

Supplemental Structural Calculations

for
N Graham Street Apartments

311 NE Graham Street
Portland, OR 97212

Prepared for

Lisac Brothers Constuction
December 2023

JOB NUMBER: LSC-03

****Limitations****

Engineer was retained in limited capacity for this project. Design is based on information provided by the client, who is solely responsible for the accuracy of same. No responsibility and/or liability is assumed by, or is to be assigned to the engineer for items beyond that shown on these sheets.

15 sheets total including this cover sheet



EXPIRES: 12-31-2023

**Harper
HHPR Houf Peterson
Righellis Inc.**

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Cantilevered Retaining Wall

Project File: lsc-03.ec6

LIC# : KW-06016466, Build:20.22.12.28

Harper Houf Peterson Righellis Inc.

(c) ENERCALC INC 1983-2022

DESCRIPTION: NE Corner

EFP INCREASED FROM TYPICAL
 35 PCF TO ACCOUNT FOR
 SLOPED BACKFILL. SEE PG 9.

Code Reference

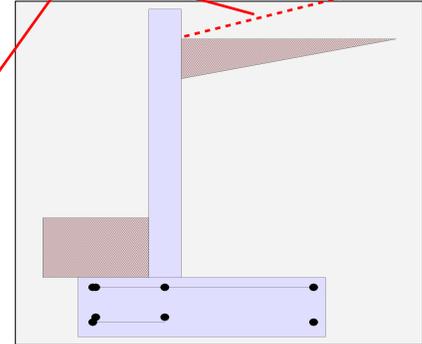
Calculations per IBC 2018 1807.3, CBC 2019, ASCE 7-16

Criteria

Retained Height	=	4.00 ft
Wall height above soil	=	0.50 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	12.00 in
Water height over heel	=	0.0 ft

Soil Data

Allow Soil Bearing	=	1,500.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	57.6 psf/ft
Passive Pressure	=	250.0 psf/ft
Soil Density, Heel	=	110.00 pcf
Soil Density, Toe	=	110.00 pcf
Footing Soil Friction	=	0.400
Soil height to ignore for passive pressure	=	12.00 in



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

Lateral Load Applied to Stem

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

Adjacent Footing Load

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

Cantilevered Retaining Wall

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DESCRIPTION: NE Corner

Design Summary

Wall Stability Ratios

Overtuning	=	2.98	OK
Sliding	=	1.54	OK
Global Stability	=	1.62	

Total Bearing Load	=	1,843	lbs
...resultant ecc.	=	5.49	in

Eccentricity within middle third

Soil Pressure @ Toe	=	940	psf	OK
Soil Pressure @ Heel	=	113	psf	OK
Allowable	=	1,500	psf	

Soil Pressure Less Than Allowable

ACI Factored @ Toe	=	1,316	psf	
ACI Factored @ Heel	=	159	psf	
Footing Shear @ Toe	=	2.6	psi	OK
Footing Shear @ Heel	=	3.8	psi	OK
Allowable	=	82.2	psi	

Sliding Calcs

Lateral Sliding Force	=	720.0	lbs	
less 100% Passive Force	=	375.0	lbs	
less 100% Friction Force	=	737.1	lbs	
Added Force Req'd	=	0.0	lbs	OK
...for 1.5 Stability	=	0.0	lbs	OK

Vertical component of active lateral soil pressure IS 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	1.600
Seismic, E	1.000

Stem Construction

Design Height Above Ftg	ft =	Stem OK	0.00
Wall Material Above "Ht"	=	Concrete	
Design Method	=	SD	SD SD
Thickness	=	5.50	
Rebar Size	=	# 4	
Rebar Spacing	=	12.00	
Rebar Placed at	=	Center	

Design Data

fb/FB + fa/Fa	=	0.427
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Total Force @ Section

Service Level	lbs =	
Strength Level	lbs =	737.3

Moment....Actual

Service Level	ft-# =	
Strength Level	ft-# =	983.0

Moment.....Allowable	=	2,298.0
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Shear.....Actual

Service Level	psi =	
Strength Level	psi =	22.3

Shear.....Allowable	psi =	82.2
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Anet (Masonry)	in2 =	
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Wall Weight	psf =	68.8
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Rebar Depth 'd'	in =	2.75
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Masonry Data

f'm	psi =	
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

MAINTAIN 8" STEM DUE TO ANCHOR BOLTS, THEREFORE THIS DESIGN IS CONSERVATIVE

Project Title:
 Engineer:
 Project ID:
 Project Descr:

Cantilevered Retaining Wall

Project File: lsc-03.ec6

LIC# : KW-06016466, Build:20.22.12.28

Harper Houf Peterson Righellis Inc.

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DESCRIPTION: NE Corner

Concrete Stem Rebar Area Details

	<u>Vertical Reinforcing</u>	<u>Horizontal Reinforcing</u>	
Bottom Stem			
As (based on applied moment) :	0.0899 in2/ft		
(4/3) * As :	0.1198 in2/ft	Min Stem T&S Reinf Area 0.594 in2	
200bd/fy : 200(12)(2.75)/60000 :	0.11 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.132 in2/ft	
0.0018bh : 0.0018(12)(5.5) :	0.1188 in2/ft	Horizontal Reinforcing Options :	
	=====	<u>One layer of :</u> <u>Two layers of :</u>	
Required Area :	0.11 in2/ft	#4@ 18.18 in	#4@ 36.36 in
Provided Area :	0.2 in2/ft	#5@ 28.18 in	#5@ 56.36 in
Maximum Area :	0.447 in2/ft	#6@ 40.00 in	#6@ 80.00 in

Footing Data

Toe Width	=	1.00 ft
Heel Width	=	2.50
Total Footing Width	=	3.50
Footing Thickness	=	12.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft
f'c = 3,000 psi	Fy =	60,000 psi
Footing Concrete Density =		150.00 pcf
Min. As % =		0.0018
Cover @ Top 2.00	@ Btm=	3.00 in

Footing Design Results

	<u>Toe</u>	<u>Heel</u>	
Factored Pressure	= 1,316	159 psf	
Mu' : Upward	= 603	799 ft-#	
Mu' : Downward	= 156	1,476 ft-#	
Mu: Design	= 447 OK	676 ft-#	OK
phiMn	= 10,188	11,388 ft-#	
Actual 1-Way Shear	= 2.61	3.80 psi	
Allow 1-Way Shear	= 82.16	82.16 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. Torsion, phi Tu	=	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: 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:

#4@ 9.26 in
 #5@ 14.35 in
 #6@ 20.37 in

If two layers of horizontal bars:

#4@ 18.52 in
 #5@ 28.70 in
 #6@ 40.74 in

Cantilevered Retaining Wall

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DESCRIPTION: NE Corner

Summary of Overturning & Resisting Forces & Moments

ItemOVERTURNING.....		RESISTING.....			
	Force lbs	Distance ft	Moment ft-#	Force lbs	Distance ft	Moment ft-#	
HL Act Pres (ab water tbl)	720.0	1.67	1,200.0	Soil Over HL (ab. water tbl)	898.3	2.48	2,227.1
HL Act Pres (be water tbl)				Soil Over HL (bel. water tbl)		2.48	2,227.1
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 =	110.0	0.50	55.0
				Surcharge Over Toe =			
				Stem Weight(s) =	309.4	1.23	380.3
				Earth @ Stem Transitions =			
				Footing Weight =	525.0	1.75	918.8
				Key Weight =			
				Vert. Component =			
Total	= 720.0	O.T.M.	= 1,200.0	Total	= 1,842.7 lbs	R.M.	= 3,581.1
Resisting/Overturning Ratio		=	2.98	* Axial live load NOT included in total displayed, or used for overturning resistance, but is included for soil pressure calculation.			
Vertical Loads used for Soil Pressure =		1,842.7 lbs					

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS NOT 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) 0.034 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.

Project Title:
Engineer:
Project ID:
Project Descr:

Cantilevered Retaining Wall

Project File: lsc-03.ec6

LIC# : KW-06016466, Build:20.22.12.28

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DESCRIPTION: NE Corner

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 (25.4.2.3a) =	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 segment =	6.00 in
As Provided =	0.2000 in ² /ft
As Required =	0.1100 in ² /ft

Cantilevered Retaining Wall

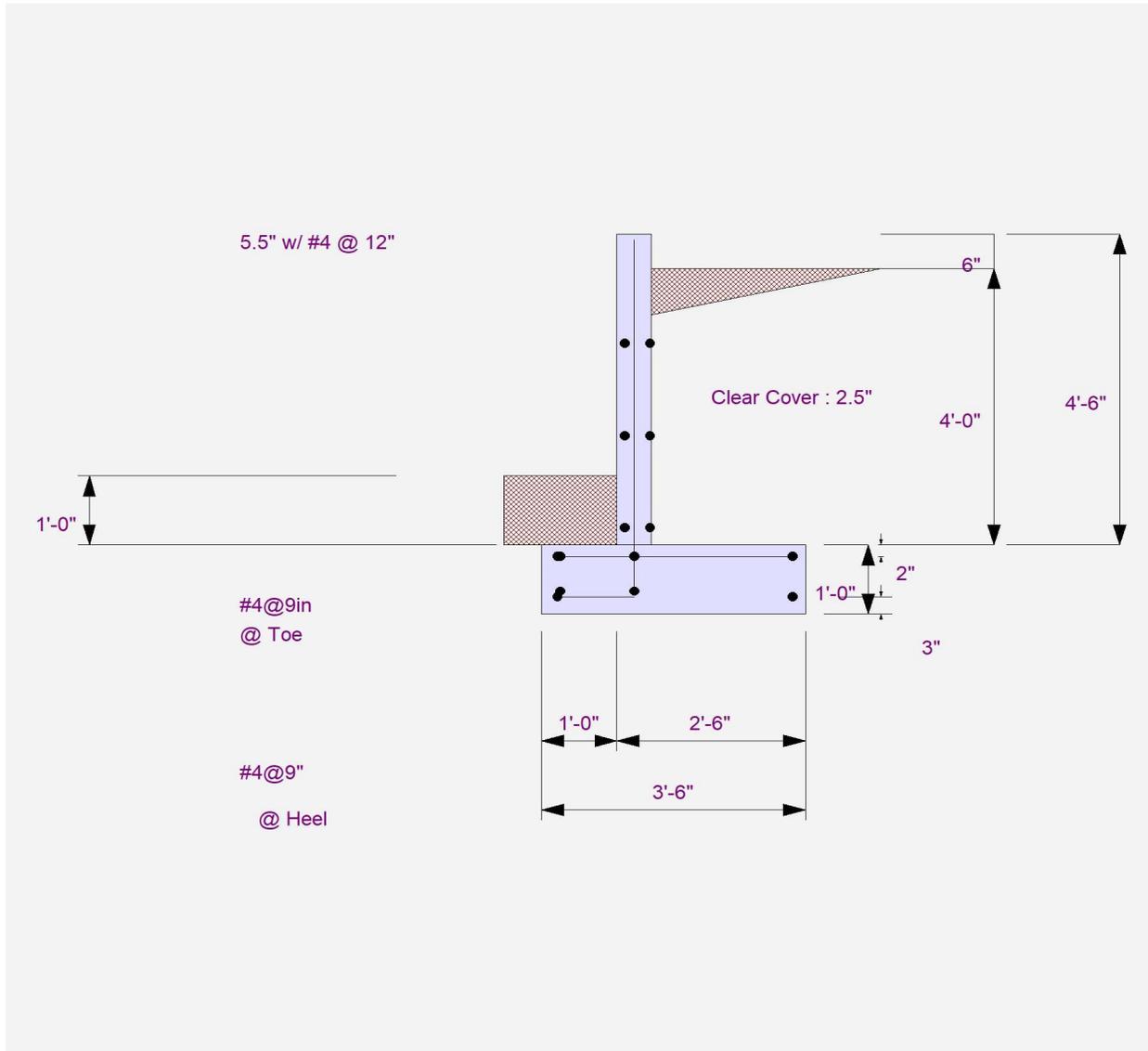
Project File: lsc-03.ec6

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DESCRIPTION: NE Corner



Cantilevered Retaining Wall

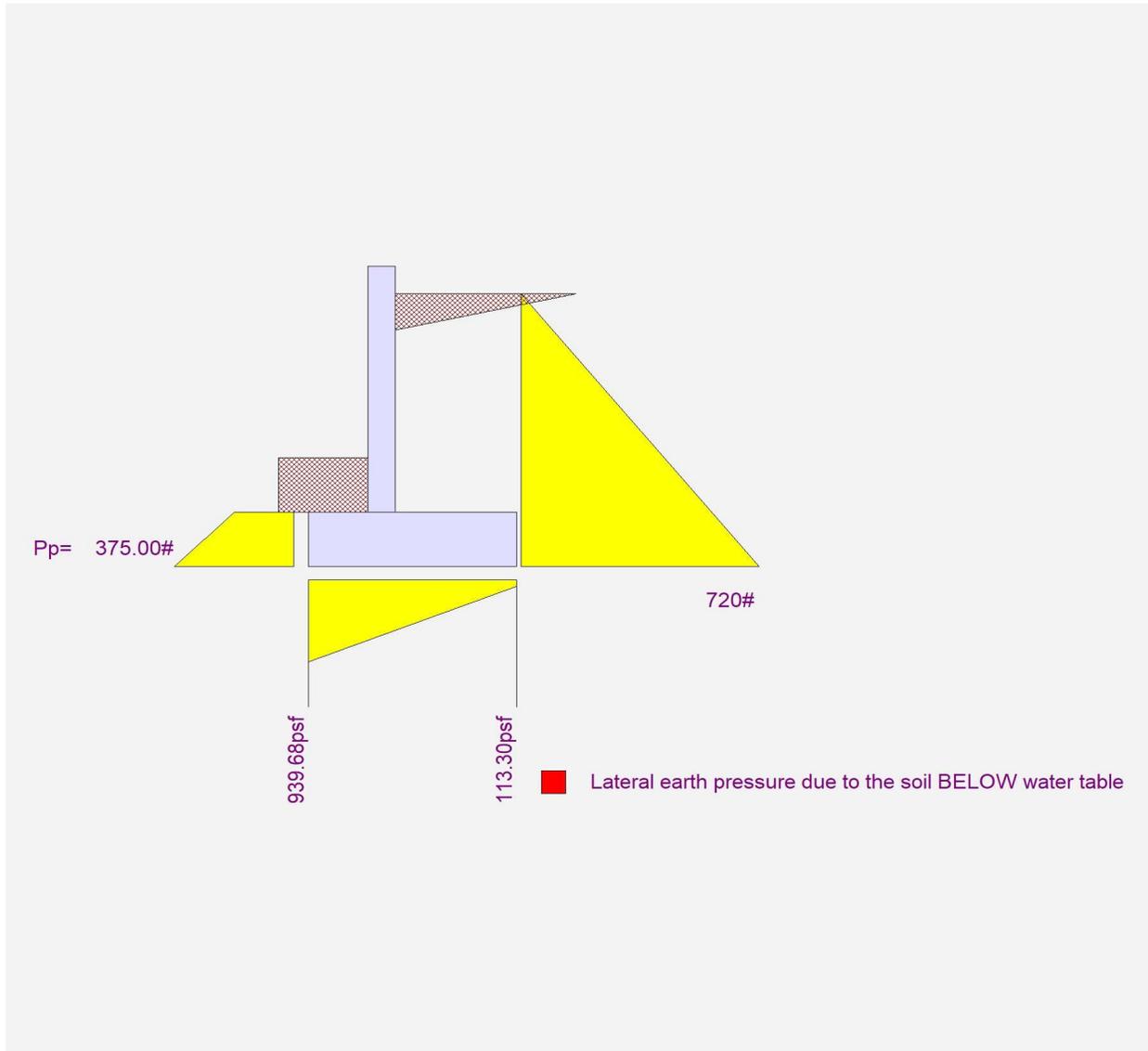
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DESCRIPTION: NE Corner



Retaining Wall Soil Forces Calculation

Retained Soil Heel Side

Retained Soil Friction Angle	$\phi =$	30	degrees	
Retained Soil Density	$\gamma =$	120	pcf	
Backslope		2:1	H:V	
Back Slope Angle	$\beta =$	26.57	degrees	
Batter Angle @ back of retaining wall	$\alpha =$	90	degrees	
MSE Wall or Heel Present in Retaining Wall?		Yes		
Soil Wall Friction Angle (Assumed ϕ if yes, $\phi/2$ if no)	$\delta =$	30	degrees	

Passive Soil Toe Side

Toe Soil Friction Angle	$\phi_t =$	30	degrees	
Toe Soil Density	$\gamma_t =$	120	pcf	
Wall Batter (for MSE gravity walls only)		Vertical	degrees	
Batter Angle @ back of retaining wall	$\alpha_t =$	0	degrees	
MSE Wall?		No		
Soil Wall Friction Angle (Assumed ϕ if yes, $\phi/2$ if no)	$\delta_t =$	15	degrees	

Rankine Method (Preferred EFP Calculation)

Active Pressure

Coefficient of Active Earth Pressure	$K_a =$	0.537		
Active Pressure	$P_a =$	1159.18 lbs		Resultant load

Active Pressure Density	$\gamma_{Act} =$	64.40 psf/ft	
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Equivalent Fluid Pressure (EFP) Level Back Slope

Coefficient of Horizontal Active Earth Pressure	$K_{ah} =$	0.480		
Active Lateral Pressure	$P_{ah} =$	1036.80 lbs		Resultant load

Equivalent Fluid Pressure (EFP)	$\gamma_{EFP} =$	57.60 psf/ft	ENERCALC - Active Soil Pressure (use flat backfill)
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PLANTER WALL AT SE

Project Title:
 Engineer:
 Project ID:
 Project Descr:

Cantilevered Retaining Wall

Project File: LSC-03 SW Planters and Shoring Walls.ec6

LIC# : KW-06016466, Build:20.22.12.28

Harper Houf Peterson Righellis Inc.

(c) ENERCALC INC 1983-2022

DESCRIPTION: 12/23 REV Stormwater Planter Wall Bldg Stem wall

Code Reference

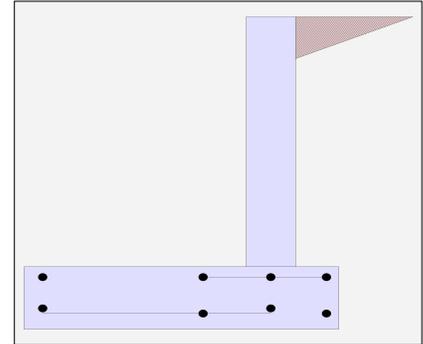
Calculations per IBC 2021 1807.3, ASCE 7-16

Criteria

Retained Height	=	4.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	0.00 in
Water height over heel	=	0.0 ft

Soil Data

Allow Soil Bearing	=	2,500.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
Passive Pressure	=	390.0 psf/ft
Soil Density, Heel	=	110.0 pcf
Soil Density, Toe	=	110.0 pcf
Footing Soil Friction	=	0.420
Soil height to ignore for passive pressure	=	12.00 in



Surcharge Loads

Surcharge Over Heel	=	0.0 psf
NOT Used To Resist Sliding & Overturning		
Surcharge Over Toe	=	0.0
NOT 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	=	4.000
(Multiplier used on soil density)		

Lateral Load Applied to Stem

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

Uniform Seismic Force	=	20.000
Total Seismic Force	=	100.000

Adjacent Footing Load

Adjacent Footing Load	=	1,250.0 lbs
Footing Width	=	5.00 ft
Eccentricity	=	0.00 in
Wall to Ftg CL Dist	=	6.00 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-06016466, Build:20.22.12.28

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DESCRIPTION: 12/23 REV Stormwater Planter Wall Bldg Stem wall

Design Summary

Stem Construction

Bottom

Wall Stability Ratios

Overturning	=	3.27	OK
Sliding	=	0.98	UNSTABLE!
Global Stability	=	2.02	
Total Bearing Load	=	1,294	lbs
...resultant ecc.	=	1.66	in
Eccentricity within middle third			
Soil Pressure @ Toe	=	364	psf OK
Soil Pressure @ Heel	=	245	psf OK
Allowable	=	2,500	psf
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	510	psf
ACI Factored @ Heel	=	343	psf
Footing Shear @ Toe	=	6.4	psi OK
Footing Shear @ Heel	=	1.8	psi OK
Allowable	=	82.2	psi

Sliding Calcs

Lateral Sliding Force	=	636.0	lbs
less 100% Passive Force	=	0.0	lbs
less 100% Friction Force	=	624.7	lbs
Added Force Req'd	=	11.4	lbs NG
....for 1.5 Stability	=	329.4	lbs NG

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	1.600
Seismic, E	1.000

Design Height Above Ftg

ft =	Stem OK	0.00
Wall Material Above "Ht"	=	Concrete
Design Method	=	SD
Thickness	=	8.00
Rebar Size	=	# 4
Rebar Spacing	=	12.00
Rebar Placed at	=	Center

Design Data

fb/FB + fa/Fa	=	0.508
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Total Force @ Section

Service Level	lbs =	
Strength Level	lbs =	674.8

Moment....Actual

Service Level	ft-# =	
Strength Level	ft-# =	1,741.8

Moment....Allowable	=	3,423.0
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Shear....Actual

Service Level	psi =	
Strength Level	psi =	14.1

Shear.....Allowable	psi =	52.9
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Anet (Masonry)	in2 =	
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Wall Weight	psf =	100.0
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Rebar Depth 'd'	in =	4.00
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Masonry Data

f'm	psi =	
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

SLIDING OKAY WHEN CONSIDERING ENTIRE PLANTER AS UNIT

Project Title:
 Engineer:
 Project ID:
 Project Descr:

Cantilevered Retaining Wall

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LIC# : KW-06016466, Build:20.22.12.28

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DESCRIPTION: 12/23 REV Stormwater Planter Wall Bldg Stem wall

Concrete Stem Rebar Area Details

Bottom Stem	<u>Vertical Reinforcing</u>	<u>Horizontal Reinforcing</u>	
As (based on applied moment) :	0.1051 in2/ft		
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :	
	=====	<u>One layer of :</u> <u>Two layers of :</u>	
Required Area :	0.1728 in2/ft	#4@ 16.67 in	#4@ 33.33 in
Provided Area :	0.2 in2/ft	#5@ 25.83 in	#5@ 51.67 in
Maximum Area :	0.6503 in2/ft	#6@ 36.67 in	#6@ 73.33 in

Footing Data

Toe Width	=	3.00 ft
Heel Width	=	1.25
Total Footing Width	=	4.25
Footing Thickness	=	12.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft
f'c =	3,000 psi	Fy = 60,000 psi
Footing Concrete Density	=	150.00 pcf
Min. As %	=	0.0015
Cover @ Top	2.00	@ Btm.= 3.00 in

Footing Design Results

		<u>Toe</u>	<u>Heel</u>	
Factored Pressure	=	510	343 psf	
Mu' : Upward	=	2,117	60 ft-#	
Mu' : Downward	=	810	120 ft-#	
Mu: Design	=	1,307 NG	61 ft-#	NG
phiMn	=	7,699	8,599 ft-#	
Actual 1-Way Shear	=	6.40	1.81 psi	
Allow 1-Way Shear	=	82.16	82.16 psi	
Toe Reinforcing	=	# 4 @ 12.00 in		
Heel Reinforcing	=	# 4 @ 12.00 in		
Key Reinforcing	=	None Spec'd		
Footing Torsion, Tu	=		0.00 ft-lbs	
Footing Allow. Torsion, phi Tu	=		0.00 ft-lbs	

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

Other Acceptable Sizes & Spacings

Toe: #4@ 11.11 in, #5@ 17.22 in, #6@ 24.44 in, #7@ 33.33 in, #8@ 43.88 in, #9@ 55.55 in, #10@ 70.55 in

Heel: #4@ 11.11 in, #5@ 17.22 in, #6@ 24.44 in, #7@ 33.33 in, #8@ 43.88 in, #9@ 55.55 in, #10@ 70.55 in

Key: No key defined

Min footing T&S reinf Area 0.92 in2
 Min footing T&S reinf Area per foot 0.22 in2 /ft

If one layer of horizontal bars:

#4@ 11.11 in
 #5@ 17.22 in
 #6@ 24.44 in

If two layers of horizontal bars:

#4@ 22.22 in
 #5@ 34.44 in
 #6@ 48.89 in

Cantilevered Retaining Wall

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LIC# : KW-06016466, Build:20.22.12.28

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DESCRIPTION: 12/23 REV Stormwater Planter Wall Bldg Stem wall

Summary of Overturning & Resisting Forces & Moments

ItemOVERTURNING.....		RESISTING.....			
	Force lbs	Distance ft	Moment 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)	256.7	3.96	1,016.0
HL Act Pres (be water tbl)				Soil Over HL (bel. water tbl)		3.96	1,016.0
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 =	128.5	1.78	229.0	Axial Dead Load on Stem =			
Added Lateral Load =				* Axial Live Load on Stem =			
Load @ Stem Above Soil =				Soil Over Toe =			
Seismic Earth Load =	70.0	2.50	175.0	Surcharge Over Toe =			
=				Stem Weight(s) =	400.0	3.33	1,333.3
Total =	636.0	O.T.M. =	1,133.1	Earth @ Stem Transitions =			
				Footing Weight =	637.5	2.13	1,354.7
				Key Weight =			
				Vert. Component =			
Resisting/Overturning Ratio =			3.27	Total =	1,294.2 lbs	R.M.=	3,704.0
Vertical Loads used for Soil Pressure =		1,294.2 lbs					

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

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 NOT 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) 0.010 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.

Project Title:
Engineer:
Project ID:
Project Descr:

Cantilevered Retaining Wall

Project File: LSC-03 SW Planters and Shoring Walls.ec6

LIC# : KW-06016466, Build:20.22.12.28

Harper Houf Peterson Righellis Inc.

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DESCRIPTION: 12/23 REV Stormwater Planter Wall Bldg Stem wall

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 segment =	7.67 in
As Provided =	0.2000 in ² /ft
As Required =	0.1728 in ² /ft

Cantilevered Retaining Wall

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