Project Title:
Engineer:
Project ID:
Project Descr:

ENERCALC Cloud Project ID: 285618

Cantilevered Retaining Wall

Project File: 400 e_ 20th st_upland_013718.EC6

LIC# : KW-06013718, Build:20.26.10.15 San Mina Engieering (c) ENERCALC, LLC 1982-2026

DESCRIPTION: 6 ft Retaining Wall

Code References

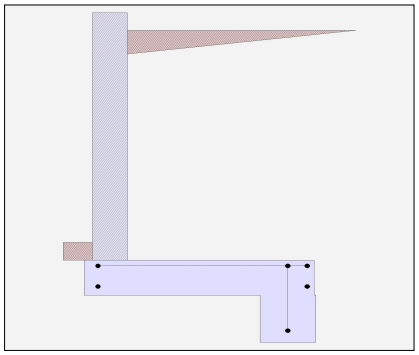
Governing Code : IBC 2024
Referenced Design Standard(s) : ACI 318-19 , TMS 402-22

Criteria

Retained Height	=	6.50 ft
Wall height above soil	=	0.50 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water table above bottom of footing	=	0.0 ft

Soil Data

Allow Soil Bearing	=	2,000.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	40.0 psf/ft
	=	
Passive Pressure	=	300.0 psf/ft
Soil Density, Heel	=	110.00 pcf
Soil Density, Toe	=	110.00 pcf
Footing||Soil Friction	=	0.400
Soil height to ignore for passive pressure	=	12.00 in



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	=	100.0 #/ft
...Height to Top	=	6.50 ft
...Height to Bottom	=	0.00 ft
Load Type	=	Dead Load (D) (Service Level)
Wind on Exposed Stem (Strength Level)	=	0.0 psf

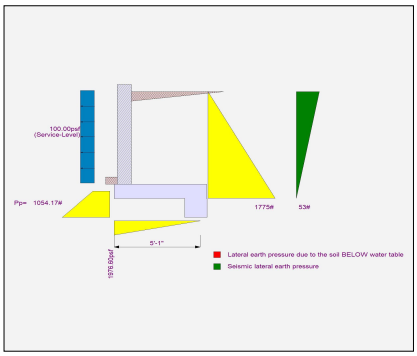
Adjacent Footing Load

Adjacent Footing Load	=	0.0 #/ft
Footing Width	=	0.00 ft
Eccentricity	=	0.00 in
Wall to Ftg CL Dist	=	0.00 ft
Footing Type		Line Load (plf)
Base Above/Below Soil at Back of Wall	=	0.000 ft
Poisson's Ratio	=	0.300

Surcharge Loads

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

A modeled surcharge always affects soil bearing pressure and footing (toe and heel) design.
The decisions above control only the surcharges used as resistance to sliding and overturning.



Earth Pressure Seismic Load

Method : Inverted Triangular
Load at top of Inverted Triangular Distribution . . . . . = 20.000 psf (Strength)

Total Strength-Level Seismic Load. . . . . = 75.000 lbs
Total Service-Level Seismic Load. . . . . = 52.500 lbs



Project Title:
Engineer:
Project ID:
Project Descr:

ENERCALC Cloud Project ID: 285618

Cantilevered Retaining Wall

Project File: 400 e_ 20th st_upland_013718.EC6

LIC# : KW-06013718, Build:20.26.10.15 San Mina Engieering (c) ENERCALC, LLC 1982-2026

DESCRIPTION: 6 ft Retaining Wall

Design Summary

Wall Stability Ratios (seismic is present)

Overturning FS		2.48	OK
Overturning min reqd FS		1.10	
Sliding FS		1.68	OK
Sliding min reqd FS		1.10	
Global Stability	=	1.72	

Service Level Soil Pressures

Total Bearing Load	=	5,059	lbs
...resultant ecc.	=	12.52	in
Eccentricity outside middle third			
Soil Pressure @ Toe	=	1,977	psf OK
Soil Pressure @ Heel	=	0	psf OK
Allowable	=	2,000	psf
Soil Pressure Less Than Allowable			

Factored Soil Pressures

ACI Factored @ Toe	=	2,767	psf
ACI Factored @ Heel	=	0	psf
Footing Shear @ Toe	=	4.8	psi OK
Footing Shear @ Heel	=	1.1	psi OK
Allowable	=	100.6	psi

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

Load Factors

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

Stem Construction

		Bottom		
		Stem OK		
Design Height Above Ftg	ft =	0.00		
Wall Material Above "Ht"	=	Masonry		
Design Method	=	ASD	SD	SD
Thickness	=	10.00		
Rebar Size	=	# 5		
Rebar Spacing	=	8		
Rebar Placed at	=	Edge		
Design Data				
fb/Fb (+ fa/Fa for Masonry)	=	**0.882**		
Total Force @ Section				
Service Level	lbs =	1,568.7		
Strength Level	lbs =			
Moment....Actual				
Service Level	ft-# =	4,243.8		
Strength Level	ft-# =			
Moment.....Allowable	=	4,910.9		
Shear Friction at Stem/Footing Interface				
Service Level Shear Force, V				1,569 lb
Allowable Shear Friction Force				5,030 lb
TMS 402-22 8.3.6 Eq 8-26, M/(V*dv) = 4.48 - no μ term				
Shear.....Actual				
Service Level	psi =	13.6		
Strength Level	psi =			
Shear.....Allowable	psi =	45.2		
Anet (Masonry)	in2 =	115.50		
Wall Weight	psf =	109.0		
Rebar Depth 'd'	in =	7.25		
Masonry Data				
f'm	psi =	1,500		
Fs	psi =	20,000		
Solid Grouting	=	Yes		
Modular Ratio 'n'	=	21.48		
Equiv. Solid Thick.	in =	9.63		
Masonry Block Type	=	Normal Weight		
Radius of Gyration	in =	2.78		
Concrete Data				
f'c	psi =			
β1	=			
Fy	psi =			

Summary of Sliding Forces

	FS = 1.0	FS = 1.1	FS = 1.5
Lateral Force @ Base of Footing	1,827.50 lbs	2,010.25 lbs	2,741.25 lbs
less 100% Passive Force	- 1,054.17 lbs	- 1,054.17 lbs	- 1,054.17 lbs
less 100% Friction Force	- 2,023.73 lbs	- 2,023.73 lbs	- 2,023.73 lbs
Added Resisting Force Required	0.0 lbs		
Added Resisting Force Required for 1.1 Factor of Safety		0.00 lbs	
Added Resisting Force Required for 1.5 Factor of Safety			0.00 lbs

Sliding Factor of Safety = 1.684: 1.00

Project Title:
Engineer:
Project ID:
Project Descr:

ENERCALC Cloud Project ID: 285618

Cantilevered Retaining Wall

Project File: 400 e_ 20th st_upland_013718.EC6

LIC# : KW-06013718, Build:20.26.10.15 San Mina Engieering (c) ENERCALC, LLC 1982-2026

DESCRIPTION: 6 ft Retaining Wall

Footing Data

Toe Width	=	0.20 ft
Heel Width	=	5.30
Total Footing Width	=	5.50
Footing Thickness	=	12.00 in
Key Width	=	16.00 in
Key Depth	=	16.00 in
Key Distance from Toe	=	4.20 ft

f'c = 4,500 psi Fy = 60,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel	Key	
Factored Pressure	=	2,767	0		psf
Mu' : Upward	=	55	6,145		ft-#
Mu' : Downward	=	15	11,321		ft-#
Mu: Design	=	39	5,175	2,066	ft-#
Toe Reinforcing	=	# 5 @ 14.35 in			
Heel Reinforcing	=	# 5 @ 14.35 in			
Key Reinforcing	=	# 5 @ 10.00 in			

Mu:Design @ Toe	39.450 ft-#	
phiMn Toe	9,935.0 ft-#	OK
As,min <= As,Toe <= As,max		OK
Mu:Design @ Heel	5,175.11 ft-#	
phiMn Heel	11,102.0 ft-#	OK
As,min <= As,Heel <= As,max		OK
Mu:Design @ Key	2,065.88 ft-#	
phiMn Key	12,985.0 ft-#	OK
As,min <= As,Key <= As,max		OK

Footing T&S Reinforcing Options

Min footing T&S reinf Area = 1.43 in2
Min footing T&S reinf Area per foot = 0.26 in2/ft

If one layer of horizontal bars:	If two layers of 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

Key T&S Reinforcing Options

Min key T&S reinf Area 0.46 in2

Options: 3#4, 2#5, 2#6

Project Title:
Engineer:
Project ID:
Project Descr:

ENERCALC Cloud Project ID: 285618

Cantilevered Retaining Wall

Project File: 400 e_ 20th st_upland_013718.EC6

LIC# : KW-06013718, Build:20.26.10.15 San Mina Engieering (c) ENERCALC, LLC 1982-2026

DESCRIPTION: 6 ft Retaining Wall

Summary of Overturning & Resisting Forces & Moments

Item		.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	=	1,125.0	2.50	2,812.5
HL Act Pres (be water tbl)	=			
Hydrostatic Force	=			
Buoyant Force	=			
Surcharge over Heel	=			
Surcharge Over Toe	=			
Adjacent Footing Load	=			
Added Lateral Load	=	650.0	4.25	2,762.5
Load @ Stem Above Soil	=			
Seismic Earth Load	=	52.5	5.00	262.5
	=			
			O.T.M. =	5,837.5

Item		.....RESISTING FOR OTM..... Force lbs	Distance ft	Moment ft-#	.....RESISTING FOR SOIL BEARING..... Force lbs	Distance ft	Moment ft-#
Soil Over HL (ab. water tbl)	=	3,193.7	3.27	10,432.6	3,193.7	3.27	10,432.6
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	=	11.0	0.10	1.1	11.0	0.10	1.1
Surcharge Over Toe	=						
Stem Weight(s)	=	763.0	0.62	470.5	763.0	0.62	470.5
Earth @ Stem Transitions	=						
Footing Weight	=	825.0	2.75	2,268.8	825.0	2.75	2,268.8
Key Weight	=	266.7	4.87	1,297.8	266.7	4.87	1,297.8
Vert. Component	=		1.03			1.03	
Total =		5,059.3 lbs	**R.M. =**	14,470.8	**Total =** 5,059.3 lbs	**R.M. =**	14,470.8

* Axial live load is EXCLUDED from total displayed above for Resisting Moment in the overturning analysis, but it is INCLUDED in the Resisting Moment in the Soil Pressure analysis

Resisting/Overturning Ratio = **2.48**

Vertical Loads used for OT Analysis = 5,059.3 lbs

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

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)	0.070	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.

DESCRIPTION: 6 ft Retaining Wall

Rebar Lap & Embedment Lengths Information

Stem Design Segment: Bottom
Stem Design Height: 0.00 ft above top of footing
Calculated Rebar Stress, fs = 17283.13 psi

K_cover=2.0625, K_spacing=8, K_diam=5.625, and K_min=2.0625

Lap Splice length for #5 bar specified in this stem design segment (TMS 402-22 Eq. 6-2) =	38.14 in
Development length for #5 bar specified in this stem design segment =	38.14 in
Hooked embedment length into footing for #5 bar specified in this stem design segment =	7.23 in
As Provided =	0.4650 in2/ft
As Required =	0.1324 in2/ft
Ψ r: Confining Reinforcement Factor =	1.00
Ψ o: Location Factor =	1.00
Ψ c: Concrete Strength Factor =	0.90

Project Title:
Engineer:
Project ID:
Project Descr:

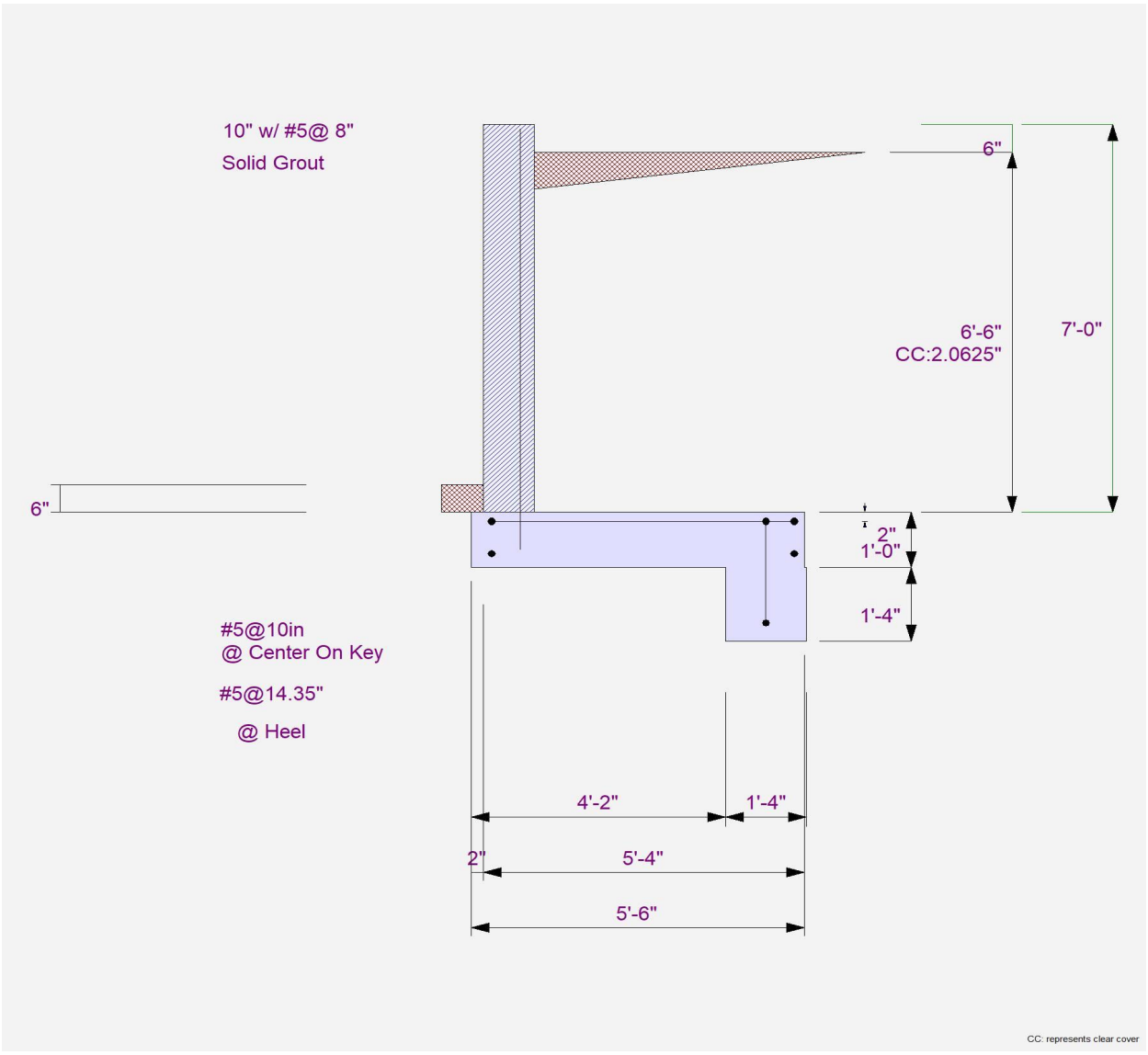
ENERCALC Cloud Project ID: 285618

Cantilevered Retaining Wall

Project File: 400 e_ 20th st_upland_013718.EC6

LIC# : KW-06013718, Build:20.26.10.15 San Mina Engieering (c) ENERCALC, LLC 1982-2026

DESCRIPTION: 6 ft Retaining Wall



Project Title:
Engineer:
Project ID:
Project Descr:

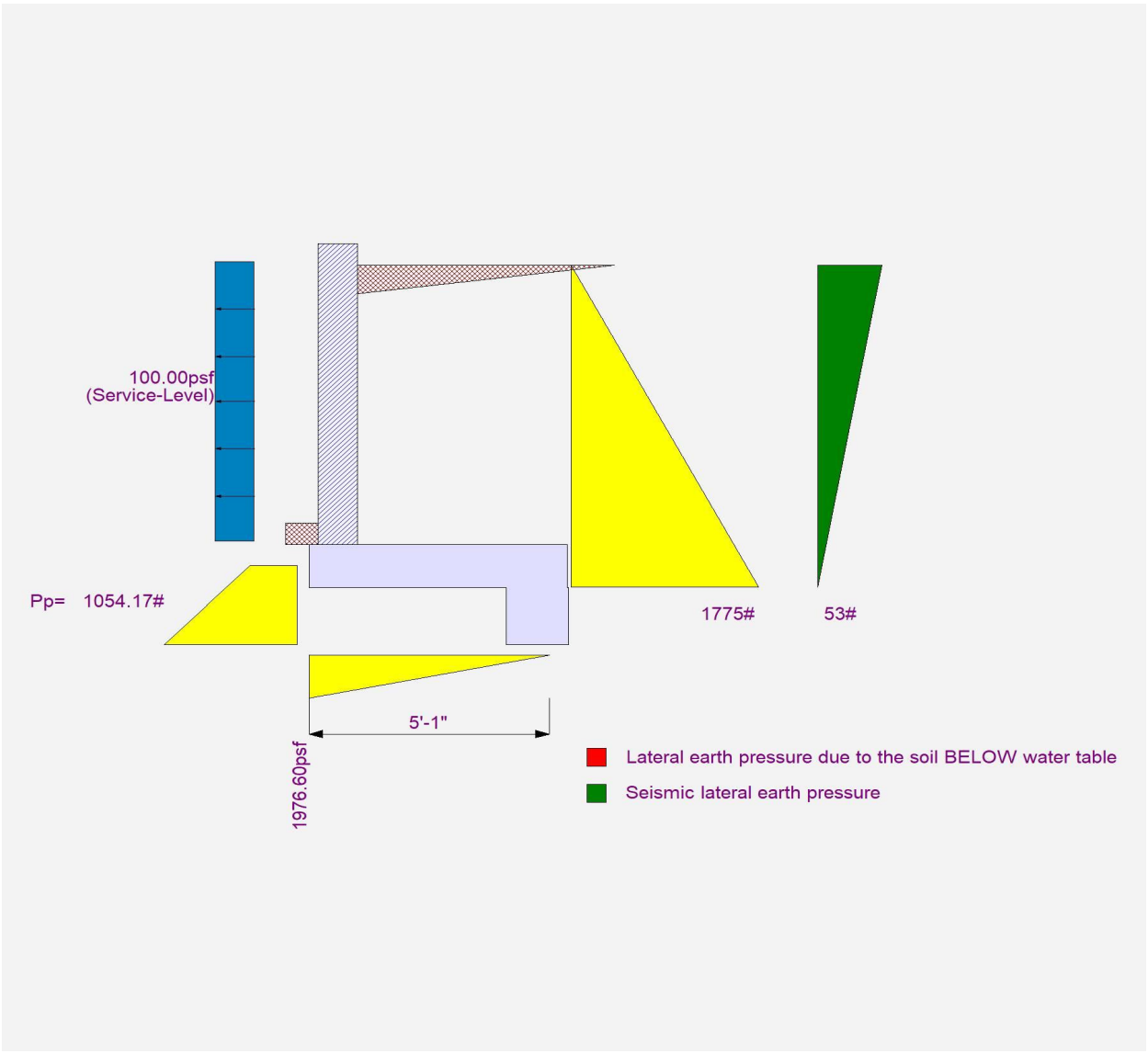
ENERCALC Cloud Project ID: 285618

Cantilevered Retaining Wall

Project File: 400 e_ 20th st_upland_013718.EC6

LIC# : KW-06013718, Build:20.26.10.15 San Mina Engieering (c) ENERCALC, LLC 1982-2026

DESCRIPTION: 6 ft Retaining Wall



Project Title:
Engineer:
Project ID:
Project Descr:

ENERCALC Cloud Project ID: 285618

Cantilevered Retaining Wall

Project File: 400 e_ 20th st_upland_013718.EC6

LIC# : KW-06013718, Build:20.26.10.15 San Mina Engieering (c) ENERCALC, LLC 1982-2026

DESCRIPTION: 4 ft Retaining Wall

Code References

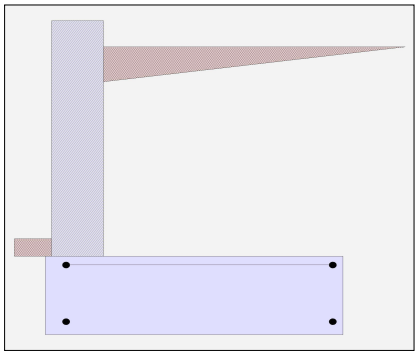
Governing Code : IBC 2024
Referenced Design Standard(s) : ACI 318-19 , TMS 402-22

Criteria

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

Soil Data

Allow Soil Bearing	=	2,000.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	40.0 psf/ft
	=	
Passive Pressure	=	300.0 psf/ft
Soil Density, Heel	=	110.00 pcf
Soil Density, Toe	=	110.00 pcf
Footing||Soil Friction	=	0.400
Soil height to ignore for passive pressure	=	12.00 in



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	=	100.0 #/ft
...Height to Top	=	4.00 ft
...Height to Bottom	=	0.00 ft
Load Type	=	Dead Load (D) (Service Level)
Wind on Exposed Stem (Strength Level)	=	0.0 psf

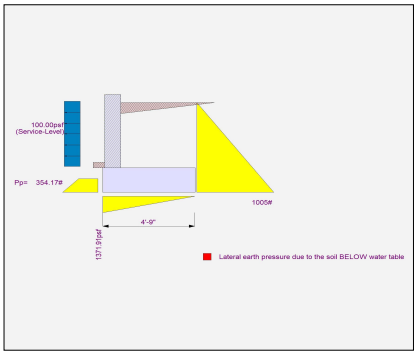
Adjacent Footing Load

Adjacent Footing Load	=	0.0 #/ft
Footing Width	=	0.00 ft
Eccentricity	=	0.00 in
Wall to Ftg CL Dist	=	0.00 ft
Footing Type		Line Load (plf)
Base Above/Below Soil at Back of Wall	=	0.000 ft
Poisson's Ratio	=	0.300

Surcharge Loads

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

A modeled surcharge always affects soil bearing pressure and footing (toe and heel) design.
The decisions above control only the surcharges used as resistance to sliding and overturning.



Project Title:
Engineer:
Project ID:
Project Descr:

ENERCALC Cloud Project ID: 285618

Cantilevered Retaining Wall

Project File: 400 e_ 20th st_upland_013718.EC6

LIC# : KW-06013718, Build:20.26.10.15 San Mina Engieering (c) ENERCALC, LLC 1982-2026

DESCRIPTION: 4 ft Retaining Wall

Design Summary

Wall Stability Ratios (seismic is not present)

Overturning FS		3.08	OK
Overturning min reqd FS		1.50	
Sliding FS		1.66	OK
Sliding min reqd FS		1.50	
Global Stability	=	1.99	

Service Level Soil Pressures

Total Bearing Load	=	3,276	lbs
...resultant ecc.	=	9.70	in
Eccentricity outside middle third			
Soil Pressure @ Toe	=	1,372	psf OK
Soil Pressure @ Heel	=	0	psf OK
Allowable	=	2,000	psf
Soil Pressure Less Than Allowable			

Factored Soil Pressures

ACI Factored @ Toe	=	1,921	psf
ACI Factored @ Heel	=	0	psf
Footing Shear @ Toe	=	0.9	psi OK
Footing Shear @ Heel	=	0.6	psi OK
Allowable	=	100.6	psi

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

Load Factors

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

Stem Construction

		Bottom		
		Stem OK		
Design Height Above Ftg	ft =	0.00		
Wall Material Above "Ht"	=	Masonry		
Design Method	=	ASD	SD	SD
Thickness	=	10.00		
Rebar Size	=	# 5		
Rebar Spacing	=	16		
Rebar Placed at	=	Edge		
Design Data				
fb/Fb (+ fa/Fa for Masonry)	=	**0.492**		
Total Force @ Section				
Service Level	lbs =	720.0		
Strength Level	lbs =			
Moment....Actual				
Service Level	ft-# =	1,226.7		
Strength Level	ft-# =			
Moment.....Allowable	=	2,541.3		
Shear Friction at Stem/Footing Interface				
Service Level Shear Force, V				720 lb
Allowable Shear Friction Force				2,586 lb
TMS 402-22 8.3.6 Eq 8-26, M/(V*dv) = 2.82 - no μ term				
Shear.....Actual				
Service Level	psi =	6.2		
Strength Level	psi =			
Shear.....Allowable	psi =	44.6		
Anet (Masonry)	in2 =	115.50		
Wall Weight	psf =	109.0		
Rebar Depth 'd'	in =	7.25		
Masonry Data				
f'm	psi =	1,500		
Fs	psi =	20,000		
Solid Grouting	=	Yes		
Modular Ratio 'n'	=	21.48		
Equiv. Solid Thick.	in =	9.63		
Masonry Block Type	=	Normal Weight		
Radius of Gyration	in =	2.78		
Concrete Data				
f'c	psi =			
β1	=			
Fy	psi =			

Summary of Sliding Forces

	FS = 1.0	FS = 1.5
Lateral Force @ Base of Footing	1,005.00 lbs	1,507.50 lbs
less 100% Passive Force	- 354.167 lbs	- 354.167 lbs
less 100% Friction Force	- 1,310.20 lbs	- 1,310.20 lbs
Added Resisting Force Required	0.0 lbs	
Added Resisting Force Required for 1.5 Factor of Safety		0.00 lbs

Sliding Factor of Safety = 1.656: 1.00

Project Title:
Engineer:
Project ID:
Project Descr:

ENERCALC Cloud Project ID: 285618

Cantilevered Retaining Wall

Project File: 400 e_ 20th st_upland_013718.EC6

LIC# : KW-06013718, Build:20.26.10.15 | San Mina Engieering | (c) ENERCALC, LLC 1982-2026

DESCRIPTION: 4 ft Retaining Wall

Footing Data

Toe Width	=	0.10 ft
Heel Width	=	4.70
Total Footing Width	=	4.80
Footing Thickness	=	18.00 in

f'c = 4,500 psi Fy = 60,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel	
Factored Pressure	=	1,921	0	psf
Mu' : Upward	=	10	3,801	ft-#
Mu' : Downward	=	8	6,608	ft-#
Mu: Design	=	1	2,807	ft-#
Toe Reinforcing	=	# 5 @ 9.57 in		
Heel Reinforcing	=	# 5 @ 9.56 in		

Mu:Design @ Toe	1.420 ft-#	
phiMn Toe	25,253.0 ft-#	OK
As,min <= As,Toe <= As,max		OK

Mu:Design @ Heel	2,807.22 ft-#	
phiMn Heel	27,023.0 ft-#	OK
As,min <= As,Heel <= As,max		OK

Footing T&S Reinforcing Options

Min footing T&S reinf Area = 1.87 in2
Min footing T&S reinf Area per foot = 0.39 in2/ft

If one layer of horizontal bars:	If two layers of of horizontal bars:
#4@ 6.17 in	#4@ 12.35 in
#5@ 9.57 in	#5@ 19.14 in
#6@ 13.58 in	#6@ 27.16 in

Project Title:
Engineer:
Project ID:
Project Descr:

ENERCALC Cloud Project ID: 285618

Cantilevered Retaining Wall

Project File: 400 e_ 20th st_upland_013718.EC6

LIC# : KW-06013718, Build:20.26.10.15 San Mina Engieering (c) ENERCALC, LLC 1982-2026

DESCRIPTION: 4 ft Retaining Wall

Summary of Overturning & Resisting Forces & Moments

Item		.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	=	605.0	1.83	1,109.2
HL Act Pres (be water tbl)	=			
Hydrostatic Force	=			
Buoyant Force	=			
Surcharge over Heel	=			
Surcharge Over Toe	=			
Adjacent Footing Load	=			
Added Lateral Load	=	400.0	3.50	1,400.0
Load @ Stem Above Soil	=			
O.T.M.	=			2,509.2

Item		.....RESISTING FOR OTM..... Force lbs	Distance ft	Moment ft-#	.....RESISTING FOR SOIL BEARING..... Force lbs	Distance ft	Moment ft-#
Soil Over HL (ab. water tbl)	=	1,701.3	2.87	4,877.2	1,701.3	2.87	4,877.2
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	=	3.7	0.05	0.2	3.7	0.05	0.2
Surcharge Over Toe	=						
Stem Weight(s)	=	490.5	0.52	253.4	490.5	0.52	253.4
Earth @ Stem Transitions	=						
Footing Weight	=	1,080.0	2.40	2,592.0	1,080.0	2.40	2,592.0
Key Weight	=						
Vert. Component	=		0.93			0.93	
Total =		3,275.5 lbs	**R.M. =**	7,722.8	**Total =** 3,275.5 lbs	**R.M. =**	7,722.8

* Axial live load is EXCLUDED from total displayed above for Resisting Moment in the overturning analysis, but it is INCLUDED in the Resisting Moment in the Soil Pressure analysis

Resisting/Overturning Ratio = **3.08**

Vertical Loads used for OT Analysis = 3,275.5 lbs

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)	0.036	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.

DESCRIPTION: 4 ft Retaining Wall

Rebar Lap & Embedment Lengths Information

Stem Design Segment: Bottom
Stem Design Height: 0.00 ft above top of footing
Calculated Rebar Stress, fs = 9653.85 psi

K_cover=2.0625, K_spacing=16, K_diam=5.625, and K_min=2.0625

Lap Splice length for #5 bar specified in this stem design segment (TMS 402-22 Eq. 6-2) =	38.14 in
Development length for #5 bar specified in this stem design segment =	38.14 in
Hooked embedment length into footing for #5 bar specified in this stem design segment =	7.23 in
As Provided =	0.2325 in2/ft
As Required =	0.0378 in2/ft
Ψ r: Confining Reinforcement Factor =	1.00
Ψ o: Location Factor =	1.00
Ψ c: Concrete Strength Factor =	0.90

Project Title:
Engineer:
Project ID:
Project Descr:

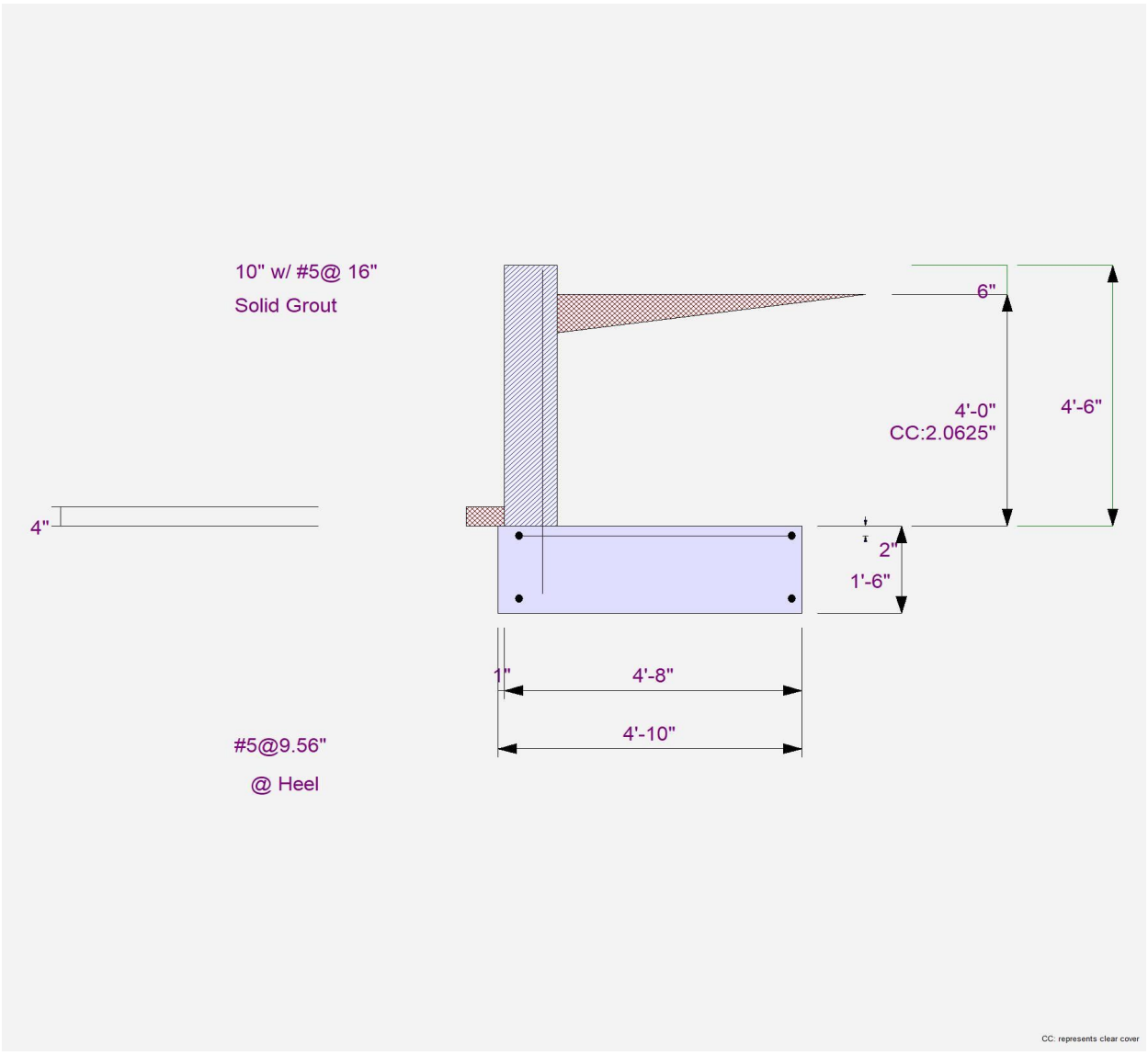
ENERCALC Cloud Project ID: 285618

Cantilevered Retaining Wall

Project File: 400 e_ 20th st_upland_013718.EC6

LIC# : KW-06013718, Build:20.26.10.15 San Mina Engieering (c) ENERCALC, LLC 1982-2026

DESCRIPTION: 4 ft Retaining Wall



Project Title:
Engineer:
Project ID:
Project Descr:

ENERCALC Cloud Project ID: 285618

Cantilevered Retaining Wall

Project File: 400 e_ 20th st_upland_013718.EC6

LIC# : KW-06013718, Build:20.26.10.15 San Mina Engieering (c) ENERCALC, LLC 1982-2026

DESCRIPTION: 4 ft Retaining Wall

