Dealing Edd $=$ $3,324$ hbsInternational Dealing Edd $=$ $3,330$ pointInternational Dealing Edd $=$ $2,467$ pointSoil Pressure @ Toe $=$ $2,467$ pointSoil Pressure @ Heel $=$ 0 pointAllowable $=$ $3,333$ pointSoil Pressure Less Than AllowableStrength LevelACI Factored @ Toe $=$ $2,604$ pointACI Factored @ Toe $=$ $2,604$ pointFooting Shear @ Toe $=$ 28.3 pointFooting Shear @ Toe $=$ 28.3 pointAllowable $=$ 19.4 pointAllowable $=$ 82.2 pointSliding CalcsStrength LevelLateral Sliding Force $=$ $2,310.0$ lbsShearAllowableAnet (Masonry)Nall Weight	= lbs = lbs = ft-# = ft-# = =	0.952 2,988.0 10,044.0			
IntersectionIntersectionIntersectionSoil Pressure @ Toe=2,467 psfOKSoil Pressure @ Heel=0 psfOKAllowable=3,333 psfService LevelSoil Pressure Less Than AllowableStrength LevelACI Factored @ Toe=2,604 psfACI Factored @ Toe=2,604 psfACI Factored @ Toe=28.3 psiFooting Shear @ Toe=28.3 psiFooting Shear @ Heel=19.4 psiAllowable=82.2 psiSliding CalcsStrength LevelLateral Sliding Force=Lateral Sliding Force=100% Passive Force-1,056.3 lbsAnet (Masonry)less 100% Friction Force=1,814.9 lbsWall Weight	lbs = lbs = ft-# = ft-# = =	2,988.0 10,044.0			
Soil Pressure @ Ťoe=2,467 psf OKTotal Force @ SectionSoil Pressure @ Heel=0 psf OKService LevelAllowable=3,333 psfStrength LevelSoil Pressure Less Than AllowableACI Factored @ Toe=2,604 psfACI Factored @ Toe=2,604 psfService LevelACI Factored @ Heel=0 psfStrength LevelFooting Shear @ Toe=28.3 psi OKMomentActualFooting Shear @ Heel=19.4 psi OKShearAllowableAllowable=82.2 psiStrength LevelSliding CalcsStrength LevelStrength LevelLateral Sliding Force=2,310.0 lbsShearAllowableless 100% Passive Force-1,056.3 lbsAnet (Masonry)less 100% Friction Force=1,814.9 lbsWall Weight	lbs = ft-# = ft-# = =	10,044.0			
Allowable= $3,333$ psfStervice LevelAllowable= $3,333$ psfStrength LevelACI Factored @ Toe= $2,604$ psfService LevelACI Factored @ Heel=0 psfStrength LevelFooting Shear @ Toe= 28.3 psi OKMomentActualFooting Shear @ Heel=19.4 psi OKMomentAllowableAllowable= 82.2 psiStrength LevelSliding CalcsStrength LevelStrength LevelLateral Sliding Force= $2,310.0$ lbsShearAllowableless 100% Passive Force- $1,056.3$ lbsAnet (Masonry)less 100% Friction Force= $1,814.9$ lbsWall Weight	lbs = ft-# = ft-# = =	10,044.0			
Allowable=3,333 psfStrength LevelSoil Pressure Less Than AllowableAllowableMomentActualACI Factored @ Toe=2,604 psfService LevelACI Factored @ Heel=0 psfStrength LevelFooting Shear @ Toe=28.3 psi OKMomentAllowableFooting Shear @ Heel=19.4 psi OKMomentAllowableAllowable=82.2 psiStrength LevelSliding CalcsStrength LevelStrength LevelLateral Sliding Force=2,310.0 lbsShearAllowableless 100% Passive Force-1,056.3 lbsAnet (Masonry)less 100% Friction Force=-1,814.9 lbsWall Weight	ft-# = ft-# = =	10,044.0			
Soil Pressure Less Than AllowableMomentActualACI Factored @ Toe=2,604 psfService LevelACI Factored @ Heel=0 psfStrength LevelFooting Shear @ Toe=28.3 psi OKMomentAllowableFooting Shear @ Heel=19.4 psi OKMomentAllowableAllowable=82.2 psiStrength LevelSliding CalcsStrength LevelStrength LevelLateral Sliding Force=2,310.0 lbsShearAllowableless 100% Passive Force-1,056.3 lbsAnet (Masonry)less 100% Friction Force=-1,814.9 lbsWall Weight	ft-# = ft-# = =	10,044.0			
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Footing Shear @ Toe = 28.3 psi OK MomentAllowable Footing Shear @ Heel = 19.4 psi OK MomentAllowable Allowable = 82.2 psi ShearActual Sliding Calcs Strength Level Strength Level Lateral Sliding Force = 2,310.0 lbs ShearAllowable less 100% Passive Force - 1,056.3 lbs Anet (Masonry) less 100% Friction Force = - 1,814.9 lbs Wall Weight	=	,			
Footing Shear @ Toe = 28.3 psi OK Footing Shear @ Heel = 19.4 psi OK Allowable = 82.2 psiMomentAllowable ShearActual Service Level Strength LevelSliding Calcs Lateral Sliding Force = 2,310.0 lbs less 100% Passive Force - 1,056.3 lbs less 100% Friction Force = - 1,814.9 lbsMomentAllowable ShearActual ShearAllowable Anet (Masonry) Wall Weight		,			
Footing Shear @ Heel = 19.4 psi OK Allowable = 82.2 psi Sliding Calcs Strength Level Lateral Sliding Force = 2,310.0 lbs ShearAllowable less 100% Passive Force - 1,056.3 lbs Anet (Masonry) less 100% Friction Force = - 1,814.9 lbs Wall Weight		10,042.0			
Allowable = 82.2 psi Service Level Sliding Calcs Strength Level Lateral Sliding Force = 2,310.0 lbs ShearAllowable less 100% Passive Force - 1,056.3 lbs Anet (Masonry) less 100% Friction Force = - 1,814.9 lbs Wall Weight					
Sliding Calcs Strength Level Lateral Sliding Force = 2,310.0 lbs ShearAllowable less 100% Passive Force - 1,056.3 lbs Anet (Masonry) less 100% Friction Force = - 1,814.9 lbs Wall Weight	noi –				
Lateral Sliding Force $=$ 2,310.0 lbsShearAllowableless 100% Passive Force $=$ 1,056.3 lbsAnet (Masonry)less 100% Friction Force $=$ $=$ 1,814.9 lbsWall Weight	psi =				
Latit in the initial containing in the initial contai	psi =	39.8			
less 100% Friction Force \equiv - 1,814.9 lbs Wall Weight	psi =	57.4			
	in2 =				
	psf =	100.0			
Added Force Req'd = 0.0 lbs OK Rebar Depth 'd'	in =	6.25			
for 1.5 Stability = 593.9 lbs NG					
Masonry Data					
/ertical component of active lateral soil pressure IS f'm considered in the calculation of soil bearing pressures. Fs	psi =				
considered in the calculation of soil bearing pressures. Fs Solid Grouting	psi =				
	=				
	=				
Building CodeEquiv. Solid Thick.Dead Load1.200Masonry Block Type	=				
Live Load A COO		ASD			
Earth, H 1.600 Masonry Design Method	=	ASD			
Wind, W 1.000 f'c	psi =	3,000.0			
Seismic, E 1.000 Fy	psi =	60,000.0			

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6 (c) ENERCALC INC 1983-2023

LIC# : KW-06016450, Build:20.24.05.02

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

(c) ENERCALC INC 1983-2023

DESCRIPTION: 9' Retained -EQ (P_Line)

Concrete Stem Rebar Area Details

Bottom Stem As (based on applied moment) :	Vertical Reinforcing 0.3763 in2/ft	Horizontal Reinf	orcing	
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinf	orcing Options :	
0.0010011.0.0016(12)(6).	0.1728 112/11		0 1	
	===========	One layer of :	Two layers of :	
Required Area :	0.3763 in2/ft	#4@ 13.89 in	#4@ 27.78 in	
Provided Area :	0.4 in2/ft	#5@ 21.53 in	#5@ 43.06 in	
Maximum Area :	1.016 in2/ft	#6@ 30.56 in	#6@ 61.11 in	
Exactly a Data	E a strand			

Footing Data

Toe Width	=	3.17 ft
Heel Width	=	1.33
Total Footing Width	= -	4.50
Footing Thickness	=	12.00 in
Key Width	=	12.00 in
Key Depth	=	8.00 in
Key Distance from Toe	; =	0.00 ft
f'c = 3,000 psi Footing Concrete Dens	Fy = sity =	60,000 psi 150.00 pcf
Min. As %	=	0.0018
Cover @ Top 2.00	@ E	3tm.= 3.00 in

Footing Design Results

		Toe	<u>Heel</u>	<u>Key</u>	
Factored Pressure	=	2,604	0		psf
Mu' : Upward	=	8,113	0		ft-#
Mu' : Downward	=	1,266	1,219		ft-#
Mu: Design	=	6,847	1,219	724	ft-#
φ Mn	=	15,044	2,739	2,739	ft-#
Actual 1-Way Shear	=	28.32	19.40	12.71	psi
Allow 1-Way Shear	=	51.33	43.82	43.82	psi
Toe Reinforcing	=	# 4 @ 6.00 in			
Heel Reinforcing	=	None Spec'd			
Key Reinforcing	=	None Spec'd			
Footing Torsion, Tu		=	0.00 ft-lbs		
Footing Allow. Torsio	n, գ	oTn =	0.00 ft-lbs		

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

Other Acceptable Sizes & Spacings

Toe: #4@ 9.25 in, #5@ 14.35 in, #6@ 20.37 in, #7@ 27.77 in, #8@ 36.57 in, #9@ 46.29 in, #10@ 58.79 in

Heel: phiMn = phi*5*lambda*sqrt(fc)*Sm

Key: phiMn = phi*5*lambda*sqrt(fc)*Sm

Min footing T&S reinf Area	1.17 in2
Min footing T&S reinf Area per foot	0.26 in2 /ft
If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 9.26 in	#4@ 18.52 in
#5@ 14.35 in	#5@ 28.70 in
#6@ 20.37 in	#6@ 40.74 in

LIC# : KW-06016450, Build:20.24.05.02

Project File: Retaining Walls - Updated.ec6

DESCRIPTION: 9' Retained -EQ (P_Line)

QUANTUM CONSULTING ENGINEERS

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Summary of Overturning & Resisting Forces & Moments

		OV	ERTURNING			RE	SISTING	
Item		Force lbs	Distance ft	Moment ft-#		Force Ibs	Distance ft	Moment ft-#
HL Act Pres (ab water th	ol)	1,750.0	3.33	5,833.3	Soil Over HL (ab. water tbl)	716.4	4.17	2,986.2
HL Act Pres (be water the Hydrostatic Force	,	,		-,	Soil Over HL (bel. water tbl) Water Table		4.17	2,986.2
Buoyant Force	=				Sloped Soil Over Heel =			
Surcharge over Heel	=				Surcharge Over Heel =			
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 So	il =				Soil Over Toe =	190.2	1.59	301.5
Seismic Earth Load	=	560.0	5.00	2,800.0	Surcharge Over Toe =			
	=			,	Stem Weight(s) =	900.0	3.50	3,153.0
					Earth @ Stem Transitions =			
Total	=	2,310.0	O.T.M. =	8,633.3	Footing Weight =	675.0	2.25	1,518.8
					Key Weight =	100.0	0.50	50.0
Resisting/Overturnin	•		=	1.37	Vert. Component =	842.7	4.50	3,792.2
Vertical Loads used f	for So	il Pressure	= 3,424.3	B lbs	Total =	3,424.3	bs R.M.=	11,801.6
If seismic is included, th	ne OT	M and slidin	a ratios		* Axial live load NOT included resistance, but is included fo			r overturning

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

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)	0.137	in

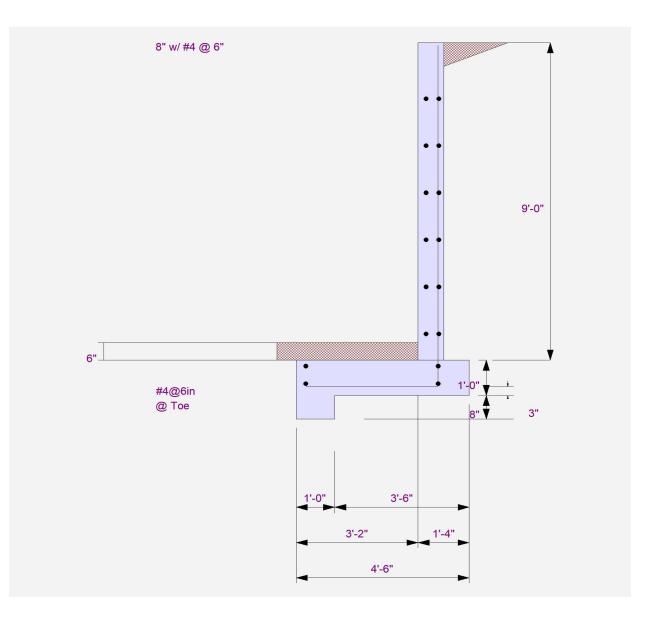
The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe,

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

Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023
DESCRIPTION: 9' Retained -EQ (P_I	_ine)	
Rebar Lap & Embedment Lengths Inf	ormation	
Stem Design Segment: Bottom		
Stem Design Height: 0.00 ft above top of for	bting	
Lap Splice length for #4 bar specified in this ste	m design segment (25.4.2.4a) =	17.09 in
Development length for #4 bar specified in this s	stem design segment =	13.15 in
Hooked embedment length into footing for #4 ba	ar specified in this stem design segment =	5.63 in
As Provided =		0.4000 in2/ft
As Required =		0.3763 in2/ft

Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023

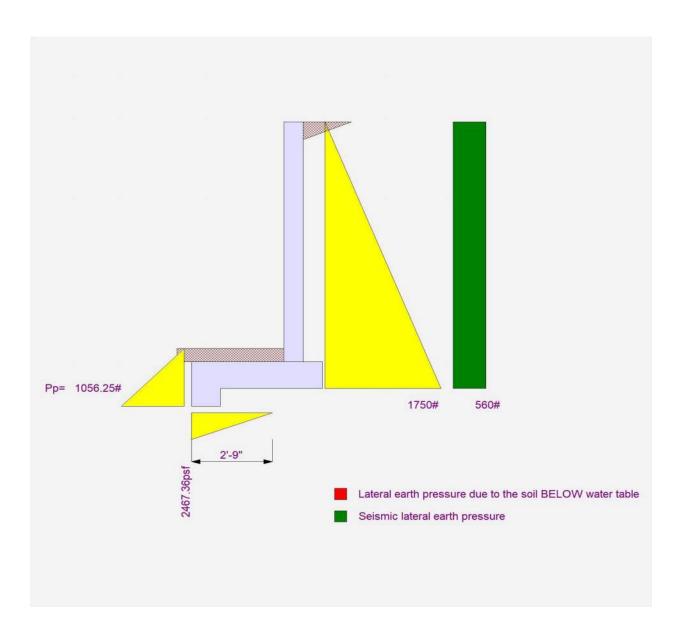
DESCRIPTION: 9' Retained -EQ (P_Line)



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DESCRIPTION: 9' Retained -EQ (P_Line)



LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 9' Retained (P_LINE) QUANTUM CONSULTING ENGINEERS

= 2,500.0 psf

=

=

=

=

=

=

=

=

=

=

35.0 psf/ft

450.0 psf/ft

120.00 pcf

120.00 pcf

0.00 in

0.0 #/ft

0.0 psf

0.00 ft

0.00 ft

 Seismic (E) (Strength Level)

0.530

Project File: Retaining Walls - Updated.ec6

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Code Reference

Calculations per IBC 2021 1807.3, ASCE 7-16

Criteria

Retained Height	=	9.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water table above		
bottom of footing	=	0.0 ft

Surcharge Loads

Surcharge Over Heel Used To Resist Slid Surcharge Over Toe Used for Sliding & C	ling & Ov =	0.0
Axial Load Appl	ied to	Stem
Axial Dead Load	=	0.0 lbs

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

Equivalent Fluid Pressure Method

Soil Data Allow Soil Bearing

Active Heel Pressure

Passive Pressure

Soil Density, Heel

Soil Density, Toe

Lateral Load

Load Type

Footing||Soil Friction

Soil height to ignore

...Height to Top ...Height to Bottom

(Strength Level)

Wind on Exposed Stem _

for passive pressure

Lateral Load Applied to Stem

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		Corood Footing
rooung rype		Spread Footing
Base Above/Below Soil at Back of Wall	=	0.0 ft

LIC# : KW-06016450, Build:20.24.05.02

QUANTUM CONSULTING ENGINEERS

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Project File: Retaining Walls - Updated.ec6

DESCRIPTION: 9' Retained (P_LINE)

Design Summary			Stem Construction		Bottom			
			Design Height Above Ftg	 4	Stem OK			
Wall Stability Ratios			Wall Material Above "Ht"	ft = =	0.00 Concrete			
Overturning	=	1.83 OK	Design Method	=	SD	SD	SD	
Sliding	=	1.62 OK	Thickness	=	8.00	30	30	
Global Stability	=	1.23	Rebar Size	_	# 4			
Clobal Clability	-	1.20	Rebar Spacing	=	6.00			
Total Bearing Load	=	3,353 lbs	Rebar Placed at	=	Edge			
resultant ecc.	_	7.60 in	Design Data		0			
Eccentricity with	in mid		fb/FB + fa/Fa	=	0.645			
Soil Pressure @ Toe	=	1,542 psf OK	Total Force @ Section					
Soil Pressure @ Heel	=	70 psf OK	Service Level	lbs =				
Allowable	=	2,500 psf	Strength Level	lbs =	2,268.0			
Soil Pressure Less			MomentActual					
ACI Factored @ Toe	=	1,617 psf	Service Level	ft-# =				
ACI Factored @ Heel	=	73 psf	Strength Level	ft-# =	6,804.0			
Footing Shear @ Toe	=	19.7 psi OK	MomentAllowable	=	10,542.0			
Footing Shear @ Heel	=	18.3 psi OK	ShearActual					
Allowable	=	82.2 psi	Service Level	psi =				
			Strength Level	•	00.0			
Sliding Calcs			0	psi =	30.2			
Lateral Sliding Force	=	1,750.0 lbs	ShearAllowable	psi =	57.4			
less 100% Passive Force		1,056.3 lbs	Anet (Masonry)	in2 =				
less 100% Friction Force	;≡ -	1,777.0 lbs	Wall Weight	psf =	100.0			
Added Force Req'd	=	0.0 lbs OK	Rebar Depth 'd'	in =	6.25			
for 1.5 Stability	=	0.0 lbs OK						
			Masonry Data					
Vertical component of active			f'm	psi =				
considered in the calculation	n of so	oil bearing pressures		psi =				
			Solid Grouting	=				
Load Factors Building Code			Modular Ratio 'n'	=				
Dead Load		1.200	Equiv. Solid Thick.	=				
Live Load		1.600	Masonry Block Type	=				
Earth, H		1.600	Masonry Design Method	=	ASD			
Wind, W		1.000	Concrete Data	no:	2 000 0			
Seismic, E		1.000	f'c Ev	psi =	3,000.0			
		1.000	Fy	psi =	60,000.0			

LIC# : KW-06016450, Build:20.24.05.02

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

(c) ENERCALC INC 1983-2023

DESCRIPTION: 9' Retained (P_LINE)

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinf	orcing
As (based on applied moment) :	0.2549 in2/ft		
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinf	orcing Options :
		One layer of :	Two layers of :
Required Area :	0.2549 in2/ft	#4@ 13.89 in	#4@ 27.78 in
Provided Area :	0.4 in2/ft	#5@ 21.53 in	#5@ 43.06 in
Maximum Area :	1.016 in2/ft	#6@ 30.56 in	#6@ 61.11 in

Footing Data

Toe Width Heel Width		= =		.83 ft .33
Total Footing W	idth	=	4	.16
Footing Thickne	SS	=	12.	00 in
Key Width Key Depth Key Distance fro	om Toe	= = =	8.	00 in 00 in 00 ft
f'c = 3,000 Footing Concret Min. As % Cover @ Top	0 psi e Density 2.00	=	150 0.00	00 psi .00 pcf 18 3.00 in

Footing Design Results

		Toe	<u>Heel</u>	<u>Key</u>	
Factored Pressure	=	1,617	73		psf
Mu' : Upward	=	5,072	34		ft-#
Mu' : Downward	=	1,009	1,219		ft-#
Mu: Design	=	4,063	1,185	749	ft-#
φ Mn	=	15,044	2,739	2,739	ft-#
Actual 1-Way Shear	=	19.70	18.31	13.03	psi
Allow 1-Way Shear	=	51.33	43.82	43.82	psi
Toe Reinforcing	=	# 4 @ 6.00 in			
Heel Reinforcing	=	None Spec'd			
Key Reinforcing	=	None Spec'd			
Footing Torsion, Tu		=	0.00 ft-lbs		
Footing Allow. Torsio	n, φ	Tn =	0.00 ft-lbs		

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

Other Acceptable Sizes & Spacings

Toe: #4@ 9.25 in, #5@ 14.35 in, #6@ 20.37 in, #7@ 27.77 in, #8@ 36.57 in, #9@ 46.29 in, #10@ 58.79 in

Heel: phiMn = phi*5*lambda*sqrt(fc)*Sm

Key: phiMn = phi*5*lambda*sqrt(fc)*Sm

Min footing T&S reinf Area	1.08	in2
Min footing T&S reinf Area per foot	0.26	in2 /ft
If one layer of horizontal bars:	If two lay	ers of horizontal bars:
#4@ 9.26 in	#4@1	8.52 in
#5@ 14.35 in	#5@ 2	8.70 in
#6@ 20.37 in	#6@ 4	0.74 in

LIC# : KW-06016450, Build:20.24.05.02

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

(c) ENERCALC INC 1983-2023

DESCRIPTION: 9' Retained (P_LINE)

Summary of Overturning & Resisting Forces & Moments

	OV	ERTURNING			RE	SISTING	
Item	Force lbs	Distance ft	Moment ft-#		Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	1,750.0	3.33	5,833.3	Soil Over HL (ab. water tbl)	716.4	3.83	2,742.6
HL Act Pres (be water tbl)	,		-,	Soil Over HL (bel. water tbl)		3.83	2,742.6
Hydrostatic Force				Water Table			
Buoyant Force =				Sloped Soil Over Heel =			
Surcharge over Heel =				Surcharge Over Heel =			
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 =	169.8	1.42	240.3
				Surcharge Over Toe =			
=				Stem Weight(s) =	900.0	3.16	2,847.0
				Earth @ Stem Transitions =			,
Total =	1,750.0	O.T.M. =	5,833.3	Footing Weight =	624.0	2.08	1,297.9
				Key Weight =	100.0	0.50	50.0
Resisting/Overturning Rat	io	=	1.83	Vert. Component =	842.7	4.16	3,505.7
Vertical Loads used for So	il Pressure	= 3,352.9	9 lbs	Total =	3.352.9	bs R.M.=	10,683.5

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 Modulus250.0pciHorizontal Defl @ Top of Wall (approximate only)0.093in

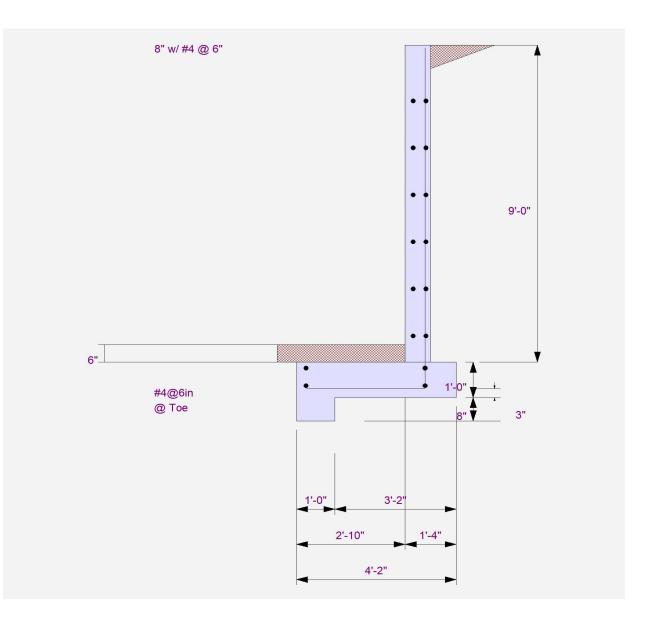
The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe,

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

Cantilevered Retaining Wall	Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02 QUAN	JM CONSULTING ENGINEERS (c) ENERCALC INC 1983-2023
DESCRIPTION: 9' Retained (P_LINE)	
Rebar Lap & Embedment Lengths Information	
Stem Design Segment: Bottom	
Stem Design Height: 0.00 ft above top of footing	
Lap Splice length for #4 bar specified in this stem design seg	ent (25.4.2.4a) = 17.09 in
Development length for #4 bar specified in this stem design set	ment = 13.15 in
Hooked embedment length into footing for #4 bar specified in	is stem design segment = 5.63 in
As Provided =	0.4000 in2/ft
As Required =	0.2549 in2/ft

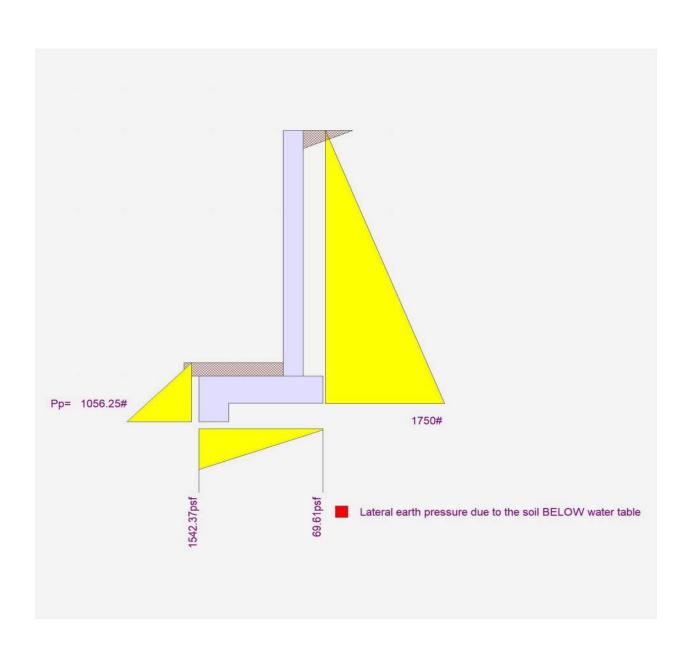
Project File: Retaining Walls - Updated.ed	~
JM CONSULTING ENGINEERS (c) ENERCALC INC 1983-2	.023
ITI	ITUM CONSULTING ENGINEERS (c) ENERCALC INC 1983-2

DESCRIPTION: 9' Retained (P_LINE)





DESCRIPTION: 9' Retained (P_LINE)



LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 8' Retained - EQ (P_LINE)

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

(c) ENERCALC INC 1983-2023

Code Reference

Calculations per IBC 2021 1807.3, ASCE 7-16

Criteria

Retained Height	=	8.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water table above		
bottom of footing	=	0.0 ft

Surcharge Loads

Surcharge Over Heel Used To Resist Sliding Surcharge Over Toe Used for Sliding & Ove Axial Load Applied	= rturning	0.0
Axial Dead Load Axial Live Load Axial Load Eccentricity	= = =	0.0 lbs 0.0 lbs 0.0 in

Earth Pressure Seismic Load

Method : Uniform Multiplier Used = 8.000 (Multiplier used on soil density)

Allow Soil Bearing Equivalent Fluid Pressure	= Meth	3,333.0 Iod	psf
Active Heel Pressure	=	35.0	psf/ft
	=		
Passive Pressure	=	450.0	psf/ft
Soil Density, Heel	=	120.00	pcf
Soil Density, Toe	=	120.00	pcf
Footing Soil Friction	=	0.530	
Soil height to ignore for passive pressure	=	0.00	in

Soil Data

Lateral Load Applied to Stem

Lateral Load Height to Top Height to Bottom	= = =	0.0 #/ft 0.00 ft 0.00 ft
Load Type	=	Seismic (E) (Strength Level)
Wind on Exposed Ster (Strength Level)	n _	0.0 psf

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

Uniform Seismic Force	=	72.000
Total Seismic Force	=	648.000

LIC# : KW-06016450, Build:20.24.05.02

QUANTUM CONSULTING ENGINEERS

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Project File: Retaining Walls - Updated.ec6

DESCRIPTION: 8' Retained - EQ (P_LINE)

		tem Construction		Bottom			
		Design Height Above Ftg	ft =	Stem OK 0.00			
		Wall Material Above "Ht"					
=			=	SD	SD	SD	
=	1.37 Ratio < 1.5	[!] Thickness	=	8.00			
=	1.29	Rebar Size	=	# 4			
		Rebar Spacing	=	9.00			
=	2,836 lbs	Rebar Placed at	=	Edge			
=	14.40 in						
			=	0.985			
		Service Level	lbs =				
_			lbs =	2,368.0			
	· ·						
	•	Strength Level	ft-# =	7,082.7			
		MomentAllowable	=	7,185.3			
		ShearActual					
=	82.2 psi	Service Level	psi =				
		Strength Level	•				
	1 971 1 lba	•					
_	,		•				
		(),					
_	,	U	•				
		Rebar Depth d	in =	6.25			
=	247.5 105 106	Masonry Data					
latera	al soil pressure IS		noi –				
			•				
0.00	in boaring procouroo.						
		U U					
			_				
	1.200	•					
	1.600	, , , , , , , , , , , , , , , , , , , ,		ASD			
	1.600						
	1.000	f'c	psi =	3,000.0			
	1.000			,			
	= = = = = = = = = = = = = = = = = = =	 1.37 Ratio < 1.5 1.37 Ratio < 1.5 1.29 2,836 lbs 14.40 in emiddle third 2,363 psf OK 0 psf OK 3,333 psf Than Allowable 2,511 psf 0 psf 23.4 psi OK 14.7 psi OK 23.4 psi OK 1,056.3 lbs 1,056.3 lbs 1,502.9 lbs 0.0 lbs OK 247.5 lbs NG lateral soil pressure IS of soil bearing pressures. 1.200 1.600 1.000 	 1.36 Ratio < 1.5! 1.37 Ratio < 1.5! 1.29 2.836 lbs 14.40 in e middle third 2.363 psf OK 0 psf OK 3,333 psf Than Allowable 2,511 psf 0 psf 23.4 psi OK 14.7 psi OK 23.4 psi OK 14.7 psi OK 1.502.9 lbs 1,056.3 lbs 2 1,556.3 lbs 3 1,502.9 lbs 2 1,556.3 lbs 2 1,556.3 lbs 3 1,502.9 lbs 2 1,556.3 lbs 3 1,502.9 lbs 2 1,27.5 lbs NG 1200 1.600 1.600 1.600 1.600 1.000 1.000 1.000 	= 1.36 Ratio < 1.5! $= 1.37 Ratio < 1.5!$ $= 1.29$ $= 2.836 lbs$ $= 14.40 in$ $e middle third$ $= 2,363 psf OK$ $= 0 psf OK$ $= 3,333 psf$ Than Allowable = 2,511 psf $= 0 psf$ $= 23.4 psi OK$ $= 14.7 psi OK$ $= 14.7 psi OK$ $= 1.871.1 lbs$ $- 1,056.3 lbs$ $= -1,056.3 lbs$ $= 0.0 lbs OK$ $= 247.5 lbs NG$ $lateral soil pressure IS of soil bearing pressures.$ 1.200 1.600 1.600 1.600 1.000 $= 1.29$ $Design Method = Thickness = Rebar Spacing = Rebar Spacing = Rebar Placed at = ERebar Spacing = Rebar Spacing = Rebar Placed at = ERebar Spacing = Rebar Spacing = Strength Level lbs = Strength Level lbs = MomentActual Service Level psi = Strength Lev$	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$

LIC# : KW-06016450, Build:20.24.05.02

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

(c) ENERCALC INC 1983-2023

DESCRIPTION: 8' Retained - EQ (P_LINE)

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinfo	orcing
As (based on applied moment) :	0.2654 in2/ft		
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinfo	orcing Options :
		One layer of :	Two layers of :
Required Area :	0.2654 in2/ft	#4@ 13.89 in	#4@ 27.78 in
Provided Area :	0.2667 in2/ft	#5@ 21.53 in	#5@ 43.06 in
Maximum Area :	1.016 in2/ft	#6@ 30.56 in	#6@ 61.11 in
Exactly an Data	E a strand		

Footing Data

Toe Width	= 2.83 ft
Heel Width	= 1.17
Total Footing Width	= 4.00
Footing Thickness	= 12.00 in
Key Width	= 12.00 in
Key Depth	= 8.00 in
Key Distance from Toe	e = 0.00 ft
f'c = 3,000 psi	Fy = 60,000 psi
Footing Concrete Dens	sity = 150.00 pcf
Min. As %	= 0.0018
Cover @ Top 2.00	@ Btm.= 3.00 in

Footing Design Results

		Toe	<u>Heel</u>	<u>Key</u>	
Factored Pressure	=	2,511	0		psf
Mu' : Upward	=	6,118	0		ft-#
Mu': Downward	=	1,009	718		ft-#
Mu: Design	=	5,109	718	694	ft-#
φ Mn	=	10,188	2,739	2,739	ft-#
Actual 1-Way Shear	=	23.41	14.69	12.34	psi
Allow 1-Way Shear	=	44.84	43.82	43.82	psi
Toe Reinforcing	=	# 4 @ 9.00 in			
Heel Reinforcing	=	None Spec'd			
Key Reinforcing	=	None Spec'd			
Footing Torsion, Tu		=	0.00 ft-lbs		
Footing Allow. Torsio	n, q	Tn =	0.00 ft-lbs		

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

Other Acceptable Sizes & Spacings

Toe: #4@ 9.25 in, #5@ 14.35 in, #6@ 20.37 in, #7@ 27.77 in, #8@ 36.57 in, #9@ 46.29 in, #10@ 58.79 in

Heel: phiMn = phi*5*lambda*sqrt(fc)*Sm

Key: phiMn = phi*5*lambda*sqrt(fc)*Sm

Min footing T&S reinf Area	1.04	in2
Min footing T&S reinf Area per foot	0.26	in2 /ft
If one layer of horizontal bars:	If two lay	ers of horizontal bars:
#4@ 9.26 in	#4@1	8.52 in
#5@ 14.35 in	#5@ 2	8.70 in
#6@ 20.37 in	#6@4	0.74 in

LIC# : KW-06016450, Build:20.24.05.02

Project File: Retaining Walls - Updated.ec6

DESCRIPTION: 8' Retained - EQ (P_LINE)

QUANTUM CONSULTING ENGINEERS

(c) ENERCALC INC 1983-2023

Summary of Overturning & Resisting Forces & Moments

		OV	ERTURNING			RE	SISTING	
Item		Force lbs	Distance ft	Moment ft-#		Force Ibs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	1,417.5	3.00	4,252.5	Soil Over HL (ab. water tbl)	483.2	3.75	1,811.2
HL Act Pres (be water tbl Hydrostatic Force	<i>,</i>	, -		,	Soil Over HL (bel. water tbl) Water Table		3.75	1,811.2
Buoyant Force	=				Sloped Soil Over Heel =			
Surcharge over Heel	=				Surcharge Over Heel =			
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 =	169.8	1.42	240.3
Seismic Earth Load	=	453.6	4.50	2,041.2	Surcharge Over Toe =			
	=				Stem Weight(s) =	800.0	3.16	2,530.7
T - 4 - 1		4 074 4		0.000 7	Earth @ Stem Transitions =			
Total	=	1,871.1	O.T.M. =	6,293.7	Footing Weight =	600.0	2.00	1,200.0
					Key Weight =	100.0	0.50	50.0
Resisting/Overturning	-		=	1.36	Vert. Component =	682.6	4.00	2,730.4
Vertical Loads used for	or Soi	Pressure	= 2,835.6	6 lbs	Total =	2,835.6 lt	os R.M.=	8,562.5
If seismic is included, the	e OTI	V and slidir	g ratios		* Axial live load NOT included in resistance, but is included for			r overturning

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

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) 0.131 in

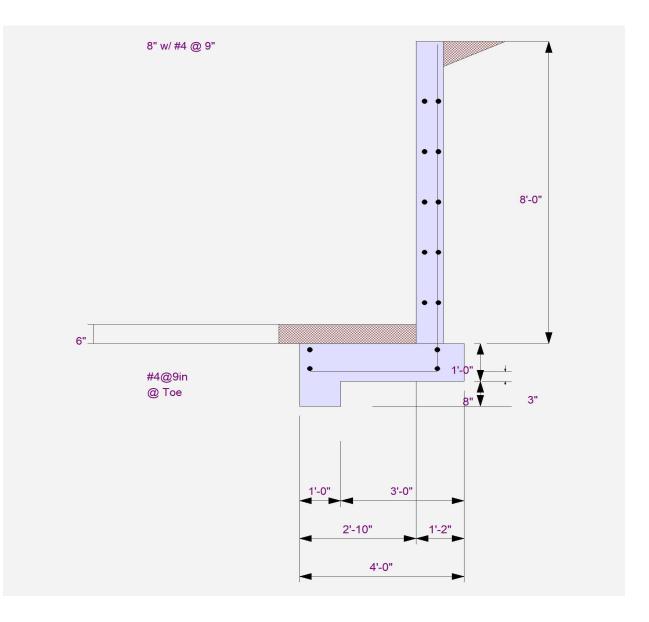
The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe,

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

Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023
DESCRIPTION: 8' Retained - EQ (P	_LINE)	
Rebar Lap & Embedment Lengths In	formation	
Stem Design Segment: Bottom		
Stem Design Height: 0.00 ft above top of fo	oting	
Lap Splice length for #4 bar specified in this ste	em design segment (25.4.2.4a) =	17.09 in
Development length for #4 bar specified in this	stem design segment =	13.15 in
Hooked embedment length into footing for #4 b	ar specified in this stem design segment =	5.63 in
As Provided =		0.2667 in2/ft
As Required =		0.2654 in2/ft

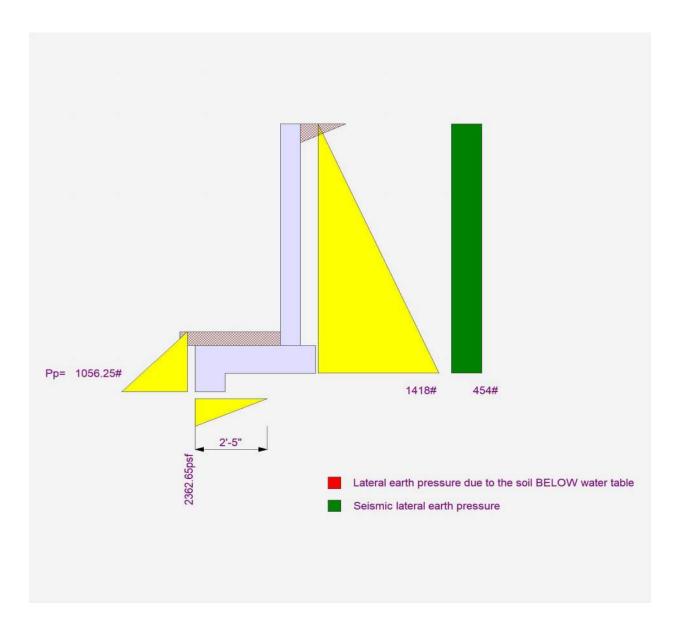
Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023

DESCRIPTION: 8' Retained - EQ (P_LINE)





DESCRIPTION: 8' Retained - EQ (P_LINE)



LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 8' Retained (P_LINE) QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

(c) ENERCALC INC 1983-2023

Code Reference

Calculations per IBC 2021 1807.3, ASCE 7-16

Criteria

Retained Height	=	8.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water table above		
bottom of footing	=	0.0 ft

Surcharge Loads

Surcharge Over Hee Used To Resist Slid Surcharge Over Toe Used for Sliding & C	ing & Ov =	0.0
Axial Load Appl	ied to S	Stem
Axial Dead Load	=	0.0 lbs

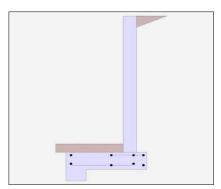
Axial Live Load	=	0.0 lbs
Axial Load Eccentricity	=	0.0 in

Soil Data			
Allow Soil Bearing		2,500.0 ps	f
Equivalent Fluid Pressure	e Metr	nod	
Active Heel Pressure	=	35.0 ps	f/ft
	=		
Passive Pressure	=	450.0 ps	f/ft
Soil Density, Heel	=	120.00 pc	f
Soil Density, Toe	=	120.00 pc	f
Footing Soil Friction	=	0.530	
Soil height to ignore			

Soil height to ignore for passive pressure = 0.00 in

Lateral Load Applied to Stem

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



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
Footing Type Base Above/Below Soil at Back of Wall	=	Spread Footing 0.0 ft

LIC# : KW-06016450, Build:20.24.05.02

QUANTUM CONSULTING ENGINEERS

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Project File: Retaining Walls - Updated.ec6

DESCRIPTION: 8' Retained (P_LINE)

	Stem Construction		Bottom			
_	Design Height Above Etc	_ , _	Stem OK			
	Design Height Above Ftg Wall Material Above "Ht"		0.00			
		=	Concrete SD	SD	SD	
	Design Method Thickness	=	8.00	5D	30	
	Rebar Size	=	8.00 # 4			
	Rebar Spacing	=	10.00			
	Rebar Placed at	_	Edge			
	Design Data		Luge			
	fb/FB + fa/Fa	=	0.735			
ЭK	Total Force @ Section					
ЭК	Service Level	lbs =				
	Strength Level	lbs =	1,792.0			
	MomentActual		2			
	Service Level	ft-# =				
	Strength Level	ft-# =	4,778.7			
ЭК	MomentAllowable	=	6,495.1			
ЭК	ShearActual		0,10011			
	Service Level	psi =				
	Strength Level	psi =	23.9			
	ShearAllowable	•	23.9 48.4			
		psi =	40.4			
	Anet (Masonry)	in2 =	100.0			
	Wall Weight	psf =	100.0			
)K	Rebar Depth 'd'	in =	6.25			
ЭК	Masonry Data					
IS	f'm					
sure	_	psi =				
Juici	Solid Grouting	psi = =				
	Modular Ratio 'n'	_				
	Equiv. Solid Thick.	=				
	Masonry Block Type	_				
	Masonry Design Method		ASD			
	Concrete Data					
	f'c	psi =	3,000.0			
	Fy	psi =	60,000.0			
	-		-			

Design Summary

Wall Stability Ratios Overturning Sliding Global Stability	= = =	2.01 1.81 1.29		
Total Bearing Load	=	2,836		
resultant ecc. Eccentricity within	= a mid	5.76	ın	
Soil Pressure @ Toe	=	1,219	psf	ОK
Soil Pressure @ Heel	=		, psf	
Allowable	=	2,500		
Soil Pressure Less	Than		-	
ACI Factored @ Toe ACI Factored @ Heel	=	1,296 211		
Footing Shear @ Toe	=	15.2	psi	OK
Footing Shear @ Heel	=	14.2	•	OK
Allowable	=	82.2	psi	
Sliding Calcs				
Lateral Sliding Force	=	1,417.5		
less 100% Passive Force		1,056.3		
less 100% Friction Force	-	.,		
Added Force Req'd	=		lbs lbs	
for 1.5 Stability	=	0.0	IDS	UN

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

1.200
1.600
1.600
1.000
1.000

Cantilevered Retaining Wall LIC# : KW-06016450, Build:20.24.05.02

DESCRIPTION: 8' Retained (P_LINE)

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.179 in2/ft	
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :
		One layer of : Two layers of :
Required Area :	0.179 in2/ft	#4@ 13.89 in #4@ 27.78 in
Provided Area :	0.24 in2/ft	#5@ 21.53 in #5@ 43.06 in
Maximum Area :	1.016 in2/ft	#6@ 30.56 in #6@ 61.11 in

Footing Data

Toe Width	=	2.83 ft
Heel Width	=	1.17
Total Footing Width	=	4.00
Footing Thickness	=	12.00 in
Key Width	=	12.00 in
Key Depth	=	8.00 in
Key Distance from To	e =	0.00 ft
f'c = 3,000 psi	Fy =	60,000 psi
Footing Concrete Der	nsity =	150.00 pcf
Min. As %	=	0.0018
Cover @ Top 2.0	0 @	Btm.= 3.00 in

Footing Design Results

QUANTUM CONSULTING ENGINEERS

		Toe	<u>Heel</u>	<u>Key</u>	
Factored Pressure	=	1,296	211		psf
Mu' : Upward	=	4,166	32		ft-#
Mu': Downward	=	1,009	718		ft-#
Mu: Design	=	3,156	686	694	ft-#
φ Mn	=	10,188	11,388	2,739	ft-#
Actual 1-Way Shear	=	15.23	14.23	12.34	psi
Allow 1-Way Shear	=	44.84	43.25	43.82	psi
Toe Reinforcing	=	# 4 @ 9.00 in			
Heel Reinforcing	=	# 4 @ 9.00 in			
Key Reinforcing	=	None Spec'd			
Footing Torsion, Tu		=	0.00 ft-lbs		
Footing Allow. Torsio	n, գ	Tn =	0.00 ft-lbs		

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

Other Acceptable Sizes & Spacings

Toe: #4@ 9.25 in, #5@ 14.35 in, #6@ 20.37 in, #7@ 27.77 in, #8@ 36.57 in, #9@ 46.29 in, #10@ 58.79 in

Heel: #4@ 9.25 in, #5@ 14.35 in, #6@ 20.37 in, #7@ 27.77 in, #8@ 36.57 in, #9@ 46.29 in, #10@ 58.79 in

Key: phiMn = phi*5*lambda*sqrt(fc)*Sm

Min footing T&S reinf Area	1.04 in2
Min footing T&S reinf Area per foot	0.26 in2 /ft
If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 9.26 in	#4@ 18.52 in
#5@ 14.35 in	#5@ 28.70 in
#6@ 20.37 in	#6@ 40.74 in

Project File: Retaining Walls - Updated.ec6

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LIC# : KW-06016450, Build:20.24.05.02

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

(c) ENERCALC INC 1983-2023

DESCRIPTION: 8' Retained (P_LINE)

Summary of Overturning & Resisting Forces & Moments

OVERTURNING			RESISTING				
Item	Force lbs	Distance ft	Moment ft-#		Force Ibs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl) HL Act Pres (be water tbl) Hydrostatic Force	1,417.5	3.00	4,252.5	Soil Over HL (ab. water tbl) Soil Over HL (bel. water tbl) Water Table	483.2	3.75 3.75	1,811.2 1,811.2
Buoyant Force = Surcharge over Heel = Surcharge Over Toe = Adjacent Footing Load =				Sloped Soil Over Heel = Surcharge Over Heel = Adjacent Footing Load = Axial Dead Load on Stem =			
Added Lateral Load = Load @ Stem Above Soil =				* Axial Live Load on Stem = Soil Over Toe = Surcharge Over Toe =	169.8	1.42	240.3
=				Stem Weight(s) = Earth @ Stem Transitions =	800.0	3.16	2,530.7
Total =	1,417.5	O.T.M. =	4,252.5	Footing Weight = Key Weight =	600.0 100.0	2.00 0.50	1,200.0 50.0
Resisting/Overturning Ra Vertical Loads used for S			2.01 5 lbs	Vert. Component = Total = * Axial live load NOT included in	682.6 2,835.6	4.00 os R.M.=	2,730.4 8,562.5

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 Modulus250.0pciHorizontal Defl @ Top of Wall (approximate only)0.068in

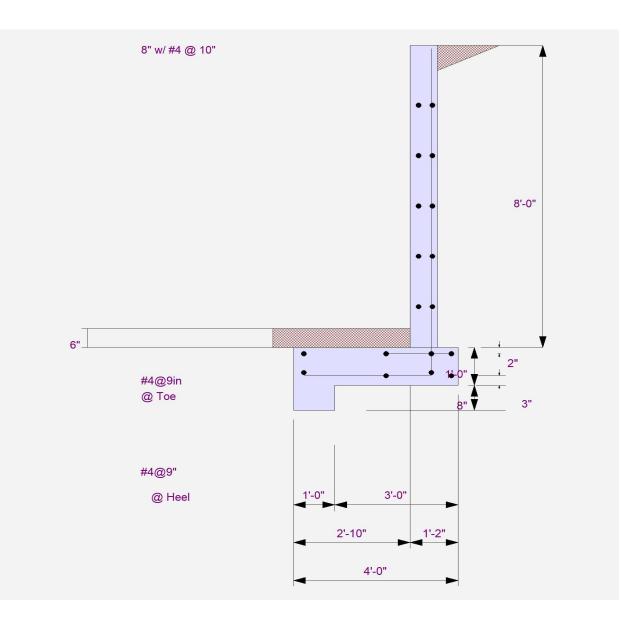
The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe,

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

Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6			
LIC# : KW-06016450, Build:20.24.05.02 QU	ANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023			
DESCRIPTION: 8' Retained (P_LINE)					
Rebar Lap & Embedment Lengths Information	1				
Stem Design Segment: Bottom					
Stem Design Height: 0.00 ft above top of footing					
Lap Splice length for #4 bar specified in this stem design se	egment (25.4.2.4a) =	17.09 in			
Development length for #4 bar specified in this stem design	13.15 in				
Hooked embedment length into footing for #4 bar specified	5.63 in				
As Provided =		0.2400 in2/ft			
As Required =		0.2387 in2/ft			

Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023

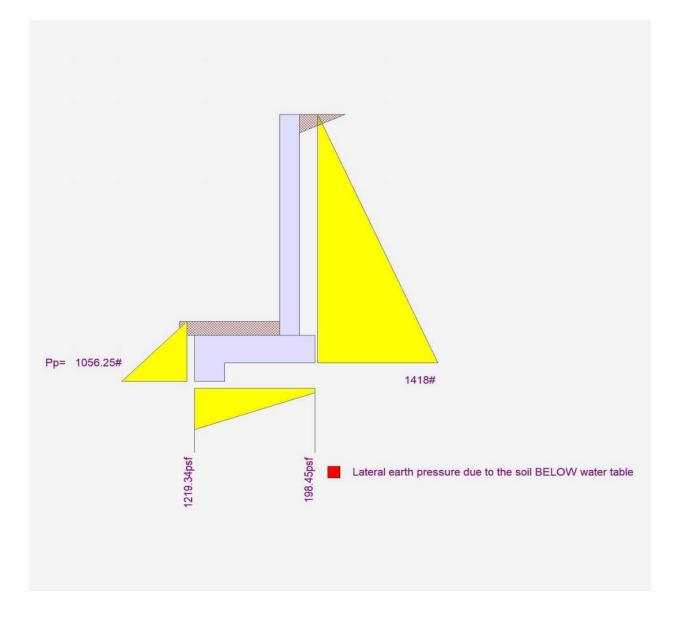
DESCRIPTION: 8' Retained (P_LINE)



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DESCRIPTION: 8' Retained (P_LINE)



LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 7' Retained - EQ (P_LINE)

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

(c) ENERCALC INC 1983-2023

Code Reference

Calculations per IBC 2021 1807.3, ASCE 7-16

Criteria

Retained Height	=	7.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water table above		
bottom of footing	=	0.0 ft

Surcharge Loads

Axial Load Applied to StemAxial Dead Load=0.0 lbsAxial Live Load=0.0 lbs	Surcharge Over Heel Used To Resist Sliding Surcharge Over Toe Used for Sliding & Ove	´= erturning	0.0
Axial Load Eccentricity _ 0.0 in	Axial Dead Load	=	0.0 lbs

Earth Pressure Seismic Load

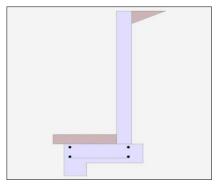
Method : Uniform Multiplier Used = 8.000 (Multiplier used on soil density)

Allow Soil Bearing Equivalent Fluid Pressure	= Meth	3,333.0 psf iod
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	450.0 psf/ft
Soil Density, Heel	=	120.00 pcf
Soil Density, Toe	=	120.00 pcf
Footing Soil Friction	=	0.530
Soil height to ignore for passive pressure	=	0.00 in

Soil Data

Lateral Load Applied to Stem

Lateral Load Height to Top Height to Bottom	= = =	0.0 #/ft 0.00 ft 0.00 ft
Load Type	=	Seismic (E) (Strength Level)
Wind on Exposed Sten (Strength Level)	n =	0.0 psf



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
r ooung rypo		opread r boung
Base Above/Below Soil at Back of Wall	=	0.0 ft

Uniform Seismic Force	=	64.000
Total Seismic Force	=	512.000

LIC# : KW-06016450, Build:20.24.05.02

Project File: Retaining Walls - Updated.ec6 (c) ENERCALC INC 1983-2023

DESCRIPTION: 7' Retained - EQ (P_LINE)

Design Summary		5	Stem Construction		Bottom			
			Design Height Above Ftg	ft =	Stem OK 0.00			
Wall Stability Ratios			Wall Material Above "Ht"		_			
Overturning	=	1.42 Ratio < 1.5	! Design Method	=	SD	SD	SD	
Sliding	=	1.58 OK	Thickness	=	8.00			
Global Stability	=	1.47	Rebar Size	=	# 4			
			Rebar Spacing	=	9.00			
Total Bearing Load	=	2.427 lbs	Rebar Placed at	=	Edge			
resultant ecc.	=	11.92 in	Design Data					
Eccentricity outs			fb/FB + fa/Fa	=	0.663			
Soil Pressure @ Toe	=	2,138 psf OK	Total Force @ Section					
Soil Pressure @ Heel	=	0 psf OK	Service Level	lbs =				
Allowable	=	3,333 psf	Strength Level	lbs =	1,820.0			
Soil Pressure Less ACI Factored @ Toe			MomentActual					
ACI Factored @ Toe ACI Factored @ Heel	=	2,328 psf 0 psf	Service Level	ft-# =				
		•	Strength Level	ft-# =	4,769.3			
Footing Shear @ Toe	=	19.4 psi OK	MomentAllowable	=	7,185.3			
Footing Shear @ Heel	=	12.2 psi OK	ShearActual					
Allowable	=	82.2 psi	Service Level	psi =				
Sliding Color			Strength Level	, psi =				
Sliding Calcs Lateral Sliding Force		1.478.4 lbs	ShearAllowable	psi =	-			
less 100% Passive Ford	= •e -	1,478.4 lbs 1.056.3 lbs	Anet (Masonry)	in2 =				
less 100% Friction Ford		1,286.3 lbs	Wall Weight	psf =				
	_	0.0 lbs OK	•	•				
Added Force Req'd	=		Rebar Depth 'd'	in =	6.25			
for 1.5 Stability	=	0.0 lbs OK	Masonry Data					
Vertical component of activ	o lator	21 anussara lias le	f'm	no: -				
considered in the calculatio				psi = psi =				
		n boaring procedues.	Solid Grouting	psi –				
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		1.000	f'c	psi =	3,000.0			
Seismic, E		1.000		psi =	,			
Seismic, E		1.000	Fy	psi =	60,000.0			

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6 (c) ENERCALC INC 1983-2023

LIC# : KW-06016450, Build:20.24.05.02 QU/ DESCRIPTION: 7' Retained - EQ (P_LINE)

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinfo	orcing
As (based on applied moment) :	0.1787 in2/ft		
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinfo	orcing Options :
		One layer of :	Two layers of :
Required Area :	0.1787 in2/ft	#4@ 13.89 in	#4@ 27.78 in
Provided Area :	0.2667 in2/ft	#5@ 21.53 in	#5@ 43.06 in
Maximum Area :	1.016 in2/ft	#6@ 30.56 in	#6@ 61.11 in

Footing Data

Toe Width	=	2.33 ft
Heel Width	= _	1.17
Total Footing Width	=	3.50
Footing Thickness	=	12.00 in
Key Width	=	12.00 in
Key Depth	=	8.00 in
Key Distance from Toe	9 =	0.00 ft
f'c = 3,000 psi	Fy =	60,000 psi
Footing Concrete Dens	sity =	150.00 pcf
Min. As %	=	0.0018
Cover @ Top 2.00) @	Btm.= 3.00 in

Footing Design Results

		Toe	<u>Heel</u>	<u>Key</u>	
Factored Pressure	=	2,328	0		psf
Mu' : Upward	=	4,157	0		ft-#
Mu' : Downward	=	684	585		ft-#
Mu: Design	=	3,473	585	685	ft-#
φ Mn	=	10,188	2,739	2,739	ft-#
Actual 1-Way Shear	=	19.40	12.17	12.23	psi
Allow 1-Way Shear	=	44.84	43.82	43.82	psi
Toe Reinforcing	=	# 4 @ 9.00 in			
Heel Reinforcing	=	None Spec'd			
Key Reinforcing	=	None Spec'd			
Footing Torsion, Tu		=	0.00 ft-lbs		
Footing Allow. Torsio	n, q	oTn =	0.00 ft-lbs		

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

Other Acceptable Sizes & Spacings

Toe: #4@ 9.25 in, #5@ 14.35 in, #6@ 20.37 in, #7@ 27.77 in, #8@ 36.57 in, #9@ 46.29 in, #10@ 58.79 in

Heel: phiMn = phi*5*lambda*sqrt(fc)*Sm

Key: phiMn = phi*5*lambda*sqrt(fc)*Sm

Min footing T&S reinf Area	0.91 in2
Min footing T&S reinf Area per foot	0.26 in2 /ft
If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 9.26 in	#4@ 18.52 in
#5@ 14.35 in	#5@ 28.70 in
#6@ 20.37 in	#6@ 40.74 in

LIC# : KW-06016450, Build:20.24.05.02

Project File: Retaining Walls - Updated.ec6

DESCRIPTION: 7' Retained - EQ (P_LINE)

QUANTUM CONSULTING ENGINEERS

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Summary of Overturning & Resisting Forces & Moments

		OV	ERTURNING			RE	SISTING	
Item	F	Force Ibs	Distance ft	ft-#		Force Ibs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl))	1,120.0	2.67	2,986.7	Soil Over HL (ab. water tbl)	422.8	3.25	1,373.4
HL Act Pres (be water tbl) Hydrostatic Force		,	-	,	Soil Over HL (bel. water tbl) Water Table		3.25	1,373.4
Buoyant Force	=				Sloped Soil Over Heel =			
Surcharge over Heel	=				Surcharge Over Heel =			
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 =	139.8	1.17	162.9
Seismic Earth Load	=	358.4	4.00	1,433.6	Surcharge Over Toe =			
	=			·	Stem Weight(s) =	700.0	2.66	1,864.3
- / -		4 470 4			Earth @ Stem Transitions =			
Total	=	1,478.4	O.T.M. =	4,420.3	Footing Weight =	525.0	1.75	918.8
					Key Weight =	100.0	0.50	50.0
Resisting/Overturning	,			1.42	Vert. Component =	539.3	3.50	1,887.7
Vertical Loads used fo	or Soil F	ressure =	= 2,426.9) lbs	Total =	2,426.9	os R.M.=	6,257.0
If seismic is included, the	OTM a	and slidin	g ratios		* Axial live load NOT included in resistance, but is included for			r overturning

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

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

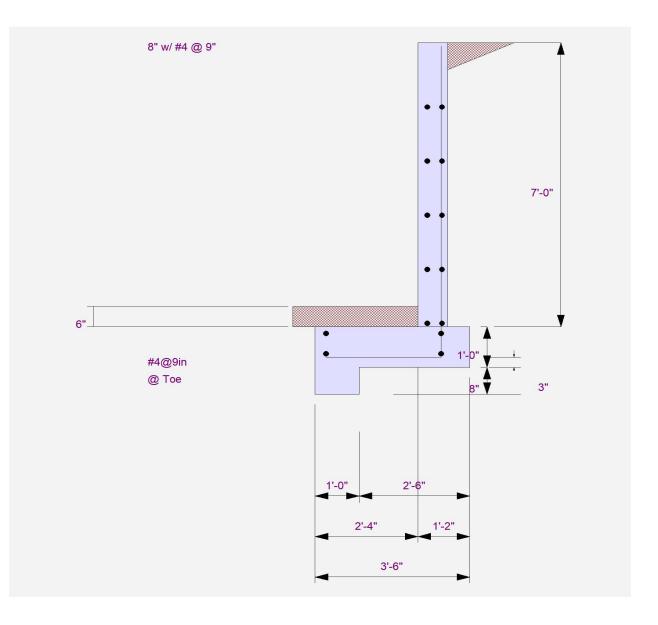
The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe,

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

Cantilevered Retaining Wall	Project File: Retaining Walls - Updated.ec6		
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-	
DESCRIPTION: 7' Retained - EQ (P_LI	NE)		
Rebar Lap & Embedment Lengths Infor	mation		
Stem Design Segment: Bottom			
Stem Design Height: 0.00 ft above top of footing]		
Lap Splice length for #4 bar specified in this stem d	esign segment (25.4.2.4a) =	17.09 in	
Development length for #4 bar specified in this sten	n design segment =	13.15 in	
Hooked embedment length into footing for #4 bar s	pecified in this stem design segment =	5.63 in	
As Provided =		0.2667 in2/ft	
As Required =		0.2383 in2/ft	

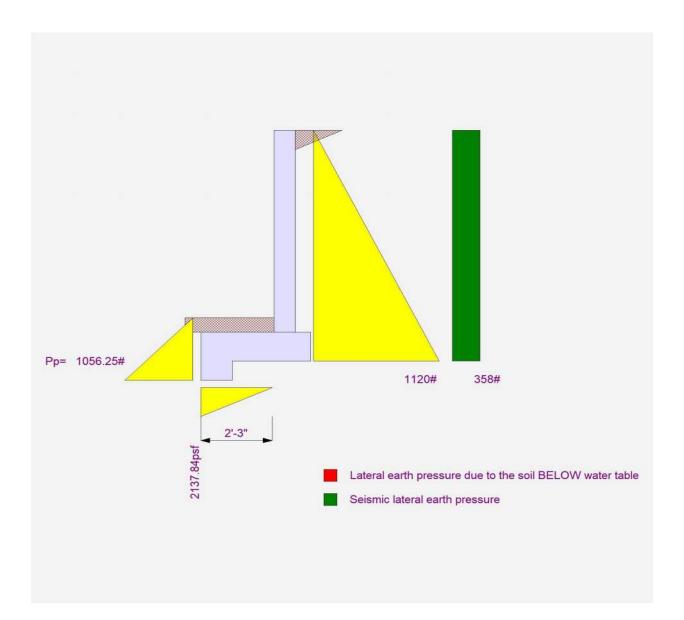
Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023

DESCRIPTION: 7' Retained - EQ (P_LINE)





DESCRIPTION: 7' Retained - EQ (P_LINE)



LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 7' Retained (P_LINE) QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

(c) ENERCALC INC 1983-2023

Code Reference

Calculations per IBC 2021 1807.3, ASCE 7-16

Criteria

Retained Height	=	7.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water table above		
bottom of footing	=	0.0 ft

Surcharge Loads

Surcharge Over Hee Used To Resist Slid Surcharge Over Toe Used for Sliding & C	ling & Ov =	0.0
Axial Load Appl	ied to S	Stem
Axial Dead Load	=	0.0 lbs

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

Soil Data		
Allow Soil Bearing Equivalent Fluid Pressure		2,500.0 psf nod
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	450.0 psf/ft
Soil Density, Heel	=	120.00 pcf
Soil Density, Toe	=	120.00 pcf
Footing Soil Friction	=	0.600
Soil height to ignore for passive pressure	=	0.00 in

Lateral Load Applied to Stem

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

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		

LIC# : KW-06016450, Build:20.24.05.02

QUANTUM CONSULTING ENGINEERS

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Project File: Retaining Walls - Updated.ec6

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DESCRIPTION: 7' Retained (P_LINE)

Design Summary			Stem Construction	_	Bottom			
			Design Height Above Ftg	ft =	Stem OK 0.00			
Wall Stability Ratios			Wall Material Above "Ht"	=	Concrete			
Overturning	=	1.95 OK	Design Method	_	SD	SD	SD	
Sliding	=	1.68 OK	Thickness	_	8.00	00	00	
Global Stability	=	1.47	Rebar Size	=	# 4			
			Rebar Spacing	=	9.00			
Total Bearing Load	=	2,293 lbs	Rebar Placed at	=	5.75 i			
resultant ecc.	=	5.12 in	Design Data					
Eccentricity with	n mid		fb/FB + fa/Fa	=	0.486			
Soil Pressure @ Toe	=	1,213 psf OK	Total Force @ Section					
Soil Pressure @ Heel	=	160 psf OK	Service Level	lbs =				
Allowable		2,500 psf	Strength Level	lbs =	1,372.0			
Soil Pressure Less			MomentActual					
ACI Factored @ Toe ACI Factored @ Heel	=	1,299 psf	Service Level	ft-# =				
	=	171 psf	Strength Level	ft-# =	3,201.3			
Footing Shear @ Toe	=	9.5 psi OK	MomentAllowable	=	6,585.3			
Footing Shear @ Heel	=	11.1 psi OK	ShearActual					
Allowable	=	82.2 psi	Service Level	psi =				
			Strength Level	psi =	19.9			
Sliding Calcs			ShearAllowable	•	51.6			
Lateral Sliding Force	=	1,120.0 lbs		psi =	01.0			
less 100% Passive Force	-	506.3 lbs	Anet (Masonry)	in2 =				
less 100% Friction Force	_	1,376.0 lbs	Wall Weight	psf =	100.0			
Added Force Req'd	=	0.0 lbs OK	Rebar Depth 'd'	in =	5.75			
for 1.5 Stability	=	0.0 lbs OK	Maganny Data					
		-1 '1	Masonry Data					
Vertical component of active				psi =				
considered in the calculation	10150	bil bearing pressures	Solid Grouting	psi =				
Load Factors			0	=				
Building Code			Modular Ratio 'n'					
Dead Load		1.200	Equiv. Solid Thick. Masonry Block Type	=				
Live Load		1.600	Masonry Design Method		ASD			
Earth, H		1.600	Concrete Data	=	ASD			
Wind, W		1.000	f'c	psi =	3,000.0			
Seismic, E		1.000	Fy	psi =	60,000.0			
, _			• 3	P01 -	00,000.0			

LIC# : KW-06016450, Build:20.24.05.02

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

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DESCRIPTION: 7' Retained (P_LINE)

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinfo	orcing
As (based on applied moment) :	0.131 in2/ft		
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinfo	orcing Options :
		One layer of :	Two layers of :
Required Area :	0.1728 in2/ft	#4@ 13.89 in	#4@ 27.78 in
Provided Area :	0.2667 in2/ft	#5@ 21.53 in	#5@ 43.06 in
Maximum Area :	0.9347 in2/ft	#6@ 30.56 in	#6@ 61.11 in
Footing Data	Easting	Docian Poculte	

Footing Data

Toe Width	=	2.17 ft
Heel Width	=	1.17
Total Footing Width	=	3.34
Footing Thickness	=	12.00 in

f'c = 3,00	00 psi l	Fy =	60,0	00 psi
Footing Concre	ete Density		150	.00 pcf
Min. As %	2.00	=	0.00	18
Cover @ Top		@	Btm. =	3.00 in

Footing Design Results

		Toe	Heel	
Factored Pressure	=	1,299	171	psf
Mu' : Upward	=	2,484	29	ft-#
Mu' : Downward	=	593	585	ft-#
Mu: Design	=	1,890	556	ft-#
φ Mn	=	2,739	2,739	ft-#
Actual 1-Way Shear	=	9.46	11.10	psi
Allow 1-Way Shear	=	43.82	43.82	psi
Toe Reinforcing	=	None Spec'd		
Heel Reinforcing	=	None Spec'd		
Key Reinforcing	=	None Spec'd		
Footing Torsion, Tu		=	0.00 ft-lb	s
Footing Allow. Torsion	η, φ	Tn =	0.00 ft-lb	s

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

Other Acceptable Sizes & Spacings

Toe: phiMn = phi*5*lambda*sqrt(fc)*Sm

Heel: phiMn = phi*5*lambda*sqrt(fc)*Sm

Key: No key defined

Min footing T&S reinf Area	0.87	in2
Min footing T&S reinf Area per foot	0.26	in2 /ft
If one layer of horizontal bars:	If two lay	ers of horizontal bars:
#4@ 9.26 in	#4@1	8.52 in
#5@ 14.35 in	#5@ 2	8.70 in
#6@ 20.37 in	#6@4	0.74 in

LIC# : KW-06016450, Build:20.24.05.02

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

(c) ENERCALC INC 1983-2023

DESCRIPTION: 7' Retained (P_LINE)

Summary of Overturning & Resisting Forces & Moments

	OV	ERTURNING			RE	SISTING	
Item	Force lbs	Distance ft	Moment ft-#		Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	1,120.0	2.67	2,986.7	Soil Over HL (ab. water tbl)	422.8	3.09	1,305.7
HL Act Pres (be water tbl)	,		,	Soil Over HL (bel. water tbl)		3.09	1,305.7
Hydrostatic Force				Water Table			
Buoyant Force =				Sloped Soil Over Heel =			
Surcharge over Heel =				Surcharge Over Heel =			
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 =	130.2	1.09	141.3
= =				Surcharge Over Toe =			
=				Stem Weight(s) =	700.0	2.50	1,752.3
				Earth @ Stem Transitions =			,
Total =	1,120.0	O.T.M. =	2,986.7	Footing Weight =	501.0	1.67	836.7
				Key Weight =			
Resisting/Overturning Rat		=	1.95	Vert. Component =	539.3	3.34	1,801.4
Vertical Loads used for So	il Pressure	= 2,293.3	3 lbs	Total =	2.293.3	os R.M.=	5,837.4

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) 0.071 in

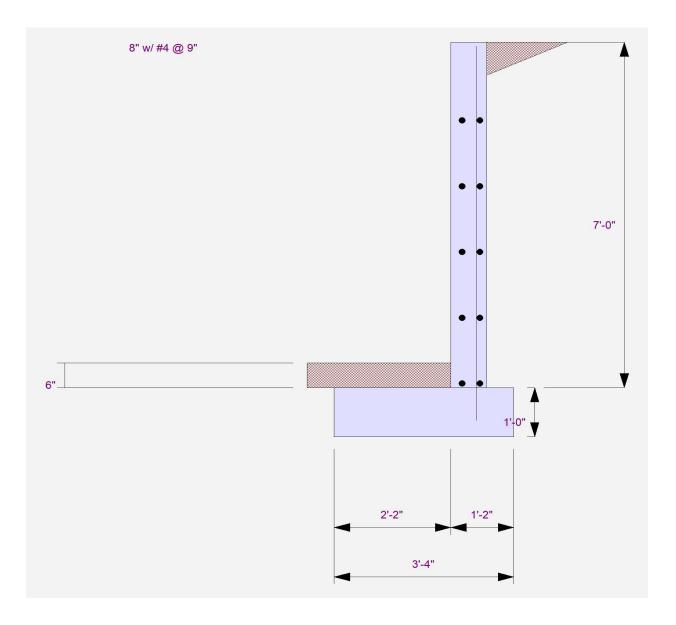
The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe,

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

Cantilevered Retaining Wall	Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02 QUA	TUM CONSULTING ENGINEERS (c) ENERCALC INC 1983-2023
DESCRIPTION: 7' Retained (P_LINE)	
Rebar Lap & Embedment Lengths Information	
Stem Design Segment: Bottom	
Stem Design Height: 0.00 ft above top of footing	
Lap Splice length for #4 bar specified in this stem design seg	nent (25.4.2.4a) = 17.09 in
Development length for #4 bar specified in this stem design s	egment = 13.15 in
Hooked embedment length into footing for #4 bar specified in	this stem design segment = 5.63 in
As Provided =	0.2667 in2/ft
As Required =	0.1746 in2/ft

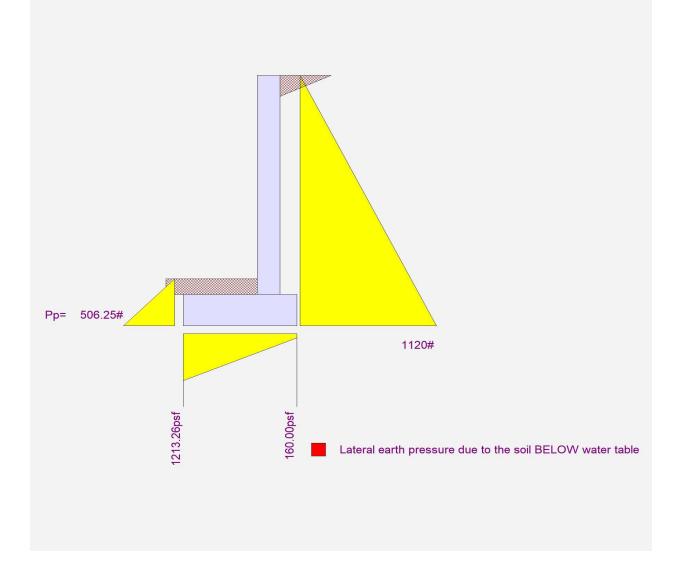
Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023

DESCRIPTION: 7' Retained (P_LINE)



DESCRIPTION: 7' Retained (P_LINE)





LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 6' Retained - EQ (P_Line)

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

(c) ENERCALC INC 1983-2023

Code Reference

Calculations per IBC 2021 1807.3, ASCE 7-16

Criteria

Retained Height	=	6.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water table above		
bottom of footing	=	0.0 ft

Surcharge Loads

Surcharge Over Heel Used To Resist Sliding Surcharge Over Toe Used for Sliding & Ove Axial Load Applied	= erturning	0.0
Axial Dead Load Axial Live Load Axial Load Eccentricity	= = =	0.0 lbs 0.0 lbs 0.0 in

Earth Pressure Seismic Load

Method : Uniform Multiplier Used = 8.000 (Multiplier used on soil density)

Allow Soil Bearing Equivalent Fluid Pressure	= Moth	3,333.0	psf
Active Heel Pressure	=		psf/ft
	=		
Passive Pressure	=	450.0	psf/ft
Soil Density, Heel	=	120.00	pcf
Soil Density, Toe	=	120.00	pcf
Footing Soil Friction	=	0.530	
Soil height to ignore for passive pressure	=	0.00	in

Soil Data

Lateral Load Applied to Stem

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

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

Uniform Seismic Force = 56.000 Total Seismic Force = 392.000

LIC# : KW-06016450, Build:20.24.05.02

Project File: Retaining Walls - Updated.ec6 (c) ENERCALC INC 1983-2023

DESCRIPTION: 6' Retained - EQ (P_Line)

Design Summary		S	tem Construction		Bottom			
			Design Height Above Ftg	ft =	Stem OK 0.00			
Wall Stability Ratios			Wall Material Above "Ht"		_			
Overturning	=	1.39 Ratio < 1.5		=	SD	SD	SD	
Sliding	=	1.30 Ratio < 1.5	Thickness	=	8.00			
Global Stability	=	1.60	Rebar Size	=	# 4			
,			Rebar Spacing	=	12.00			
Total Bearing Load	=	1.823 lbs	Rebar Placed at	=	5.75 i			
resultant ecc.	=	10.41 in	Design Data					
Eccentricity outsi	de mi		fb/FB + fa/Fa	=	0.605			
Soil Pressure @ Toe	=	1,922 psf OK	Total Force @ Section					
Soil Pressure @ Heel	=	0 psf OK	Service Level	lbs =				
Allowable	=	3,333 psf	Strength Level	lbs =	1,344.0			
Soil Pressure Less			MomentActual					
ACI Factored @ Toe	=	2,081 psf	Service Level	ft-# =				
ACI Factored @ Heel	=	0 psf	Strength Level	ft-# =	3,024.0			
Footing Shear @ Toe	=	11.8 psi OK	MomentAllowable	=	4,998.0			
Footing Shear @ Heel	=	8.4 psi OK	ShearActual		,			
Allowable	=	82.2 psi	Service Level	psi =				
			Strength Level	psi =	19.5			
Sliding Calcs			ShearAllowable	•	46.9			
Lateral Sliding Force	=	1,131.9 lbs		psi =	46.9			
less 100% Passive Force		506.3 lbs	Anet (Masonry)	in2 =				
less 100% Friction Force		966.2 lbs	Wall Weight	psf =	100.0			
Added Force Req'd	=	0.0 lbs OK	Rebar Depth 'd'	in =	5.75			
for 1.5 Stability	=	225.4 lbs NG	Maaanmy Data					
	- -+		Masonry Data					
ertical component of active			Fs	psi =				
onsidered in the calculation	norse	bil bearing pressures.	Solid Grouting	psi =				
Load Factors			Modular Ratio 'n'	=				
Building Code								
Dead Load		1.200	Equiv. Solid Thick.	=				
Live Load		1.600	Masonry Block Type	=				
Earth, H		1.600	Masonry Design Method	=	ASD			
Wind, W		1.000	f'c	psi =	3,000.0			
Seismic, E		1.000	Fy	psi =	60,000.0			
Colonio, L		1.000	i y	P31 =	00,000.0			

Cantilevered Retaining Wall LIC# : KW-06016450, Build:20.24.05.02

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

(c) ENERCALC INC 1983-2023

DESCRIPTION: 6' Retained - EQ (P_Line)

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing Horizontal Reinforcing			
As (based on applied moment) :	0.1237 in2/ft			
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinf	orcing Options :	
		One layer of :	Two layers of :	
Required Area :	0.1728 in2/ft	#4@ 13.89 in	#4@ 27.78 in	
Provided Area :	0.2 in2/ft	#5@ 21.53 in	#5@ 43.06 in	
Maximum Area :	0.9347 in2/ft	#6@ 30.56 in	#6@ 61.11 in	
Footing Data	Footing Design Results			

Toe Width	=	2.00 ft
Heel Width	=	1.00
Total Footing Width	= _	3.00
Footing Thickness	=	12.00 in

f'c = 3,0	000 psi F	⁻ y_=	60,0	000 psi
Footing Concr	ete Density		150	.00 pcf
Min. As % Cover @ Top	2.00	= @	0.00)18 3.00 in

Tee

		Toe	<u>Heel</u>	
Factored Pressure	=	2,081	0	psf
Mu' : Upward	=	2,700	0	ft-#
Mu': Downward	=	504	278	ft-#
Mu: Design	=	2,196	278	ft-#
φ Mn	=	2,739	2,739	ft-#
Actual 1-Way Shear	=	11.81	8.41	psi
Allow 1-Way Shear	=	43.82	43.82	psi
Toe Reinforcing	=	None Spec'd		
Heel Reinforcing	=	None Spec'd		
Key Reinforcing	=	None Spec'd		
Footing Torsion, Tu		=	0.00 ft-lb	s
Footing Allow. Torsio	n, q	Tn =	0.00 ft-lb	s

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

Other Acceptable Sizes & Spacings

Toe: phiMn = phi*5*lambda*sqrt(fc)*Sm

Heel: phiMn = phi*5*lambda*sqrt(fc)*Sm

Key: No key defined

n footing T&S reinf Area
1 footing T&S reinf Area per foot
ne layer of horizontal bars:
#4@ 9.26 in
≴5@ 14.35 in
≇6@ 20.37 in
n footing T&S reinf Area per foot ne layer of horizontal bars: #4@ 9.26 in #5@ 14.35 in

LIC# : KW-06016450, Build:20.24.05.02

Project File: Retaining Walls - Updated.ec6

DESCRIPTION: 6' Retained - EQ (P_Line)

QUANTUM CONSULTING ENGINEERS

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Summary of Overturning & Resisting Forces & Moments

		OV	ERTURNING.			RE	SISTING	
Item		Force lbs	Distance ft	Moment ft-#		Force Ibs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl	I)	857.5	2.33	2,000.8	Soil Over HL (ab. water tbl)	240.0	2.83	680.0
HL Act Pres (be water tbl Hydrostatic Force	,			_,	Soil Over HL (bel. water tbl) Water Table		2.83	680.0
Buoyant Force	=				Sloped Soil Over Heel =			
Surcharge over Heel	=				Surcharge Over Heel =			
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 Soi	=				Soil Over Toe =	120.0	1.00	120.0
Seismic Earth Load	=	274.4	3.50	960.4	Surcharge Over Toe =			
	=				Stem Weight(s) =	600.0	2.33	1,400.0
					Earth @ Stem Transitions =			
Total	=	1,131.9	O.T.M. =	2,961.2	Footing Weight =	450.0	1.50	675.0
					Key Weight =			
Resisting/Overturning				1.39	Vert. Component =	412.9	3.00	1,238.8
Vertical Loads used for	or Soil	Pressure	= 1,822.9	lbs	Total =	1,822.9	os R.M.=	4,113.8
If seismic is included, the	e OTM	l and slidin	a ratios		* Axial live load NOT included resistance, but is included for			r overturning

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

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) 0.107 in

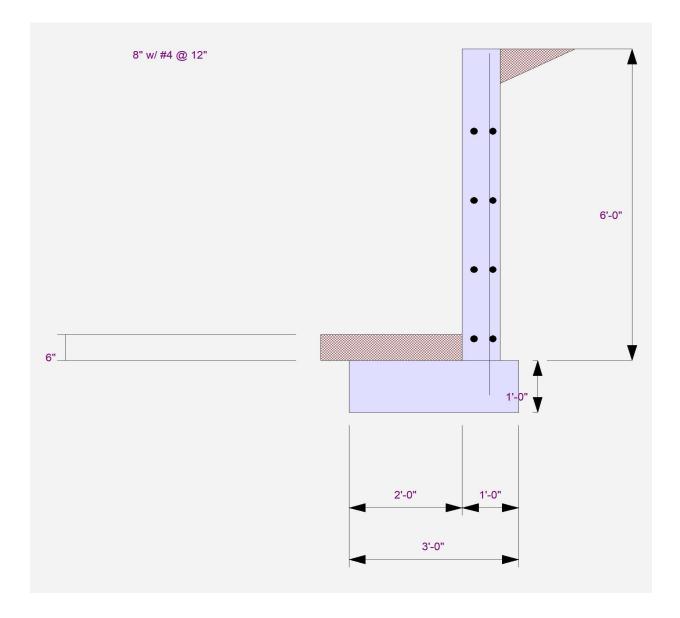
The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe,

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

Cantilevered Retaining Wall	Project File: Retaining Walls - Updated.ec6		
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983	
DESCRIPTION: 6' Retained - EQ (P_	Line)		
Rebar Lap & Embedment Lengths Info	ormation		
Stem Design Segment: Bottom			
Stem Design Height: 0.00 ft above top of foo	ting		
Lap Splice length for #4 bar specified in this ster	n design segment (25.4.2.4a) =	17.09 in	
Development length for #4 bar specified in this s	tem design segment =	13.15 in	
Hooked embedment length into footing for #4 ba	r specified in this stem design segment =	5.63 in	
As Provided =		0.2000 in2/ft	
As Required =		0.1728 in2/ft	

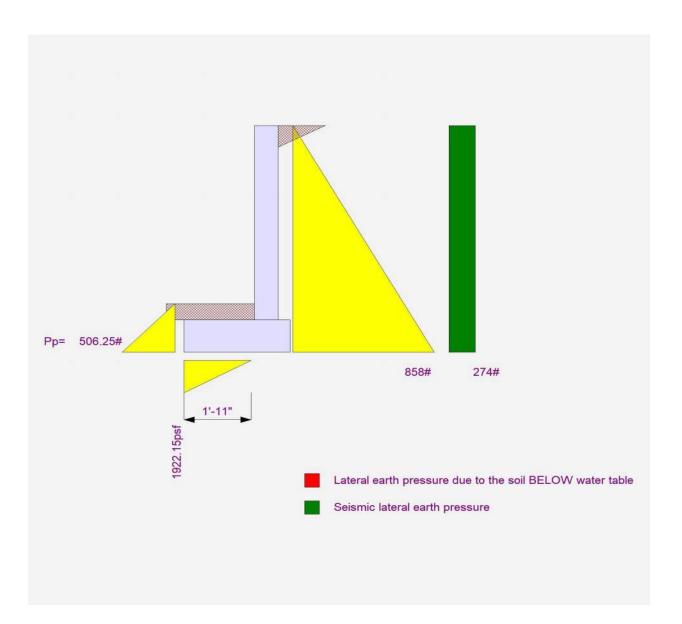
Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023

DESCRIPTION: 6' Retained - EQ (P_Line)





DESCRIPTION: 6' Retained - EQ (P_Line)



LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 6' Retained (P_Line) QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

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Code Reference

Calculations per IBC 2021 1807.3, ASCE 7-16

Criteria

Retained Height	=	6.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	12.00 in
Water table above		
bottom of footing	=	0.0 ft

Surcharge Loads

Surcharge Over Hee Used To Resist Slid Surcharge Over Toe Used for Sliding & C	ling & Ov =	0.0
Axial Load Appl	ied to S	Stem
Axial Dead Load	=	0.0 lbs

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

Allow Soil Bearing Equivalent Fluid Pressure	= Meth	2,500.0	psf
Active Heel Pressure	=		psf/ft
	=		
Passive Pressure	=	450.0	psf/ft
Soil Density, Heel	=	120.00	pcf
Soil Density, Toe	=	120.00	pcf
Footing Soil Friction	=	0.530	
Soil height to ignore for passive pressure	=	0.00	in

Soil Data

Lateral Load Applied to Stem

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

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		

LIC# : KW-06016450, Build:20.24.05.02

QUANTUM CONSULTING ENGINEERS

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Project File: Retaining Walls - Updated.ec6

DESCRIPTION: 6' Retained (P_Line)

Design	Summary
--------	---------

Wall Stability Ratios Overturning Sliding Global Stability	= = =	2.12 OK 2.25 OK 1.79
Total Bearing Load resultant ecc. Eccentricity withi	= = n middle	1,943 lbs 4.21 in e third
Soil Pressure @ Toe Soil Pressure @ Heel Allowable Soil Pressure Less ACI Factored @ Toe	= = =	1,102 psf OK 193 psf OK 2,500 psf
ACI Factored @ Heel Footing Shear @ Toe Footing Shear @ Heel	- - -	213 psf 6.8 psi OK 7.7 psi OK
Allowable Sliding Calcs	=	82.2 psi
Lateral Sliding Force less 100% Passive Force less 100% Friction Force Added Force Req'd for 1.5 Stability		857.5 lbs 900.0 lbs ,029.8 lbs 0.0 lbs OK 0.0 lbs OK

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

Less I Frankright	
Load Factors	
Building Code	
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.000
Seismic, E	1.000

St	em Construction	_	Bottom		
	Design Height Above Ftg	ft =	Stem OK 0.00		
	Wall Material Above "Ht"	=	Concrete		
	Design Method	_	SD	SD	SD
	Thickness	_	8.00	00	00
	Rebar Size	_	# 4		
	Rebar Spacing	=	12.00		
	Rebar Placed at	=	5.75 i		
	Design Data				
	fb/FB + fa/Fa	=	0.403		
	Total Force @ Section				
	Service Level	lbs =			
	Strength Level	lbs =	1,008.0		
	MomentActual				
	Service Level	ft-# =			
	Strength Level	ft-# =	2,016.0		
	MomentAllowable	=	4,998.0		
	ShearActual				
	Service Level	psi =			
	Strength Level	psi =	14.6		
	ShearAllowable	psi =	46.9		
	Anet (Masonry)	in2 =			
	Wall Weight	psf =	100.0		
	Rebar Depth 'd'	in =	5.75		
	Rebai Deptiti u	=	5.75		
	Masonry Data				
	f'm	psi =			
es.	Fs	psi =			
	Solid Grouting	. =			
	Modular Ratio 'n'	=			
	Equiv. Solid Thick.	=			
	Masonry Block Type	=			
	Masonry Design Method	=	ASD		
	Concrete Data				
	f'c	psi =	3,000.0		
	Fy	psi =	60,000.0		

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

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LIC# : KW-06016450, Build:20.24.05.02 **DESCRIPTION:** 6' Retained (P_Line)

Cantilevered Retaining Wall

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinfo	Horizontal Reinforcing	
As (based on applied moment) :	0.0825 in2/ft			
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinfo	orcing Options :	
		One layer of :	Two layers of :	
Required Area :	0.1728 in2/ft	#4@ 13.89 in	#4@ 27.78 in	
Provided Area :	0.2 in2/ft	#5@ 21.53 in	#5@ 43.06 in	
Maximum Area :	0.9347 in2/ft	#6@ 30.56 in	#6@ 61.11 in	
Footing Data	Footing	Design Results		

FOOLING Data

Toe Width	=	2.00 ft
Heel Width	=	1.00
Total Footing Width	=	3.00
Footing Thickness	=	12.00 in

f'c = 3,00	00 psi I	=y_=	60,0	00 psi
Footing Concre	ete Density		150	.00 pcf
Min. As % Cover @ Top	2.00	= @		18 3.00 in

rooting Design Results

		<u>Toe</u>	<u>Heel</u>	
Factored Pressure	=	1,215	213	psf
Mu' : Upward	=	1,984	14	ft-#
Mu' : Downward	=	648	278	ft-#
Mu: Design	=	1,336	264	ft-#
φ Mn	=	2,739	2,739	ft-#
Actual 1-Way Shear	=	6.75	7.66	psi
Allow 1-Way Shear	=	43.82	43.82	psi
Toe Reinforcing	=	None Spec'd		
Heel Reinforcing	=	None Spec'd		
Key Reinforcing	=	None Spec'd		
Footing Torsion, Tu		=	0.00 ft-lb	S
Footing Allow. Torsion	n, q	Tn =	0.00 ft-lb	S

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

Other Acceptable Sizes & Spacings

Toe: phiMn = phi*5*lambda*sqrt(fc)*Sm

Heel: phiMn = phi*5*lambda*sqrt(fc)*Sm

Key: No key defined

n footing T&S reinf Area
1 footing T&S reinf Area per foot
ne layer of horizontal bars:
#4@ 9.26 in
≴5@ 14.35 in
≇6@ 20.37 in
n footing T&S reinf Area per foot ne layer of horizontal bars: #4@ 9.26 in #5@ 14.35 in

LIC#: KW-06016450, Build:20.24.05.02

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

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DESCRIPTION: 6' Retained (P_Line)

Summary of Overturning & Resisting Forces & Moments

		ERTURNING				SISTING	
Item	Force lbs	Distance ft	ft-#		Force Ibs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	857.5	2.33	2,000.8	Soil Over HL (ab. water tbl)	240.0	2.83	680.0
HL Act Pres (be water tbl)			,	Soil Over HL (bel. water tbl) Water Table		2.83	680.0
Hydrostatic Force Buoyant Force =				Sloped Soil Over Heel =			
Surcharge over Heel =				Surcharge Over Heel =			
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 =	240.0	1.00	240.0
=				Surcharge Over Toe =			4 400 0
				Stem Weight(s) = Earth @ Stem Transitions =	600.0	2.33	1,400.0
Total =	857.5	0.T.M. =	2,000.8	Footing Weight =	450.0	1.50	675.0
			,	Key Weight =	430.0	1.50	075.0
Resisting/Overturning Rat	tio	=	2.12	Vert. Component =	412.9	3.00	1,238.8
Vertical Loads used for Sc	il Pressure	= 1,942.9	9 lbs	Total =	1,942.9 I	bs R.M.=	4,233.8

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)

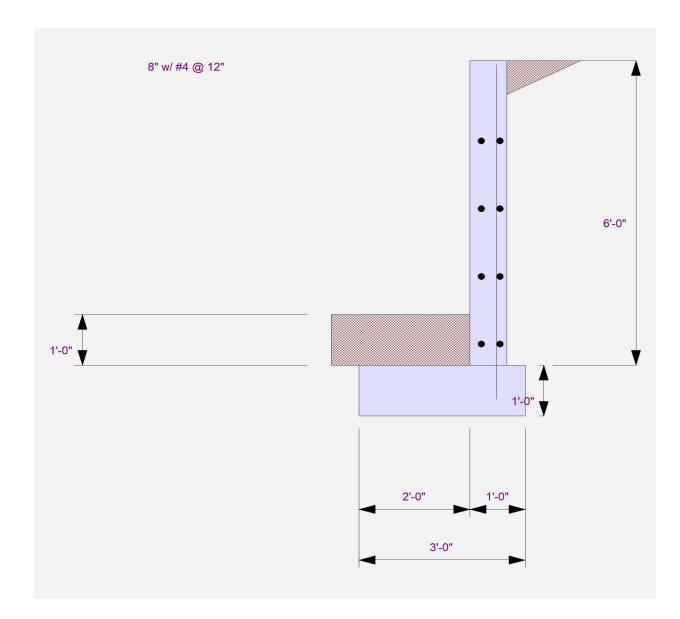
Soil Spring Reaction Modulus250.0pciHorizontal Defl @ Top of Wall (approximate only)0.061in

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

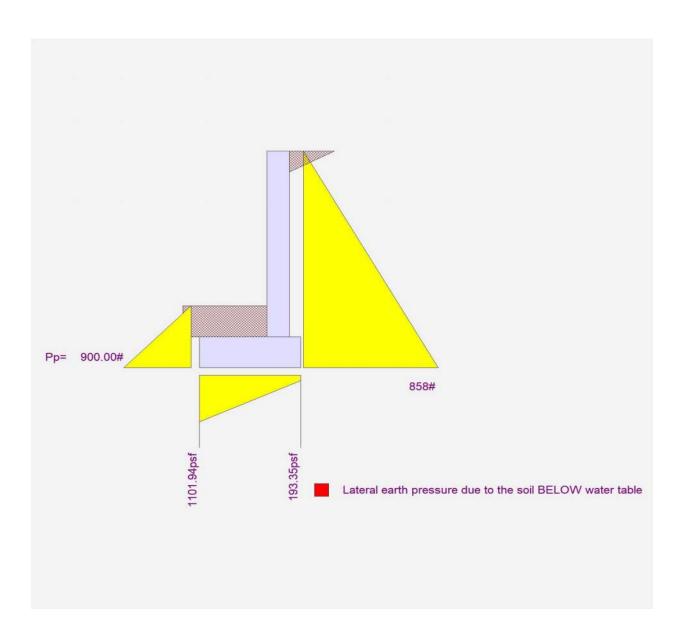
because the wall would then tend to rotate into the retained soil.

Cantilevered Retaining Wall		Project File: Retaining Walls - Upda	ated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC	1983-2023
DESCRIPTION: 6' Retained (P_Line)			
Rebar Lap & Embedment Lengths Inform	ation		
Stem Design Segment: Bottom			
Stem Design Height: 0.00 ft above top of footing			
Lap Splice length for #4 bar specified in this stem des	ign segment (25.4.2.4a) =	17.09 in	
Development length for #4 bar specified in this stem of	lesign segment =	13.15 in	
Hooked embedment length into footing for #4 bar spe	cified in this stem design segment =	5.63 in	
As Provided =		0.2000 in2/ft	
As Required =		0.1728 in2/ft	

Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023
DESCRIPTION: 6' Retained (P_Line)		







LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 5' Retained - EQ (P_Line)

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

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Code Reference

Calculations per IBC 2021 1807.3, ASCE 7-16

Criteria

Retained Height	=	5.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water table above		
bottom of footing	=	0.0 ft

Surcharge Loads

Surcharge Over Heel Used To Resist Sliding Surcharge Over Toe Used for Sliding & Ove Axial Load Applied	= rturning	0.0
Axial Dead Load Axial Live Load Axial Load Eccentricity	= = =	0.0 lbs 0.0 lbs 0.0 in

Earth Pressure Seismic Load

Method : Uniform Multiplier Used = 8.000 (Multiplier used on soil density)

Allow Soil Bearing Equivalent Fluid Pressure		3,333.0 od	psf
Active Heel Pressure	=	35.0	psf/ft
	=		
Passive Pressure	=	450.0	psf/ft
Soil Density, Heel	=	120.00	pcf
Soil Density, Toe	=	120.00	pcf
Footing Soil Friction	=	0.530	
Soil height to ignore for passive pressure	=	0.00	in

Soil Data

Lateral Load Applied to Stem

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

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

Uniform Seismic Force = 48.000 Total Seismic Force = 288.000

LIC# : KW-06016450, Build:20.24.05.02 **DESCRIPTION:** 5' Retained - EQ (P_Line)

Design Summary		St	em Construction		Bottom			
			Design Height Above Ftg		Stem OK			
Wall Stability Ratios			Wall Material Above "Ht"	π= =	0.00 Concrete			
Overturning	=	1.28 Ratio < 1.5!	Design Method	=	SD	SD	SD	
Sliding	=	1.51 OK	Thickness	=	6.00	30	30	
Global Stability	=	1.91	Rebar Size	_	# 4			
Global Stability	-	1.91	Rebar Spacing	=	<i>"</i>			
Total Bearing Load	=	1.408 lbs	Rebar Placed at	=	3.75 i			
resultant ecc.	=	9.56 in	Design Data		0.101			
Eccentricity outsid			fb/FB + fa/Fa	=	0.726			
Soil Pressure @ Ťoe	=	2,546 psf OK	Total Force @ Section					
Soil Pressure @ Heel	=	0 psf OK	Service Level	lbs =				
Allowable	=	3,333 psf	Strength Level	lbs =	940.0			
Soil Pressure Less			MomentActual					
ACI Factored @ Toe	=	2,797 psf	Service Level	ft-# =				
ACI Factored @ Heel	=	0 psf	Strength Level	ft-# =	1,766.7			
Footing Shear @ Toe	=	9.0 psi OK	MomentAllowable	=	2,431.7			
Footing Shear @ Heel	=	7.8 psi OK	ShearActual		_,			
Allowable	=	82.2 psi	Service Level	psi =				
			Strength Level	•	20.9			
Sliding Calcs			ShearAllowable	psi =	20.9 49.1			
Lateral Sliding Force	=	831.6 lbs		psi =	49.1			
less 100% Passive Force	-	506.3 lbs	Anet (Masonry)	in2 =				
less 100% Friction Force	-	746.1 lbs	Wall Weight	psf =	75.0			
Added Force Req'd	=	0.0 lbs OK	Rebar Depth 'd'	in =	3.75			
for 1.5 Stability	=	0.0 lbs OK	Macanny Data					
(artical component of active	lotorol		Masonry Data					
ertical component of active onsidered in the calculatior			Fs	psi =				
	1 01 5011	beaming pressures.	Solid Grouting	psi = =				
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		1.000	f'c	psi =	3,000.0			
Seismic, E		1.000	Fy	psi =	60,000.0			

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Project File: Retaining Walls - Updated.ec6

psf ft-#

ft-# ft-# ft-# psi psi

Cantilevered Retaining Wall

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6 (c) ENERCALC INC 1983-2023

LIC# : KW-06016450, Build:20.24.05.02 **DESCRIPTION:** 5' Retained - EQ (P_Line)

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinfe	orcing
As (based on applied moment) :	0.1144 in2/ft		
0.0018bh : 0.0018(12)(6) :	0.1296 in2/ft	Horizontal Reinfo	orcing Options :
		One layer of :	Two layers of :
Required Area :	0.1296 in2/ft	#4@ 18.52 in	#4@ 37.04 in
Provided Area :	0.15 in2/ft	#5@ 28.70 in	#5@ 57.41 in
Maximum Area :	0.6096 in2/ft	#6@ 40.74 in	#6@ 81.48 in
Footing Data	Footing Design Results		

Heel Reinforcing Key Reinforcing

Footing Torsion, Tu

Footing Allow. Torsion, φ Tn

Toe Width	=	1.33 ft
Heel Width	=	1.00
Total Footing Width	= _	2.33
Footing Thickness	=	12.00 in

f'c = 3,0	000 psi F	y =	60,0	000 psi
Footing Concr	ete Density		150	.00 pcf
Min. As % Cover @ Top	2.00	= @	0.00)18 3.00 in

		<u>Toe</u>	Heel
Factored Pressure	=	2,797	0
Mu' : Upward	=	1,486	0
Mu' : Downward	=	223	355
Mu: Design	=	1,264	355
φ Mn	=	2,739	2,739
Actual 1-Way Shear	=	8.99	7.79
Allow 1-Way Shear	=	43.82	43.82
Toe Reinforcing	=	None Spec'd	

= None Spec'd = None Spec'd 0.00 ft-lbs = = 0.00 ft-lbs

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

Other Acceptable Sizes & Spacings

Toe: phiMn = phi*5*lambda*sqrt(fc)*Sm

Heel: phiMn = phi*5*lambda*sqrt(fc)*Sm

Key: No key defined

0.60	in2
0.26	in2 /ft
If two lay	ers of horizontal bars:
#4@ 1	8.52 in
#5@ 2	8.70 in
#6@4	0.74 in
	0.26 <u>If two lay</u> #4@ 1 #5@ 2

Project File: Retaining Walls - Updated.ec6 QUANTUM CONSULTING ENGINEERS

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LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 5' Retained - EQ (P_Line)

Summary of Overturning & Resisting Forces & Moments

		OV	ERTURNING			RE	SISTING	
Item		Force lbs	Distance ft	Moment ft-#		Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tb	I)	630.0	2.00	1,260.0	Soil Over HL (ab. water tbl)	300.0	2.08	624.0
HL Act Pres (be water tb Hydrostatic Force	,			.,	Soil Over HL (bel. water tbl) Water Table		2.08	624.0
Buoyant Force	=				Sloped Soil Over Heel =			
Surcharge over Heel	=				Surcharge Over Heel =			
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 Soi	=				Soil Over Toe =	79.8	0.67	53.1
Seismic Earth Load	=	201.6	3.00	604.8	Surcharge Over Toe =			
	=	20110	0.00	00.110	Stem Weight(s) =	375.0	1.58	592.5
					Earth @ Stem Transitions =			
Total	=	831.6	O.T.M. =	1,864.8	Footing Weight =	349.5	1.17	407.2
					Key Weight =			
Resisting/Overturning	•		=	1.28	Vert. Component =	303.4	2.33	706.9
Vertical Loads used for	or So	il Pressure	= 1,407.7	7 lbs	Total =	1,407.7	os R.M.=	2,383.6
If seismic is included, th	e OT	M and slidir	ng ratios		* Axial live load NOT included resistance, but is included for			r overturning

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

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)

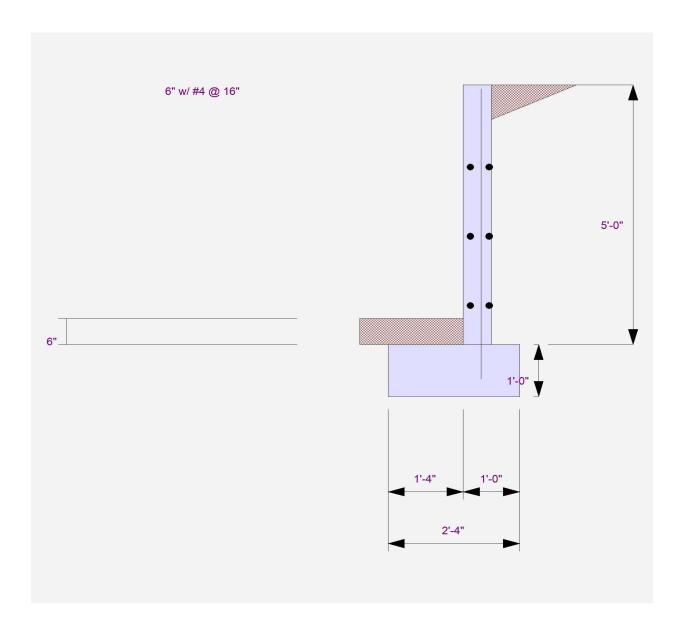
Soil Spring Reaction Modulus 250.0 pci Horizontal Defl @ Top of Wall (approximate only) 0.152 in

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.

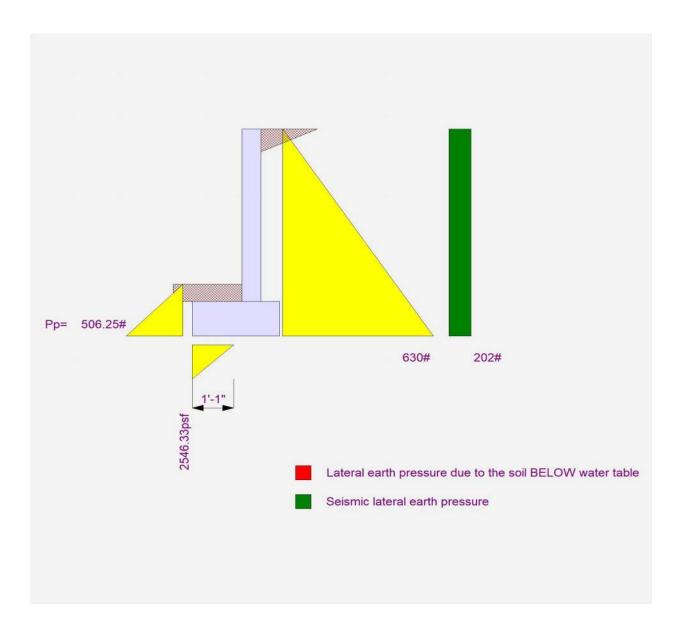
Cantilevered Retaining Wall	Project File: Retaining Walls - Updated.ec6	
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-202
DESCRIPTION: 5' Retained - EQ (P_	Line)	
Rebar Lap & Embedment Lengths Int	formation	
Stem Design Segment: Bottom		
Stem Design Height: 0.00 ft above top of for	oting	
Lap Splice length for #4 bar specified in this ste	m design segment (25.4.2.4a) =	17.09 in
Development length for #4 bar specified in this s	13.15 in	
Hooked embedment length into footing for #4 ba	ar specified in this stem design segment =	5.63 in
As Provided =		0.1500 in2/ft
As Required =		0.1500 in2/ft

Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023
DESCRIPTION: 5' Retained - EQ (P_Line)		





DESCRIPTION: 5' Retained - EQ (P_Line)



LIC# : KW-06016450, Build:20.24.04.09 DESCRIPTION: 5' Retained (P_Line) QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls.ec6 (c) ENERCALC INC 1983-2023

Code Reference

Calculations per IBC 2021 1807.3, ASCE 7-16

Criteria

Retained Height	=	5.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water table above		
bottom of footing	=	0.0 ft

Surcharge Loads

Surcharge Over Hee Used To Resist Slid Surcharge Over Toe Used for Sliding & C	ing & Ov =	0.0			
Axial Load Applied to Stem					
Axial Dead Load Axial Live Load	=	0.0 lbs 0.0 lbs			

Axial Live Load	=	0.0 lb
Axial Load Eccentricity	=	0.0 in

Allow Soil Bearing Equivalent Fluid Pressure	= Meth	2,000.0	psf
Active Heel Pressure	=		psf/ft
	=		
Passive Pressure	=	525.0	psf/ft
Soil Density, Heel	=	120.00	pcf
Soil Density, Toe	=	120.00	pcf
Footing Soil Friction	=	0.530	
Soil height to ignore for passive pressure	=	0.00	in

Soil Data

Lateral Load Applied to Stem

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

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

LIC# : KW-06016450, Build:20.24.04.09

QUANTUM CONSULTING ENGINEERS

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Project File: Retaining Walls.ec6

Design Summary			Stem Construction		Bottom			
			Design Height Above Ftg	ft =	Stem OK 0.00			
Wall Stability Ratios			Wall Material Above "Ht"	=	Concrete			
Overturning	=	1.89 OK	Design Method	=	SD	SD	SD	SD
Sliding	=	2.12 OK	Thickness	=	6.00			
Global Stability	=	1.91	Rebar Size	=				
			Rebar Spacing	=				
Total Bearing Load	=	1,408 lbs	Rebar Placed at	=	3.75 i			
resultant ecc.	=	4.40 in	Design Data		0.470			
Eccentricity within			fb/FB + fa/Fa	=	0.479			
Soil Pressure @ Toe	=	1,175 psf OK	Total Force @ Section					
Soil Pressure @ Heel	=	33 psf OK	Service Level	lbs =				
Allowable Soil Pressure Less	= Thon	2,000 psf	Strength Level	lbs =	700.0			
ACI Factored @ Toe	=	1,290 psf	MomentActual					
ACI Factored @ Heel	=	37 psf		ft-# =				
		•	Strength Level	ft-# =	1,166.7			
Footing Shear @ Toe	=	4.4 psi OK	MomentAllowable	=	2,431.7			
Footing Shear @ Heel Allowable	=	7.1 psi OK	ShearActual					
Allowable	=	82.2 psi	Service Level	psi =				
Cliding Color			Strength Level	psi =	15.6			
Sliding Calcs Lateral Sliding Force		630.0 lbs	ShearAllowable	psi =				
Ū	=		Anet (Masonry)	in2 =				
less 100% Passive Force less 100% Friction Force		590.6 lbs 746.1 lbs	(),					
	_		Wall Weight	psf =				
Added Force Req'd	=	0.0 lbs OK	Rebar Depth 'd'	in =	3.75			
for 1.5 Stability	=	0.0 lbs OK	Masonry Data					
/ertical component of active	latora		f'm	noi -				
considered in the calculation				psi =				
	01 001	i souring probbulo	Solid Grouting	psi = =				
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	-	7.00			
Wind, W		1.000	f'c	psi =	3,000.0			
Seismic, E		1.000	Fy	psi =	,			

LIC# : KW-06016450, Build:20.24.04.09 **DESCRIPTION:** 5' Retained (P_Line) QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls.ec6 (c) ENERCALC INC 1983-2023

Concrete Stem Rebar Area Details

Bottom Stem As (based on applied moment) :	Vertical Reinforcing 0.0756 in2/ft	Horizontal Reinfo	orcing
0.0018bh : 0.0018(12)(6) :	0.1296 in2/ft	Horizontal Reinfo	orcing Options :
		One layer of :	Two layers of :
Required Area :	0.1296 in2/ft	#4@ 18.52 in	#4@ 37.04 in
Provided Area :	0.15 in2/ft	#5@ 28.70 in	#5@ 57.41 in
Maximum Area :	0.6096 in2/ft	#6@ 40.74 in	#6@ 81.48 in
Footing Data	Footing I	Design Results	

1.33 ft Toe Width = Heel Width = 1.00 Total Footing Width = 2.33 Footing Thickness 12.00 in =

f'c = 3,00 Footing Concret	0 psi I e Density	=y_=	60,0 150	00 psi .00 pcf
Min. As %	-	=	0.00	18
Cover @ Top	2.00	@ E	3tm.=	3.00 in

		<u>Toe</u>	<u>Heel</u>	
Factored Pressure	=	1,290	37	psf
Mu' : Upward	=	930	16	ft-#
Mu' : Downward	=	223	355	ft-#
Mu: Design	=	707	339	ft-#
φ Mn	=	2,739	2,739	ft-#
Actual 1-Way Shear	=	4.39	7.08	psi
Allow 1-Way Shear	=	43.82	43.82	psi
Toe Reinforcing	=	None Spec'd		
Heel Reinforcing	=	None Spec'd		
Key Reinforcing	=	None Spec'd		
Footing Torsion, Tu		=	0.00 ft-lb	S
Footing Allow. Torsion	n,	Tn =	0.00 ft-lb	S

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

Other Acceptable Sizes & Spacings

Toe: phiMn = phi*5*lambda*sqrt(fc)*Sm

Heel: phiMn = phi*5*lambda*sqrt(fc)*Sm

Key: No key defined

Min footing T&S reinf Area	0.60	in2
Min footing T&S reinf Area per foot	0.26	in2 /ft
If one layer of horizontal bars:	If two lay	ers of horizontal bars:
#4@ 9.26 in	#4@ 1	8.52 in
#5@ 14.35 in	#5@ 2	8.70 in
#6@ 20.37 in	#6@4	0.74 in
#4@ 9.26 in	#4@ 1	8.52 in 8.70 in

LIC# : KW-06016450, Build:20.24.04.09

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls.ec6 (c) ENERCALC INC 1983-2023

DESCRIPTION: 5' Retained (P_Line)

Summary of Overturning & Resisting Forces & Moments

		ERTURNING				SISTING	
Item	Force lbs	Distance ft	ft-#		Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	630.0	2.00	1,260.0	Soil Over HL (ab. water tbl)	300.0	2.08	624.0
HL Act Pres (be water tbl) Hydrostatic Force			,	Soil Over HL (bel. water tbl) Water Table		2.08	624.0
Buoyant Force =				Sloped Soil Over Heel =			
Surcharge over Heel =				Surcharge Over Heel =			
Surcharge Over Toe =				Adjacent Footing Load =			
Adjacent Footing Load =				Axial Dead Load on Stem =			
Added Lateral Load =				* Axial Live Load on Stem =			
_oad @ Stem Above Soil =				Soil Over Toe =	79.8	0.67	53.1
=				Surcharge Over Toe =			
_				Stem Weight(s) =	375.0	1.58	592.5
				Earth @ Stem Transitions =			
Total =	630.0	O.T.M. =	1,260.0	Footing Weight =	349.5	1.17	407.2
				Key Weight =			
Resisting/Overturning Rat	io	=	1.89	Vert. Component =	303.4	2.33	706.9
Vertical Loads used for So	il Pressure	= 1,407.7	7 lbs	Total =	1.407.7	bs R.M.=	2,383.6

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 Modulus250.0pciHorizontal Defl @ Top of Wall (approximate only)0.070in

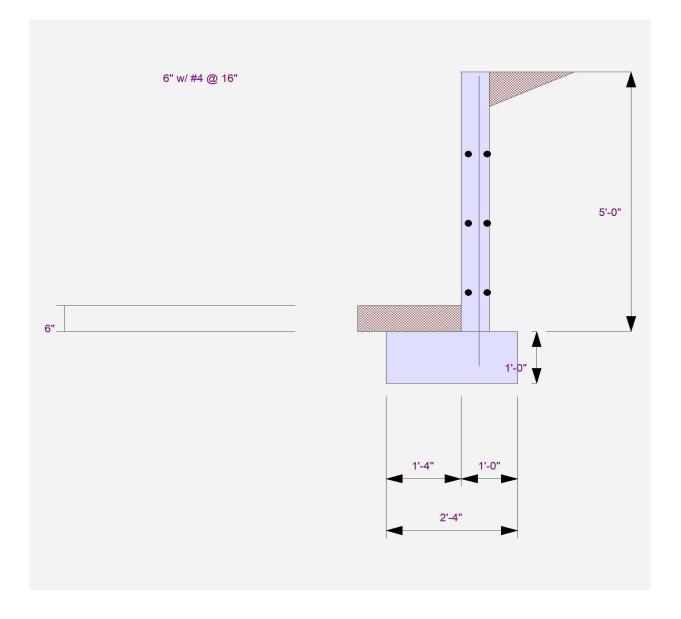
The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe,

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

Cantilevered Retaining Wall		Project File: Retaining Walls.e
LIC# : KW-06016450, Build:20.24.04.09	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-
DESCRIPTION: 5' Retained (P_Line)		
Rebar Lap & Embedment Lengths Infor	nation	
Stem Design Segment: Bottom		
Stem Design Height: 0.00 ft above top of footing	1	
Lap Splice length for #4 bar specified in this stem d	esign segment (25.4.2.4a) =	17.09 in
Development length for #4 bar specified in this ster	n design segment =	13.15 in
Hooked embedment length into footing for #4 bar sp	pecified in this stem design segment =	5.63 in
As Provided =	0.1500 in2/ft	
As Required =		0.1296 in2/ft

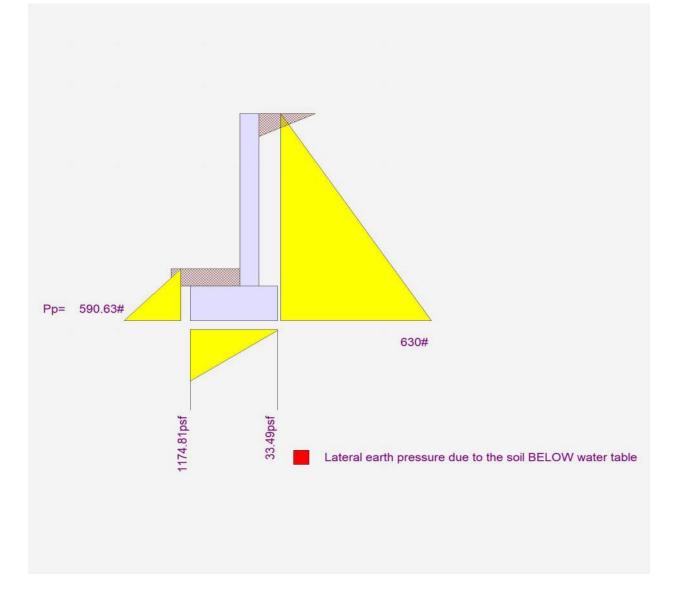
Cantilevered Retaining Wall		Project File: Retaining Walls.ec6
LIC# : KW-06016450, Build:20.24.04.09	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023
	N	

DESCRIPTION: 5' Retained (P_Line)



Cantilevered Retaining Wall		Project File: Retaining Walls.ec6
LIC# : KW-06016450, Build:20.24.04.09	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023

DESCRIPTION: 5' Retained (P_Line)



LIC# : KW-06016450, Build:20.24.04.09 DESCRIPTION: 4' Retained - EQ (P_Line)

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls.ec6 (c) ENERCALC INC 1983-2023

Code Reference

Calculations per IBC 2021 1807.3, ASCE 7-16

Criteria

Retained Height	=	4.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water table above		
bottom of footing	=	0.0 ft

Surcharge Loads

Surcharge Over Heel Used To Resist Sliding Surcharge Over Toe Used for Sliding & Ove Axial Load Applied	= rturning	0.0
Axial Dead Load Axial Live Load Axial Load Eccentricity	= = =	0.0 lbs 0.0 lbs 0.0 in

Earth Pressure Seismic Load

Method : Uniform Multiplier Used = 5.000 (Multiplier used on soil density)

		psf
=		psf/ft
=		
=	525.0	psf/ft
=	120.00	pcf
=	120.00	pcf
=	0.530	
=	0.00	in
	Meth = = = = =	= = 525.0 = 120.00 = 120.00 = 0.530

Soil Data

Lateral Load Applied to Stem

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

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

Uniform Seismic Force = 25.000 Total Seismic Force = 125.000

LIC# : KW-06016450, Build:20.24.04.09

Project File: Retaining Walls.ec6 (c) ENERCALC INC 1983-2023

DESCRIPTION: 4' Retained - EQ (P_Line)

=		Design Height Above Ftg		Stem OK				
=			ft =	0.00				
=		Wall Material Above "Ht"	=	Concrete				
	1.66 OK	Design Method	=	SD	SD	SD	SD	
=	2.27 OK	Thickness	=	8.00				
=	2.36	Rebar Size	=	# 4				
		Rebar Spacing	=	12.00				
=	1.131 lbs	Rebar Placed at	=	Edge				
=	5.31 in							
e middl			=	0.146				
=		Total Force @ Section						
=		Service Level	lbs =					
=	2,667 psf	Strength Level	lbs =	548.0				
		MomentActual						
	· ·	Service Level	ft-# =					
		Strength Level	ft-# =	797.3				
	•	MomentAllowable	=	5,448.0				
		ShearActual						
=	82.2 psi	Service Level	psi =					
		Strength Level	•	73				
		0						
_			•	45.0				
		(),		100.0				
_		U	•					
		Rebar Depth 'd'	in =	6.25				
=	0.0 IDS OK	Masonry Data						
latoral	soil prossuro IS	-						
01 3011	bearing pressures							
		Ū						
	1.200							
	1.600	, , ,		ASD				
	1.600	, ,						
	1.000	f'c	psi =	3,000.0				
	1.000		psi =	60,000.0				
	= = = = = = = = = = = = = = = = = = =	= 1,131 lbs = 5.31 in = middle third = 1,353 psf OK = 0 psf OK = 2,667 psf Than Allowable = 1,541 psf = 0 psf = 2.7 psi OK = 4.9 psi OK = 82.2 psi = 525.0 lbs - 590.6 lbs = 0.0 lbs OK = 0.0 lbs OK lateral soil pressure IS of soil bearing pressures 1.200 1.600 1.600 1.000	= 1,131 lbs Rebar Spacing = 1,131 lbs Rebar Spacing = 5.31 in Besign Data = 1,353 psf OK fb/FB + fa/Fa = 0 psf OK Service Level = 0 psf Strength Level MomentActual Service Level = 0.7 psi OK Strength Level = 2.7 psi OK Service Level = 2.7 psi OK Strength Level = 4.9 psi OK Service Level = 525.0 lbs ShearAllowable - 590.6 lbs Anet (Masonry) = 0.0 lbs OK Rebar Depth 'd' atteral soil pressure IS fm Fs of soil bearing pressures. Solid Grouting 1.200 1.600 Masonry Data 1.600 1.600 The solid Thick. 1.000 1.000 fc	Rebar Spacing==1,131 lbsRebar Spacing==1,353 psf OKRebar Placed at==1,353 psf OKfb/FB + fa/Fa==0 psf OKService Levellbs ==1,541 psfService Levellbs ==0 psfService Levellbs =Than AllowableService Levellbs ==0 psfService Levellbs ==0 psfService Levellbs ==2.7 psi OKService Levelft-# ==2.7 psi OKService Levelft-# ==2.7 psi OKService Levelpsi ==82.2 psiShearActualService Level=590.6 lbsShearAllowablepsi ==500.6 lbsAnet (Masonry)in2 ==0.0 lbs OKRebar Depth 'd'in =Iateral soil pressure IS of soil bearing pressures.fmpsi =1.2001.600Masonry Datafm1.2001.600Masonry Design Method=1.000fcpsi =fcpsi =	Rebar Spacing=12.00Rebar Spacing=10.0Rebar Spacing=Rebar Spacing=Rebar Spacing=Rebar Spacing=Rebar Spacing=Rebar Spacing=Rebar Spacing=Strength LevelInsiRebar SpacingShearAllowableRebar Spacing=Solid Grouting=Rebar Spacing=Rebar Spacing=Rebar Spacing=Rebar Spacing=Rebar Spacing=Rebar Spacing=Rebar Spacing=Rebar Spacing=Rebar Spacing=Rebar Spacing=Strength Levelpsi =Strength Levelpsi =Rebar Spac	Rebar Spacing=12.00=1,131 lbsRebar Placed at=Edge=5.31 inDesign Data=0.146=1,353 psf OKTotal Force @ Sectionservice Levellbs ==1,541 psfStrength Levellbs =548.0=0 psfMomentActualService Levelft+# ==0 psfStrength Levelft # =797.3=2.7 psi OKMomentActualService Levelpsi ==82.2 psiShearAllowable=5,448.0=525.0 lbsShearAllowablepsi =7.3=525.0 lbsShearAllowablepsi =7.3=525.0 lbsShearAllowablepsi =45.6-599.3 lbsWall Weightpsf =100.0=0.0 lbs OKRebar Depth 'd'in =6.25=0.0 lbs OKFspsi =#ateral soil pressure IS of soil bearing pressures.fmpsi =1.200Masonry Data=1.600Masonry Block Type=1.600Masonry Design MethodASD1.600Concrete Datapsi =1.600fcpsi =1.600fcpsi =1.600fcpsi =1.600fcpsi =1.600fcpsi =1.600fcpsi =1.600fcpsi =1.600fcpsi =1.600fc <t< td=""><td>Rebar Spacing=12.00=1,131 lbsRebar Placed at=Edge=5.31 inDesign Data=0.146=1,353 psf OKfb/FB + fa/Fa=0.146=0 psf OKService Levellbs ==0 psf OKStrength Levellbs ==0 psfStrength Levellbs ==0 psfStrength Levelft-# ==0 psfStrength Levelft-# ==0 psfStrength Levelfs ==2.7 psi OKMomentActual=82.2 psiShearAllowable==525.0 lbsShearAllowablepsi =-599.6 lbsAnet (Masonry)in2 ==0.0 lbs OKRebar Depth 'd'in ==0.0 lbs OKRebar Depth 'd'in ==0.0 lbs OKPsi ==1.600Masonry Datafmpsi =fmpsi =fmpsi =fildforcete Datafildfild=Assonry Design Method=1.600Masonry Design Method=1.600frpsi =1.000frpsi =1.000frpsi =1.000frpsi =1.000frpsi =1.000frpsi =1.000frpsi =1.000frpsi =1.000frpsi =1.000fr</td><td>Rebar Spacing=12.00$=$1,131 lbs 5.31 inRebar Placed at$=$$=$1,353 psf OKDesign Data$=$$=$1,353 psf OKTotal Force @ Section$=$0 psf OKService Levellbs =$=$2.667 psfStrength Levellbs =Than AllowableMomentActual$=$0 psf OKService Levelft-# =$=$0 psfStrength Levelft-# =$=$0 psfStrength Levelft-# =$=$0 psfStrength Levelpsi =$=$2.2 psiShearActual$=$Strength Levelpsi =$=$525.0 lbsShearAllowablepsi =$=$50.6 lbsMasonry Data$=$0.0 lbs OKRebar Depth 'd'in =$=$0.0 lbs OKFspsi =$=$0.0 lbs OKMasonry Data$=$1.600Masonry B</td></t<>	Rebar Spacing=12.00=1,131 lbsRebar Placed at=Edge=5.31 inDesign Data=0.146=1,353 psf OKfb/FB + fa/Fa=0.146=0 psf OKService Levellbs ==0 psf OKStrength Levellbs ==0 psfStrength Levellbs ==0 psfStrength Levelft-# ==0 psfStrength Levelft-# ==0 psfStrength Levelfs ==2.7 psi OKMomentActual=82.2 psiShearAllowable==525.0 lbsShearAllowablepsi =-599.6 lbsAnet (Masonry)in2 ==0.0 lbs OKRebar Depth 'd'in ==0.0 lbs OKRebar Depth 'd'in ==0.0 lbs OKPsi ==1.600Masonry Datafmpsi =fmpsi =fmpsi =fildforcete Datafildfild=Assonry Design Method=1.600Masonry Design Method=1.600frpsi =1.000frpsi =1.000frpsi =1.000frpsi =1.000frpsi =1.000frpsi =1.000frpsi =1.000frpsi =1.000frpsi =1.000fr	Rebar Spacing=12.00 $=$ 1,131 lbs 5.31 inRebar Placed at $=$ $=$ 1,353 psf OKDesign Data $=$ $=$ 1,353 psf OKTotal Force @ Section $=$ 0 psf OKService Levellbs = $=$ 2.667 psfStrength Levellbs =Than AllowableMomentActual $=$ 0 psf OKService Levelft-# = $=$ 0 psfStrength Levelft-# = $=$ 0 psfStrength Levelft-# = $=$ 0 psfStrength Levelpsi = $=$ 2.2 psiShearActual $=$ Strength Levelpsi = $=$ 525.0 lbsShearAllowablepsi = $=$ 50.6 lbsMasonry Data $ =$ 0.0 lbs OKRebar Depth 'd'in = $=$ 0.0 lbs OKFspsi = $=$ 0.0 lbs OKMasonry Data $ =$ 1.600Masonry B

LIC# : KW-06016450, Build:20.24.04.09

QUANTUM CONSULTING ENGINEERS

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DESCRIPTION: 4' Retained - EQ (P_Line)

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinf	orcing
As (based on applied moment) :	0.0299 in2/ft		
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinf	orcing Options :
		One layer of :	Two layers of :
Required Area :	0.1728 in2/ft	#4@ 13.89 in	#4@ 27.78 in
Provided Area :	0.2 in2/ft	#5@ 21.53 in	#5@ 43.06 in
Maximum Area :	1.016 in2/ft	#6@ 30.56 in	#6@ 61.11 in
Footing Data	Footing Design Results		

Fooling Data

Toe Width	=	1.00 ft
Heel Width	=	1.00
Total Footing Width	=	2.00
Footing Thickness	=	12.00 in

f'c = 3,00	0 psi	Fy =	60,0	000 psi
Footing Concret	e Density	y =	150	.00 pcf
Min. As %	2.00	=	0.00)18
Cover @ Top		@.F	Stm.=	3.00 in

		<u>Toe</u>	Heel
Factored Pressure	=	1,541	
Mu' : Upward	=	617	

	_	1,041	0	por
Mu' : Upward	=	617	0	ft-#
Mu' : Downward	=	126	154	ft-#
Mu: Design	=	491	154	ft-#
φMn	=	2,739	2,739	ft-#
Actual 1-Way Shear	=	2.75	4.91	psi
Allow 1-Way Shear	=	43.82	43.82	psi
Toe Reinforcing	=	None Spec'd		
Heel Reinforcing	=	None Spec'd		
Key Reinforcing	=	None Spec'd		
Footing Torsion, Tu		=	0.00 ft-lbs	6
Footing Allow. Torsion	η, φ	Tn =	0.00 ft-lbs	5

0

psf

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

Other Acceptable Sizes & Spacings

Toe: phiMn = phi*5*lambda*sqrt(fc)*Sm

Heel: phiMn = phi*5*lambda*sqrt(fc)*Sm

Key: No key defined

Min footing T&S reinf Area	0.52	in2
Min footing T&S reinf Area per foot	0.26	in2 /ft
If one layer of horizontal bars:	If two lay	ers of horizontal bars:
#4@ 9.26 in	#4@1	8.52 in
#5@ 14.35 in	#5@2	8.70 in
#6@ 20.37 in	#6@4	0.74 in

Project File: Retaining Walls.ec6

LIC# : KW-06016450, Build:20.24.04.09

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls.ec6 (c) ENERCALC INC 1983-2023

DESCRIPTION: 4' Retained - EQ (P_Line)

Summary of Overturning & Resisting Forces & Moments

		OV	ERTURNING			RE	ESISTING	
Item		Force lbs	Distance ft	Moment ft-#		Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water th	ol)	437.5	1.67	729.2	Soil Over HL (ab. water tbl)	160.0	1.83	293.3
HL Act Pres (be water the Hydrostatic Force	'				Soil Over HL (bel. water tbl) Water Table		1.83	293.3
Buoyant Force	=				Sloped Soil Over Heel =			
Surcharge over Heel	=				Surcharge Over Heel =			
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 So	oil =				Soil Over Toe =	60.0	0.50	30.0
Seismic Earth Load	=	87.5	2.50	218.8	Surcharge Over Toe =			
	=				Stem Weight(s) =	400.0	1.33	533.3
					Earth @ Stem Transitions =			
Total	=	525.0	O.T.M. =	947.9	Footing Weight =	300.0	1.00	300.0
					Key Weight =			
Resisting/Overturnir	•		=	1.66	Vert. Component =	210.7	2.00	421.4
Vertical Loads used	for So	il Pressure	= 1,130.	7 lbs	Total =	1,130.7	bs R.M.=	1,578.0
If seismic is included, th	he OT	M and slidir	ng ratios		* Axial live load NOT included resistance, but is included for			r overturning

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

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

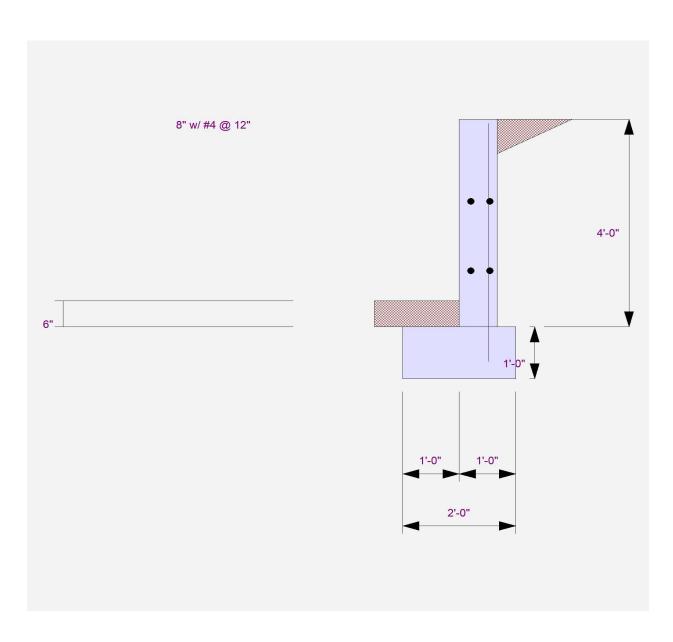
Horizontal Defl @ Top of Wall (approximate only) 0.075 in

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.

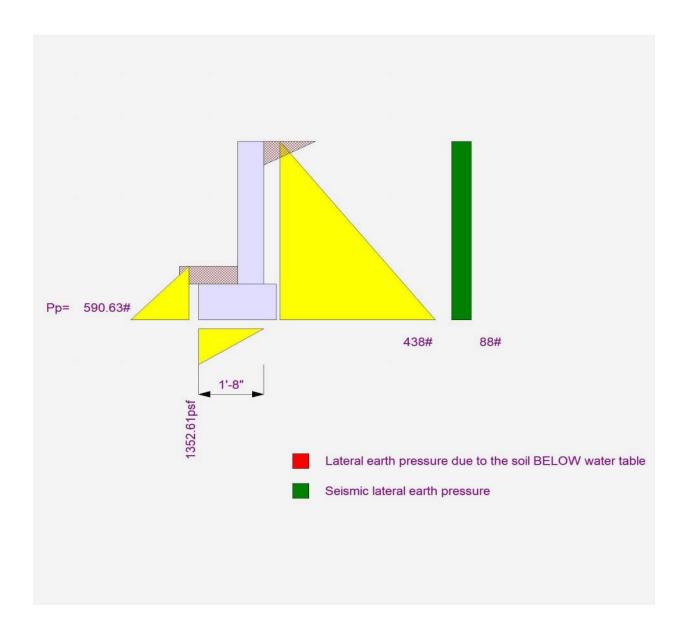
Cantilevered Retaining Wall		Project File: Retaining Walls.ec6
LIC# : KW-06016450, Build:20.24.04.09	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023
DESCRIPTION: 4' Retained - EQ (P_L	ine)	
Rebar Lap & Embedment Lengths Info	ormation	
Stem Design Segment: Bottom		
Stem Design Height: 0.00 ft above top of foot	ing	
Lap Splice length for #4 bar specified in this stem	design segment (25.4.2.4a) =	17.09 in
Development length for #4 bar specified in this ste	em design segment =	13.15 in
Hooked embedment length into footing for #4 bar	specified in this stem design segment =	5.63 in
As Provided =		0.2000 in2/ft
As Required =		0.1728 in2/ft

Cantilevered Retaining Wall		Project File: Retaining Walls.ec6
LIC# : KW-06016450, Build:20.24.04.09	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023
DESCRIPTION: 4' Retained - EQ (P_Line)	





DESCRIPTION: 4' Retained - EQ (P_Line)



LIC# : KW-06016450, Build:20.24.04.09 DESCRIPTION: 4' Retained (P_Line) QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls.ec6 (c) ENERCALC INC 1983-2023

Code Reference Calculations per IBC 2021 1807.3, ASCE 7-16

Criteria

Retained Height	=	4.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water table above		
bottom of footing	=	0.0 ft

Surcharge Loads

Surcharge Over Hee Used To Resist Slid Surcharge Over Toe Used for Sliding & 0	ding & Ov = =	0.0			
Axial Load Applied to Stem					
Axial Dead Load Axial Live Load	=	0.0 lbs 0.0 lbs			

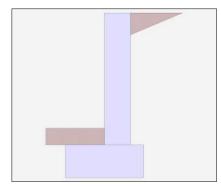
Axial Live Load	=	0.0 lbs
Axial Load Eccentricity	=	0.0 in

Soil Data		
Allow Soil Bearing Equivalent Fluid Pressur		2,000.0 psf
Active Heel Pressure	=	35.0 psf/ft
	=	

Passive Pressure	=	525.0 psf/ft
Soil Density, Heel	=	120.00 pcf
Soil Density, Toe	=	120.00 pcf
Footing Soil Friction	=	0.530
Soil height to ignore for passive pressure	=	0.00 in

Lateral Load Applied to Stem

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



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

LIC# : KW-06016450, Build:20.24.04.09

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Project File: Retaining Walls.ec6

DESCRIPTION: 4' Retained (P_Line)

Design Summary			Stem Construction		Bottom			
			Design Height Above Ftg	ft =	Stem OK 0.00			
Wall Stability Ratios			Wall Material Above "Ht"	n = =	Concrete			
Overturning	=	2.16 OK	Design Method	_	SD	SD	SD	SD
Sliding	=	2.72 OK	Thickness	_	8.00	00	0D	00
Global Stability	=	2.36	Rebar Size	=	# 4			
Clobal Clability	-	2.00	Rebar Spacing	=	12.00			
Total Bearing Load	=	1,131 lbs	Rebar Placed at	=	Edge			
resultant ecc.	=	2.99 in	Design Data					
Eccentricity with	in mido		fb/FB + fa/Fa	=	0.109			
Soil Pressure @ Toe	=	988 psf OK	Total Force @ Section					
Soil Pressure @ Heel	=	143 psf OK	Service Level	lbs =				
Allowable	=	2,000 psf	Strength Level	lbs =	448.0			
Soil Pressure Less ACI Factored @ Toe			MomentActual					
ACI Factored @ Toe ACI Factored @ Heel	=	1,126 psf 162 psf		ft-# =				
		•	Strength Level	ft-# =	597.3			
Footing Shear @ Toe	=	1.9 psi OK	MomentAllowable	=	5,448.0			
Footing Shear @ Heel Allowable	=	4.2 psi OK	ShearActual					
Allowable	=	82.2 psi	Service Level	psi =				
Sliding Calcs			Strength Level	psi =	6.0			
Lateral Sliding Force	=	437.5 lbs	ShearAllowable	psi =	45.6			
less 100% Passive Force	_	590.6 lbs	Anet (Masonry)	in2 =	1010			
less 100% Friction Force		599.3 lbs	Wall Weight	psf =	100.0			
Added Force Reg'd	=	0.0 lbs OK	Rebar Depth 'd'	in =	6.25			
for 1.5 Stability	=	0.0 lbs OK	Rebai Deptit d	=	0.25			
	_		Masonry Data					
/ertical component of active	e latera	al soil pressure IS	f'm	psi =				
considered in the calculation	n of so	il bearing pressure	s. Fs	psi =				
			Solid Grouting	=				
Load Factors			Modular Ratio 'n'	=				
Building Code		4 000	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		1.000	f'c	psi =	3,000.0			
Seismic, E		1.000	Fy	psi =	60,000.0			

LIC# : KW-06016450, Build:20.24.04.09

DESCRIPTION: 4' Retained (P_Line)

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinfo	orcing
As (based on applied moment) :	0.0224 in2/ft		
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinfo	orcing Options :
		One layer of :	Two layers of :
Required Area :	0.1728 in2/ft	#4@ 13.89 in	#4@ 27.78 in
Provided Area :	0.2 in2/ft	#5@ 21.53 in	#5@ 43.06 in
Maximum Area :	1.016 in2/ft	#6@ 30.56 in	#6@ 61.11 in

Footing Data

Toe Width	=	1.00 ft
Heel Width	=	1.00
Total Footing Width	=	2.00
Footing Thickness	=	12.00 in

f'c = 3,000) psi	Fy =	60,0	000 psi
Footing Concrete	e Densit	y =	150	.00 pcf
Min. As %	2.00	=	0.00)18
Cover @ Top		@.B	stm =	3.00 in

Footing Design Results

QUANTUM CONSULTING ENGINEERS

		<u>Toe</u>	<u>Heel</u>	
Factored Pressure	=	1,126	162	psf
Mu' : Upward	=	483	12	ft-#
Mu' : Downward	=	126	154	ft-#
Mu: Design	=	357	142	ft-#
φ Mn	=	2,739	2,739	ft-#
Actual 1-Way Shear	=	1.89	4.23	psi
Allow 1-Way Shear	=	43.82	43.82	psi
Toe Reinforcing	=	None Spec'd		
Heel Reinforcing	=	None Spec'd		
Key Reinforcing	=	None Spec'd		
Footing Torsion, Tu		=	0.00 ft-lb	s
Footing Allow. Torsio	n, գ	Tn =	0.00 ft-lb	s

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

Other Acceptable Sizes & Spacings

Toe: phiMn = phi*5*lambda*sqrt(fc)*Sm

Heel: phiMn = phi*5*lambda*sqrt(fc)*Sm

Key: No key defined

Min footing T&S reinf Area	0.52	in2
Min footing T&S reinf Area per foot	0.26	in2 /ft
If one layer of horizontal bars:	If two lay	ers of horizontal bars:
#4@ 9.26 in	#4@1	8.52 in
#5@ 14.35 in	#5@2	8.70 in
#6@ 20.37 in	#6@4	0.74 in

Project File: Retaining Walls.ec6

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LIC# : KW-06016450, Build:20.24.04.09

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Project File: Retaining Walls.ec6 (c) ENERCALC INC 1983-2023

DESCRIPTION: 4' Retained (P_Line)

Summary of Overturning & Resisting Forces & Moments

		ERTURNING				SISTING	
Item	Force lbs	Distance ft	ft-#		Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	437.5	1.67	729.2	Soil Over HL (ab. water tbl)	160.0	1.83	293.3
HL Act Pres (be water tbl) Hydrostatic Force		-	-	Soil Over HL (bel. water tbl) Water Table		1.83	293.3
Buoyant Force =				Sloped Soil Over Heel =			
Surcharge over Heel =				Surcharge Over Heel =			
Surcharge Over Toe =				Adjacent Footing Load =			
Adjacent Footing Load =				Axial Dead Load on Stem =			
Added Lateral Load =				* Axial Live Load on Stem =			
_oad @ Stem Above Soil =				Soil Over Toe =	60.0	0.50	30.0
				Surcharge Over Toe =			
-				Stem Weight(s) =	400.0	1.33	533.3
				Earth @ Stem Transitions =			
Total =	437.5	O.T.M. =	729.2	Footing Weight =	300.0	1.00	300.0
				Key Weight =			
Resisting/Overturning Ra	tio	=	2.16	Vert. Component =	210.7	2.00	421.4
Vertical Loads used for So	oil Pressure	= 1,130.7	7 lbs	Total = * Avial live load NOT included i	,	bs R.M.=	1,578.0

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)

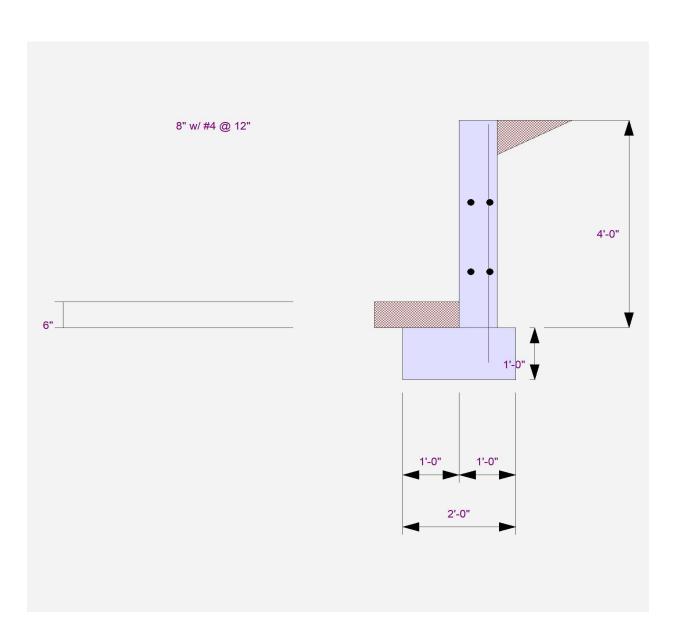
Soil Spring Reaction Modulus250.0pciHorizontal Defl @ Top of Wall (approximate only)0.055in

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.

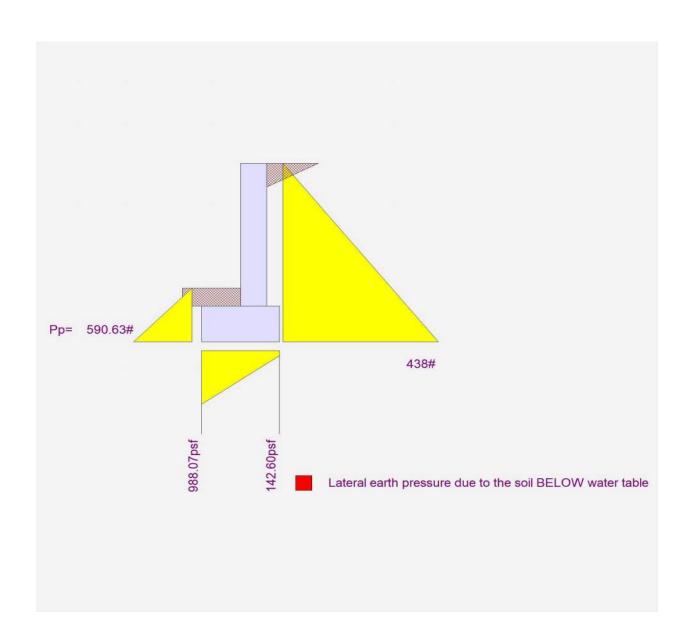
Cantilevered Retaining Wall		Project File: Retaining V	Valls.ec6
LIC# : KW-06016450, Build:20.24.04.09 DESCRIPTION: 4' Retained (P_Line)	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC IN(C 1983-2023
Rebar Lap & Embedment Lengths Informat	ion		
Stem Design Segment: Bottom			
Stem Design Height: 0.00 ft above top of footing			
Lap Splice length for #4 bar specified in this stem desig	n segment (25.4.2.4a) =	17.09 in	
Development length for #4 bar specified in this stem de	sign segment =	13.15 in	
Hooked embedment length into footing for #4 bar specif	ied in this stem design segment =	5.63 in	
As Provided =		0.2000 in2/ft	
As Required =		0.1728 in2/ft	

Cantilevered Retaining Wall		Project File: Retaining Walls.ec6
LIC# : KW-06016450, Build:20.24.04.09	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023
DESCRIPTION: 4' Retained (P_Line)		



Cantilevered Retaining Wall		Project File: Retaining Walls.ec6
LIC# : KW-06016450, Build:20.24.04.09	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023

DESCRIPTION: 4' Retained (P_Line)



LIC# : KW-06016450, Build:20.24.05.02

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Soil Data

Project File: Retaining Walls - Updated.ec6

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DESCRIPTION: 7' Retained - EQ (7' Terrace Wall)

0.0 ft

Code Reference

Calculations per IBC 2021 1807.3, ASCE 7-16

Criteria

Retained Height	=	7.50 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water table above		

=

Surcharge Loads

bottom of footing

Surcharge Over Heel Used To Resist Slid Surcharge Over Toe Used for Sliding & C	ing & Ov =	0.0		
Axial Load Applied to Stem				
Axial Dead Load Axial Live Load	=	0.0 lbs 0.0 lbs		

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

Allow Soil Bearing Equivalent Fluid Pressure	= Meth	=,000.0	psf
Active Heel Pressure	=		psf/ft
	=		
Passive Pressure	=	450.0	psf/ft
Soil Density, Heel	=	120.00	pcf
Soil Density, Toe	=	120.00	pcf
Footing Soil Friction	=	0.530	
Soil height to ignore for passive pressure	=	0.00	in

Lateral Load Applied to Stem

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

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

LIC# : KW-06016450, Build:20.24.05.02

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Project File: Retaining Walls - Updated.ec6

DESCRIPTION: 7' Retained - EQ (7' Terrace Wall)

Design Summary			Stem Construction		Bottom			
			Design Height Above Ftg	ft =	Stem OK 0.00			
Wall Stability Ratios			Wall Material Above "Ht"	=				
Overturning	=	1.73 OK	Design Method	=	SD	SD	SD	
Sliding	=	1.63 OK	Thickness	=	8.00	02	02	
Global Stability	=	1.69	Rebar Size	=	# 4			
			Rebar Spacing	=	10.00			
Total Bearing Load	=	2,926 lbs	Rebar Placed at	=	Center			
resultant ecc.	=	7.26 in	Design Data					
Eccentricity outs	ide mi		fb/FB + fa/Fa	=	0.968			
Soil Pressure @ Toe	=	2,179 psf OK	Total Force @ Section					
Soil Pressure @ Heel	=	0 psf OK	Service Level	lbs =				
Allowable	=	2,500 psf	Strength Level	lbs =	1,575.0			
Soil Pressure Less			MomentActual					
ACI Factored @ Toe ACI Factored @ Heel	=	2,416 psf	Service Level	ft-# =				
	=	0 psf	Strength Level	ft-# =	3,937.5			
Footing Shear @ Toe	=	7.4 psi OK	MomentAllowable	=	4,065.1			
Footing Shear @ Heel	=	17.6 psi OK	ShearActual		,			
Allowable	=	82.2 psi	Service Level	psi =				
			Strength Level	psi =	32.8			
Sliding Calcs			ShearAllowable	•	52.0 56.2			
Lateral Sliding Force	=	1,264.4 lbs		psi =	50.2			
less 100% Passive Ford		506.3 lbs	Anet (Masonry)	in2 =	100.0			
less 100% Friction Force		1,550.8 lbs	Wall Weight	psf =	100.0			
Added Force Req'd	=	0.0 lbs OK	Rebar Depth 'd'	in =	4.00			
for 1.5 Stability	=	0.0 lbs OK	Masonry Data					
(artical component of activ			f'm					
ertical component of activ considered in the calculatio				psi =				
	11 01 30	bil bearing pressures	Solid Grouting	psi = =				
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	-	700			
Wind, W		1.000	f'c	psi =	3,000.0			
Seismic, E		1.000	Fy	psi =	60,000.0			
			1	1	,			

LIC# : KW-06016450, Build:20.24.05.02 QUANT

QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6 (c) ENERCALC INC 1983-2023

DESCRIPTION: 7' Retained - EQ (7' Terrace Wall)

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinfo	orcing
As (based on applied moment) :	0.2377 in2/ft		
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinfo	orcing Options :
	===========	One layer of :	Two layers of :
Required Area :	0.2377 in2/ft	#4@ 13.89 in	#4@ 27.78 in
Provided Area :	0.24 in2/ft	#5@ 21.53 in	#5@ 43.06 in
Maximum Area :	0.6503 in2/ft	#6@ 30.56 in	#6@ 61.11 in
Footing Data	Footing	Design Results	
Toe Width –	1 17 ft	Тое	Hool

I de Width	=	1.17 ft
Heel Width	=	1.83
Total Footing Width	=	3.00
Footing Thickness	=	12.00 in

f'c = 3,00	0 psi	Fy =	60,0	000 psi
Footing Concret	e Density	y =	150	.00 pcf
Min. As %	2.00	=	0.00)18
Cover @ Top		@ E	3tm.=	3.00 in

		Toe	Heel	
Factored Pressure	=	2,416	0	psf
Mu' : Upward	=	1,413	92	ft-#
Mu': Downward	=	172	1,986	ft-#
Mu: Design	=	1,241	1,894	ft-#
φ Mn	=	2,739	2,739	ft-#
Actual 1-Way Shear	=	7.43	17.63	psi
Allow 1-Way Shear	=	43.82	43.82	psi
Toe Reinforcing	=	None Spec'd		
Heel Reinforcing	=	None Spec'd		
Key Reinforcing	=	None Spec'd		
Footing Torsion, Tu		=	0.00 ft-lb	os
Footing Allow. Torsio	n, գ	Tn =	0.00 ft-lb	S

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

Other Acceptable Sizes & Spacings

Toe: phiMn = phi*5*lambda*sqrt(fc)*Sm

Heel: phiMn = phi*5*lambda*sqrt(fc)*Sm

Key: No key defined

00	n2
0.26 i	n2 /ft
If two layers	s of horizontal bars:
#4@ 18.	52 in
#5@ 28.	70 in
#6@ 40.	74 in
	0.26 i I <u>f two layer</u> #4@ 18. #5@ 28.

Project File: Retaining Walls - Updated.ec6

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LIC# : KW-06016450, Build:20.24.05.02 QUANTU
DESCRIPTION: 7' Retained - EQ (7' Terrace Wall)

Summary of Overturning & Resisting Forces & Moments

	OV	ERTURNING	·		RE	SISTING	
Item	Force lbs	Distance ft	Moment ft-#		Force Ibs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	1,264.4	2.83	3,582.4	Soil Over HL (ab. water tbl)	1,047.0	2.42	2,532.0
HL Act Pres (be water tbl)	, -		- ,	Soil Over HL (bel. water tbl)		2.42	2,532.0
Hydrostatic Force				Water Table			
Buoyant Force =				Sloped Soil Over Heel =			
Surcharge over Heel =				Surcharge Over Heel =			
Surcharge Over Toe =				Adjacent Footing Load =			
Adjacent Footing Load =				Axial Dead Load on Stem =			
Added Lateral Load =				* Axial Live Load on Stem =			
_oad @ Stem Above Soil =				Soil Over Toe =	70.2	0.59	41.1
= =				Surcharge Over Toe =			
-				Stem Weight(s) =	750.0	1.50	1,127.5
				Earth @ Stem Transitions =			
Total =	1,264.4	O.T.M. =	3,582.4	Footing Weight =	450.0	1.50	675.0
				Key Weight =			
Resisting/Overturning Rat	tio	=	1.73	Vert. Component =	608.9	3.00	1,826.6
Vertical Loads used for So	il Pressure	= 2,926.7	1 lbs	Total =	2,926.1	os R.M.=	6,202.1

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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)

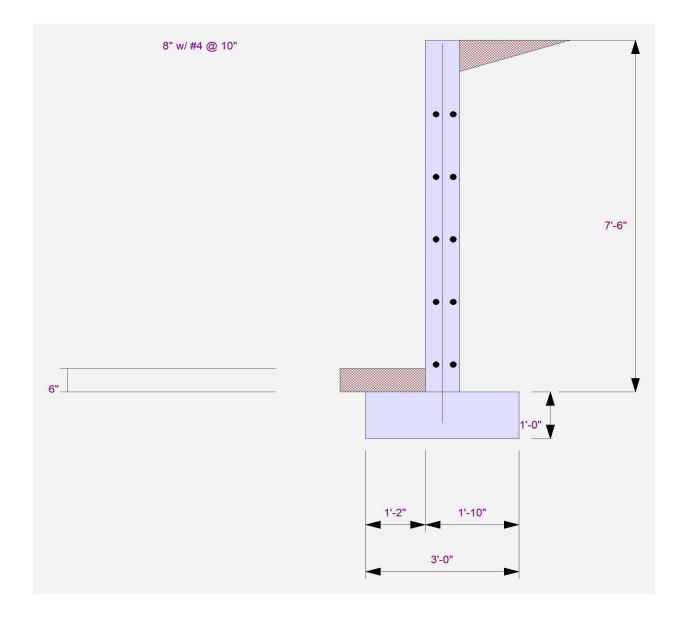
Soil Spring Reaction Modulus	250.0	pci
Horizontal Defl @ Top of Wall (approximate only)	0.151	in

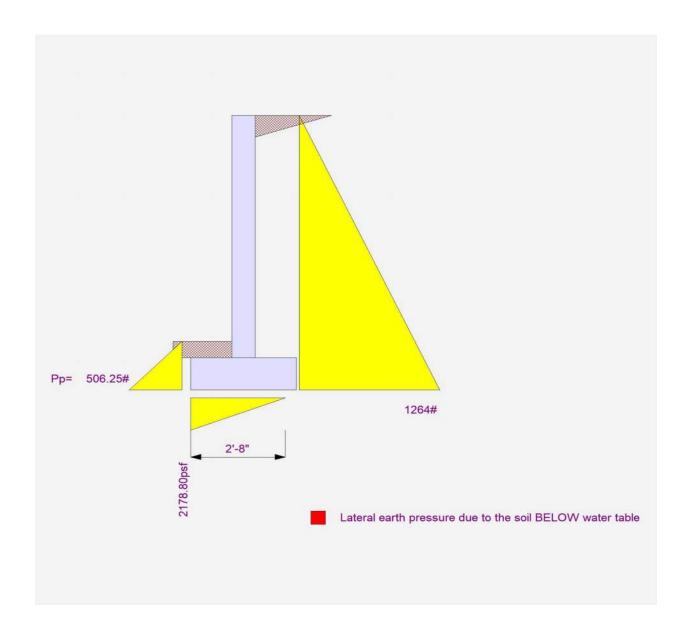
The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe,

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

Cantilevered Retaining Wall	Project File: Retaining Walls - Updated.ec6	
LIC# : KW-06016450, Build:20.24.05.02 QUANTUM CONSULTING ENGINEERS		(c) ENERCALC INC 1983-2023
DESCRIPTION: 7' Retained - EQ (7'	Terrace Wall)	
Rebar Lap & Embedment Lengths Inf	formation	
Stem Design Segment: Bottom		
Stem Design Height: 0.00 ft above top of for	Dting	
Lap Splice length for #4 bar specified in this ste	m design segment (25.4.2.4a) =	17.09 in
Development length for #4 bar specified in this s	stem design segment =	13.15 in
Hooked embedment length into footing for #4 ba	ar specified in this stem design segment =	5.63 in
As Provided =		0.2400 in2/ft
As Required =		0.2377 in2/ft

Cantilevered Retaining Wall		Project File: Retaining Walls - Updated.ec6
LIC# : KW-06016450, Build:20.24.05.02	QUANTUM CONSULTING ENGINEERS	(c) ENERCALC INC 1983-2023
DESCRIPTION: 7' Retained - EQ (7	' Terrace Wall)	





Restrained Retaining Wall

LIC# : KW-06016450, Build:20.24.05.02 **DESCRIPTION:** 7' Terrace Wall QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

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Code Reference

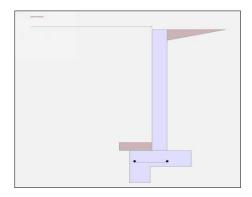
Calculations per IBC 2021 1807.3, ASCE 7-16

Criteria

Retained Height	=	7.50 ft
Wall height above soil	=	ft
Total Wall Height	=	7.50 ft
Top Support Height	=	7.5 ft
Slope Behind Wall	=	0
Height of Soil over Toe	=	6 in

Allow Soil Bearing Equivalent Fluid Pressure	= Metho	2,500.0 od	psf
At-Rest Heel Pressure	=	55.0	psf/ft
	=		psf/ft
Passive Pressure	=	450.0	psf/ft
Soil Density	=	120.0	pcf
Footing Soil Frictior	=	0.5250	psf
Soil height to ignore for passive pressure	=	0.0	in

Soil Data



Curr	hor	a 0 1	oads
Sur	ildi	уе с	Juaus

= ding & Over	psf turning		
Surcharge Over Toe = psf Used for Sliding & Overturning			
Axial Load Applied to Stem			
=	lbs lbs		
=	in		
	Stem		

Earth Pressure Seismic Load

Design Summary

Total Bearing Load resultant ecc.	=	2,470.0 lbs 0.0 in
Soil Pressure @ Toe Soil Pressure @ Heel	=	823.33 psf OK 823.33 psf OK
Allowable Soil Pressure Less	= Tha	psf n Allowable
ACI Factored @ Toe ACI Factored @ Heel	=	988.0 psf 988.0 psf
Footing Shear @ Toe Footing Shear @ Heel	=	3.246 psi OK -2.644 psi OK
Allowable	=	82.158 psi
Reaction at Top Reaction at Bottom	=	308.346 lbs 1,677.50 lbs
Sliding Calcs Lateral Sliding Force	=	1,677.50 lbs

Vertical component of active lateral soil pressure IS NOT considered in the calculation of soil bearing

Load Factors -

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

Uniform Lateral Lo	oad App	blied to Stem	
Lateral Load	=	0.0 #/ft	
Height to Top Height to Bottom	=	7.50 ft 0.0 ft	
Load Type	=	Seismic (E)	
Wind on Exposed S	Stem =	(Strength Lev 0.00 psf (Strength Lev	,
Wind acts left-to-rig	ght towa	rd retention sid	de.
K _h Soil Density M	ultiplier	= 0.2 g	Adc

Adjacent Footing Load

Adjacent Footing Load	=	lbs
Footing Width Eccentricity	=	ft in
Wall to Ftg CL Dist	=	ft
Footing Type		Line Load
Base Above/Below Soil at Back of Wall	=	ft
Poisson's Ratio	=	0.3
ded seismic per unit area	=	0.0 psf

Concrete Stem Construction

8.00 in Thickness = Fy = 100.0 psf Wall Weight = f'c = Stem is FIXED to top of footing

60000 psi 3000 psi

	@ Top Support		Mmax Between Top & Base	@ Base of Wall	
		Stem OK	Stem OK	Stem OK	
Design Height Above Ftg	=	7.5 ft	4.187 ft	0.00 ft	
Rebar Size	=	# 4	# 4	# 4	
Rebar Spacing	=	10.00 in	10.00 in	10.00 in	
Rebar Placed at	=	Center	Center	Center	
Rebar Depth 'd'	=	4.0 in	4.0 in	4.0 in	
Design Data fb/FB + fa/Fa	=		0.272	0.609	
MuActual	=	0.0 ft-#	1,106.84 ft-#	2,475.05 ft-#	
Mn * PhiAllowable	=	4,065.12 ft-#	4,065.12 ft-#	4,065.12 ft-#	
Shear Force @ this height	=	494.993 lbs		1,980.01 lbs	
ShearActual	=	10.312 psi		41.250 psi	
ShearAllowable	=	56.196 psi		56.196 psi	

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Restrained Retaining Wall

LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 7' Terrace Wall

Footing Strengths & I	Dimen	sions
Toe Width Heel Width Total Footing Width	= = =	.16666666 ft .83333333 3.0
Footing Thickness	=	12.0 in
Key Width Key Depth Key Distance from Toe	= = =	12.0 in 12.0 in 0.0 ft
f'c = 3,000 psi Footing Concrete Dens Min. As % Cover @ Top = 2	ity = =	= 60000 psi 150 pcf 0.0018 2 Btm.= 3 in

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Footing Design Results

Project File: Retaining Walls - Updated.ec6

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		<u>Toe</u>	<u>Heel</u>	Key	
Factored Pressure	=	988.0	988.0		psf
Mu' : Upward	=	672.39			ft-#
Mu' : Downward	=	171.50			ft-#
Mu: Design	=	501	185	1,411.6	ft-#
Actual 1-Way Shear	=	3.246	-2.644	17.8	psi
Allow 1-Way Shear	=	43.818	43.818	0.0	psi
Other Acceptable Siz	es &	Spacings	:		
Toe: # 7 @ 18.00 in		-or-	phiMn = ph	ii * 5 * Iambda	* sqrt(fc) * Sm
Heel: None Spec'd		-or-	phiMn = ph	ii * 5 * Iambda	* sqrt(fc) * Sm
Key: # 0 @ 0.00 in		-or-	phiMn = ph	ii * 5 * lambda	* sqrt(fc)
Min footing T&S rein Min footing T&S reinf If one layer of horizor	Area	a per foot	0.26 ir	n2 n2 /ft horizontal ba	rs:
#4@ 9.26 in			#4@ 18.52 i		
#5@ 14.35 in			#5@ 28.70 i		
#6@ 20.37 in			#6@ 40.74 i	n	

Summary of Forces on Footing : Slab is NOT providing sliding, stem is FIXED at footing

Forces acting on footing Sliding Forces	g for slidi	ng & soil pressur	e Load & Moment Sumn	narv F	or Footing : Fo	r Soil Pressure Cal	cs
Stem Shear @ Top of Fo	oting =	1,237.50 lbs	Moment @ Top of Footing		•	=	-1,546.91ft-#
Heel Active Pressure	=	440.0	Surcharge Over Heel		0.0	0.0	0.0
Sliding Force	=	1.677.50 lbs	Adjacent Footing Load	=	0.0 lbs	0.0 ft	0.0ft-#
onang roroo	_	1,011100 1.50	Axial Dead Load on Stem	=	0.0 lbs	0.0 ft	0.0ft-#
			Soil Over Toe	=	70.0 lbs	0.5833 ft	40.833ft-#
Stem is specified to be fixed	l to footir	ig, and top	Surcharge Over Toe	=	0.0 lbs	0.0 ft	0.0ft-#
restraint is assumed to read	ct out any	tendency for	Stem Weight	=	750.0 lbs	1.50 ft	1,125.0ft-#
moment at the footing/soil i	nterface.	so uniform	Soil Over Heel	=	1,050.0 lbs	2.417 ft	2,537.50ft-#
soil pressure is assumed.	,		Footing Weight	=	600.0 lbs	1.126 ft	= -1,546.91 ft-# .0 0.0 .0 ft 0.0 ft-# .0 ft 0.0 ft-# .3 ft 40.83 ft-# .0 ft 0.0 ft-# .0 ft 0.0 ft-# .0 ft 1,125.0 ft-# .7 ft 2,537.50 ft-# .26 ft 675.50 ft-#
			Total Vertical Force	≣	2,470.0 lbs	Base Moment =	2,831.93ft-#

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

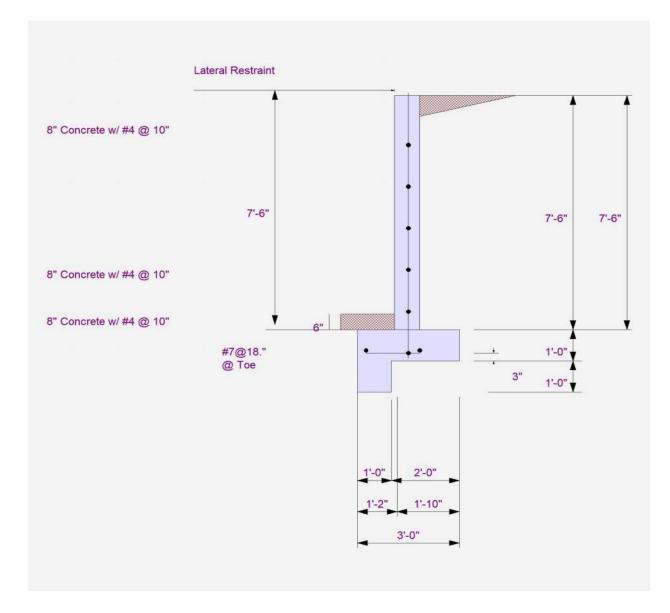
Rebar Lap & Embedment Lengths Information



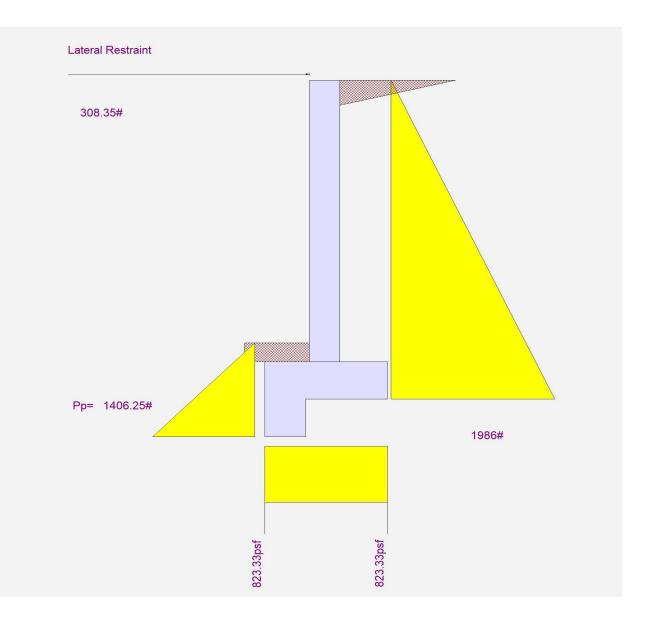
DESCRIPTION: 7' Terrace Wall

QUANTUM CONSULTING ENGINEERS

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DESCRIPTION: 7' Terrace Wall



Restrained Retaining Wall

LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 7' Terrace Wall - EQ QUANTUM CONSULTING ENGINEERS

Project File: Retaining Walls - Updated.ec6

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Code Reference

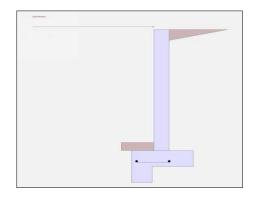
Calculations per IBC 2021 1807.3, ASCE 7-16

Criteria

Retained Height Wall height above soil Total Wall Height	=	7.50 ft ft 7.50 ft
Top Support Height	=	7.5 ft
Slope Behind Wall Height of Soil over Toe	= =	0 6 in

= Metho	2,500.0 psf od
=	55.0 psf/ft
=	0.0 psf/ft
=	450.0 psf/ft
=	120.0 pcf
=	0.5250 psf
=	in
	= = =

Soil Data



Surcharge Loads

Surcharge Over Heel >>>Used To Resist Sli Surcharge Over Toe Used for Sliding & Ove Axial Load Applied to 3	= rturning	psf turning psf
Axial Dead Load	=	lbs
Axial Live Load	=	lbs
Axial Load Eccentricity	=	in

Earth Pressure Seismic Load

Design Summary

Total Bearing Load	=	2,470.0 lbs
resultant ecc.	=	0.0 in
Soil Pressure @ Toe	=	823.33 psf OK
Soil Pressure @ Heel	=	823.33 psf OK
Allowable Soil Pressure Less ACI Factored @ Toe ACI Factored @ Heel	Tha	psf n Allowable 988.0 psf 988.0 psf
Footing Shear @ Toe	=	3.246 psi OK
Footing Shear @ Heel	=	-2.644 psi OK
Allowable	=	82.158 psi
Reaction at Top Reaction at Bottom	=	409.596 lbs 1,846.25 lbs
Sliding Calcs Lateral Sliding Force	=	1,846.25 lbs

Vertical component of active lateral soil pressure IS NOT considered in the calculation of soil bearing

Load Factors -

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

Uniform Lateral Load Applied to Stem						
Lateral Load	=	60.0 #/ft				
Height to Top Height to Botton	= n =	7.50 ft ft				
Load Type	=	Seismic (E)				
Wind on Exposed	I Stem =	(Strength Lev 0.00 psf (Strength Lev				
Wind acts left-to-right toward retention side.						
K _h Soil Density	Multiplier	= 0.2 g	Add			

Adjacent Footing Load

Adjacent Footing Load	=	lbs
Footing Width Eccentricity	=	ft in
Wall to Ftg CL Dist	=	ft
Footing Type		Line Load
Base Above/Below Soil at Back of Wall	=	ft
Poisson's Ratio	=	0.3
led seismic per unit area	=	0.0 psf

Concrete Stem Construction

8.00 in Thickness = Fy = 100.0 psf Wall Weight = f'c = Stem is FIXED to top of footing

60000 psi 3000 psi

	@	Top Support	Mmax Between Top & Base	@ Base of Wall
		Stem OK	Stem OK	Stem OK
Design Height Above Ftg	=	7.5 ft	4.277 ft	0.00 ft
Rebar Size	=	# 4	# 4	# 4
Rebar Spacing	=	10.00 in	10.00 in	10.00 in
Rebar Placed at	=	Center	Center	Center
Rebar Depth 'd'	=	4.0 in	4.0 in	4.0 in
Design Data				
fb/FB + fa/Fa	=		0.338	0.733
MuActual	=	0.0 ft-#	1,373.97 ft-#	2,981.30 ft-#
Mn * PhiAllowable	=	4,065.12 ft-#	4,065.12 ft-#	4,065.12 ft-#
Shear Force @ this height	=	699.66 lbs		2,317.51 lbs
ShearActual	=	14.576 psi		48.281 psi
ShearAllowable	=	56.196 psi		56.196 psi

Restrained Retaining Wall

LIC# : KW-06016450, Build:20.24.05.02 DESCRIPTION: 7' Terrace Wall - EQ

Footing Strengths & Dimensions					
Toe Width Heel Width Total Footing Width Footing Thickness	= = =	.16666666 ft . <u>83333333</u> 3.0 12.0 in			
Key Width Key Depth Key Distance from Toe	= = =	12.0 in 12.0 in ft			
f'c = 3,000 psi Footing Concrete Densit Min. As % Cover @ Top = 2 i	=	= 60000 psi 150 pcf 0.0018 2 Btm.= 3 in			

QUANTUM CONSULTING ENGINEERS

Footing Design Results

Project File: Retaining Walls - Updated.ec6 (c) ENERCALC INC 1983-2023

		<u>Toe</u>	<u>Heel</u>	<u>Key</u>	
Factored Pressure	=	988.0	988.0		psf
Mu' : Upward	=	672.39			ft-#
Mu': Downward	=	171.50			ft-#
Mu: Design	=	501	185	1,411.6	ft-#
Actual 1-Way Shear	=	3.246	-2.644	17.8	psi
Allow 1-Way Shear	=	43.818	43.818	43.8	psi
Other Acceptable Siz	es 8	Spacings	:		
Toe: # 7 @ 18.00 in		-or-	phiMn = phi	* 5 * lambda	* sqrt(fc) * Sm
Heel: None Spec'd		-or-			* sqrt(fc) * Sm
Key: #0 @ 18.00 in		-or-	phiMn = phi	* 5 * lambda	* sqrt(fc)
Min footing T&S rein Min footing T&S reinf		a per foot		2 /ft	
If one layer of horizor	ntal k	oars: If t	wo layers of l	norizontal ba	rs:
#4@ 9.26 in			#4@ 18.52 in		
#5@ 14.35 in			#5@ 28.70 in		
#6@ 20.37 in			#6@ 40.74 in		

Summary of Forces on Footing : Slab is NOT providing sliding, stem is FIXED at footing

Forces acting on footing Sliding Forces	for slid	ing & soil pressur	e Load & Moment Sum	mary F	or Footing : Fo	r Soil Pressure Cal	cs
Stem Shear @ Top of Footing = 1,406.25 lbs		Moment @ Top of Footing Applied from Stem			=	-1,800.03ft-#	
Heel Active Pressure	=	440.0	Surcharge Over Heel		0.0	0.0	0.0
Sliding Force	=	1.846.25 lbs	Adjacent Footing Load	=	0.0 lbs	0.0 ft	0.0ft-#
	1,010120180	Axial Dead Load on Sterr	ו =	0.0 lbs	0.0 ft	0.0ft-#	
			Soil Over Toe	=	70.0 lbs	0.5833 ft	40.833ft-#
em is specified to be fixed to footing, and top Sur		Surcharge Over Toe	=	0.0 lbs	0.0 ft	0.0ft-#	
restraint is assumed to react out any tendency for moment at the footing/soil interface, so uniform soil pressure is assumed.		Stem Weight	=	750.0 lbs	1.50 ft	1,125.0ft-#	
		Soil Over Heel	=	1,050.0 lbs	2.417 ft	2,537.50ft-#	
		Footing Weight	=	600.0 lbs	1.126 ft	675.50ft-#	
in process is accurate			Total Vertical Force	=	2,470.0 lbs	Base Moment =	2,578.80ft-#

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Restrained Retaining Wall

LIC# : KW-06016450, Build:20.24.05.02

QUANTUM CONSULTING ENGINEERS

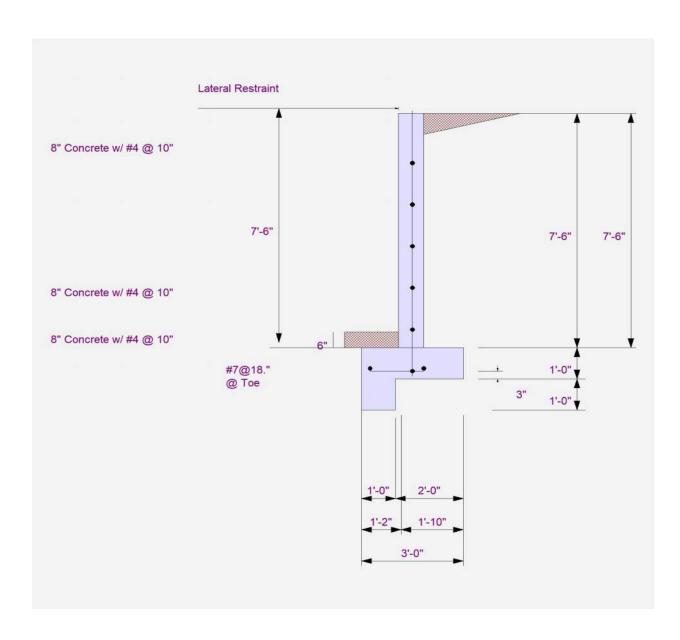
Project File: Retaining Walls - Updated.ec6 (c) ENERCALC INC 1983-2023

DESCRIPTION: 7' Terrace Wall - EQ

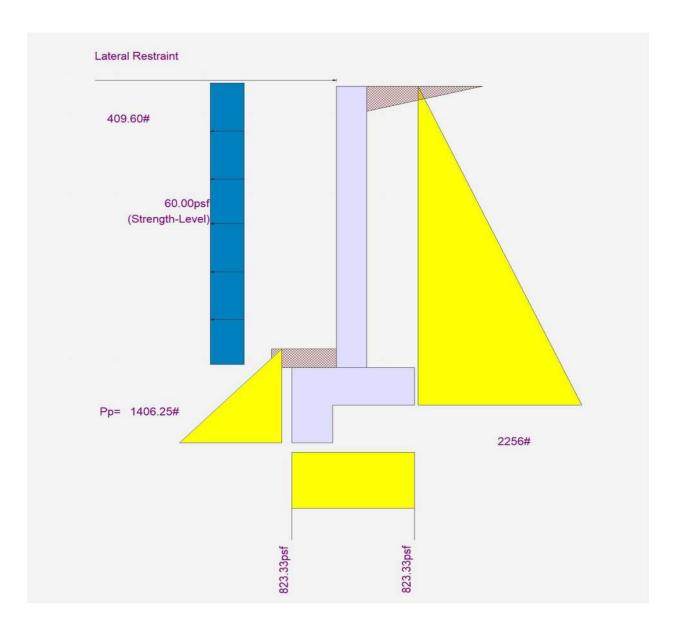
Rebar Lap & Embedment Lengths Information



DESCRIPTION: 7' Terrace Wall - EQ



DESCRIPTION: 7' Terrace Wall - EQ





CENTERIS SOUTH YARD 1023 39TH AVE SE PUYALLUP, WA 38374

QUANTUM JOB NUMBER: 23444.01

PIPE FRAMES

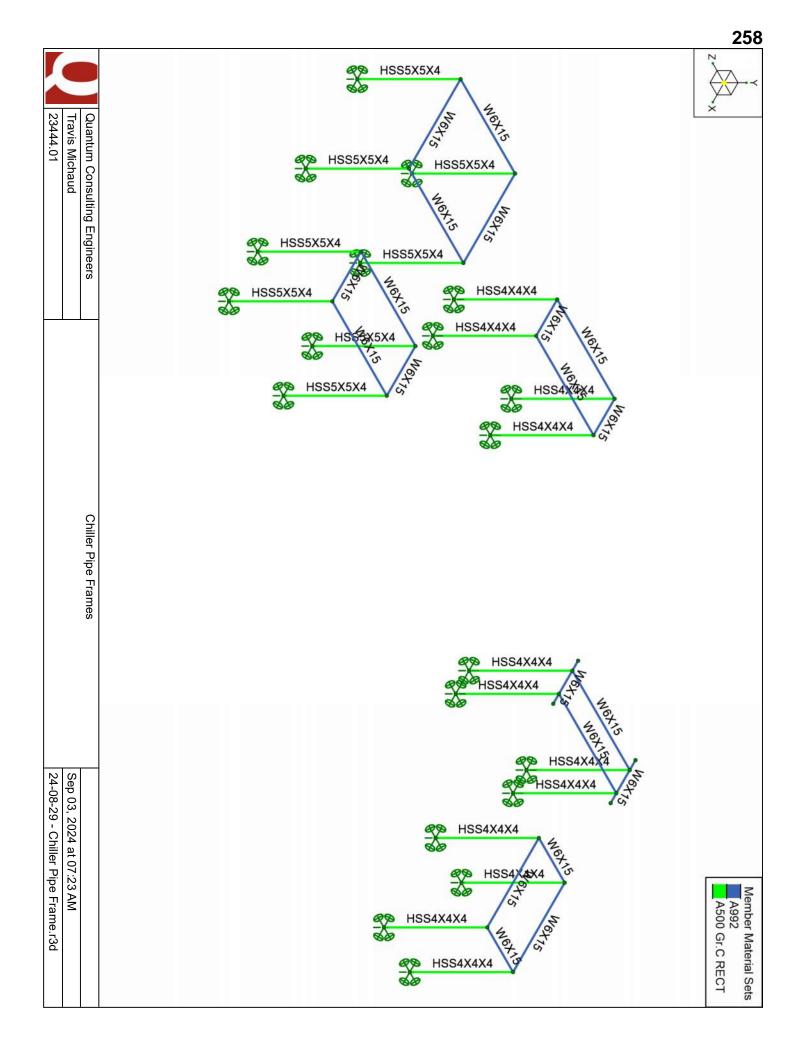
Seismic Base Shear for the Equivalent Lateral Force Procedure Per IBC 2021 & ASCE 7-16 Chapter 15.4

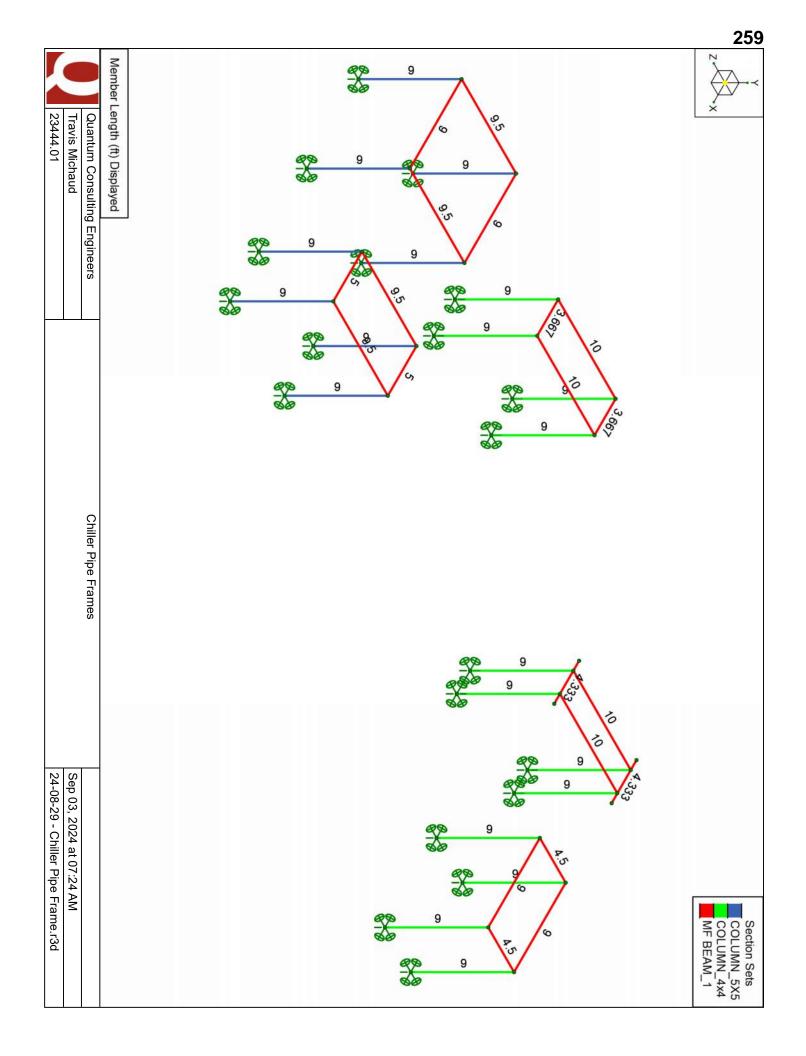
257

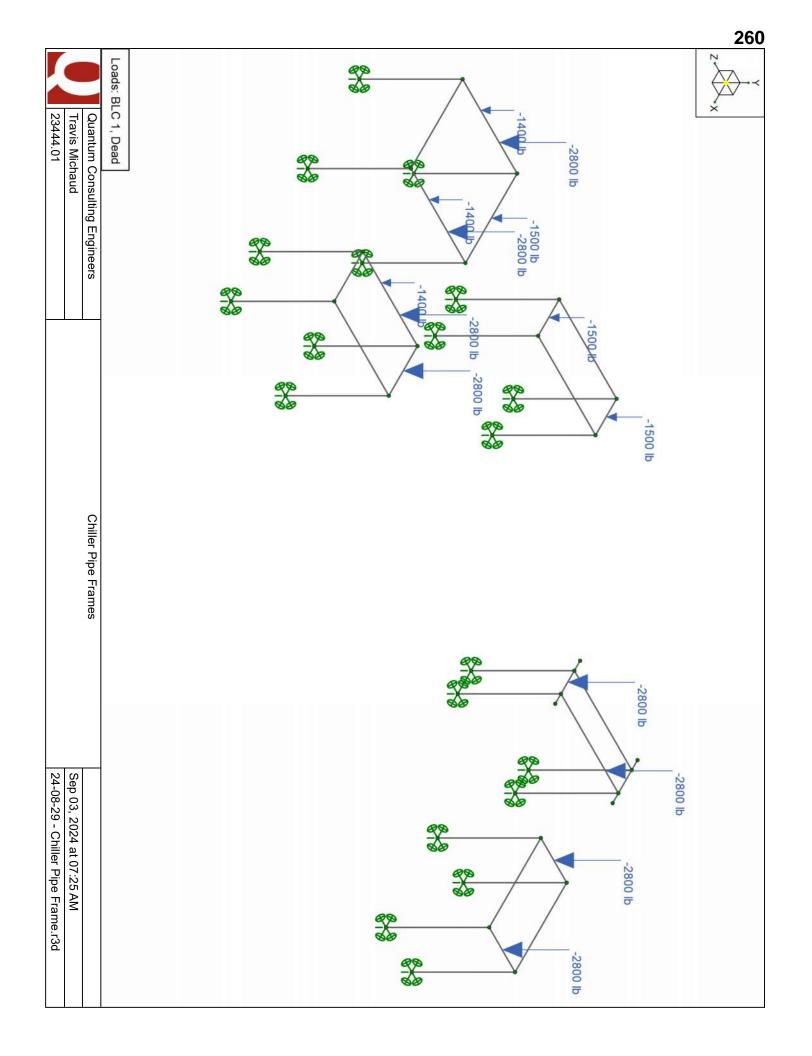
<u>Site Ground Motion</u> S ₁ (g-sec): 0.43 S _S (g-sec): 1.26	_					
$\begin{tabular}{ c c c c c } Latitude: 47.1590 & Longitude: -122.2794 \\ \hline \begin{tabular}{ c c c c c } Latitude: 47.1590 & Longitude: -122.2794 \\ \hline \begin{tabular}{ c c c c c c c c c c c c c c c c c c c$				allup WA 98374		
$\begin{array}{c c} Structure Classification \\ Risk Category: II per ASCE Table 1.5-1 \\ \hline \\ Seismic Force-Resisting System: Steel Ordinary Moment Frames \\ R: 3 1/2 per ASCE Table 15.4-2 \\ W_0: 3 per ASCE Table 15.4-2 \\ C_0: 3 1/4 per ASCE Table 15.4-2 \\ C_0: 3 1/4 per ASCE Table 15.4-2 \\ h_n (ft): 10.00 height above the base to the highest level of the structure \\ \hline \\ Site Ground Motion \\ S_1 (g-sec): 0.43 S_2 (g-sec): 1.26 \\ Site Class: C Per Geotechnical Report per ASCE 11 \\ F_r 1.50 F_s 1.20 \\ S_{b1} (g-sec): 0.65 S_{MS} (g-sec): 1.51 \\ S_{D2} (g-sec): 0.43 S_{D3} S_{D3} (g-sec): 1.01 \\ SDC: D per ASCE 11.6 \\ I_{E}: 1.00 per ASCE Table 1.5-2 \\ \hline \\ Fundamental Period per ASCE 12.82 \\ \hline \\ Reid Method: Approximate Fundamental Period Structure Systems T_1 (sec): 0.11 Ct * hnx per ASCE Eq. 12.8-7 \\ T_{use} (sec): 0.11 Ct * hnx per ASCE Eq. 12.8-7 \\ T_{use} (sec): 0.11 Ct * hnx per ASCE Eq. 12.8-2 \\ C_{s-max}: - = S_{D1} T_L / (T_a^{2r}R _E) for T < T_L per ASCE Eq. 12.8-3 \\ C_{s-max}: - = S_{D1} T_L / (T_a^{2r}R _E) for T < T_L per ASCE Eq. 12.8-4 \\ C_{s-min}: 0.044 per ASCE Eq. 15.4-1 \\ C_{s-min}: - = 0.8S_L / (R/I_E) for T_s > 0.6g per ASCE Eq. 12.8-4 \\ C_{s-min}: - = 0.8S_L / (R/I_E) for T_s > 0.6g per ASCE Eq. 15.4-2 \\ C_{s-min}: - = 0.8S_L / (R/I_E) for T_s > 0.6g per ASCE Eq. 12.8-4 \\ C_{s-min}: - = 0.8S_L / (R/I_E) for T_s > 0.6g per ASCE Eq. 12.8-4 \\ C_{s-min}: - = 0.8S_L / (R/I_E) for T_s > 0.6g per ASCE Eq. 12.8-4 \\ C_{s-min}: - = 0.8S_L / (R/I_E) for T_s > 0.6g per ASCE Eq. 12.8-4 \\ C_{s-min}: - = 0.8S_L / (R/I_E) for T_s > 0.6g per ASCE Eq. 12.8-4 \\ C_{s-min}: - = 0.8S_L / (R/I_E) for T_s > 0.6g per ASCE Eq. 15.4-2 \\ C_{s-min}: - = 0.8S_L / (R/I_E) for T_s > 0.6g per ASCE Eq. 15.4-2 \\ C_{s-min}: - = 0.8S_L / (R/I_E) for T_s > 0.6g per ASCE Eq. 15.4-2 \\ C_{s-min}: - = 0.8S_L / (R/I_E) for T_s > 0.6g per ASCE Eq. 15.4-2 \\ C_{s-min}: - = 0.8S_L / (R/I_E) for T_s > 0.6g per ASCE Eq. 15.4-2 \\ C_{s-min}: - = 0.8S_L / (R/I_E) for T_s > 0.6g per ASCE Eq. 15.4-2 \\ C_{s-min}: - = 0.8S_L / (R/I_E) for T_s > 0.6g per ASCE E$					-122	2794
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Site Ground Motion S_1 (g-sec): 0.43 S_8 (g-sec): 1.26 Site Class: C Per Geotechnical Report per ASCE 11.4.3 F, 1.50 F_a 1.20 Sum (g-sec): 0.65 Sum (g-sec): 1.51 Sob (g-sec): 0.43 Sob (g-sec): 1.01 SDC: D per ASCE 11.6 1.5-2 Fundamental Period per ASCE 12.82 Period Method: Approximate Fundamental Period Structure Type: All Other Structural Systems T _L (sec): 6.00 ASCE Figures 22-14 through 22-17 T_s: 0.43 Ta (sec): 0.11 Ct * hnx per ASCE Eq. 12.8-7 T _{use} (sec): 0.11 ct * nnx per ASCE Eq. 12.8-7 T _{use} (sec): 0.11 ct * nnx per ASCE Eq. 12.8-7 T _{use} (sec): 0.11 ct * nnx per ASCE Eq. 12.8-7 C _{s:} 0.287 = Sps/ (R/le) per ASCE Eq. 12.8-2 C _{s-max} : 1.100 = Sps/ (R/le) for T <= T_L per ASCE Eq. 12.8-3				· ·		
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$I_{E}: 1.00 \text{ per ASCE Table 1.5-2}$ $\begin{array}{cccc} Fundamental Period per ASCE 12.8.2 \\ Period Method: All Other Structural Systems \\ T_{L}(sec): 6.00 \\ ASCE Figures 22-14 through 22-17 \\ T_{5}: 0.43 \\ Ta (sec): 0.11 \\ Ct * hnx per ASCE Eq. 12.8-7 \\ T_{use} (sec): 0.11 \\ Ct * hnx per ASCE Eq. 12.8-7 \\ T_{use} (sec): 0.11 \\ C_{s}: 0.287 \\ S_{DS}/(R/I_{E}) per ASCE Eq. 12.8-2 \\ C_{s-max}: 1.100 \\ S_{D1}/(T_{a}^{*}R/I_{E}) for T <= T_{L} per ASCE Eq. 12.8-3 \\ C_{s-max}: - \\ S_{D1}^{*}T_{L}/(T_{a}^{2*}R/I_{E}) for T > T_{L} per ASCE Eq. 12.8-4 \\ C_{s-min}: 0.044 \\ per ASCE Eq. 15.4-1 \\ C_{s-min}: - \\ C_{s-min}: - \\ 0.287 \\ \end{array}$:): 1.01	
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$\begin{array}{cccc} \mbox{Period Method:} & \mbox{Approximate Fundamental Period All Other Structural Systems} \\ T_L (sec): & \mbox{6.00} & \mbox{ASCE Figures 22-14 through 22-17} \\ T_s: & \mbox{0.43} \\ \mbox{Ta (sec):} & \mbox{0.11} & \mbox{Ct * hnx per ASCE Eq. 12.8-7} \\ \mbox{T}_{use} (sec): & \mbox{0.11} & \mbox{Ct * hnx per ASCE Eq. 12.8-7} \\ \mbox{T}_{use} (sec): & \mbox{0.11} & \mbox{-} <= TL \\ \mbox{Equivalent Lateral Force Procedure Design Base Shear per ASCE 12.8} \\ \mbox{C}_s: & \mbox{0.287} & = \mbox{S}_{DS} / (R/I_E) \mbox{ per ASCE Eq. 12.8-2} \\ \mbox{C}_{s-max}: & \mbox{1.100} & = \mbox{S}_{D1} / (T_a^*R/I_E) \mbox{ for T} <= T_L \mbox{per ASCE Eq. 12.8-3} \\ \mbox{C}_{s-max}: & \mbox{-} & \mbox{=} & \mbox{S}_{D1} / (T_a^{2*}R/I_E) \mbox{ for T} > T_L \mbox{per ASCE Eq. 12.8-4} \\ \mbox{C}_{s-min}: & \mbox{-} & \mbox{=} & \mbox{0.044} \mbox{ per ASCE Eq. 15.4-1} \\ \mbox{C}_{s-use}: & \mbox{0.287} \\ \mbox{=} & \mbox{0.287} \end{array}$	Fundamental Period	per ASCE 12	2.8.2			
$T_{L} (sec): 6.00 \text{ ASCE Figures 22-14 through 22-17} \\ T_{s}: 0.43 \\ Ta (sec): 0.11 \text{ Ct * hnx per ASCE Eq. 12.8-7} \\ T_{use} (sec): 0.11 `<= TL \\ \hline \begin{tabular}{lllllllllllllllllllllllllllllllllll$	Pe	riod Method:	Approx			
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$\begin{array}{rcl} Ta \ (sec): & 0.11 & Ct * hnx \ per \ ASCE \ Eq. \ 12.8-7 \\ T_{use} \ (sec): & 0.11 & {}^- <= TL \\ \hline \end{array}$		· · ·		ASCE Figures 22-14 throug	yn 22-17	
$\begin{array}{rll} T_{use} \ (sec): & 0.11 & \neg <= TL \end{array} \\ \hline \begin{tabular}{lllllllllllllllllllllllllllllllllll$		I _s :	0.43			
$\begin{array}{rll} T_{use} \ (sec): & 0.11 & \neg <= TL \end{array} \\ \hline \begin{tabular}{lllllllllllllllllllllllllllllllllll$		Ta (sec):	0.11	Ct * hnx per ASCE Eq. 12.8	3-7	
$\begin{array}{rcl} \hline & \textbf{Equivalent Lateral Force Procedure Design Base Shear per ASCE 12.8} \\ & C_s: & 0.287 & = S_{DS} / (R/I_E) \ \text{per ASCE Eq. 12.8-2} \\ & C_{s-max}: & 1.100 & = S_{D1} / (T_a * R/I_E) \ \text{for T} <= T_L \ \text{per ASCE Eq. 12.8-3} \\ & C_{s-max}: & & = S_{D1} * T_L / (T_a^{2*} R/I_E) \ \text{for T} > T_L \ \text{per ASCE Eq. 12.8-4} \\ & C_{s-min}: & 0.044 & \ \text{per ASCE Eq. 15.4-1} \\ & C_{s-min}: & & = 0.8S_1 / (R/I_E) \ \text{for S}_1 => 0.6g \ \text{per ASCE Eq. 15.4-2} \\ & C_{s-use}: & 0.287 \end{array}$		· · /		. ,		
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C_{s-min} : = 0.8S ₁ / (R/I _E) for S ₁ => 0.6g per ASCE Eq. 15.4-2 C_{s-use} : 0.287			0.044		L I	•
C _{s-use} : 0.287					6g per ASCE E	q. 15.4-2
			0.287	, .		
V : 0.287 W = C _{S-use} * W per ASCE Eq. 12.8-1		•				
		V :	0.287 W	= C _{S-use} * W per ASCE Eq.	12.8-1	

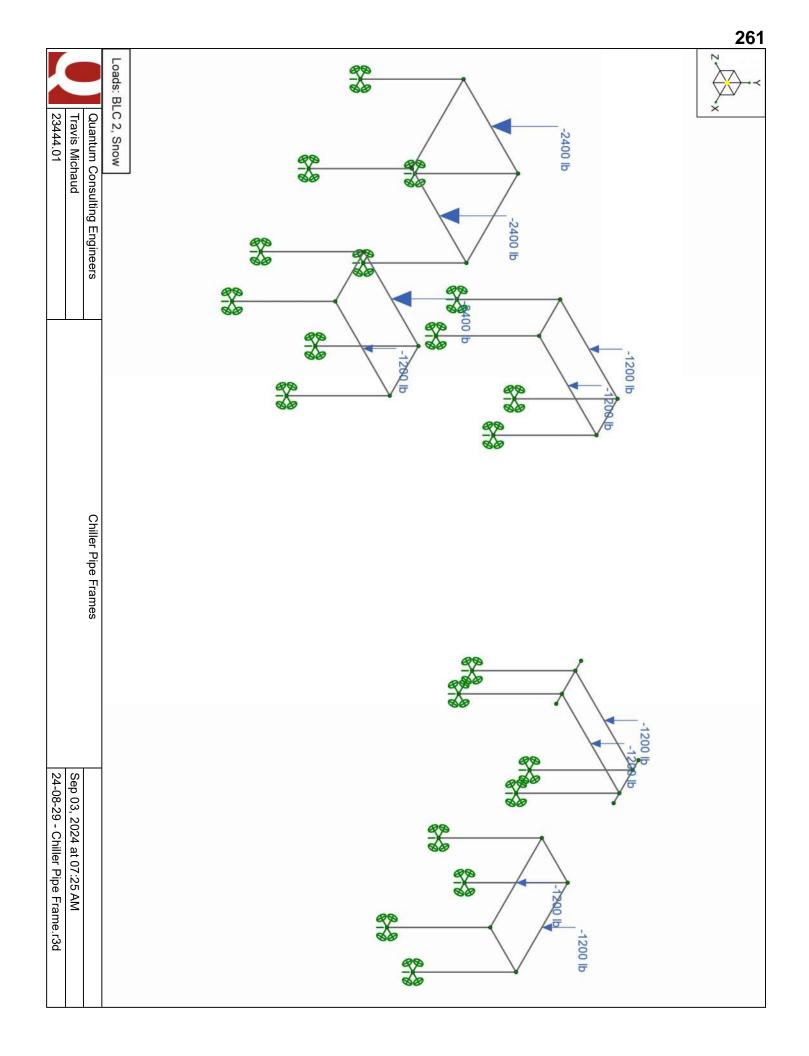


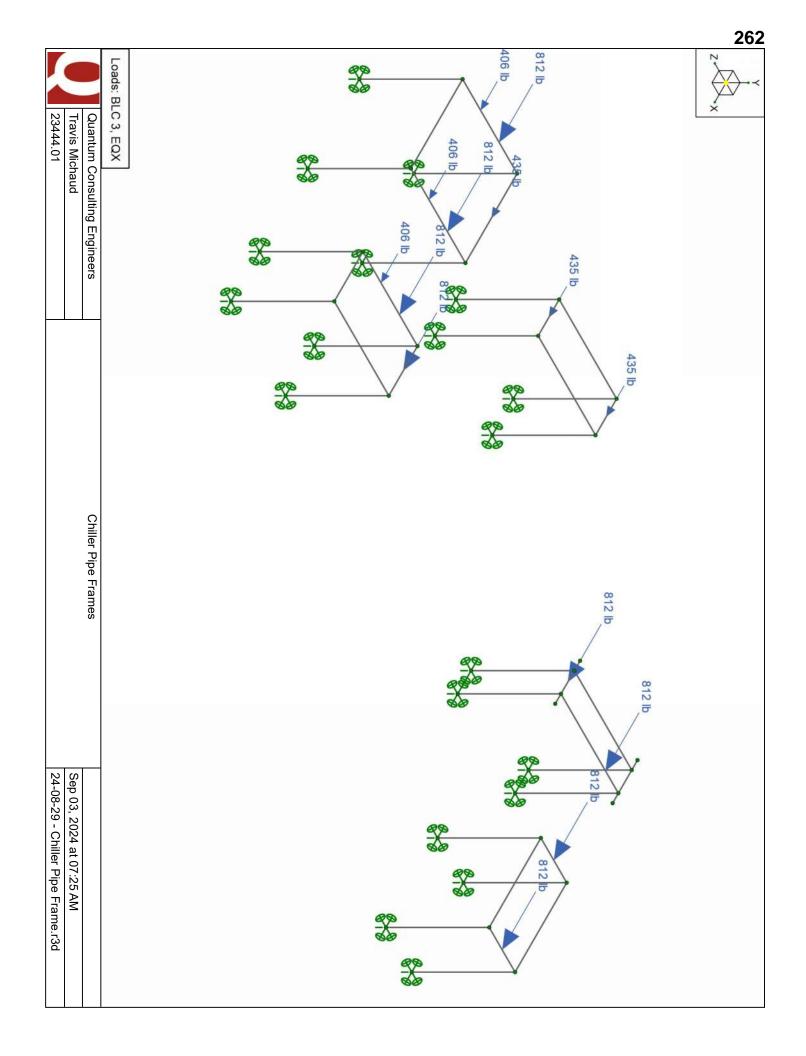
Quantum Consulting Engineers LLC	Project:	Centeris	Date:	9/3/24	Job No:	23444.01
1511 Third Avenue, Suite 323			Designer:	TVM	Sheet:	1
Seattle, WA 98101	Client:	Centeris	Checked By:			

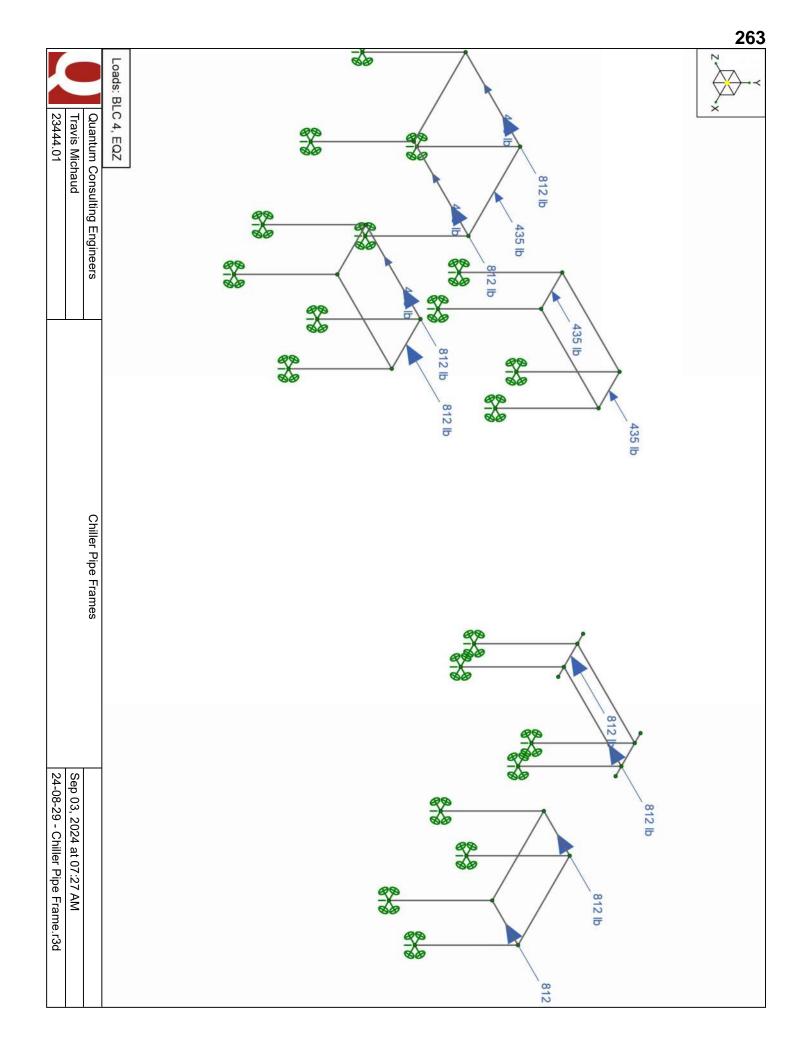


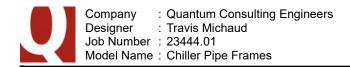








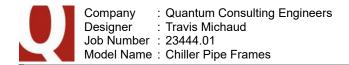




9/3/2024 7:26:17 AM Checked By : __

Basic Load Cases

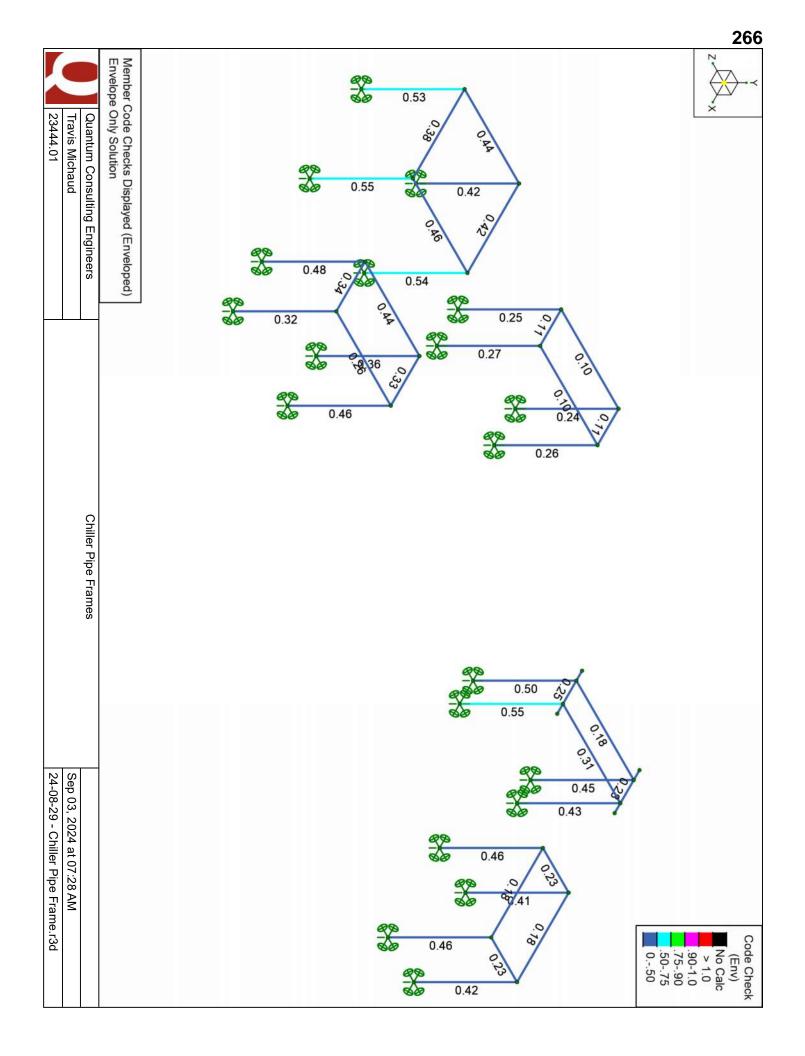
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1	Dead	DL - Dead Load		-1		16
2	Snow	None				12
3	EQX	ELX - Earthquake Load X	0.29			16
4	EQZ	ELZ - Earthquake Load Z			0.29	16

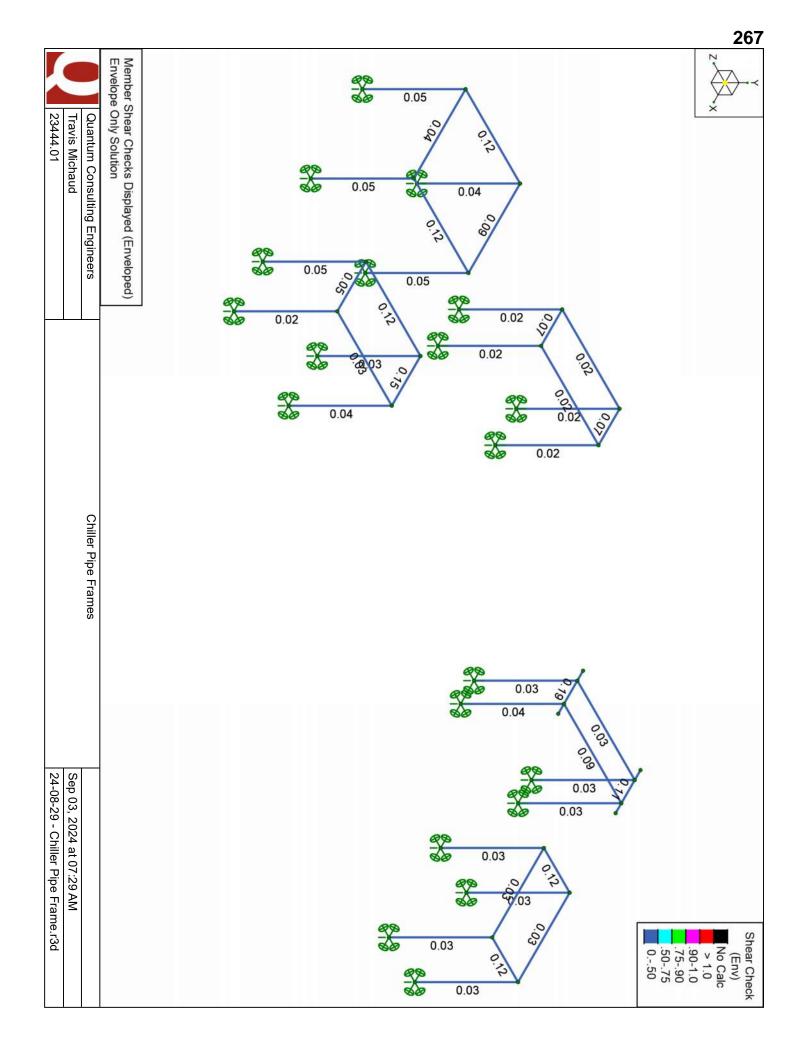


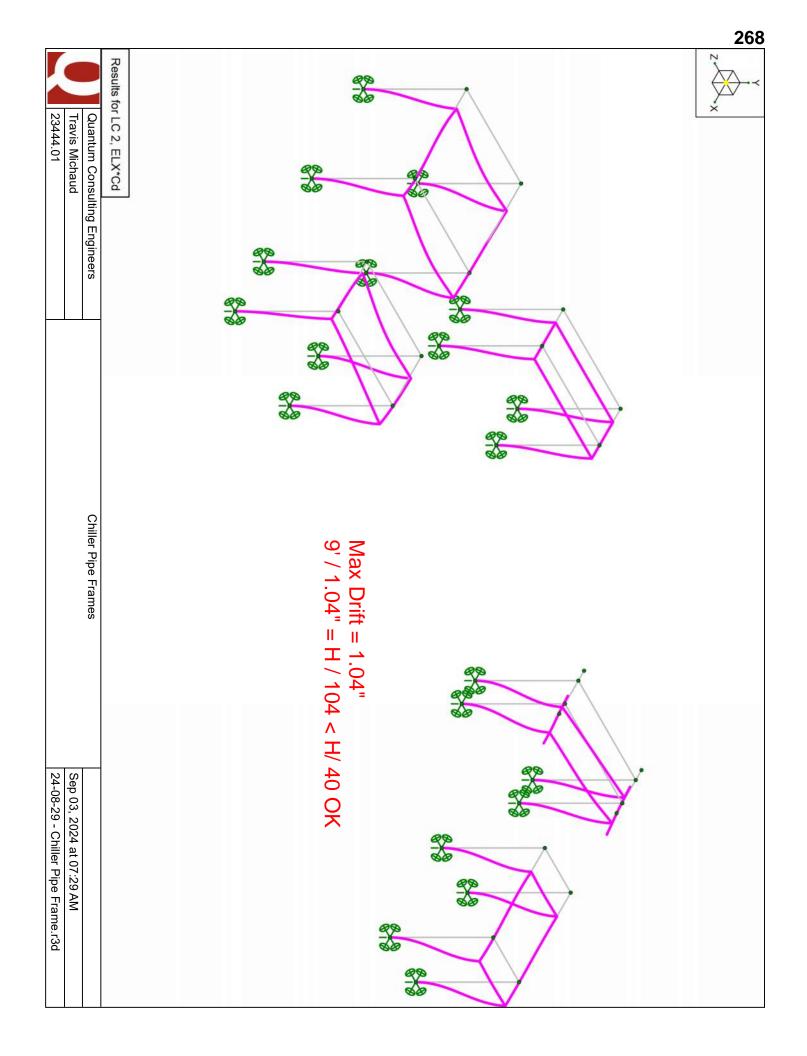
9/3/2024 7:28:13 AM Checked By : __

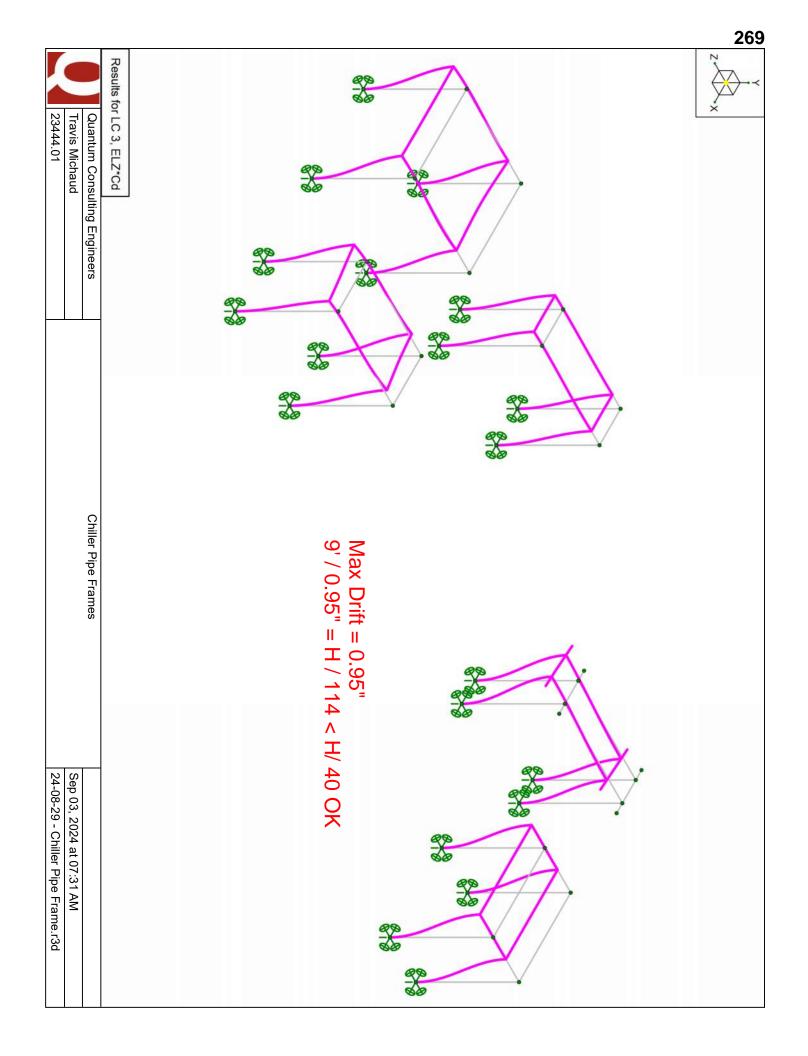
Load Combinations

	Description	Solve	P-Delta	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
1	ELX		Y	ELX	1								
2	ELX*Cd		Y	ELX	3								
3	ELZ*Cd		Y	ELZ	3								
4	ASD												
5	IBC 16-8	Yes	Y	DL	1								
6	IBC 16-10 (b)	Yes	Y	DL	1	SL	1						
7	IBC 16-12 (b) (a)	Yes	Y	DL	1	SDS*DL	0.14	ELX	0.7	ELZ	0.21		
8		Yes	Y	DL	1	SDS*DL	0.14	ELZ	0.7	ELX	0.21		
9	IBC 16-14 (a)	Yes	Y	DL	1	SDS*DL	0.105	ELX	0.525	ELZ	0.158	SL	0.75
10		Yes	Y	DL	1	SDS*DL	0.105	ELZ	0.525	ELX	0.158	SL	0.75
11	IBC 16-16 (a)	Yes	Y	DL	0.6	SDS*DL	-0.14	ELX	0.7	ELZ	0.21		
12	. ,	Yes	Y	DL	0.6	SDs*DL	-0.14	ELZ	0.7	ELX	0.21		
13	IBC 16-12 (b) (a) OS	Yes	Y	DL	1	SDS*DL	0.14	ELX	1.75	ELZ	0.525		
14		Yes	Y	DL	1	SDs*DL	0.14	ELZ	1.75	ELX	0.525		
15	IBC 16-14 (a) OS		Y	DL	1	SDS*DL	0.105	ELX	1.31	ELZ	0.39	SL	0.75
16	. ,		Y	DL	1	SDs*DL	0.105	ELZ	1.31	ELX	0.39	SL	0.75
17	IBC 16-16 (a) OS		Y	DL	0.6	SDS*DL	-0.14	ELX	1.75	ELZ	0.525		
18			Y	DL	0.6	SDS*DL	-0.14	ELZ	1.75	ELX	0.525		
19	Base Plate LRFD												
20	IBC 16-5		Y	DL	1.2	SDS*DL	0.2	ELX	1	ELZ	0.3	SL	0.2
21			Y	DL	1.2	SDS*DL	0.2	ELZ	1	ELX	0.3	SL	0.2
22	IBC 16-7		Y	DL	0.9	SDs*DL	-0.2	ELX	1	ELZ	0.3		
23			Y	DL	0.9	SDS*DL	-0.2	ELZ	1	ELX	0.3		
24	IBC 16-5 (os-a)		Y	DL	1.2	SDS*DL	0.2	ELX	2.5	ELZ	0.75	SL	0.2
25			Y	DL	1.2	SDs*DL	0.2	ELZ	2.5	ELX	0.75	SL	0.2
26	IBC 16-7 (os-a)		Y	DL	0.9	SDS*DL	-0.2	ELX	2.5	ELZ	0.75		
27			Y	DL	0.9	SDS*DL	-0.2	ELZ	2.5	ELX	0.75		









SIMPSON

Strong-Tie

Anchor Designer™ for Concrete Software Version 3.3.2404.1

Company:	QCE	Date:	9/8/2022
Engineer:	TVM	Page:	1/7
Project:	Centeris		
Address:			
Phone:			
E-mail:			

1.Project information

Project description: Chiller Narrow Frames Location: Fastening description:

2. Input Data & Anchor Parameters

General Design method:ACI 318-19 Units: Imperial units

Anchor Information:

Anchor type: Bonded anchor Material: F1554 Grade 36 Diameter (inch): 0.750 Effective Embedment depth, her (inch): 8.000 Code report: ICC-ES ESR-4057 Anchor ductility: Yes hmin (inch): 9.75 c_{ac} (inch): 18.55 C_{min} (inch): 1.75 S_{min} (inch): 3.00

Recommended Anchor

Anchor Name: SET-3G[™] - SET-3G w/ 3/4"Ø F1554 Gr. 36 Code Report: ICC-ES ESR-4057



Comment:

Base Material

Concrete: Normal-weight Concrete thickness, h (inch): 12.00 State: Cracked Compressive strength, f'c (psi): 3000 Ψc,v: 1.0 Reinforcement condition: Supplementary reinforcement not present Supplemental edge reinforcement: Not applicable Reinforcement provided at corners: No Ignore concrete breakout in tension: No Ignore concrete breakout in shear: No Hole condition: Dry concrete Inspection: Periodic Temperature range, Short/Long: 150/110°F Reduced installation torque (for AT-3G): Not applicable Ignore 6do requirement: Not applicable Build-up grout pad: No

Base Plate

Length x Width x Thickness (inch): 10.00 x 10.00 x 0.63 Yield stress: 50000 psi

Profile type/size: 4X4X1/4

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Strong-Tie

Anchor Designer™ for Concrete Software Version 3.3.2404.1

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E-mail:			

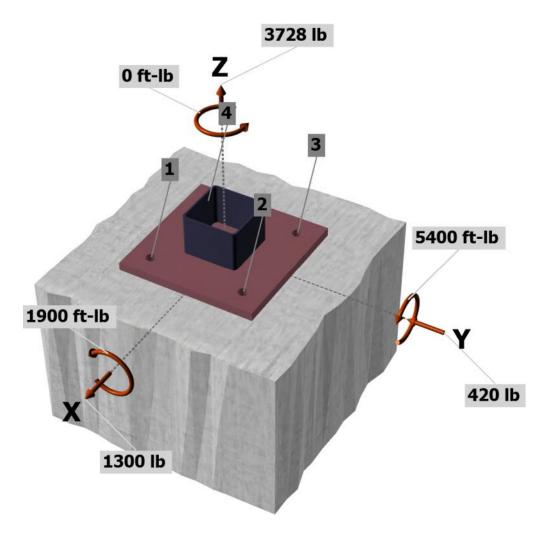
Load and Geometry

Load factor source: ACI 318 Section 5.3 Load combination: not set Seismic design: Yes Anchors subjected to sustained tension: No Ductility section for tension: 17.10.5.3 (d) is satisfied Ductility section for shear: 17.10.6.3 (c) is satisfied Ω_0 factor: not set Apply entire shear load at front row: No Anchors only resisting wind and/or seismic loads: No

Strength level loads:

Nua [lb]: 3728 Vuax [lb]: 1300 Vuay [lb]: -420 Mux [ft-lb]: 1900 Muy [ft-lb]: 5400 Muz [ft-lb]: 0



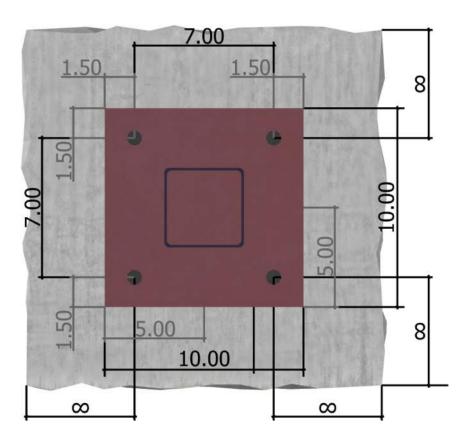




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<Figure 2>



3. Resulting Anchor Forces

Anchor	Tension load, Nua (Ib)	Shear load x, V _{uax} (Ib)	Shear load y, V _{uay} (lb)	Shear load combined, $\sqrt{(V_{uax})^2+(V_{uay})^2}$ (lb)
1	0.0	325.0	-105.0	341.5
2	389.9	325.0	-105.0	341.5
3	6184.5	325.0	-105.0	341.5
4	4351.9	325.0	-105.0	341.5
Sum	10926.3	1300.0	-420.0	1366.2

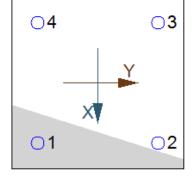
Maximum concrete compression strain (‰): 0.23 Maximum concrete compression stress (psi): 992

Resultant tension force (lb): 10926

Resultant compression force (lb): 7198

Eccentricity of resultant tension forces in x-axis, e'_{Nx} (inch): 0.45 Eccentricity of resultant tension forces in y-axis, e'_{Ny} (inch): 2.08 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





Strong-Tie

SIMPSON Anchor Designer™ for **Concrete Software** Version 3.3.2404.1

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4. Steel Strength of Anchor in Tension (Sec. 17.6.1)

Nsa (lb)	ϕ	ϕN_{sa} (lb)							
19370	0.75	14528							
Concret	- Drockout C	trongth of An	ahar in Tanai	on (Boo 176)	2)				
	<i>h_{ef}^{1.5}</i> (Eq. 17.)	itrength of An 6.2.2.1)	chor in Tensio	<u>on (Sec. 17.6.</u>	<u>2</u>]				
<i>k</i> _c	λα	ŕ _c (psi)	h _{ef} (in)	N _b (lb)					
17.0	1.00	3000	8.000	21069					
0.75 <i>¢N_{cbg}</i> =(0.75¢(A _№ /A	Nco) $\Psi_{ec,N} \Psi_{ed,N} \Psi_{c}$	$\Psi_{cp,N} \Psi_{cp,N} N_b$ (Sec.	17.5.1.2 & Eq.	. 17.6.2.1a)				
A_{Nc} (in ²)	A_{Nco} (in ²)	c _{a,min} (in)	$\Psi_{ec,N}$	$\Psi_{ed,N}$.	Ψ _{c,N}	$\Psi_{cp,N}$	N _b (lb)	ϕ	0.75 <i>¢N_{cbg}</i> (lb)
912.00	576.00 e Strength o	- f Anchor in Te	0.821 ension (Sec. 1	1.000 7.6.5)	1.00	1.000	21069	0.65	13351
6. Adhesive					1.00	1.000	21069	0.65	13351
6. Adhesive	e Strength o					1.000	21069 <i>τ_{k,cr}</i> (psi)	0.65	13351
6. Adhesive τ _{k,cr} = τ _{k,cr} f _{shc}	e Strength o ort-termKsat(f°c / 2	2,500) ⁿ α _{N.seis}	ension (Sec. 1	<u>7.6.5)</u>				0.65	13351
6. Adhesive $\tau_{k,cr} = \tau_{k,cr} f_{shc}$ $\frac{\tau_{k,cr} (psi)}{1310}$	<mark>e Strength o</mark> ort-termKsat(f [°] c / 2 fshort-term	2,500) ⁿ α _{N.seis} K _{sat} 1.00	e <mark>nsion (Sec. 1</mark> α _{N.seis}	7.6.5) f'c (psi)) n		T _{k,cr} (psi)	0.65	13351
6. Adhesive $\tau_{k,cr} = \tau_{k,cr} f_{shc}$ $\tau_{k,cr} (psi)$ 1310 $N_{ba} = \lambda_{a} \tau_{cr} \pi$	e Strength o ort-termKsat(f'c/2 fshort-term 1.00	2,500) ⁿ α _{N.seis} K _{sat} 1.00	e <mark>nsion (Sec. 1</mark> α _{N.seis}	7.6.5) f'c (psi)) n 0.24		T _{k,cr} (psi)	0.65	13351
$\frac{6. \text{ Adhesive}}{t_{k,cr} = \tau_{k,cr}f_{shc}}$ $\frac{\tau_{k,cr} \text{ (psi)}}{1310}$ $N_{ba} = \lambda_{a}\tau_{cr}\pi$ λ_{a}	e Strength o ^{nrt-term} K _{sat} (f'c/2 f _{short-term} 1.00 dahef (Eq. 17.6	2,500) ⁿ a _{N.seis} <u>K_{sat}</u> 1.00 5.5.2.1)	ension (Sec. 1 α _{N.seis} 1.00	<u>7.6.5)</u> <u>f'</u> c (psi) 3000) n 0.24		T _{k,cr} (psi)	0.65	13351
6. Adhesive $\tau_{k,cr} = \tau_{k,cr} f_{shc}$ $\frac{\tau_{k,cr} (psi)}{1310}$ $N_{ba} = \lambda_{a} \tau_{cr} \pi$ λ_{a} 1.00	e Strength o prt-termKsat(f'c/2 fshort-term 1.00 dahef (Eq. 17.6 Tcr (psi) 1369	2,500) ⁿ α _{N.seis} <u>K_{sat}</u> 1.00 5.5.2.1) d _a (in)	ension (Sec. 1 α _{N.seis} 1.00 <i>het</i> (in) 8.000	<u>7.6.5)</u> <u>f'c (psi)</u> 3000 <u>Nba</u> (lb) 25797) n 0.24		T _{k,cr} (psi)	0.65	13351
6. Adhesive $T_{K,cr} = T_{K,cr} f_{shc}$ $T_{K,cr} (psi)$ 1310 $N_{ba} = \lambda_{a} T_{cr} \pi$ λ_{a} 1.00	e Strength o prt-termKsat(f'c/2 fshort-term 1.00 dahef (Eq. 17.6 Tcr (psi) 1369	$(500)^n \alpha_{N.seis}$ K_{sat} 1.00 5.5.2.1) d_a (in) 0.75	ension (Sec. 1 α _{N.seis} 1.00 <i>het</i> (in) 8.000	<u>7.6.5)</u> <u>f'c (psi)</u> 3000 <u>Nba</u> (lb) 25797) n 0.24		T _{k,cr} (psi)	0.65 - \$	13351 0.75 <i>¢N₂g</i> (lb)

8. Steel Strength of Anchor in Shear (Sec. 17.7.1)

	V _{sa} (lb)	$\phi_{ ext{grout}}$	ϕ	αv,seis	$\phi_{ ext{grout}} lpha_{ ext{V}, ext{seis}} \phi_{ ext{V}sa} ext{(lb)}$
_	11625	1.0	0.65	0.75	5667

10. Concrete Pryout Strength of Anchor in Shear (Sec. 17.7.3)

SIMPS	SON A	nchor Desig	nor™ for	Cor	npany: Q	CE		Date:	9/8/2022
	_			Eng	jineer: T	VM		Page:	5/7
Strong		oncrete Sof	tware	Pro	ject: C	enteris			•
	e Vi	ersion 3.3.2404.1		Add	lress:				
	-			Pho	one:				
				E-m	nail:				
$\phi V_{cpg} = \phi m$	in <i>kcpN₂g</i> ; <i>k</i> ₀	$p_{p}N_{cbg} = \phi \min k_{cp} $	ANa / ANa0) Vec,Na	a $\Psi_{ed,Na}$ $\Psi_{cp,Na}$	Nba; Kcp(Anc/	ANco) Ψec,N Ψ	ed,N Ψc,N Ψcp,NNb] (S	Sec. 17.5.1.2 8	Eq. 17.7.3.1b
Kcp	A _{Na} (in ²			$arphi_{ec}$, cp,Na	N _{ba} (lb)	Na (lb)	
2.0	758.84	422.18	1.000	1.00	00 1	.000	25797	46369	
A _{Nc} (in ²)	A _{Nco} (in²)	$\Psi_{ec,N}$	$\Psi_{ed,N}$	$\Psi_{c,N}$	𝖓 _{cp,N}	<i>N</i> ₅ (lb)	N _{cb} (lb)	ϕ	
961.00	576.00	1.000	1.000	1.000	1.000	21069	35152	0.70	
ϕV_{cpg} (lb)									
49212									
11. Results	5								
		and Shear Ford	es (Sec. 17.8)						
Tension		Factored Lo			rength, øNո (ll	o) Ratio		Status	
Steel		6185		14528	• ·	0.43		Pass	
Concrete	breakout	10926		13351		0.82		Pass (G	Governs)
Adhesive		10926		16835		0.65		Pass	-
Shear		Factored Lo	ad, Vua (Ib)	Design St	rength, øVո (II	o) Ratio		Status	
Steel		342		5667		0.06		Pass (G	Boverns)
Steel		1000		49212		0.03		Pass	
Pryout		1366				0.00			
	n check	1300 Nua/ØNn	Vua∕∳Vn		Combined I		Permissible	Status	

SET-3G w/ 3/4"Ø F1554 Gr. 36 with hef = 8.000 inch meets the selected design criteria.

Strong-Tie

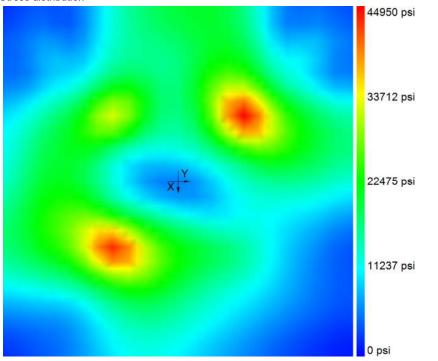
SIMPSON Anchor Designer™ for **Concrete Software** Version 3.3.2404.1

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Base Plate Thickness

Required base plate thickness: 0.625 inch	
Steel	50000 psi
Maximum stress	44950 psi
Calculated plate thickness	0.625 inch

Stress distribution



For ACI and CSA design methods, maximum base plate stress is limited to 0.9 times yield stress. For ETAG design method, maximum base plate stress is limited to yield stress divide by 1.5. Plate stress is derived using Von Mises theory.

$$\begin{split} \sigma_{xx} &= \frac{F_{xx}}{t} + \frac{6M_{xx}}{t^2} (\textcircled{a} \text{ bottom}) \text{ or } \sigma_{xx} = \frac{F_{xx}}{t} - \frac{6M_{xx}}{t^2} (\textcircled{a} \text{ top}) \\ \sigma_{yy} &= \frac{F_{yy}}{t} + \frac{6M_{yy}}{t^2} (\textcircled{a} \text{ bottom}) \text{ or } \sigma_{yy} = \frac{F_{yy}}{t} - \frac{6M_{yy}}{t^2} (\textcircled{a} \text{ top}) \\ \sigma_{xy} &= \frac{F_{xy}}{t} + \frac{6M_{yy}}{t^2} (\textcircled{a} \text{ bottom}) \text{ or } \sigma_{xy} = \frac{F_{yy}}{t} - \frac{6M_{yy}}{t^2} (\textcircled{a} \text{ top}) \\ \sigma_{xy} &= \frac{F_{xy}}{t} + \frac{6M_{yy}}{t^2} (\textcircled{a} \text{ bottom}) \text{ or } \sigma_{xy} = \frac{F_{yy}}{t} - \frac{6M_{yy}}{t^2} (\textcircled{a} \text{ top}) \\ \sigma_{xz} &= \frac{V_{x}}{t} \\ \sigma_{yz} &= \frac{V_{y}}{t} \\ \end{split}$$



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12. Warnings

- Per designer input, ductility requirements for tension have been determined to be satisfied - designer to verify.

- Per designer input, ductility requirements for shear have been determined to be satisfied - designer to verify.

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

- Refer to manufacturer's product literature for hole cleaning and installation instructions.

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1.Project information

Project description: Chiller Narrow Frames Location: Fastening description:

2. Input Data & Anchor Parameters

General Design method:ACI 318-19 Units: Imperial units

Anchor Information:

Anchor type: Bonded anchor Material: F1554 Grade 36 Diameter (inch): 0.750 Effective Embedment depth, h_{ef} (inch): 10.000 Code report: ICC-ES ESR-4057 Anchor category: -Anchor ductility: Yes h_{min} (inch): 11.75 c_{ac} (inch): 26.73 C_{min} (inch): 1.75 S_{min} (inch): 3.00

Recommended Anchor

Anchor Name: SET-3G[™] - SET-3G w/ 3/4"Ø F1554 Gr. 36 Code Report: ICC-ES ESR-4057



Comment:

Base Material

Concrete: Normal-weight Concrete thickness, h (inch): 12.00 State: Cracked Compressive strength, f'c (psi): 3000 Ψc,v: 1.0 Reinforcement condition: Supplementary reinforcement not present Supplemental edge reinforcement: Not applicable Reinforcement provided at corners: No Ignore concrete breakout in tension: No Ignore concrete breakout in shear: No Hole condition: Dry concrete Inspection: Periodic Temperature range, Short/Long: 150/110°F Reduced installation torque (for AT-3G): Not applicable Ignore 6do requirement: Not applicable Build-up grout pad: No

Base Plate

Length x Width x Thickness (inch): 12.00 x 12.00 x 1.00 Yield stress: 50000 psi

Profile type/size: 5X5X1/4

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Anchor Designer™ for Concrete Software Version 3.3.2404.1

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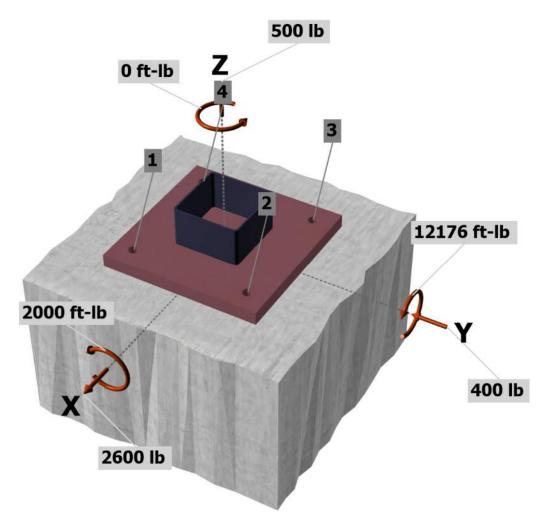
Load and Geometry

Load factor source: ACI 318 Section 5.3 Load combination: not set Seismic design: Yes Anchors subjected to sustained tension: No Ductility section for tension: 17.10.5.3 (d) is satisfied Ductility section for shear: 17.10.6.3 (c) is satisfied Ω_0 factor: not set Apply entire shear load at front row: No Anchors only resisting wind and/or seismic loads: No

Strength level loads:

 $\begin{array}{l} N_{ua} \ [lb]: 500 \\ V_{uax} \ [lb]: 2600 \\ V_{uay} \ [lb]: -400 \\ M_{ux} \ [ft-lb]: 2000 \\ M_{uy} \ [ft-lb]: 12176 \\ M_{uz} \ [ft-lb]: 0 \end{array}$



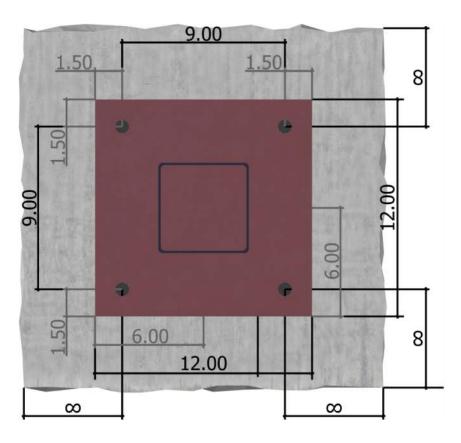




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<Figure 2>



3. Resulting Anchor Forces

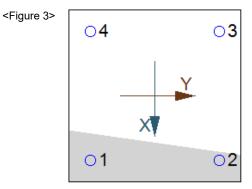
Anchor	Tension load, Nua (Ib)	Shear load x, V _{uax} (Ib)	Shear load y, V _{uay} (Ib)	Shear load combined, $\sqrt{(V_{uax})^2+(V_{uay})^2}$ (Ib)
1	0.0	650.0	-100.0	657.6
2	0.0	650.0	-100.0	657.6
3	8442.2	650.0	-100.0	657.6
4	7155.0	650.0	-100.0	657.6
Sum	15597.3	2600.0	-400.0	2630.6

Maximum concrete compression strain (‰): 0.27 Maximum concrete compression stress (psi): 1165

Resultant tension force (lb): 15597

Resultant compression force (lb): 15097

Eccentricity of resultant tension forces in x-axis, e'_{Nx} (inch): 0.37 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



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4. Steel Strength of Anchor in Tension (Sec. 17.6.1)

Nsa (lb)	ϕ	ϕN_{sa} (lb)							
19370	0.75	14528							
5. Concret	e Breakout S	trength of And	chor in Tensio	on (Sec. 17.6.)	2)				
	ch _{ef} ^{1.5} (Eq. 17.0	-		· · · · · · · · · · · · · · · · · · ·	-				
<i>k</i> c	λa	f' _c (psi)	<i>h</i> ef (in)	N _b (lb)					
17.0	1.00	3000	10.000	29445					
$0.75\phi N_{cbg} =$	0.75¢ (A _{Nc} / A	Nco) $\Psi_{ec,N} \Psi_{ed,N} \Psi_{c}$	$_{,N}\Psi_{cp,N}N_b$ (Sec.	17.5.1.2 & Eq.	17.6.2.1a)				
A_{Nc} (in ²)	A_{Nco} (in ²)	c _{a,min} (in)	$\Psi_{ec,N}$	$\Psi_{ed,N}$.	Ψ _{c,N}	$\Psi_{cp,N}$	N _b (lb)	ϕ	0.75 <i>¢N_{cbg}</i> (lb)
4470.00			0.070	4 000	4.00	4 0 0 0	00445		10010
1170.00 6. Adhesiv	900.00 e Strength o	- <u>f Anchor in Te</u>	0.976 nsion (Sec. 1	1.000 7.6.5)	1.00	1.000	29445	0.65	18210
<u>6. Adhesiv</u>					1.00	1.000	29445	0.65	18210
<u>6. Adhesiv</u>	e Strength o					1.000	29445 τ _{κ.cr} (psi)	0.65	18210
<mark>6. Adhesiv</mark> τ _{k,cr} = τ _{k,cr} f _{sh}	<mark>e Strength o</mark> ort-termK _{sat} (f [*] c / 2	,500) ⁿ α _{N.seis}	nsion (Sec. 1	<u>7.6.5)</u>		1.000		0.65	18210
<u>6. Adhesiv</u> τ _{k,cr} = τ _{k,cr} f _{sh} <u>τ_{k,cr} (psi)</u> 1310	<mark>e Strength o</mark> ort-termKsat(f [*] c / 2 fshort-term	,500) ⁿ α _{N.seis} K _{sat} 1.00	e <mark>nsion (Sec. 1</mark> α _{N.seis}	7.6.5) f'c (psij	n n	1.000	т _{к,cr} (psi)	0.65	18210
<u>6. Adhesiv</u> τ _{k,cr} = τ _{k,cr} f _{sh} <u>τ_{k,cr} (psi)</u> 1310	e Strength o ort-termKsat(fc/2 fshort-term 1.00	,500) ⁿ α _{N.seis} K _{sat} 1.00	e <mark>nsion (Sec. 1</mark> α _{N.seis}	7.6.5) f'c (psij	0 <i>n</i> 0.24	1.000	т _{к,cr} (psi)	-	18210
$6. Adhesiv$ $\tau_{k,cr} = \tau_{k,cr} f_{sh}$ $\tau_{k,cr} (psi)$ 1310 $N_{ba} = \lambda_{a} \tau_{cr} \pi$	e Strength o ort-termKsat(f'c/2 fshort-term 1.00 rdahef (Eq. 17.6	500) ⁿ α _{N.seis} <u>K_{sat}</u> 1.00 5.5.2.1)	ansion (Sec. 1 α _{N.seis} 1.00	<u>7.6.5)</u> <u>f'c (psi</u> <u>3000</u>	0 <i>n</i> 0.24	1.000	т _{к,cr} (psi)	0.65	18210
$\frac{6. \text{ Adhesiv}}{\tau_{k,cr} = \tau_{k,cr} \text{ (psi)}}$ $\frac{\tau_{k,cr} \text{ (psi)}}{1310}$ $N_{ba} = \lambda_{a} \tau_{cr} \pi$ λ_{a} 1.00	e Strength o port-termKsat(f'c/2 fshort-term 1.00 rdaher (Eq. 17.6 Tor (psi) 1369	500) ⁿ α _{N.seis} K _{sat} 1.00 5.5.2.1) da (in)	<u>α_{N.seis}</u> 1.00 <u>her</u> (in) 10.000	<u>f'c (psi)</u> <u>f'c (psi)</u> <u>3000</u> <u>Nba</u> (lb) <u>32247</u>	0 n 0.24	1.000	т _{к,cr} (psi)	0.65	18210
$\frac{6. \text{ Adhesiv}}{\tau_{k,cr} = \tau_{k,cr} \text{ (psi)}}$ $\frac{\tau_{k,cr} \text{ (psi)}}{1310}$ $N_{ba} = \lambda_{a} \tau_{cr} \pi$ λ_{a} 1.00	e Strength o port-termKsat(f'c/2 fshort-term 1.00 rdaher (Eq. 17.6 Tor (psi) 1369	500) ⁿ α _{N.seis} <u>K_{sət}</u> 1.00 5.5.2.1) <i>d</i> ₂ (in) 0.75	<u>α_{N.seis}</u> 1.00 <u>her</u> (in) 10.000	<u>f'c (psi)</u> <u>f'c (psi)</u> <u>3000</u> <u>Nba</u> (lb) <u>32247</u>	0 n 0.24	1.000 Ψ _{cp,Na}	т _{к,cr} (psi)	0.65 - φ	18210 0.75 <i>∳N₂</i> g (Ib)
6. Adhesiv $\tau_{k,cr} = \tau_{k,cr} f_{sh}$ $\tau_{k,cr} (psi)$ 1310 $N_{ba} = \lambda_a \tau_{cr}\pi_a$ λ_a 1.00 $0.75\phi N_{ag} =$	e Strength o port-termKsat(f'c/2 <u>fshort-term</u> 1.00 rdahef (Eq. 17.6 <u>tor</u> (psi) 1369 0.75¢ (A _{Na} / An	,500) ⁿ α _{N.seis} <u>K_{sat}</u> 1.00 5.5.2.1) <u>d</u> a (in) 0.75 _{Na0})Ψ _{ec.Na} Ψ _{ed.Na} &	<u>α_{N.seis}</u> 1.00 <u>her (in)</u> 10.000 V _{cp.Na} N _{ba} (Sec.	<u>7.6.5)</u> <u>f'c</u> (psi) 3000 <u>Nba</u> (lb) 32247 17.5.1.2 & Eq.	<u>n</u> 0.24 		<i>τ_{k,cr}</i> (psi) 1369	_	

8. Steel Strength of Anchor in Shear (Sec. 17.7.1)

V _{sa} (lb)	$\phi_{ ext{grout}}$	ϕ	$\alpha_{V,seis}$	$\phi_{ ext{grout}} lpha_{ ext{V,seis}} \phi_{ ext{Vsa}} ext{(lb)}$
11625	1.0	0.65	0.75	5667

10. Concrete Pryout Strength of Anchor in Shear (Sec. 17.7.3)

SIMPS		chor Desig	oor™ for	Con	npany: QCE	E		Date:	9/8/2022
		•		Eng	ineer: TVN	1		Page:	5/7
Strong		ncrete Soft	ware	Proj	ect: Cen	teris		-	
	Vers	ion 3.3.2404.1		Add	ress:				
	-			Pho					
				E-m	ail:				
$\phi V_{cpg} = \phi mi$	$n k_{cp}N_{ag};k_{cp}N$	$ _{cbg} = \phi \min _{K_{cp}}(A)$.Na / ANa0) Yec,Na	Ψed,Na Ψcp,Nal	Nba; Kcp(Anc/An	co) $arphi_{ec,N} arPsi_{ed}$, $\Psi_{c,N} \Psi_{cp,N} N_b$ (S	Sec. 17.5.1.2 &	Eq. 17.7.3.1b
Kcp	A _{Na} (in ²)	ANao (in ²)	$arphi_{ed,Na}$	$\Psi_{ec,I}$			N _{ba} (lb)	Na (lb)	
2.0	873.03	422.18	1.000	1.00	0 1.00	00	32247	66683	
A _{Nc} (in ²)	A _{Nco} (in²)	$\Psi_{ec,N}$	$\Psi_{ed,N}$	$\Psi_{c,N}$	$\Psi_{cp,N}$	<i>N</i> ₅ (lb)	N _{cb} (lb)	φ	
1521.00	900.00	1.000	1.000	1.000	1.000	29445	49762	0.70	
ϕV_{cpg} (lb)									
69667									
11. Results	<u>5</u>								
	_	nd Shear Force	<u>s (Sec. 17.8)</u>						
	_	nd Shear Force Factored Loa	. ,	Design Str	ength, øN₁ (lb)	Ratio		Status	
nteraction	_		. ,	Design Str 14528	ength, øNո (lb)	Ratio 0.58		Status Pass	
nteraction Tension Steel	of Tensile a	Factored Loa	. ,	0	ength, øNո (lb)			Pass	overns)
<u>nteraction</u> Tension	of Tensile a	Factored Loa 8442	. ,	14528	ength, øN⊧ (lb)	0.58		Pass	overns)
nteraction Tension Steel Concrete	of Tensile a	Factored Loa 8442 15597	d, N _{ua} (Ib)	14528 18210 21817	ength, øN₅ (Ib) ength, øV₅ (Ib)	0.58 0.86		Pass Pass (G	ioverns)
nteraction Tension Steel Concrete Adhesive Shear	of Tensile a	Factored Loa 8442 15597 15597	d, N _{ua} (Ib)	14528 18210 21817		0.58 0.86 0.71		Pass Pass (G Pass Status	ioverns) ioverns)
nteraction Tension Steel Concrete Adhesive	of Tensile a	Factored Loa 8442 15597 15597 Factored Loa	d, N _{ua} (Ib)	14528 18210 21817 Design Str		0.58 0.86 0.71 Ratio		Pass Pass (G Pass Status	
Tension Steel Concrete Adhesive Shear Steel	breakout	Factored Loa 8442 15597 15597 Factored Loa 658	d, N _{ua} (Ib)	14528 18210 21817 Design Str 5667		0.58 0.86 0.71 Ratio 0.12 0.04	ermissible	Pass Pass (G Pass Status Pass (G	

SET-3G w/ 3/4"Ø F1554 Gr. 36 with hef = 10.000 inch meets the selected design criteria.

Strong-Tie

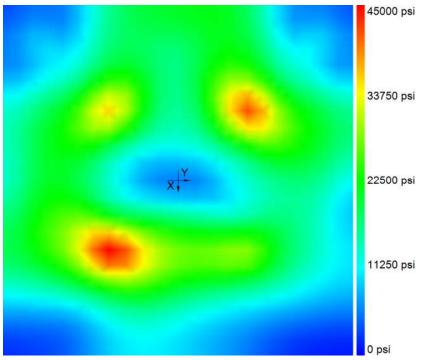
SIMPSON Anchor Designer™ for **Concrete Software** Version 3.3.2404.1

Company:	QCE	Date:	9/8/2022
Engineer:	TVM	Page:	6/7
Project:	Centeris		
Address:			
Phone:			
E-mail:			

Base Plate Thickness

Required base plate thickness: 0.784 inch	
Steel	50000 psi
Maximum stress	45000 psi
Calculated plate thickness	0.784 inch

Stress distribution



For ACI and CSA design methods, maximum base plate stress is limited to 0.9 times yield stress. For ETAG design method, maximum base plate stress is limited to yield stress divide by 1.5. Plate stress is derived using Von Mises theory.

$$\begin{split} \sigma_{xx} &= \frac{F_{xx}}{t} + \frac{6M_{xx}}{t^2} (\textcircled{@} \text{ bottom}) \text{ or } \sigma_{xx} = \frac{F_{xx}}{t} - \frac{6M_{xx}}{t^2} (\textcircled{@} \text{ top}) \\ \sigma_{yy} &= \frac{F_{yy}}{t} + \frac{6M_{yy}}{t^2} (\textcircled{@} \text{ bottom}) \text{ or } \sigma_{yy} = \frac{F_{yy}}{t} - \frac{6M_{yy}}{t^2} (\textcircled{@} \text{ top}) \\ \sigma_{xy} &= \frac{F_{yy}}{t} + \frac{6M_{yy}}{t^2} (\textcircled{@} \text{ bottom}) \text{ or } \sigma_{yy} = \frac{F_{yy}}{t} - \frac{6M_{yy}}{t^2} (\textcircled{@} \text{ top}) \\ \sigma_{xy} &= \frac{F_{yy}}{t} + \frac{6M_{yy}}{t^2} (\textcircled{@} \text{ bottom}) \text{ or } \sigma_{yy} = \frac{F_{yy}}{t} - \frac{6M_{yy}}{t^2} (\textcircled{@} \text{ top}) \\ \sigma_{xz} &= \frac{V_x}{t} \\ \sigma_{yz} &= \frac{V_y}{t} \\ \end{split}$$



Anchor Designer™ for Concrete Software Version 3.3.2404.1

Company:	QCE	Date:	9/8/2022
Engineer:	TVM	Page:	7/7
Project:	Centeris		
Address:			
Phone:			
E-mail:			

12. Warnings

- Per designer input, ductility requirements for tension have been determined to be satisfied - designer to verify.

- Per designer input, ductility requirements for shear have been determined to be satisfied - designer to verify.

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

- Refer to manufacturer's product literature for hole cleaning and installation instructions.



CENTERIS SOUTH YARD 1023 39TH AVE SE PUYALLUP, WA 38374

QUANTUM JOB NUMBER: 23444.01

EQUIPMENT ANCHORAGE



Diesel Generator Set

mtu 20V4000 DS3250 43 °C 3,250 kWe/60 Hz/Standby/480 - 13,800V

System ratings

Voltage (L-L)	480V ^{† ‡}	600V [‡]	4,160V	12,470V	13,200V	13,800V
Phase	3	3	3	3	3	3
PF	0.8	0.8	0.8	0.8	0.8	0.8
Hz	60	60	60	60	60	60
kW	3,250	3,250	3,250	3,250	3,250	3,250
kVA	4,062	4,062	4,062	4,062	4,062	4,062
Amps	4,886	3,909	563	188	177	170
skVA@30% voltage dip	7,061	1,028	8,171	5,297	5,936	6,488
Generator model*	941-VL60	941-VL70	941-M60	4P9.6-2400	4P9.6-2400	4P9.6-2400
Temp rise	130 °C/40 °C	130 °C/40 °C	130 °C/40 °C	130 °C/40 °C	130 °C/40 °C	130 °C/40 °C
Connection	6 LEAD WYE	6 LEAD WYE	6 LEAD WYE	6 LEAD WYE	6 LEAD WYE	6 LEAD WYE

* Consult the factory for alternate configuration. Generator model may end with -M or -R, depending on selection.

[†] UL 2200 offered

* CSA offered

Certifications and standards

- Emissions
 - EPA Tier 2 certified
 - South Coast Air Quality Management District (SCAQMD)
- Generator set is designed and manufactured in facilities certified to standards ISO 9001:2008 and ISO 14001:2004
- Seismic certification optional
- 2021 IBC certification
- HCAI pre-approval
- UL 2200 optional (refer to System ratings for availability)
- CSA optional (refer to System ratings for availability)
 - CSA C22.2 No. 100
 - CSA C22.2 No. 14

- Performance Assurance Certification (PAC)
 - Generator set tested to ISO 8528-5 for transient response
 - Verified product design, quality, and performance integrity
 - All engine systems are prototype and factory tested -
- Power rating
 - Accepts rated load in one step per NFPA 110
 - Permissible average power output during 24 hours of operation is approved up to 85%.

mti



A Rolls-Royce solution

NET ZERO

NAY

Renew

able fuel

Standard features*

- Single source supplier
- Global product support
- Two (2) Year/3,000 Hour Basic Limited Warranty
- 20V4000 diesel engine
 - 95.4 liter displacement
 - Common rail fuel injection
 - 4-cycle
- HVO and GtL fuels meeting fuel specification EN15940
- Complete range of accessories
- Cooling system
- Integral set-mounted
- Engine-driven fan

Standard equipment*

Engine

- Air cleaners
- Oil pump
- Oil drain extension and shut-off valve
- Full flow oil filter
- Closed crankcase ventilation
- Jacket water pump
- Inter cooler water pump
- Thermostats
- $-\,$ Blower fan and fan drive
- Radiator unit mounted
- $-\,$ Electric starting motor 24V
- Governor electronic isochronous
- Base structural steel
- $-\,$ SAE flywheel and bell housing
- Charging alternator 24V
- $-\,$ Battery box and cables
- Bulkhead fuel connectors
- Flexible exhaust connection
- EPA certified engine

Generator

- NEMA MG1, IEEE, and ANSI standards compliance for temperature rise and motor starting
- Sustained short circuit current of up to 300% of the rated current for up to 10 seconds
- Self-ventilated and drip-proof
- Superior voltage waveform
- Digital, solid state, volts-per-hertz regulator
- Brushless alternator with brushless pilot exciter
- 4 pole, rotating field
- 130 °C maximum standby temperature rise
- 2-bearing, sealed
- Flexible coupling
- Full amortisseur windings
- 125% rotor balancing
- 3-phase voltage sensing
- $-\pm$ 0.25% voltage regulation no load to full load
- 5% maximum total harmonic distortion

- Generator
 - Brushless, rotating field generator
 - 2/3 pitch windings
 - Permanent Magnet Generator (PMG) supply to regulator
- 300% short circuit capability
- Digital control panel(s)
 - UL recognized, CSA certified, NFPA 110
 - Complete system metering
 - LCD display

Digital control panel(s)

- Digital metering
- Engine parameters
- Generator protection functions
- Engine protection
- CANBus ECU communications
- Windows[®]-based software
- Multilingual capability
- Communications to remote annunciator
- Programmable input and output contacts
- UL recognized, CSA certified, CE approved
- Event recording
- IP 54 front panel rating with integrated gasket
- NFPA 110 compatible

Application data

Engine

Manufacturer	mtu
Model	20V4000G94S
Туре	4-cycle
Arrangement	20-V
Displacement: L (in³)	95.4 (5,822)
Bore: cm (in)	17 (6.69)
Stroke: cm (in)	21 (8.27)
Compression ratio	16.4:1
Rated rpm	1,800
Engine governor	electronic isochronous (ADEC)
Maximum power: kWm (bhp)	3,490 (4,680)
Steady state frequency band	± 0.25%
Air cleaner	dry

Liquid capacity

Total oil system: L (gal)	390 (103)
Engine jacket water capacity: L (gal)	205 (54.2)
After cooler water capacity: L (gal)	50 (13.2)
System coolant capacity: L (gal)	860 (227)

Electrical

Electric volts DC	24
Cold cranking amps under -17.8 °C (0 °F)	4,200
Batteries: group size	8D
Batteries: quantity	6

Fuel system

Fuel supply connection size	-16 JIC 37° female
	1" NPT adapter provided
Fuel return connection size	-16 JIC 37° female
	1" NPT adapter provided
Maximum fuel lift - cranking: m (ft)	1 (3.3)*
Maximum fuel lift - running: m (ft)	3.1 (10)
Recommended fuel	diesel #2/HVO
Total fuel flow: L/hr (gal/hr)	1,620 (428)

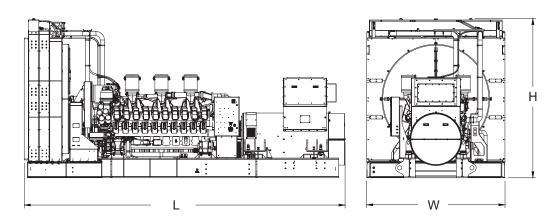
* Fuel lift pump for cranking increases lift to: m (ft) 3.1 (10)

Fuel consumption

Fuel consumption	
At 100% of power rating: L/hr (gal/hr)	844 (223)
At 75% of power rating: L/hr (gal/hr)	644 (170)
At 50% of power rating: L/hr (gal/hr)	447 (118)
Cooling - radiator system	
Ambient capacity of radiator: °C (°F)	43 (108)
Maximum restriction of cooling air: intake	43 (100)
and discharge side of radiator: kPa (in. H_2O)	0.12 (0.5)
0	1,567 (414)
Water pump capacity: L/min (gpm)	, , ,
After cooler pump capacity: L/min (gpm)	567 (150)
Heat rejection to coolant: kW (BTUM)	1,300 (73,929)
Heat rejection to after cooler: kW (BTUM)	970 (55,163)
Heat radiated to ambient: kW (BTUM)	237 (13,472)
Fan power: kW (hp)	60.6 (81.3)
Air requirements	
Aspirating: *m³/min (SCFM)	264 (9,323)
Air flow required for radiator	
cooled unit: *m³/min (SCFM)	3,082 (108,843)
Remote cooled applications; air flow required for	
dissipation of radiated generator set heat for a	
maximum of 25 °F rise: *m3/min (SCFM)	866 (30,384)
* Air density = 1.184 kg/m³ (0.0739 lbm/ft³)	
Exhaust system	
Gas temperature (stack): °C (°F)	525 (977)
Gas volume at stack temperature: m³/min (CFM)	702 (24,791)
Mantanana II. and have been an an an an	

	(= .,)
Maximum allowable back pressure at	
outlet of engine, before piping: kPa (in. H ₂ 0)	8.5 (34.1)

Weights and dimensions



Drawing above for illustration purposes only, based on standard open power 480 volt generator set. Lengths may vary with other voltages. Do not use for installation design. See website for unit specific template drawings.

System	Dimensions (LxWxH)	Weight
Open Power Unit (OPU)	7,756 x 3,072 x 3,590 mm (305.4 x 120.9 x 141.3 in)	27,340 kg (60,284 lb)

Weights and dimensions are based on open power units and are estimates only. Consult the factory for accurate weights and dimensions for your specific generator set.

Sound data

Unit type	Standby full load
Level 0 (OPU): dB(A)	95.1

Sound data is provided at 7 m (23 ft). Generator set tested in accordance with ISO 8528-10 and with infinite exhaust.

Emissions data

NO _x + NMHC	со	РМ
5.1	0.6	0.03

 All units are in g/hp-hr and shown at 100% load (not comparable to EPA weighted cycle values). Emission levels of the engine may vary with ambient temperature, barometric pressure, humidity, fuel type and quality, installation parameters, measuring instrumentation, etc. The data was obtained in compliance with US EPA regulations. The weighted cycle value (not shown) from each engine is guaranteed to be within the US EPA standards.

Rating definitions and conditions

- Standby ratings apply to installations served by a reliable utility source. The standby rating is applicable to varying loads for the duration of a power outage. No overload capability for this rating. Ratings are in accordance with ISO 8528-1, ISO 3046-1, BS 5514, and AS 2789. Average load factor: ≤ 85%.
- Nominal ratings at standard conditions: 25 °C and 300 meters (77 °F and 1,000 feet).
- Deration Factor:
 - Consult your local *mtu* Distributor for altitude derations.
 - Consult your local *mtu* Distributor for temperature derations.

288

3.25 mW Rolls Royce Generator Anchorage & Foundation Design IBC 2021, ASCE 7-16, ACI 318-19

2.) Generator

Weight:	60.3	kips
Total Height H:	141	in
Total Width B:	121	in
Total Width L:	305	in
Center of Gravity:	88.125	in
Snow Load:	25	psf

Electrical Components ap = 1 Rp = 2.5 Sds = 1.01 le = 1.25				
X Fpmin = 22.8	d by the Generator a 3 kips ASCE 7 3 kips ASCE 7 7 kips ASCE 7	-16 EQ 13.3-1 -16 EQ 13.3-2	Controls	
EQ = 22.8	3 kips			
<u>Shear Connection</u> Number of Anchors = Anchor Shear = V*Ω/# =	<mark>2.0</mark> 11 kips/and		iten HD Screw Anchors 1/2" Embed y = 7.1 kips	OK
Overturning Resistance Abo	ut Width			
Generator	C.O.G. 88.125 in	EQ 22.8 kips	OT Moment 168 k-ft	
Resisting Dead Load	Moment Arm 60.5 in	DL 60.3 kips	Res. Moment 304 k-ft	
F.O.S. = M_R / M_{OT} = Anchor Tension = M / d / # =		ision Capacity hor < Capacity		ОК



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York Air Cooled Screw Generator Foundation Design

IBC 2021, ASCE 7-16, ACI 318-19

3) Wind Design per ASCE 7-16 Chapter 29 Non-Building Structure Procedure

Wind Speed V:	104.0 mph	ASCE 7-16 Risk Category III
Exposure Cat.	B	
Exposure Coe Kz:	0.62	Table 26.10-1 (H = 20')
Direction Coe. Kd:	0.85	Table 26.6-1
Topo Coe. Kzt:	1.00	Sec. 26.8
V_Pressure qz =	14.6 psf	EQ 26.10-1
Gust Factor G:	0.85	Sec 26.11
Af =	299 sqft	
h/d =	1.17	
Cf =	1.30	Figure 29.4-1
F =	4.82 kips	EQ 29.4-1

Shear Connection

WL < EQ Shear Connection OK By Inspection

$M_{OT} = F^*H/2$	28 k-ft
$M_R = DL^*W/2$	304 k-ft
F.O.S. = M _R / M _{OT} =	10.7 OK



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York Air Cooled Screw Generator Foundation Design IBC 2021, ASCE 7-16, ACI 318-19

Bearing Analysis	
Allowable Bearing	2000 psf
Footing Width:	6.5 ft
Footing Length:	6.5 ft
Thickened Edge Width:	1.0 ft
Dead Load:	60 kips
Snow Load:	1.1 kips
1.0DL+1.0SL Pressure:	2359 psf < 2000 psf OK
Earthquake OT	168 k-ft
Applied Pressure:	3968 psf
1.15DL+0.7EQ Pressure:	5444 psf < 2000 psf * (4/3) OK
<u>Sliding Analysis</u>	
Slab-on-Grade Thickness	<mark>8</mark> in
Allow. Coefficient of Friction:	0.3
(0.7) Earthquake :	16.0 kips
Dead Load:	65 kips Includes Slab-on-Grade Weight
Sliding Resistance:	19.35 kips
Unity Check Uc =	1.21 > 1.0 OK

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KWIK Bolt 3 Expansion Anchor 3.3.6

f'_ = 2000 psi (13.8 MPa) f'_ = 3000 psi (20.7 MPa) f'_ = 4000 psi (27.6 MPa) f', = 6000 psi (41.4 MPa) Anchor Embedment Tension Shear Tension Shear Tension Shear Tension Shear Diameter Depth in. (mm) in. (mm) Ib (kN) 260 595 320 380 725 470 1-1/8 (29) (1.2) (2.6)(1.4) (1.7)(3.2)(2.1)540 625 675 705 805 1/4 2 (51) (6.4) (2.4) 675 (2.8) (3.0) (3.1) 805 910 (3.6)685 (3.0)750 810 (3.6) (4.0)3 (76) (3.6)(3) (3.3)605 670 1110 730 1345 1690 880 950 1-5/8 (41)(2.7) (3.9) (3.0) (4.9)(3.2) (6.0) (4.2) (7.5)1285 1430 1575 1940 3/8 2-1/2 (64) (9.5) (5.7) 1570 (6.4) 1570 (7.0) 1590 (8.6) 1590 (7.0) (7.0) 1620 1755 1885 (7.1)2035 (7.1) 3-1/2 (89)(7.2) (7.8) (8.4) (9.1) 1015 1875 1230 2130 1450 2380 1620 2740 2-1/4 (57) (4.5) (5.5) (10.6) (7.2)(12.2) (8.3)(9.5) (6.4) 1445 1975 2655 1/2 3-1/2 (89) (12.7) 3010 3045 (6.4) (8.8) 3010 2510 (11.8) 3045 1990 (13.4) 2250 (13.4) (11.2)(13.5) 2985 (13.5) 4-3/4 (121) (8.9) (10.0)(13.3)1650 2875 1755 3485 1860 4095 2335 2-3/4 (70) (7.3) (12.8) (7.8)(15.5) (8.3) (18.2) (10.4) 3340 4395 2455 2900 4625 5/8 4 (102) (15.9) 4625 4625 4625 (19.5) (20.6) (10.9)(12.9)(14.9)3480 (20.6)3885 (20.6) 4290 (20.6) 6260 (140) 5-1/2 (15.5) (17.3) (19.1) (27.8) 1550 3945 1950 4260 2350 2610 3-1/4 (83) (6.9) (17.5)(8.7) (18.9) (10.5) (11.6) 3250 3870 5645 4670 5645 2510 3/4 4-3/4 (121) (19.1)5535 (14.5) 5535 (17.2)(25.1) (20.8)(25.1) (11.2) 2930 (24.6) 3735 (24.6) 4530 5120 8 (203)(13.0) (16.6) (20.2) (22.8) 3870 4610 4800 3120 6080 6770 4-1/2 (114) (13.9) (27.0) (17.2)(30.1) (20.5) (21.4)4400 6400 7200 7470 7330 7470 6 (152)(25.4) 7470 7470 (33.2) (19.6)(28.5) (32.0)(33.2)(32.6)5800 (33.2)8000 (33.2) 9390 9390 9 (229)(24.9)(35.6) (41.8) (41.8)

Table 8 - Stainless Steel KWIK Bolt 3 Allowable Loads in Normal-Weight Concrete

1000

1 Intermediate load values for other concrete strengths and embedments can be calculated by linear interpolation.

Hitl, Inc. (US) 1-800-879-8000 | www.us.hitli.com | en español 1-800-879-5000 | Hitl (Canada) Corp. 1-800-363-4458 | www.hitli.co | Anchor Fastening Technical Guide 2011 301

293 0073180093.842	59366170.010
DWG NO. 0073180093.842 HOW ARD INDUSTRIES INC. LAUREL, MISS. USA 39440 THEE PHASE PAD DISTRIBUTION TRANSFORMERS CUSTOMER : CORE DATED SPEC.CORE DATED FXVA3000.0 BIL 95 TAPS SPECIAL HICH VOLTAGE 13200 IOW VOLTAGE 13	816674,0, 4584,2, 25875
	93975701Z,NM,514, 0,H01 , 0, 5, 45 745789,
DESCRIPTION 1 LV BUSHING W/INT. 10H SPADE 2 LV SPADE SUPPORT 3 2 HUL BUSHING W/INT. 10H SPADE 4 HV PORC 95BIL W/2H G-SPADE 7 NP ON DOOR, SERIAL ON TANK 8 TANK 9 COQLING RADIATORS 10 HANDHOLE & SECURITY COVER 12 LIFTING LUGS 13 JACKING PROVISIONS 14 2 HOLE HORIZ NEMA GRD PAD 15 1 IN DRAIN VALVE AND SAMPLER 21 PADLOCKABLE DOOR HANDLE 22 S PTAL LV-HV BARRIER 23 PI LATCH PENTA SEC BOLT 24 BI IN REMOVABLE SILL 25 METAL LV-HV BARRIER 46 DIAL THERM W/MAX POINTER 47 PRV VIAT 301-010-01N 48 DIAL THERM W/MAX POINTER 59 PROVISIONS FOR LIG ARR 50 OIL LEVEL PLUG 51 PREV VIAT 301-010-01N 48 D'AL THERM W/MAX POINTER 50 OIL LEVEL PLUG 51 PROVISIONS FOR LIG ARR 52 PROVISIONS FOR LIG ARR 53 PROVISIONS FOR LIG ARR 54 PROVISIONS FOR LIG ARR 55 PROVISIONS FOR LIG ARR 56	

3000 KVA Transformer Anchorage & Foundation Design IBC 2021, ASCE 7-16, ACI 318-19

2.) Transformer

Weight:	14.6	kips
Total Height H:	81	in
Total Width B:	69.3	in
Total Width L:	109.9	in
Center of Gravity:	54	in
Snow Load:	25	psf

Electr ap = Rp = Sds = Ie =	ical Components 1 2.5 1.01 1.25							
	<u>al Loads</u> al resistance is pro Fp =	2.96	kips	ASCE 7-1	I6 EQ 13.3-1			
Х	Fpmin = Fpmax =		•		l6 EQ 13.3-2 l6 EQ 13.3-3	Contro	ols	
EQ =		5.54	kips					
Numb	<u>r Connection</u> per of Anchors = or Shear = V*Ω/# :	=	<mark>2.0</mark> 2.77			1/2" Em	Screw Anchors bed 7.1 kips	ОК
<u>Overt</u>	urning Resistance	About				~		
transf	ormer		C.C 54	.G. in	EQ 5.5 kips	от м 24.9	oment k-ft	
Resis	ting Dead Load			nt Arm in	DL 14.6 kips		/loment k-ft	
	5. = M _R / M _{OT} =				ion Capacity			
Ancho	or Tension = M / d	/ # =	7.5	kips/anch	or < Capacity	=	<mark>35.7</mark> kips	OK



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Seattle, WA 98101	Client: Benaroya	Checked:			

3000 KVA Transformer Anchorage & Foundation Desig IBC 2021, ASCE 7-16, ACI 318-19

3) Wind Design per ASCE 7-16 Chapter 29 Non-Building Structure Procedure

Wind Speed V:	104.0 mph	ASCE 7-16 Risk Category III
Exposure Cat.	B	
Exposure Coe Kz:	0.62	Table 26.10-1 (H = 20')
Direction Coe. Kd:	0.85	Table 26.6-1
Topo Coe. Kzt:	1.00	Sec. 26.8
V_Pressure qz =	14.6 psf	EQ 26.10-1
Gust Factor G:	0.85	Sec 26.11
Af =	62 sqft	
h/d =	1.17	
Cf =	1.30	Figure 29.4-1
F =	1.00 kips	EQ 29.4-1

Shear Connection

WL < EQ Shear Connection OK By Inspection

$M_{OT} = F^*H/2$	3 k-ft
$M_R = DL^*W/2$	42 k-ft
F.O.S. = M _R / M _{OT} =	12.6 OK



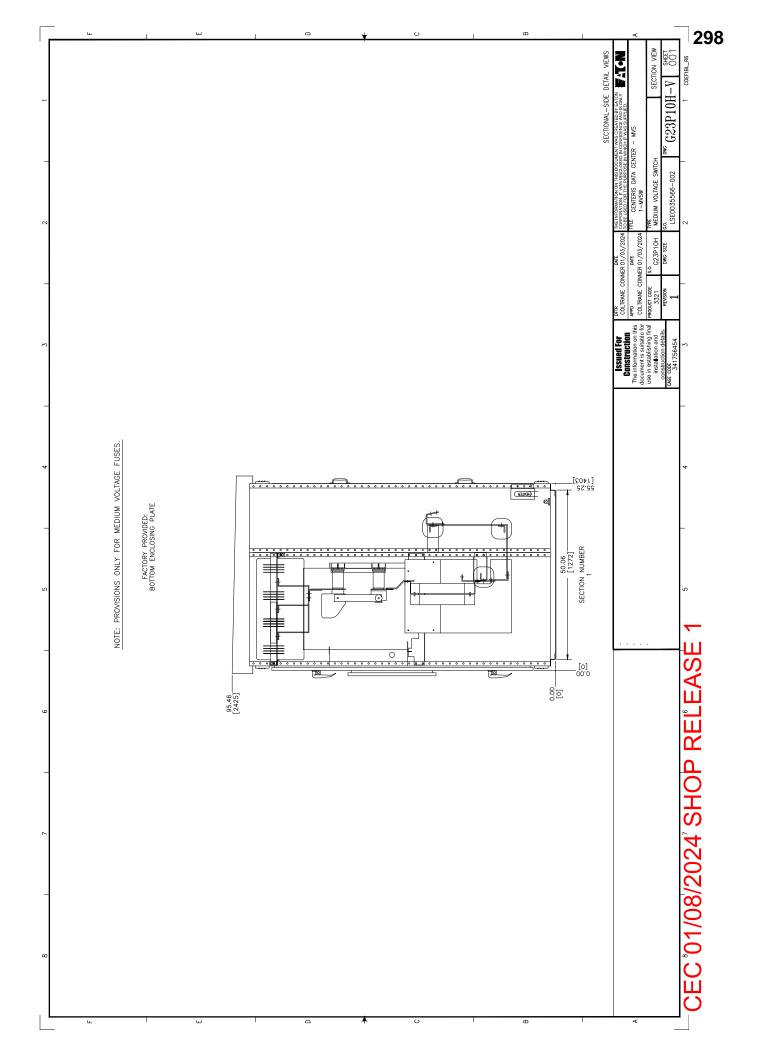
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3000 KVA Transformer Anchorage & Foundation Desig IBC 2021, ASCE 7-16, ACI 318-19

<u>Bearing Analysis</u> Allowable Bearing Footing Width: Footing Length: Thickened Edge Width:	2000 psf 6.5 ft 6.5 ft 1.0 ft
Dead Load:	15 kips
Snow Load:	1.1 kips
1.0DL+1.0SL Pressure:	603 psf < 2000 psf OK
Earthquake OT	25 k-ft
Applied Pressure:	590 psf
1.15DL+0.7EQ Pressure:	1060 psf < 2000 psf * (4/3) OK
<u>Sliding Analysis</u> Slab-on-Grade Thickness	<mark>8</mark> in
Allow. Coefficient of Friction:	0.3
(0.7) Earthquake :	3.9 kips
Dead Load:	19 kips Includes Slab-on-Grade Weight
Sliding Resistance:	5.66 kips
Unity Check Uc =	1.46 > 1.0 OK

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	<u> </u>	ш	۵	¥ °		m	1	^₄ 297
1 2 1 GENERAL INFORMATION	SYSTEM DETAILS. SYSTEM DETAILS. VOLTAGE CLAGS: VOLTAGE CLAGS: INVERTO LINE VOLTAGE: BASIC MOLLAGE: SYSTEM GROUND: SYSTEM GROUND: SYMMETRICAL SHORT CIRCUT RATING: 25 KAS, 3 WIRE ENCLOSURE DETAILS:	ENCLOSURE: DUST RESISTANT: TAMPER RESISTANT: TAMPER RESISTANT: NOR EXTERIOR COLOR: MAILE BIOL BUS DETAILS: MAITEMIL: BUS SUPPORT INSULATION: BUS SUPPORT INSULATION: DUST STREPT INVED		MIRE COLOR (GENERAL): CRAY WIRE COLOR (GENERAL): CRAY WIRE COLOR (GFOUND): CRAY WIRE COLOR (CTS): CRAY TERMINAL (CTS): NA WIRE MARKERS: TERMINAL BLOOKS (GENERAL): NA TERMINAL BLOOKS (GENERAL): TAATI TERMINAL BLOOKS (CTS): WIRE ID MIRE LABELING: CTS): WIRE ID MISE CELLANEOUS DETAILS:	- GENERAL NOTES	 ALL DOOR HANDLES AND MANUALLY OPERATED SWITCHES HAVE FROVISIONS FOR PADLOCKING 2. DOOR CANNOT BE OPENED WHEN INTERPUTER SWITCH IS CLOSED AND INTERRUPTER SWITCH CANNOT BE CLOSED WHEN DOOR IS OPENED AND INTERRUPTER SWITCH CANNOT BE CLOSED WHEN DOOR IS OPENED 4. 16⁻ x 8⁻ [466 X 204] SHATTERPROFOT VIEWING WINDOW IN FRONT OF SWITCH 	"DAVER HAZAROUS VOLTAGE" SIGN ON ALL DOORS TALL DIMENSIONS SHOWN IN INCHES [MM]. ALL WEIGHTS SHOWN IN LBS [KG].	DFM DFM DFM DFM DFM DFM DFM DFM COLITAME CONNER DI (12/2024 1000 user) Text subscience invision and transmission
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1 7			<u>و</u>	¢		36.00 [914]	₩	CEC *01/08/2024 SHOP RELE
ω	Ŀ. 1	93.46 [2428]	6	3700 lbs	88	B [0] SECTION NO	SPLT WEIGHT	CEC °01/C



IBC 2021, ASCE 7-16, ACI 318-19

1.) MV Switch

Weight:	7.4	kips
Total Height H:	95.46	in
Total Width B:	50.06	in
Total Width L:	174	in
Center of Gravity:	57.28	in
Snow Load:	25	psf

Electrical Cor ap = Rp = Sds = Ie =	1 2.5					
Fp = X Fpmin	ance is pro	vided by the ch 1.49 kips 2.80 kips 14.95 kips	ASCE 7-1 ASCE 7-1	6 EQ 13.3-1 6 EQ 13.3-2		
EQ =		2.80 kips				
<u>Shear Conne</u> Number of A Anchor Shea	nchors =	= 0.35		with 4	tan HD Anchors 1/2" Embed ^y = 4.5 kij	os OK
Overturning I	<u>Resistance</u>					
MV Switch		C.C 57.276	D.G. 6 in	EQ 2.8 kips	OT Moment 13.4 k-ft	
		Mome	nt Arm	DL	Res. Moment	
Resisting De	ad Load	25.03	3 in	7.4 kips	15 k-ft	
F.O.S. = M _R	/ M _{OT} =	1.2	2 OK			



Eaton 15 KV MV Switch Anchorage Design IBC 2021, ASCE 7-16, ACI 318-19

3) Wind Design per ASCE 7-16 Chapter 29 Non-Building Structure Procedure

Wind Speed V:	104.0 mph	ASCE 7-16 Risk Category III
Exposure Cat.	B	
Exposure Coe Kz:	0.62	Table 26.10-1 (H = 20')
Direction Coe. Kd:	0.85	Table 26.6-1
Topo Coe. Kzt:	1.00	Sec. 26.8
V_Pressure qz =	14.6 psf	EQ 26.10-1
Gust Factor G:	0.85	Sec 26.11
Af =	115 sqft	
h/d =	1.91	
Cf =	1.30	Figure 29.4-1
F =	1.86 kips	EQ 29.4-1

Shear Connection

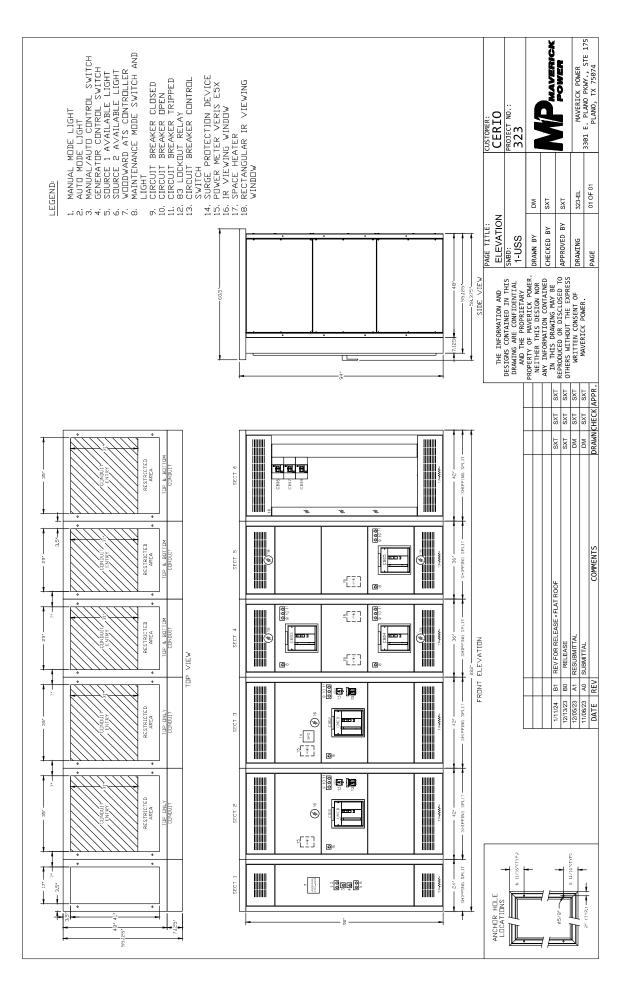
WL < EQ Shear Connection OK By Inspection

$M_{OT} = F^*H/2$	7 k-ft
$M_R = DL^*W/2$	15 k-ft
F.O.S. = M _R / M _{OT} =	2.1 OK



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							PAGE TITLE: ENCLOSURE DETAILS	HIS SWBD: PROJECT NO.: IAL 1-USS 323	JRAWN BY DM	INED CHECKED BY SXT CHECKED BY SXT	APPROVED BY SXT	DRAMING 323-ED	PAGE 01 OF 01 3301 E. PLANO PKWY., STE 175 PLANO PKWY., 55074
							THE INFORMATION AN	DESIGNS CONTAINED IN THIS DRAWING ARE CONFIDENTIAL AND THE PROPRIETARY	PROPERTY OF MAVERICK P NEITHER THIS DESIGN	ANY INFORMATION CONTA IN THIS DRAWING MAY	REPRODUCED OR DISCLOSE OTHERS WITHOUT THE EXF	WRITTEN CONSENT OF	MAVERICK FUWER.
										د T	SXT	SXT	T SXT CK APPR.
								-		CVT CVT	-		DM SXT SXT DRAWN CHECK APPR.
SWITCHBOARD GENERAL NOTES:	ELECTRIC AL CHARACTERISTICS: SYSTEM VOLTAGE: 480VAC, 60Hz, 3PH-3W SYSTEM INTERRUPT RATING: 85kAIC SYSTEM AMPERAGE: 4000A	BUS CHARACTERISTICS: SILVER PLATED COPPER CONSTRUCTION BRACING: 85kAIC PHASE BUS SIZE/MATERIAL: (4) .25x5" Cu PER PHASE GROUND BUS SIZE/MATERIAL: (1) .25x4" CU GROUND BUS	ENCLOSURE DATA: LISTING: ULB91 SWTCHBOARD LISTING: ULB91 SANDING EXTERIOR PAINT COLOR: ANSI 61 ACCESSIBILITY: FRONT ENTRY: TOP BREAKERS: ABB UL NAMEPLATE MOUNTING TYPE: RIVETED	ESTIMATED SHIPPING WEIGHT: SECTION 1: 1750 lbs SECTION 2: 2200 lbs SECTION 3: 2200 lbs SECTION 4: 2200 lbs SECTION 6: 2200 lbs SECTION 6: 1200 lbs SECTION 6: 1200 lbs SECTION 1: 2200 lbs	WIRING: All wiring to be sis wire type						B0 RELEASE	A1	11/06/23 A0 SUBMITTAL DATE REV COMMENTS



4000A Switchgear Anchorage Design IBC 2021, ASCE 7-16, ACI 318-19

1.) Switchgear

Weight:	2.2	kips
Total Height H:	94	in
Total Width B:	55.125	in
Total Width L:	42	in
Center of Gravity:	56.40	in
Snow Load:	25	psf

Electr ap = Rp = Sds = Ie =	rical Components 1 2.5 1.01 1.25					
	<u>al Loads</u> al resistance is pro Fp = Fpmin =	vided by the Sv 0.44 kips 0.83 kips	ASCE 7-1	6 EQ 13.3-1		
	•	4.44 kips				
EQ =		0.83 kips				
Numb	<u>r Connection</u> per of Anchors = or Shear = V*Ω/# =	= 0.42			itan HD Anchors 1/2" Embed / = <u>4.5</u> kips	ОК
<u>Overt</u>	urning Resistance					
Switc	hgear	56.4).G. ⊢in	EQ 0.8 kips	OT Moment 3.92 k-ft	
Resis	ting Dead Load	Mome 27.5625	nt Arm i in	DL 2.2 kips	Res. Moment 5 k-ft	
F.O.S	8. = M _R / M _{OT} =	1.3	OK			



4000A Switchgear Anchorage Design IBC 2021, ASCE 7-16, ACI 318-19

3) Wind Design per ASCE 7-16 Chapter 29 Non-Building Structure Procedure

Wind Speed V:	104.0 mph	ASCE 7-16 Risk Category III
Exposure Cat.	B	
Exposure Coe Kz:	0.62	Table 26.10-1 (H = 20')
Direction Coe. Kd:	0.85	Table 26.6-1
Topo Coe. Kzt:	1.00	Sec. 26.8
V_Pressure qz =	14.6 psf	EQ 26.10-1
Gust Factor G:	0.85	Sec 26.11
Af =	27 sqft	
h/d =	1.71	
Cf =	1.30	Figure 29.4-1
F =	0.44 kips	EQ 29.4-1

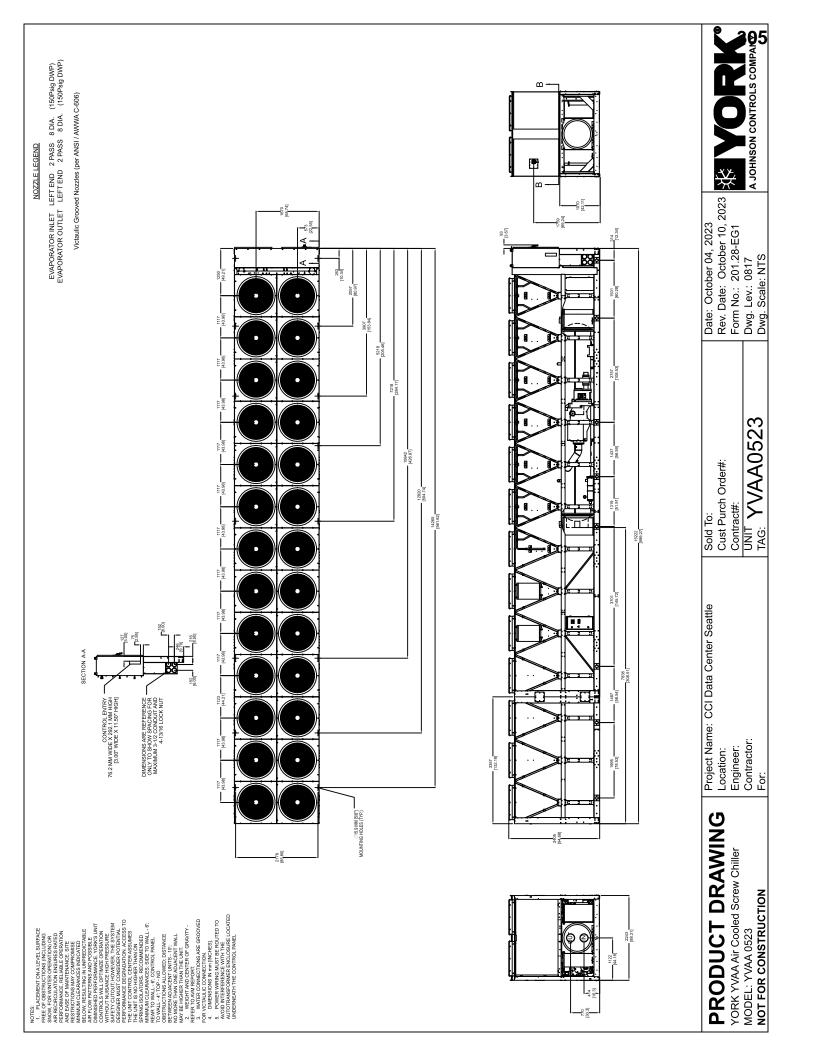
Shear Connection

WL < EQ Shear Connection OK By Inspection

$M_{OT} = F^*H/2$	2 k-ft
$M_R = DL^*W/2$	5 k-ft
$F.O.S. = M_R / M_{OT} =$	2.9 OK



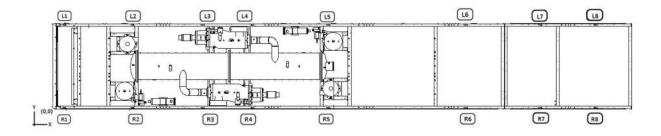
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YORK°

AVM Report

Project Name	Unit Tag	Date	Chiller Type
CCI Data Center Seattle	YVAA0523	2023-08-15	Air Cooled VSD Screw Chillers
PIN	Version		
YVAA0523JPK46BHVTXXXSAKLAXXX4556XDFXXV151W1SXGA	E.21.9.29933.0-D.98.0005		



LOCATION	X Distance (in)	Y Distance (in)	JCI PART NUMBER	SAP NUMBER	COLOUR	Operating Weights (Ib)
R1	10.4	1.3	029-25335-002	434004	Brick Red	1156
R2	81.0	1.3	029-25335-004	434005	Charcoal	2854
R3	153.8	1.3	029-25335-004	434005	Charcoal	2992
R4	205.5	1.3	029-25335-004	434005	Charcoal	2992
R5	284.2	1.3	029-25335-004	434005	Charcoal	3247
R6	426.9	1.3	029-25335-002	434004	Brick Red	1323
R7	504.7	1.3	029-25335-001	434002	Charcoal	444
R8	561.6	1.3	029-25335-002	434004	Brick Red	827
L1	10.4	87.1	029-25335-002	434004	Brick Red	1141
L2	81.0	87.1	029-25335-004	434005	Charcoal	2835
L3	153.8	87.1	029-25335-004	434005	Charcoal	2981
L4	205.5	87.1	029-25335-004	434005	Charcoal	2981
L5	284.2	87.1	029-25335-004	434005	Charcoal	3298
L6	426.9	87.1	029-25335-002	434004	Brick Red	1323
L7	504.7	87.1	029-25335-001	434002	Charcoal	444
L8	561.6	87.1	029-25335-002	434004	Brick Red	827

Total We	eight (lb)	Centre of Gravity (in)		
Operating	31665	Xg	230.8	
Shipping	30309	Yg	46.1	

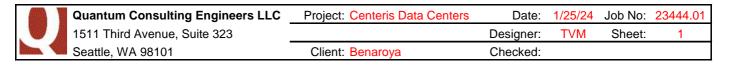
All values are de-rated by 15% apart from those which have part number. (029-25334-013 and 029-25336-014: 0% de-rated), (029-25335-004: 10% de-rated), (029-25335-001 and 029-25335-003: 25% de-rated)

IBC 2021, ASCE 7-16, ACI 318-19

1.) Chiller

Weight:	31.7	kips
Total Height H:	94.68	in
Total Width B:	85.8	in
Total Width L:	599.27	in
Center of Gravity:	46.1	in
Snow Load:	25	psf

Weight of Ch Wet-Side HV		then 25% total	weight of a	chiller and slat	o-on-grade.	
ap =	1					
Rp =	2.5					
Sds =	1.01					
le =	1.25					
<u>Lateral Load</u> Lateral resist Fp = X Fpmir Fpma	tance is pro	ovided by the chi 6.40 kips 12.00 kips 63.97 kips	ASCE 7- ASCE 7-	16 EQ 13.3-1 16 EQ 13.3-2		
EQ =		12.00 kips				
<u>Shear Conne</u> Number of A Anchor Shea	nchors =	<mark>16.0</mark> = 0.75			tan HD Anchors 1/2" Embed z = 4.5 k	kips OK
<u>Overturning</u>	Resistance	About Width				
).G.	EQ	OT Moment	
Chiller		46.1	in	12.0 kips	46.1 k-ft	
		Mome	nt Arm	DL	Res. Moment	
Resisting De	ad Load	42.9	in	31.7 kips	113 k-ft	



York Air Cooled Screw Chiller Foundation Design

IBC 2021, ASCE 7-16, ACI 318-19

3) Wind Design per ASCE 7-16 Chapter 29 Non-Building Structure Procedure

Wind Speed V:	104.0 mph	ASCE 7-16 Risk Category III
Exposure Cat.	B	
Exposure Coe Kz:	0.62	Table 26.10-1 (H = 20')
Direction Coe. Kd:	0.85	Table 26.6-1
Topo Coe. Kzt:	1.00	Sec. 26.8
V_Pressure qz =	14.6 psf	EQ 26.10-1
Gust Factor G:	0.85	Sec 26.11
Af =	394 sqft	
h/d =	1.10	
Cf =	1.30	Figure 29.4-1
F =	6.35 kips	EQ 29.4-1

Shear Connection

WL < EQ Shear Connection OK By Inspection

$M_{OT} = F^*H/2$	25 k-ft
$M_R = DL^*W/2$	113 k-ft
$F.O.S. = M_R / M_{OT} =$	4.5 OK

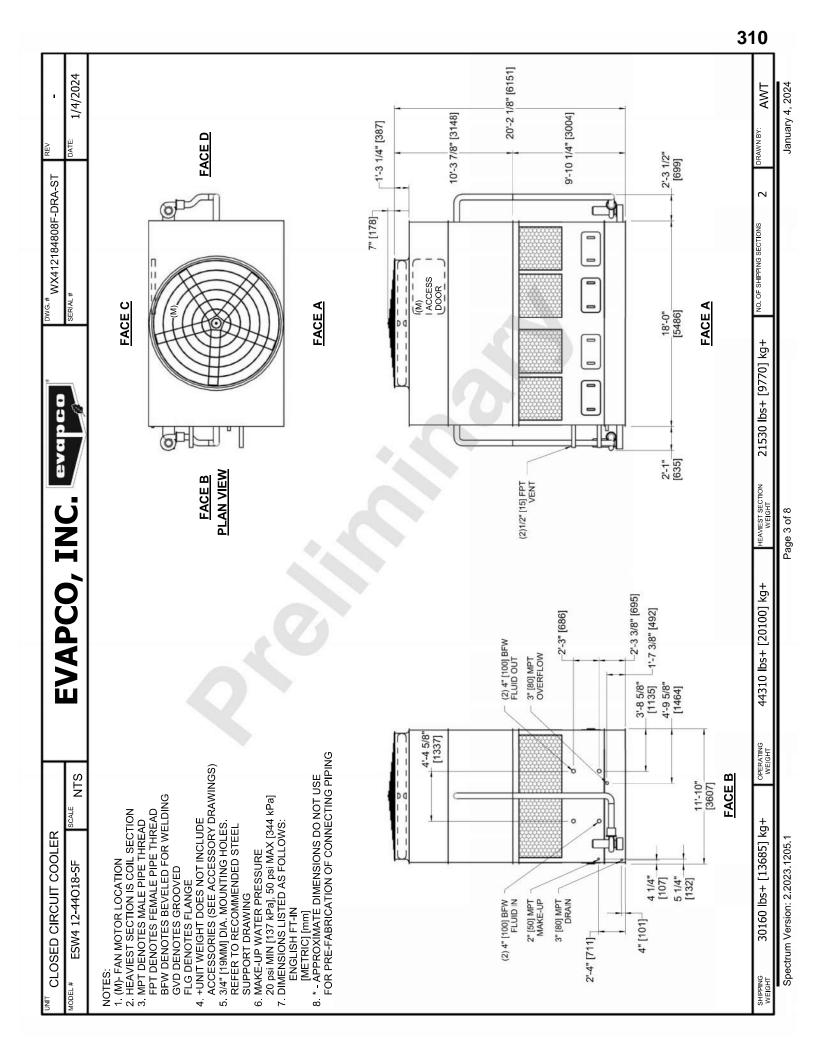


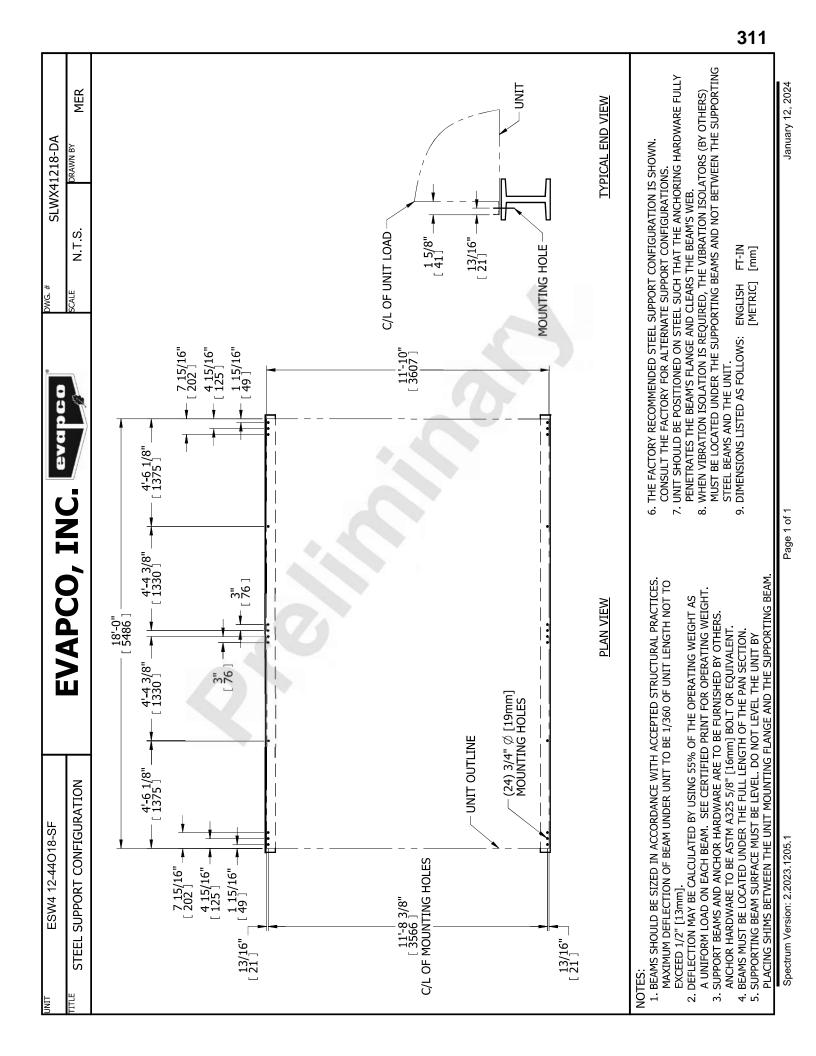
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York Air Cooled Screw Chiller Foundation Design IBC 2021, ASCE 7-16, ACI 318-19

<u>Bearing Analysis</u> Allowable Bearing Footing Width: Footing Length: Thickened Edge Width:	2000 psf 47.8 ft 8.2 ft 1.0 ft
Dead Load:	32 kips
Snow Load:	9.7 kips
1.0DL+1.0SL Pressure:	370 psf < 2000 psf OK
Earthquake OT	46 k-ft
Applied Pressure:	118 psf
1.15DL+0.7EQ Pressure:	409 psf < 2000 psf * (4/3) OK
<u>Sliding Analysis</u> Slab-on-Grade Thickness	<mark>8</mark> in
Allow. Coefficient of Friction:	0.3
(0.7) Earthquake :	8.4 kips
Dead Load:	71 kips Includes Slab-on-Grade Weight
Sliding Resistance:	21.18 kips
Unity Check Uc =	2.52 > 1.0 OK

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Evapco Cooling Tower Foundation Design

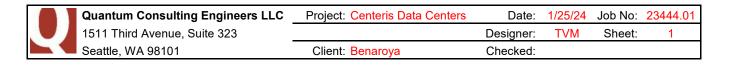
IBC 2021, ASCE 7-16, ACI 318-19

1.) Chiller

Weight:	44.3	kips
Total Height H:	242	in
Total Width B:	142	in
Total Width L:	216	in
Center of Gravity:	121	in
Snow Load:	25	psf

2) Seismic Design per ASCE 7-16 Chapter 15 Non-Building Structures

<u>Lateral System</u>				
Cooling Towers Concrete or S	teel			
R:	3.5 ASCE T	able 15.4-2		
Ω_0 :	1.75 ASCE T	able 15.4-2		
C _d :	3.0 ASCE T	able 15.4-2		
l _e :	1.25			
Lateral resistance is provided	by the cooling towe	er anchored to	the concrete slab.	
Cs =	0.35914 From Qu	uantum Seism	ic Spreadsheet	
EQ =	15.91 kips			
Shear Connection				
			itan HD Anchors	
Number of Anchors =	24.0	with 4	1/2" Embed	
			1/2" Embed	ОК
Number of Anchors = Anchor Shear = V*Ω/# =	1.16 kips/anc	with 4	1/2" Embed	OK
Number of Anchors =	1.16 kips/anc <u>Width</u>	with 4 hor < Capacit	1/2" Embed y = <u>6.4</u> kips	OK
Number of Anchors = Anchor Shear = V*Ω/# = <u>Overturning Resistance About</u>	1.16 kips/anc <u>Width</u> C.O.G.	with 4 hor < Capacit	1/2" Embed y = <u>6.4</u> kips OT Moment	ОК
Number of Anchors = Anchor Shear = V*Ω/# =	1.16 kips/anc <u>Width</u>	with 4 hor < Capacit	1/2" Embed y = <u>6.4</u> kips	OK
Number of Anchors = Anchor Shear = V*Ω/# = <u>Overturning Resistance About</u>	1.16 kips/anc <u>Width</u> C.O.G. 121 in	with 4 hor < Capacit EQ 15.9 kips	1/2" Embed y = <u>6.4</u> kips OT Moment 160 k-ft	ОК
Number of Anchors = Anchor Shear = V*Ω/# = <u>Overturning Resistance About</u> Chiller	1.16 kips/anc <u>Width</u> C.O.G. 121 in Moment Arm	with 4 hor < Capacit EQ 15.9 kips DL	1/2" Embed y = <u>6.4</u> kips OT Moment 160 k-ft Res. Moment	ОК
Number of Anchors = Anchor Shear = V*Ω/# = <u>Overturning Resistance About</u>	1.16 kips/anc <u>Width</u> C.O.G. 121 in	with 4 hor < Capacit EQ 15.9 kips	1/2" Embed y = <u>6.4</u> kips OT Moment 160 k-ft	ОК
Number of Anchors = Anchor Shear = V*Ω/# = <u>Overturning Resistance About</u> Chiller	1.16 kips/anc <u>Width</u> C.O.G. 121 in Moment Arm	with 4 hor < Capacit EQ 15.9 kips DL	1/2" Embed y = <u>6.4</u> kips OT Moment 160 k-ft Res. Moment	ОК



Evapco Cooling Tower Foundation Design IBC 2021, ASCE 7-16, ACI 318-19

3) Wind Design per ASCE 7-16 Chapter 29 Non-Building Structure Procedure

Wind Speed V:	104.0 mph	ASCE 7-16 Risk Category III
Exposure Cat.	B	
Exposure Coe Kz:	0.62	Table 26.10-1 (H = 20')
Direction Coe. Kd:	0.85	Table 26.6-1
Topo Coe. Kzt:	1.00	Sec. 26.8
V_Pressure qz =	14.6 psf	EQ 26.10-1
Gust Factor G:	0.85	Sec 26.11
Af =	363 sqft	
h/d =	1.70	
Cf =	1.30	Figure 29.4-1
F =	5.85 kips	EQ 29.4-1

Shear Connection

WL < EQ Shear Connection OK By Inspection

$M_{OT} = F^*H/2$	59 k-ft
$M_R = DL^*W/2$	262 k-ft
F.O.S. = M _R / M _{OT} =	4.4 OK

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Εv	apco Cooling Tower Found	ation Design				

<u>Bearing Analysis</u>				
Allowable Bearing	2000 psf			
Footing Width:	47.8 ft			
Footing Length:	8.2 ft			
Thickened Edge Width:	1.0 ft			
Dead Load:	44 kips			
Snow Load:	9.7 kips			
1.0DL+1.0SL Pressure:	483 psf < 2000 psf OK			
Earthquake OT	160 k-ft			
Applied Pressure:	412 psf			
1.15DL+0.7EQ Pressure:	744 psf < 2000 psf * (4/3) OK			
<u>Sliding Analysis</u>				
Slab-on-Grade Thickness	<mark>8</mark> in			
Allow. Coefficient of Friction:	0.3			
(0.7) Earthquake :	11.1 kips			
Dead Load:	83 kips Includes Slab-on-Grade Weight			
Sliding Resistance:	24.97 kips			
Unity Check Uc =	2.24 > 1.0 OK			



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