

# CK Engineering LLC.

19229 38th PL NE  
Lake Forest Park, WA 98155

Phone: (206) 417-0670

## STRUCTURAL CALCULATIONS (REVISIONS) Retaining Walls Design 24-031



3/5/2025

FALKNER RESIDENCE (CARPORT)  
5602 E. Mercer Way  
Mercer Island, WA 98040  
March 5, 2025

## Cantilevered Retaining Wall

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.25.02.26

CK Engineering LLC

(c) ENERCALC, LLC 1982-2025

**DESCRIPTION:** 4ft Wall

### Code Reference:

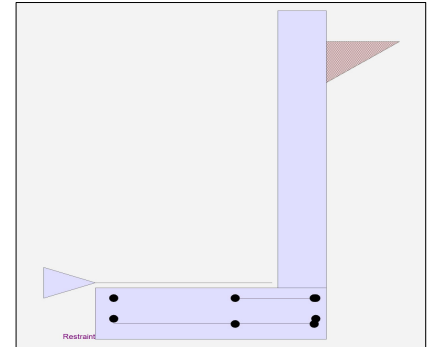
Calculations per IBC 2021, ACI 318-19, TMS 402-16

#### Criteria

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

#### Soil Data

Allow Soil Bearing	=	3,500.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	50.0 psf/ft
	=	
Passive Pressure	=	350.0 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

#### Earth Pressure Seismic Load

Method	:	Uniform
Multiplier Used	=	9.000
(Multiplier used on soil density)		

#### Stem Weight Seismic Load

#### 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

Uniform Seismic Force	=	43.500
Total Seismic Force	=	210.250

$F_p / W_p$ Weight Multiplier	=	0.200 g	Added seismic base force	63.0 lbs
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Project Title:  
 Engineer:  
 Project ID:  
 Project Descr:

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### DESCRIPTION: 4ft Wall

#### Design Summary

##### Wall Stability Ratios

Overturning = 1.28 Ratio < 1.5!  
 Slab Resists All Sliding !  
 Global Stability = 1.04  
 Total Bearing Load = 1,044 lbs  
 ...resultant ecc. = 13.17 in  
 Eccentricity outside middle third  
 Soil Pressure @ Toe = 1,161 psf OK  
 Soil Pressure @ Heel = 0 psf OK  
 Allowable = 3,500 psf  
 Soil Pressure Less Than Allowable  
 ACI Factored @ Toe = 1,625 psf  
 ACI Factored @ Heel = 0 psf  
 Footing Shear @ Toe = 11.4 psi OK  
 Footing Shear @ Heel = 0.0 psi OK  
 Allowable = 75.0 psi

##### Sliding Calcs

Lateral Sliding Force = 794.2 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 1.600  
 Seismic, E 1.000

#### Stem Construction

##### 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 = Edge

##### Design Data

fb/FB + fa/Fa = 0.384

##### Total Force @ Section

Service Level lbs =  
 Strength Level lbs = 904.0

##### Moment....Actual

Service Level ft-# =  
 Strength Level ft-# = 1,403.8

Moment.....Allowable = 3,655.6

##### Shear.....Actual

Service Level psi =  
 Strength Level psi = 12.1

Shear.....Allowable psi = 41.6

Anet (Masonry) in2 =

Wall Weight psf = 100.0

Rebar Depth 'd' in = 6.25

##### 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 = 2,500.0  
 Fy psi = 40,000.0

## Cantilevered Retaining Wall

Project File: 24-031.ec6

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### DESCRIPTION: 4ft Wall

### Concrete Stem Rebar Area Details

	<u>Vertical Reinforcing</u>	<u>Horizontal Reinforcing</u>	
Bottom Stem			
As (based on applied moment) :	0.0789 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@ 13.89 in	#4@ 27.78 in
Provided Area :	0.2 in2/ft	#5@ 21.53 in	#5@ 43.06 in
Maximum Area :	1.27 in2/ft	#6@ 30.56 in	#6@ 61.11 in

### Footing Data

Toe Width	=	2.50 ft
Heel Width	=	0.67
Total Footing Width	=	3.17
Footing Thickness	=	10.00 in
f'c =	2,500 psi	Fy = 40,000 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	=	1,625	0 psf
Mu' : Upward	=	2,385	0 ft-#
Mu' : Downward	=	469	0 ft-#
Mu: Design	=	1,916	0 ft-#
φ Mn	=	4,724	OK - Flush
Actual 1-Way Shear	=	11.42	0.00 psi
Allow 1-Way Shear	=	43.09	56.31 psi
Toe Reinforcing	=	# 4 @ 10.00 in	
Heel Reinforcing	=	Flush heel condition. No reinforcing required.	
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: #4@ 11.11 in, #5@ 17.22 in, #6@ 18 in, #7@ 18 in, #8@ 18 in, #9@ 18 in, #10@ 18 in

Heel: Flush heel condition. No reinforcing required.

Key: No key defined

Min footing T&S reinf Area                    0.68    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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### DESCRIPTION: 4ft Wall

### Summary of Overturning & Resisting Forces & Moments

Item	.....OVERTURNING.....			.....RESISTING.....			
	Force lbs	Distance ft	Moment ft-#	Force lbs	Distance ft	Moment ft-#	
HL Act Pres (ab water tbl)	584.0	1.61	940.9	Soil Over HL (ab. water tbl)	0.0	3.17	0.0
HL Act Pres (be water tbl)				Soil Over HL (bel. water tbl)		3.17	0.0
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 =			
Load @ Stem Above Soil =				Soil Over Toe =			
Seismic Earth Load =	147.2	2.42	355.7	Surcharge Over Toe =			
Seismic Stem Self Wt =	63.0	3.08	194.3	Stem Weight(s) =	450.0	2.83	1,275.0
				Earth @ Stem Transitions =			
<b>Total</b> =	794.2	<b>O.T.M.</b>	1,490.9	Footing Weight =	395.8	1.58	626.7
				Key Weight =			
				Vert. Component =			
<b>Resisting/Overturning Ratio</b>		=	<b>1.28</b>	<b>Total =</b>	845.9 lbs	<b>R.M.=</b>	1,901.8
Vertical Loads used for Soil Pressure =		1,044.4 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 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) 0.046 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:

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**DESCRIPTION:** 4ft 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) =	15.60 in
Development length for #4 bar specified in this stem design segment =	12.00 in
Hooked embedment length into footing for #4 bar specified in this stem design segment =	6.00 in
As Provided =	0.2000 in <sup>2</sup> /ft
As Required =	0.1728 in <sup>2</sup> /ft

Project Title:  
Engineer:  
Project ID:  
Project Descr:

### Cantilevered Retaining Wall

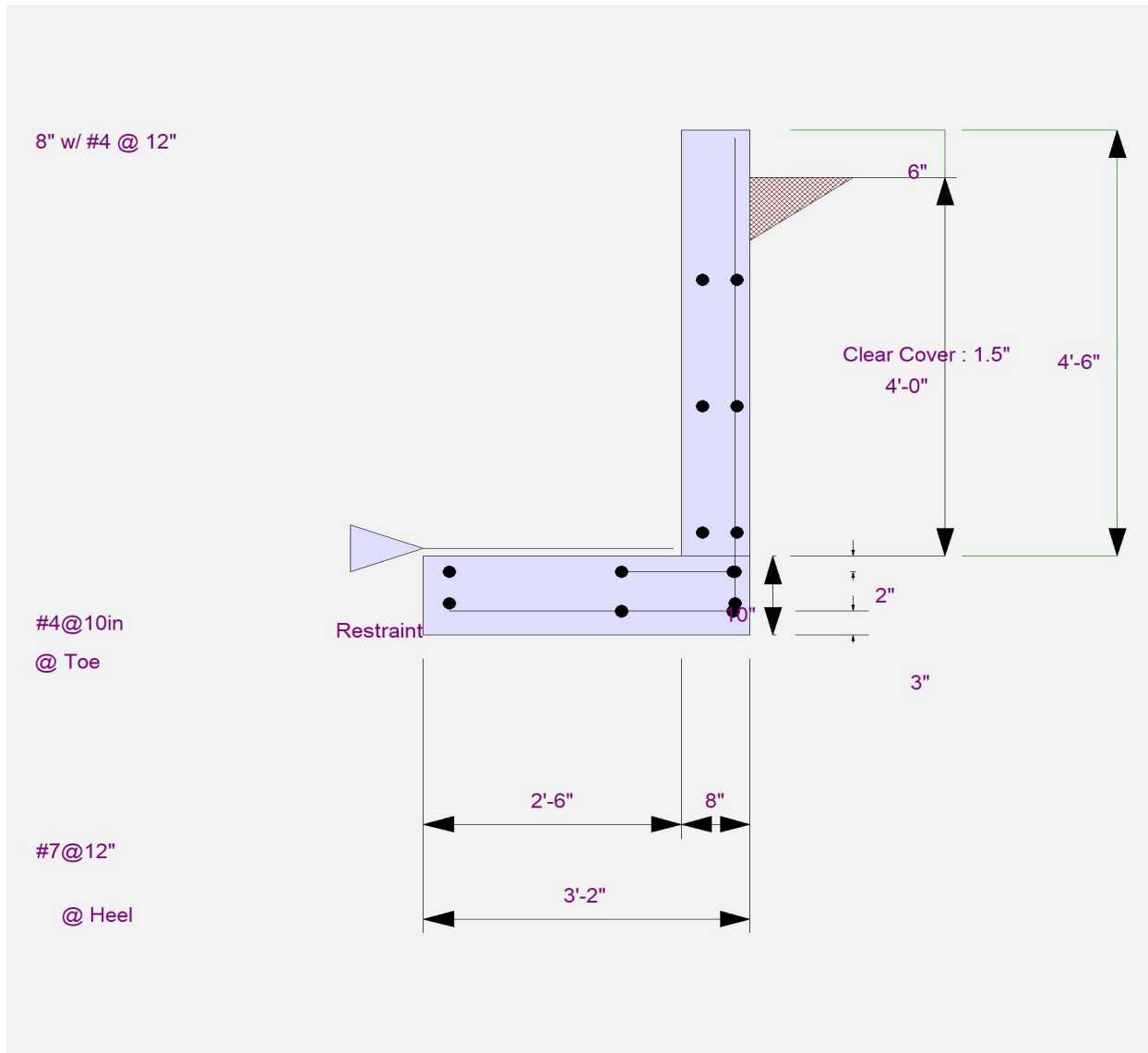
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**DESCRIPTION:** 4ft Wall



# Cantilevered Retaining Wall

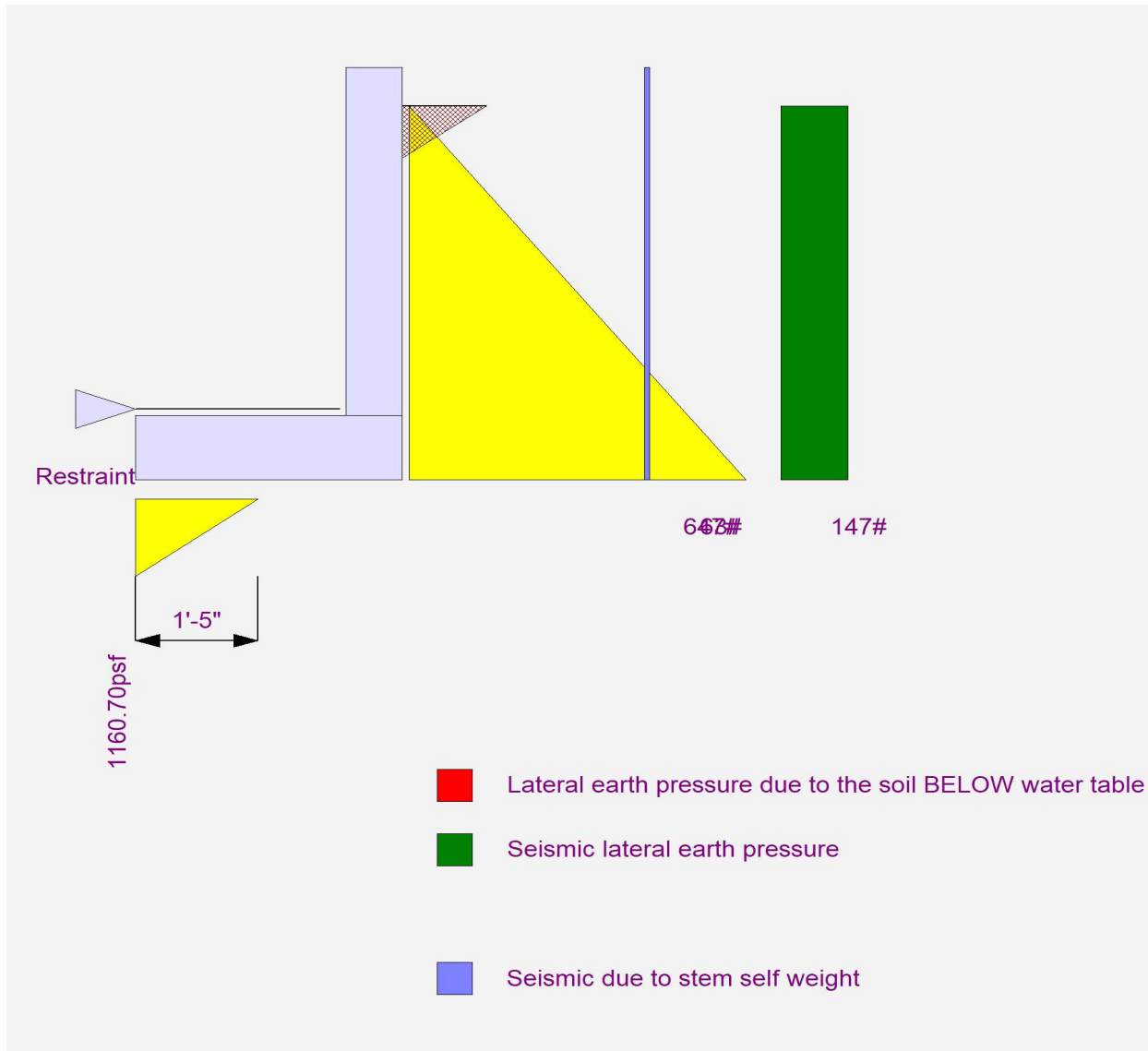
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**DESCRIPTION:** 4ft Wall



## Cantilevered Retaining Wall

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.25.02.26

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**DESCRIPTION:** 6ft Wall

### Code Reference:

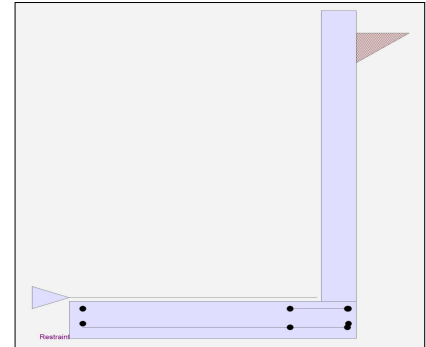
Calculations per IBC 2021, ACI 318-19, TMS 402-16

#### Criteria

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

#### Soil Data

Allow Soil Bearing	=	3,500.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	50.0 psf/ft
Passive Pressure	=	350.0 psf/ft
Soil Density, Heel	=	110.0 pcf
Soil Density, Toe	=	110.0 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

#### Earth Pressure Seismic Load

Method	:	Uniform
Multiplier Used	=	9.000
(Multiplier used on soil density)		

#### Stem Weight Seismic Load

#### 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)

Uniform Seismic Force	=	61.500
Total Seismic Force	=	420.250

$F_p / W_p$ Weight Multiplier	=	0.200 g
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#### Adjacent Footing Load

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

Added seismic base force	=	91.0 lbs
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### DESCRIPTION: 6ft Wall

#### Design Summary

##### Wall Stability Ratios

Overturning	=	1.27	Ratio < 1.5!
Slab Resists All Sliding !			
Global Stability	=	0.62	
Total Bearing Load	=	1,724	lbs
...resultant ecc.	=	22.53	in
Eccentricity outside middle third			
Soil Pressure @ Toe	=	1,065	psf OK
Soil Pressure @ Heel	=	0	psf OK
Allowable	=	3,500	psf
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	1,491	psf
ACI Factored @ Heel	=	0	psf
Footing Shear @ Toe	=	15.7	psi OK
Footing Shear @ Heel	=	0.0	psi OK
Allowable	=	75.0	psi

##### Sliding Calcs

Lateral Sliding Force	=	1,552.5	lbs
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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 =	0.00	Stem OK
Wall Material Above "Ht"	=	Concrete
Design Method	=	SD
Thickness	=	8.00
Rebar Size	=	# 4
Rebar Spacing	=	8.00
Rebar Placed at	=	Edge

##### Design Data

fb/FB + fa/Fa	=	0.814
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##### Total Force @ Section

Service Level	lbs =	
Strength Level	lbs =	1,939.0

##### Moment....Actual

Service Level	ft-# =	
Strength Level	ft-# =	4,409.5

Moment.....Allowable	=	5,412.6
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##### Shear.....Actual

Service Level	psi =	
Strength Level	psi =	25.9

Shear.....Allowable	psi =	47.6
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Anet (Masonry)	in2 =	
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Wall Weight	psf =	100.0
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Rebar Depth 'd'	in =	6.25
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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 =	2,500.0
Fy	psi =	40,000.0

Project Title:  
 Engineer:  
 Project ID:  
 Project Descr:

## Cantilevered Retaining Wall

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.25.02.26

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**DESCRIPTION: 6ft Wall**

### Concrete Stem Rebar Area Details

	<u>Vertical Reinforcing</u>	<u>Horizontal Reinforcing</u>	
Bottom Stem			
As (based on applied moment) :	0.2478 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 :	0.2478 in2/ft	#4@ 13.89 in	#4@ 27.78 in
Provided Area :	0.3 in2/ft	#5@ 21.53 in	#5@ 43.06 in
Maximum Area :	1.27 in2/ft	#6@ 30.56 in	#6@ 61.11 in

### Footing Data

Toe Width	=	4.75 ft
Heel Width	=	0.67
Total Footing Width	=	5.42
Footing Thickness	=	10.00 in
f'c =	2,500 psi	Fy = 40,000 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	=	1,491	0 psf
Mu' : Upward	=	7,282	0 ft-#
Mu' : Downward	=	1,692	0 ft-#
Mu: Design	=	5,590	0 ft-#
φ Mn	=	7,724	OK - Flush
Actual 1-Way Shear	=	15.73	0.00 psi
Allow 1-Way Shear	=	51.09	56.31 psi
Toe Reinforcing	=	# 4 @ 6.00 in	
Heel Reinforcing	=	Flush heel condition. No reinforcing required.	
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: #4@ 6.15 in, #5@ 9.53 in, #6@ 13.53 in, #7@ 18 in, #8@ 18 in, #9@ 18 in, #10@ 18 in

Heel: Flush heel condition. No reinforcing required.

Key: No key defined

Min footing T&S reinf Area 1.17 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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### DESCRIPTION: 6ft Wall

### Summary of Overturning & Resisting Forces & Moments

Item	.....OVERTURNING.....			.....RESISTING.....			
	Force lbs	Distance ft	Moment ft-#	Force lbs	Distance ft	Moment ft-#	
HL Act Pres (ab water tbl)	1,167.4	2.28	2,659.0	Soil Over HL (ab. water tbl)	0.0	5.42	0.1
HL Act Pres (be water tbl)				Soil Over HL (bel. water tbl)		5.42	0.1
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 =			
Seismic Earth Load =	294.2	3.42	1,005.1	Surcharge Over Toe =			
Seismic Stem Self Wt =	91.0	4.08	371.6	Stem Weight(s) =	650.0	5.08	3,304.2
				Earth @ Stem Transitions =			
<b>Total</b> =	<b>1,552.5</b>	<b>O.T.M. =</b>	<b>4,035.7</b>	Footing Weight =	677.1	2.71	1,833.8
				Key Weight =			
				Vert. Component =			
<b>Resisting/Overturning Ratio</b> =			<b>1.27</b>	<b>Total =</b>	<b>1,327.1 lbs</b>	<b>R.M.=</b>	<b>5,138.1</b>
Vertical Loads used for Soil Pressure =		1,724.1 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 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) 0.036 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.

Project Title:  
Engineer:  
Project ID:  
Project Descr:

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**DESCRIPTION:** 6ft 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) =	15.60 in
Development length for #4 bar specified in this stem design segment =	12.00 in
Hooked embedment length into footing for #4 bar specified in this stem design segment =	6.00 in
As Provided =	0.3000 in <sup>2</sup> /ft
As Required =	0.3304 in <sup>2</sup> /ft

Project Title:  
Engineer:  
Project ID:  
Project Descr:

# Cantilevered Retaining Wall

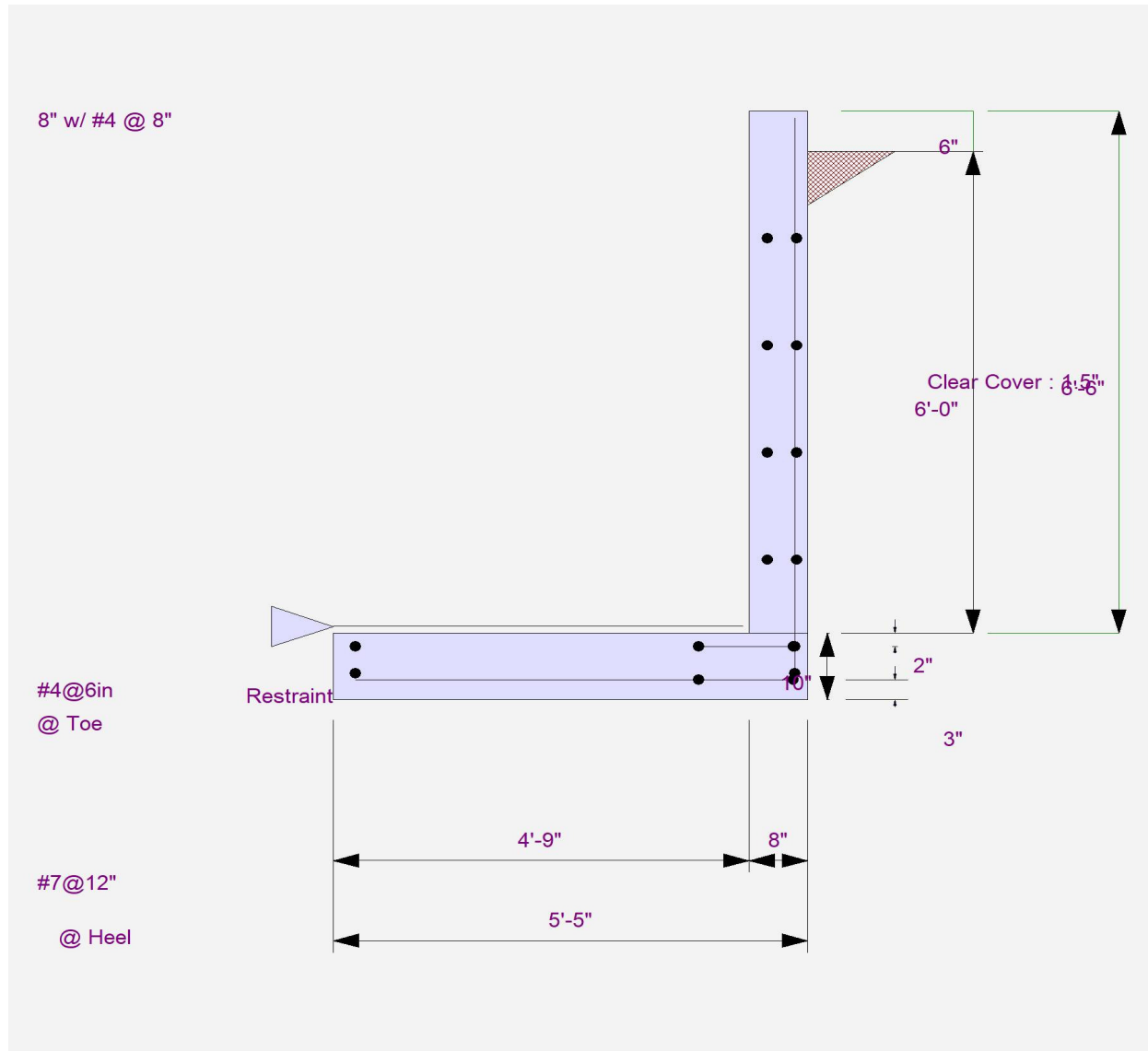
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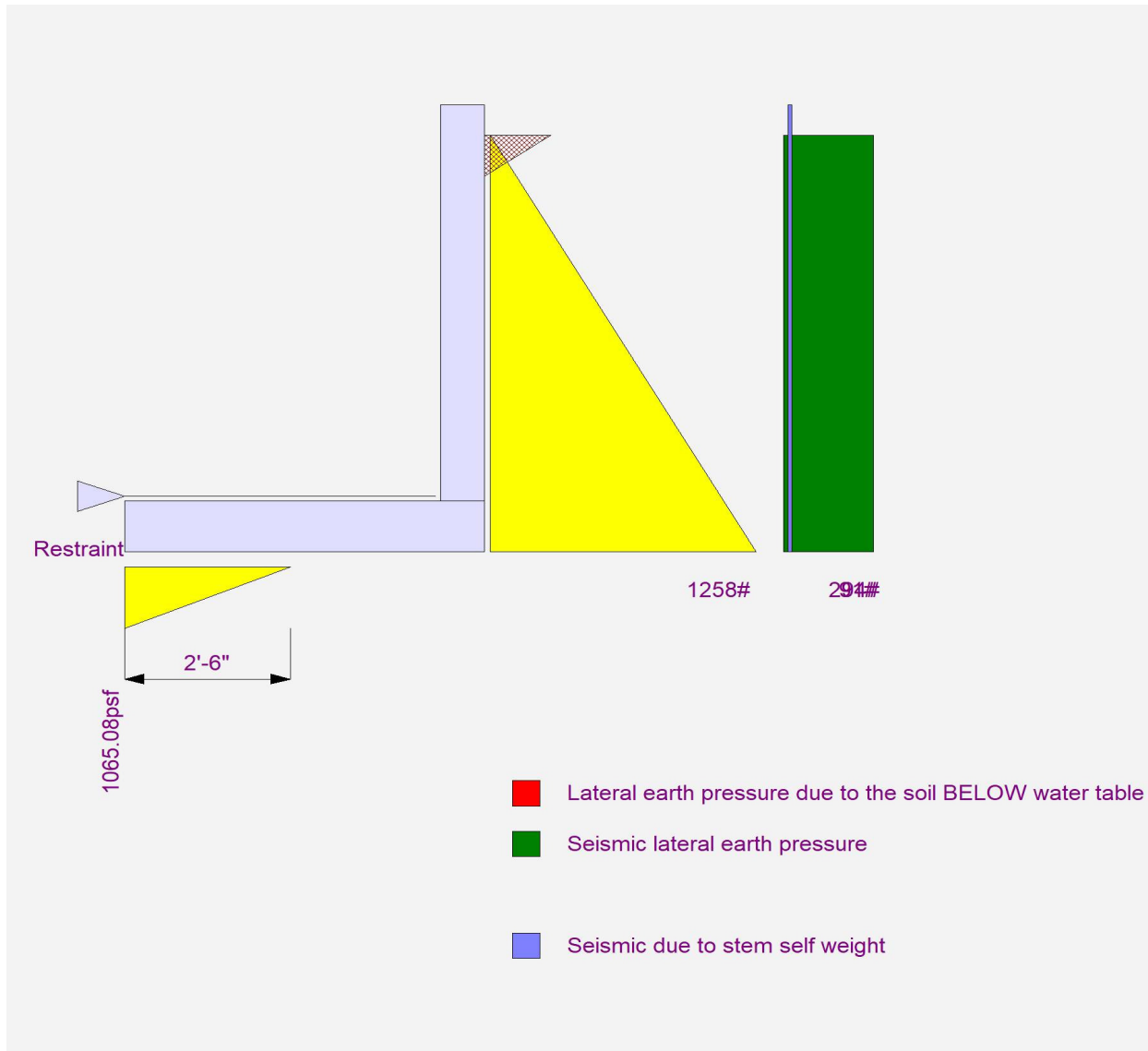
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**DESCRIPTION:** 6ft Wall



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**DESCRIPTION:** 8ft Wall

### Code Reference:

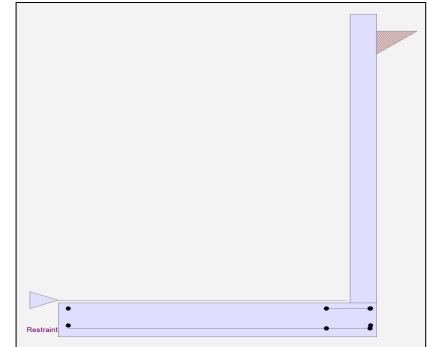
Calculations per IBC 2021, ACI 318-19, TMS 402-16

#### Criteria

Retained Height	=	8.00 ft
Wall height above soil	=	0.50 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	0.00 in
Water table above bottom of footing	=	0.0 ft

#### Soil Data

Allow Soil Bearing	=	3,500.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	50.0 psf/ft
	=	
Passive Pressure	=	350.0 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

#### Earth Pressure Seismic Load

Method	:	Uniform
Multiplier Used	=	9.000
(Multiplier used on soil density)		

#### Stem Weight Seismic Load

#### 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)

Uniform Seismic Force	=	81.000
Total Seismic Force	=	729.000

$F_p / W_p$ Weight Multiplier	=	0.200 g
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#### Adjacent Footing Load

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

Added seismic base force	=	119.0 lbs
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## Cantilevered Retaining Wall

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.25.02.26

CK Engineering LLC

(c) ENERCALC, LLC 1982-2025

### DESCRIPTION: 8ft Wall

#### Design Summary

##### Wall Stability Ratios

Overturning	=	1.24	Ratio < 1.5!
Slab Resists All Sliding !			
Global Stability	=	11.58	
Total Bearing Load	=	2,726 lbs	
...resultant ecc.	=	34.83 in	
Eccentricity outside middle third			
Soil Pressure @ Toe	=	1,287 psf	OK
Soil Pressure @ Heel	=	0 psf	OK
Allowable	=	3,500 psf	
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	1,802 psf	
ACI Factored @ Heel	=	0 psf	
Footing Shear @ Toe	=	16.4 psi	OK
Footing Shear @ Heel	=	0.0 psi	OK
Allowable	=	75.0 psi	

##### Sliding Calcs

Lateral Sliding Force	=	2,654.3 lbs
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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 =	Ratio > 1.0	0.00
Wall Material Above "Ht"	=	Concrete
Design Method	=	SD
Thickness	=	8.00
Rebar Size	=	# 5
Rebar Spacing	=	12.00
Rebar Placed at	=	Edge

##### Design Data

fb/FB + fa/Fa	=	1.248
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##### Total Force @ Section

Service Level	lbs =	
Strength Level	lbs =	3,378.0

##### Moment....Actual

Service Level	ft-# =	
Strength Level	ft-# =	10,141.2

Moment.....Allowable	=	8,121.3
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##### Shear.....Actual

Service Level	psi =	
Strength Level	psi =	45.5

Shear.....Allowable	psi =	48.3
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Anet (Masonry)	in2 =	
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Wall Weight	psf =	100.0
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Rebar Depth 'd'	in =	6.19
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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 =	2,500.0
Fy	psi =	60,000.0

**Cantilevered Retaining Wall**

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.25.02.26

CK Engineering LLC

(c) ENERCALC, LLC 1982-2025

**DESCRIPTION: 8ft Wall**

**Concrete Stem Rebar Area Details**

Bottom Stem	<u>Vertical Reinforcing</u>	<u>Horizontal Reinforcing</u>	
As (based on applied moment) :	0.384 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 :	0.384 in2/ft	#4@ 13.89 in	#4@ 27.78 in
Provided Area :	0.31 in2/ft	#5@ 21.53 in	#5@ 43.06 in
Maximum Area :	0.8382 in2/ft	#6@ 30.56 in	#6@ 61.11 in

**Footing Data**

Toe Width	=	7.25 ft
Heel Width	=	0.67
Total Footing Width	=	7.92
Footing Thickness	=	12.00 in
f'c =	2,500 psi	Fy = 60,000 psi
Footing Concrete Density	=	150.00 pcf
Min. As %	=	0.0018
Cover @ Top	2.00	@ Btm.= 3.00 in

**Footing Design Results**

		<u>Toe</u>	<u>Heel</u>	
Factored Pressure	=	1,802	0	psf
Mu' : Upward	=	17,670	0	ft-#
Mu' : Downward	=	4,731	0	ft-#
Mu: Design	=	12,940	0	ft-#
φ Mn	=	13,810	OK - Flush	
Actual 1-Way Shear	=	16.42	0.00	psi
Allow 1-Way Shear	=	45.84	52.07	psi
Toe Reinforcing	=	# 5 @ 10.00 in		
Heel Reinforcing	=	Flush heel condition. No reinforcing required.		
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: #4@ 6.82 in, #5@ 10.58 in, #6@ 15.02 in, #7@ 18 in, #8@ 18 in, #9@ 18 in, #10@ 18 in

Heel: Flush heel condition. No reinforcing required.

Key: No key defined

Min footing T&S reinf Area	2.05	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

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.25.02.26

CK Engineering LLC

(c) ENERCALC, LLC 1982-2025

**DESCRIPTION: 8ft Wall**

### Summary of Overturning & Resisting Forces & Moments

Item	.....OVERTURNING.....			.....RESISTING.....			
	Force lbs	Distance ft	Moment ft-#	Force lbs	Distance ft	Moment ft-#	
HL Act Pres (ab water tbl)	2,025.0	3.00	6,075.0	Soil Over HL (ab. water tbl)	0.0	7.92	0.2
HL Act Pres (be water tbl)				Soil Over HL (bel. water tbl)		7.92	0.2
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 =			
Seismic Earth Load =	510.3	4.50	2,296.4	Surcharge Over Toe =			
Seismic Stem Self Wt =	119.0	5.25	624.8	Stem Weight(s) =	850.0	7.58	6,445.8
				Earth @ Stem Transitions =			
<b>Total</b> =	<b>2,654.3</b>	<b>O.T.M. =</b>	<b>8,996.1</b>	Footing Weight =	1,187.5	3.96	4,700.6
				Key Weight =			
				Vert. Component =			
<b>Resisting/Overturning Ratio</b> =			<b>1.24</b>	<b>Total =</b>	<b>2,037.5 lbs</b>	<b>R.M.=</b>	<b>11,146.6</b>
Vertical Loads used for Soil Pressure =		2,726.1 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 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) 0.038 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: 24-031.ec6

LIC# : KW-06016495, Build:20.25.02.26

CK Engineering LLC

(c) ENERCALC, LLC 1982-2025

**DESCRIPTION:** 8ft Wall

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### Rebar Lap & Embedment Lengths Information

Stem Design Segment: Bottom

Stem Design Height: 0.00 ft above top of footing

Lap Splice length for #5 bar specified in this stem design segment (25.4.2.4a) =	23.40 in
Development length for #5 bar specified in this stem design segment =	18.00 in
Hooked embedment length into footing for #5 bar specified in this stem design segment =	8.27 in
As Provided =	0.3100 in <sup>2</sup> /ft
As Required =	0.3840 in <sup>2</sup> /ft

Project Title:  
Engineer:  
Project ID:  
Project Descr:

# Cantilevered Retaining Wall

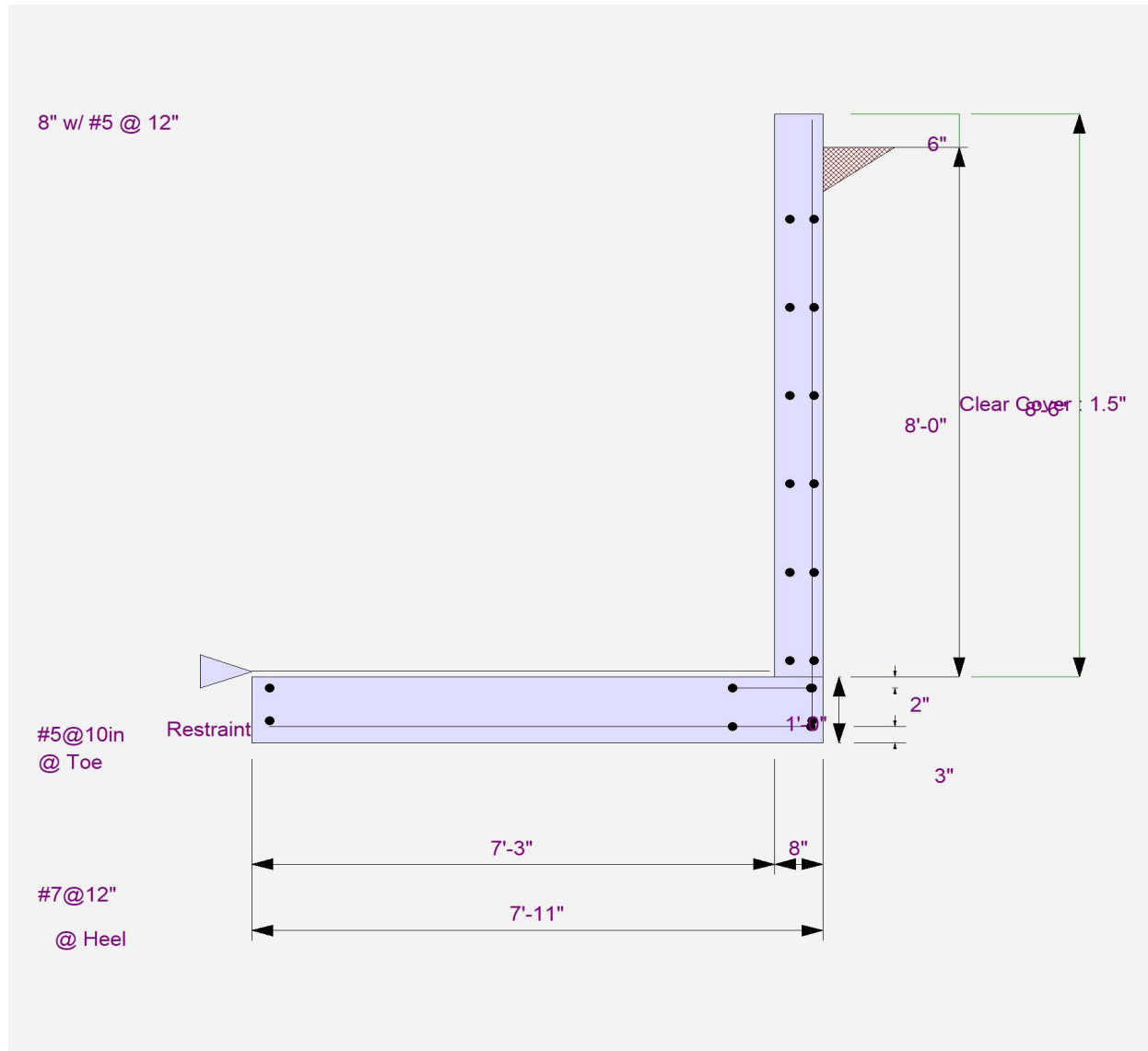
Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.25.02.26

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**DESCRIPTION:** 8ft Wall



# Cantilevered Retaining Wall

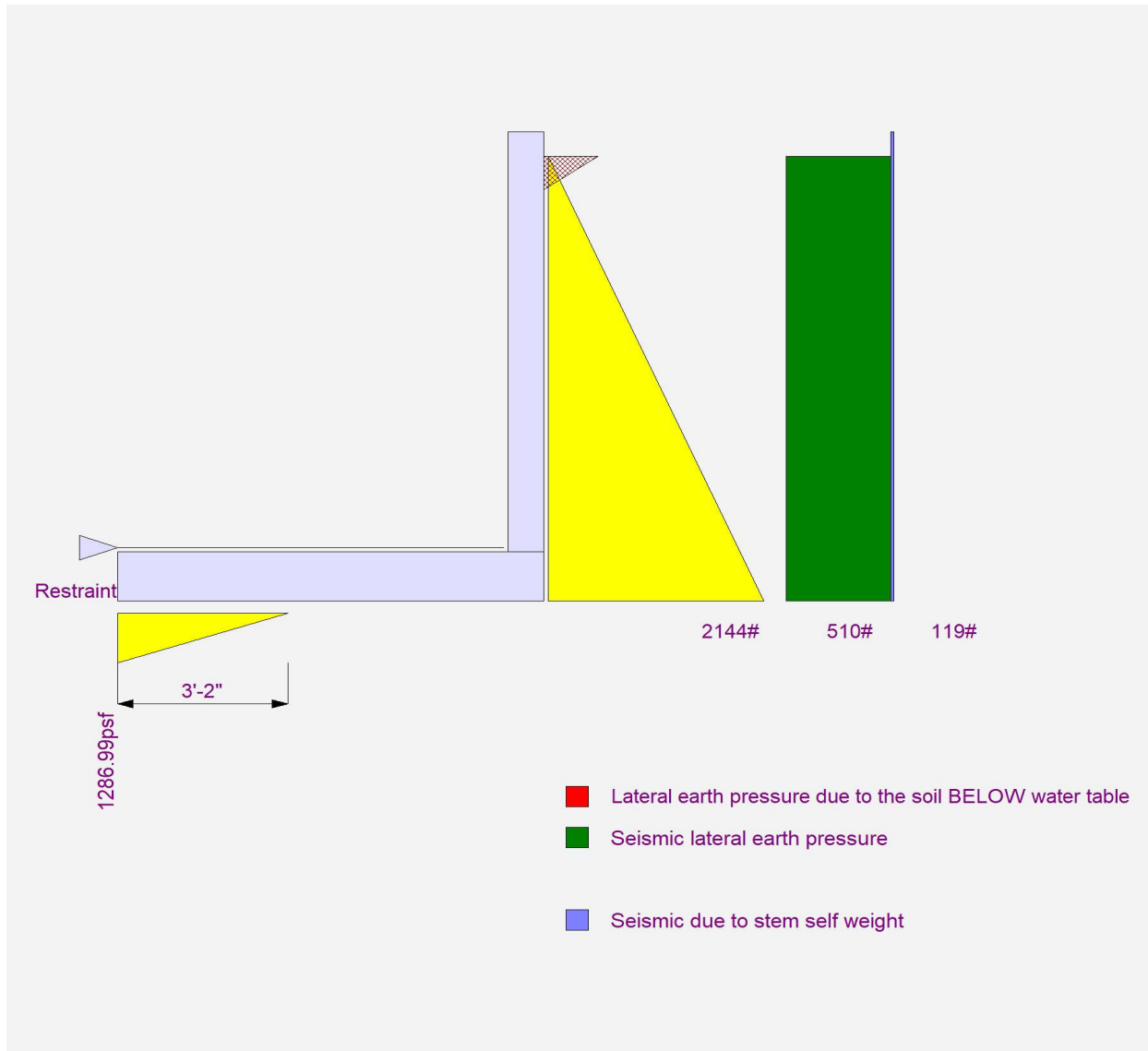
Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.25.02.26

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**DESCRIPTION:** 8ft Wall



## Cantilevered Retaining Wall

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.25.02.26

CK Engineering LLC

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**DESCRIPTION:** 9ft Wall

### Code Reference:

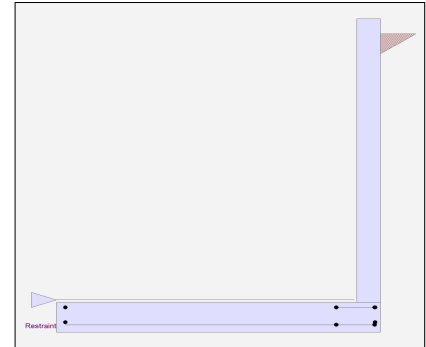
Calculations per IBC 2021, ACI 318-19, TMS 402-16

#### Criteria

Retained Height	=	9.00 ft
Wall height above soil	=	0.50 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	0.00 in
Water table above bottom of footing	=	0.0 ft

#### Soil Data

Allow Soil Bearing	=	3,500.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	50.0 psf/ft
	=	
Passive Pressure	=	350.0 psf/ft
Soil Density, Heel	=	110.0 pcf
Soil Density, Toe	=	110.0 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

#### Earth Pressure Seismic Load

Method	:	Uniform
Multiplier Used	=	9.000
(Multiplier used on soil density)		

#### Stem Weight Seismic Load

#### 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

Uniform Seismic Force	=	90.000
Total Seismic Force	=	900.000

$F_p / W_p$ Weight Multiplier	=	0.200 g	Added seismic base force	133.0 lbs
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## Cantilevered Retaining Wall

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.25.02.26

CK Engineering LLC

(c) ENERCALC, LLC 1982-2025

### DESCRIPTION: 9ft Wall

#### Design Summary

##### Wall Stability Ratios

Overturning	=	1.20	Ratio < 1.5!
Slab Resists All Sliding !			
Global Stability	=	4.04	
Total Bearing Load	=	3,175 lbs	
...resultant ecc.	=	42.38 in	
Eccentricity outside middle third			
Soil Pressure @ Toe	=	1,473 psf	OK
Soil Pressure @ Heel	=	0 psf	OK
Allowable	=	3,500 psf	
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	2,063 psf	
ACI Factored @ Heel	=	0 psf	
Footing Shear @ Toe	=	18.2 psi	OK
Footing Shear @ Heel	=	0.0 psi	OK
Allowable	=	75.0 psi	

##### Sliding Calcs

Lateral Sliding Force	=	3,263.0 lbs
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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

Wall Material Above "Ht"	=	Concrete
Design Method	=	SD
Thickness	=	8.00
Rebar Size	=	# 5
Rebar Spacing	=	8.00
Rebar Placed at	=	Edge

##### Design Data

fb/FB + fa/Fa	=	1.209
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##### Total Force @ Section

Service Level	lbs =	
Strength Level	lbs =	4,240.0

##### Moment....Actual

Service Level	ft-# =	
Strength Level	ft-# =	14,267.5

Moment.....Allowable	=	11,799.2
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##### Shear.....Actual

Service Level	psi =	
Strength Level	psi =	57.1

Shear.....Allowable	psi =	55.3
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Anet (Masonry)	in2 =	
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Wall Weight	psf =	100.0
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Rebar Depth 'd'	in =	6.19
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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 =	2,500.0
Fy	psi =	60,000.0

Project Title:  
 Engineer:  
 Project ID:  
 Project Descr:

## Cantilevered Retaining Wall

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.25.02.26

CK Engineering LLC

(c) ENERCALC, LLC 1982-2025

**DESCRIPTION:** 9ft Wall

### Concrete Stem Rebar Area Details

	<u>Vertical Reinforcing</u>	<u>Horizontal Reinforcing</u>	
Bottom Stem			
As (based on applied moment) :	0.5402 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 :	0.5402 in2/ft	#4@ 13.89 in	#4@ 27.78 in
Provided Area :	0.465 in2/ft	#5@ 21.53 in	#5@ 43.06 in
Maximum Area :	0.8382 in2/ft	#6@ 30.56 in	#6@ 61.11 in

### Footing Data

Toe Width	=	8.50 ft
Heel Width	=	0.67
Total Footing Width	=	9.17
Footing Thickness	=	12.00 in

f'c = 2,500 psi    Fy = 60,000 psi  
 Footing Concrete Density = 150.00 pcf  
 Min. As % = 0.0018  
 Cover @ Top 2.00    @ Btm = 3.00 in

### Footing Design Results

	<u>Toe</u>	<u>Heel</u>	
Factored Pressure	= 2,063	0	psf
Mu' : Upward	= 24,244	0	ft-#
Mu' : Downward	= 6,503	0	ft-#
Mu: Design	= 17,741	0	ft-#
φ Mn	= 22,203	OK - Flush	
Actual 1-Way Shear	= 18.16	0.00	psi
Allow 1-Way Shear	= 54.35	52.07	psi
Toe Reinforcing	= # 5 @ 6.00 in		
Heel Reinforcing	= Flush heel condition. No reinforcing required.		
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: #4@ 4.98 in, #5@ 7.71 in, #6@ 10.95 in, #7@ 14.94 in, #8@ 18 in, #9@ 18 in, #10@ 18 in

Heel: Flush heel condition. No reinforcing required.

Key: No key defined

Min footing T&S reinf Area            2.38    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

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.25.02.26

CK Engineering LLC

(c) ENERCALC, LLC 1982-2025

**DESCRIPTION:** 9ft Wall

### Summary of Overturning & Resisting Forces & Moments

Item	.....OVERTURNING.....			.....RESISTING.....			
	Force lbs	Distance ft	Moment ft-#	Force lbs	Distance ft	Moment ft-#	
HL Act Pres (ab water tbl)	2,500.0	3.33	8,333.3	Soil Over HL (ab. water tbl)	0.0	9.17	0.3
HL Act Pres (be water tbl)				Soil Over HL (bel. water tbl)		9.17	0.3
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 =			
Seismic Earth Load =	630.0	5.00	3,150.0	Surcharge Over Toe =			
Seismic Stem Self Wt =	133.0	5.75	764.8	Stem Weight(s) =	950.0	8.83	8,391.7
				Earth @ Stem Transitions =			
<b>Total</b> =	<b>3,263.0</b>	<b>O.T.M. =</b>	<b>12,248.1</b>	Footing Weight =	1,375.0	4.58	6,302.1
				Key Weight =			
				Vert. Component =			
<b>Resisting/Overturning Ratio</b> =			<b>1.20</b>	<b>Total =</b>	<b>2,325.0 lbs</b>	<b>R.M.=</b>	<b>14,694.1</b>
Vertical Loads used for Soil Pressure =		3,175.1 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 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) 0.042 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: 24-031.ec6

LIC# : KW-06016495, Build:20.25.02.26

CK Engineering LLC

(c) ENERCALC, LLC 1982-2025

**DESCRIPTION:** 9ft Wall

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### Rebar Lap & Embedment Lengths Information

Stem Design Segment: Bottom

Stem Design Height: 0.00 ft above top of footing

Lap Splice length for #5 bar specified in this stem design segment (25.4.2.4a) = 23.40 in

Development length for #5 bar specified in this stem design segment = 18.00 in

Hooked embedment length into footing for #5 bar specified in this stem design segment = 8.27 in

As Provided = 0.4650 in<sup>2</sup>/ft

As Required = 0.5402 in<sup>2</sup>/ft

# Cantilevered Retaining Wall

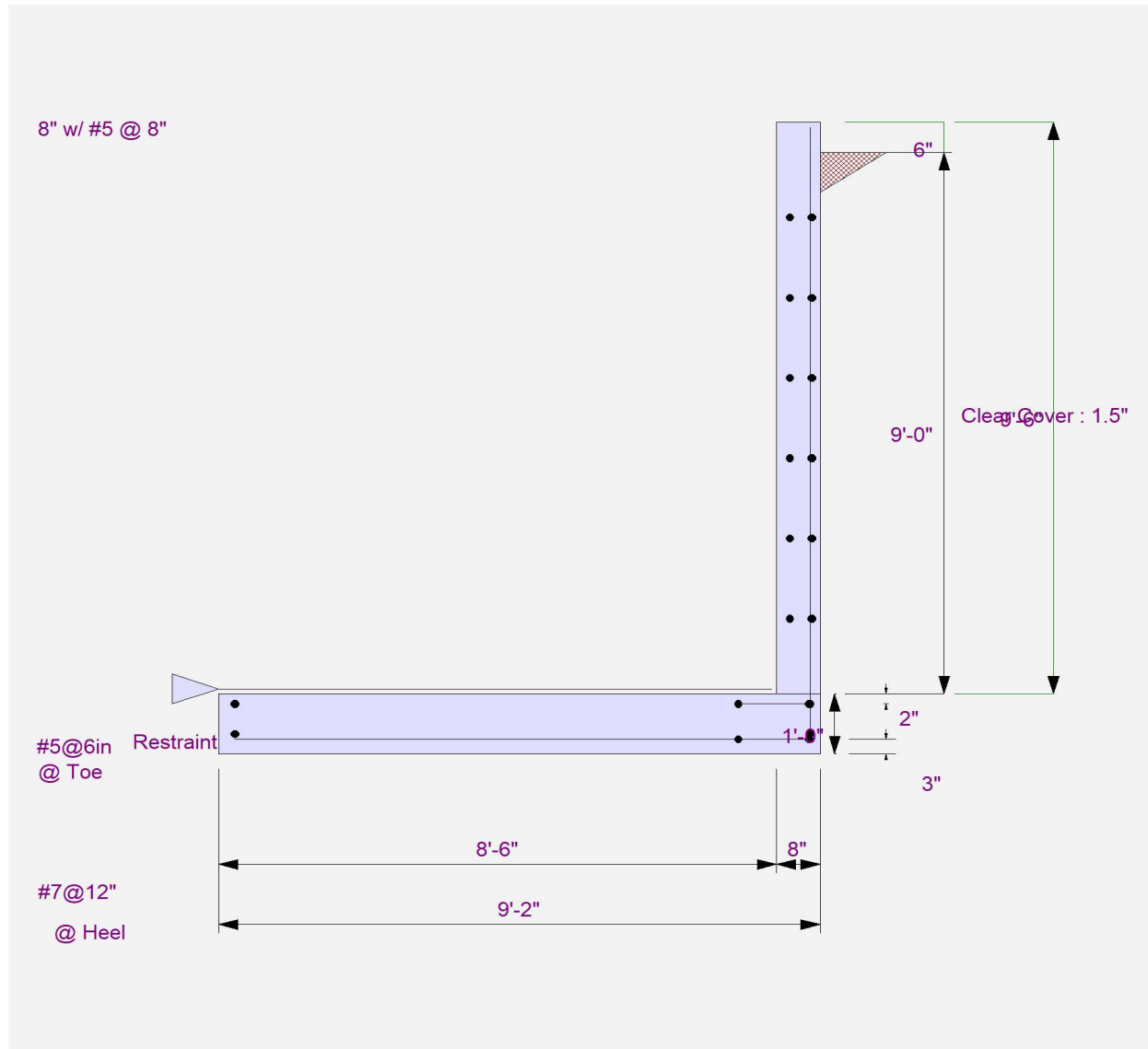
Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.25.02.26

CK Engineering LLC

(c) ENERCALC, LLC 1982-2025

**DESCRIPTION:** 9ft Wall



# Cantilevered Retaining Wall

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.25.02.26

CK Engineering LLC

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**DESCRIPTION:** 9ft Wall

