Structural Calculations For:

Arvind Residence

Site Retaining Walls

3655 73rd Avenue SE

Mercer Island, WA 98040

4-25-24

Prepared for:	SK Designs, LLC
Job #:	13271-2023-01
Date:	April 25, 2024

Project Title: Arvind Residence
Engineer: ETC/RJA
Project ID: 13271-2023-01
Project Descr: Site Retaining Walls

Cantilevered Retaining Wall

Project File: arvind.ec6

DESCRIPTION: Property Line - 6 ft

Code Reference

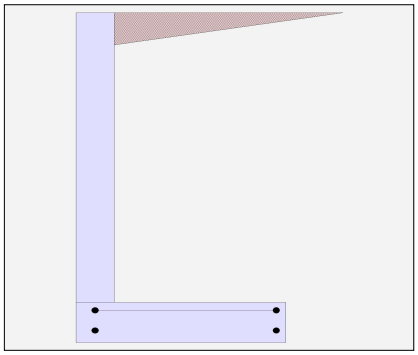
Calculations per IBC 2018 1807.3, CBC 2019, ASCE 7-16

Criteria

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

Soil Data

Allow Soil Bearing	=	2,000.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	300.0 psf/ft
Soil Density, Heel	=	125.00 pcf
Soil Density, Toe	=	125.00 pcf
Footing||Soil Friction	=	0.450
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 (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

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Design Summary

Wall Stability Ratios			
Overturning	=	3.18	OK
Sliding	=	2.05	OK
Global Stability	=	2.76	
Total Bearing Load	=	3,311 lbs	
...resultant ecc.	=	7.29 in	
Eccentricity within middle third			
Soil Pressure @ Toe	=	1,798 psf	OK
Soil Pressure @ Heel	=	6 psf	OK
Allowable	=	2,000 psf	
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	2,518 psf	
ACI Factored @ Heel	=	9 psf	
Footing Shear @ Toe	=	0.0 psi	OK
Footing Shear @ Heel	=	0.5 psi	OK
Allowable	=	75.0 psi	

Sliding Calcs

Lateral Sliding Force	=	817.2 lbs	
less 100% Passive Force	-	187.5 lbs	
less 100% Friction Force	-	1,490.1 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

		Bottom		
		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	=	Edge		
Design Data				
fb/FB + fa/Fa	=	**0.372**		
Total Force @ Section				
Service Level	lbs =			
Strength Level	lbs =	1,008.0		
Moment....Actual				
Service Level	ft-# =			
Strength Level	ft-# =	2,016.0		
Moment.....Allowable	=	5,412.6		
Shear.....Actual				
Service Level	psi =			
Strength Level	psi =	13.4		
Shear.....Allowable	psi =	75.0		
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 =	60,000.0

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Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.0755 in2/ft		
(4/3) * As :	0.1007 in2/ft	Min Stem T&S Reinf Area 1.152 in2	
200bd/fy : 200(12)(6.25)/60000 :	0.25 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in2/ft	
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :	
	==========	One layer of :	Two layers of :
Required Area :	0.1728 in2/ft	#4@ 12.50 in	#4@ 25.00 in
Provided Area :	0.2 in2/ft	#5@ 19.38 in	#5@ 38.75 in
Maximum Area :	0.8467 in2/ft	#6@ 27.50 in	#6@ 55.00 in

Footing Data

Toe Width	=	0.00 ft
Heel Width	=	3.67
Total Footing Width	=	3.67
Footing Thickness	=	10.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft

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

Footing Design Results

		Toe	Heel	
Factored Pressure	=	2,518	9	psf
Mu' : Upward	=	0	3,126	ft-#
Mu' : Downward	=	0	4,736	ft-#
Mu: Design	=	0 OK	1,610	ft-# OK
phiMn	=	19,803	10,215	ft-#
Actual 1-Way Shear	=	0.00	0.49	psi
Allow 1-Way Shear	=	0.00	75.00	psi

Toe Reinforcing = Flush toe condition. No reinforcing required.
Heel Reinforcing = # 5 @ 12.00 in
Key Reinforcing = None Spec'd
Footing Torsion, Tu = 0.00 ft-lbs
Footing Allow. Torsion, phi Tu = 0.00 ft-lbs

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

Other Acceptable Sizes & Spacings

Toe: Flush toe condition. No reinforcing required.

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

If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 11.11 in	#4@ 22.22 in
#5@ 17.22 in	#5@ 34.44 in
#6@ 24.44 in	#6@ 48.89 in

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Cantilevered Retaining Wall

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DESCRIPTION: Property Line - 6 ft

Summary of Overturning & Resisting Forces & Moments

Item	.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#	.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	817.2	2.28	1,861.3			
HL Act Pres (be water tbl)						
Hydrostatic Force						
Buoyant Force =						
Surcharge over Heel =						
Surcharge Over Toe =						
Adjacent Footing Load =						
Added Lateral Load =						
Load @ Stem Above Soil =						
=						
Soil Over HL (ab. water tbl)				2,252.5	2.17	4,884.2
Soil Over HL (bel. water tbl)					2.17	4,884.2
Watre 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 =						
Stem Weight(s) =				600.0	0.33	200.0
Earth @ Stem Transitions =						
Footing Weight =				458.8	1.84	841.8
Key Weight =						
Vert. Component =						
Total =	817.2	**O.T.M.** =	1,861.3	**Total =** 3,311.3 lbs	**R.M.=**	5,926.0

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

Resisting/Overturning Ratio = **3.18**
Vertical Loads used for Soil Pressure = 3,311.3 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)	0.082	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

DESCRIPTION: Property Line - 6 ft

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 =	18.72 in
Development length for #4 bar specified in this stem design segment =	14.40 in
Hooked embedment length into footing for #4 bar specified in this stem design segment =	7.26 in
As Provided =	0.2000 in2/ft
As Required =	0.1728 in2/ft

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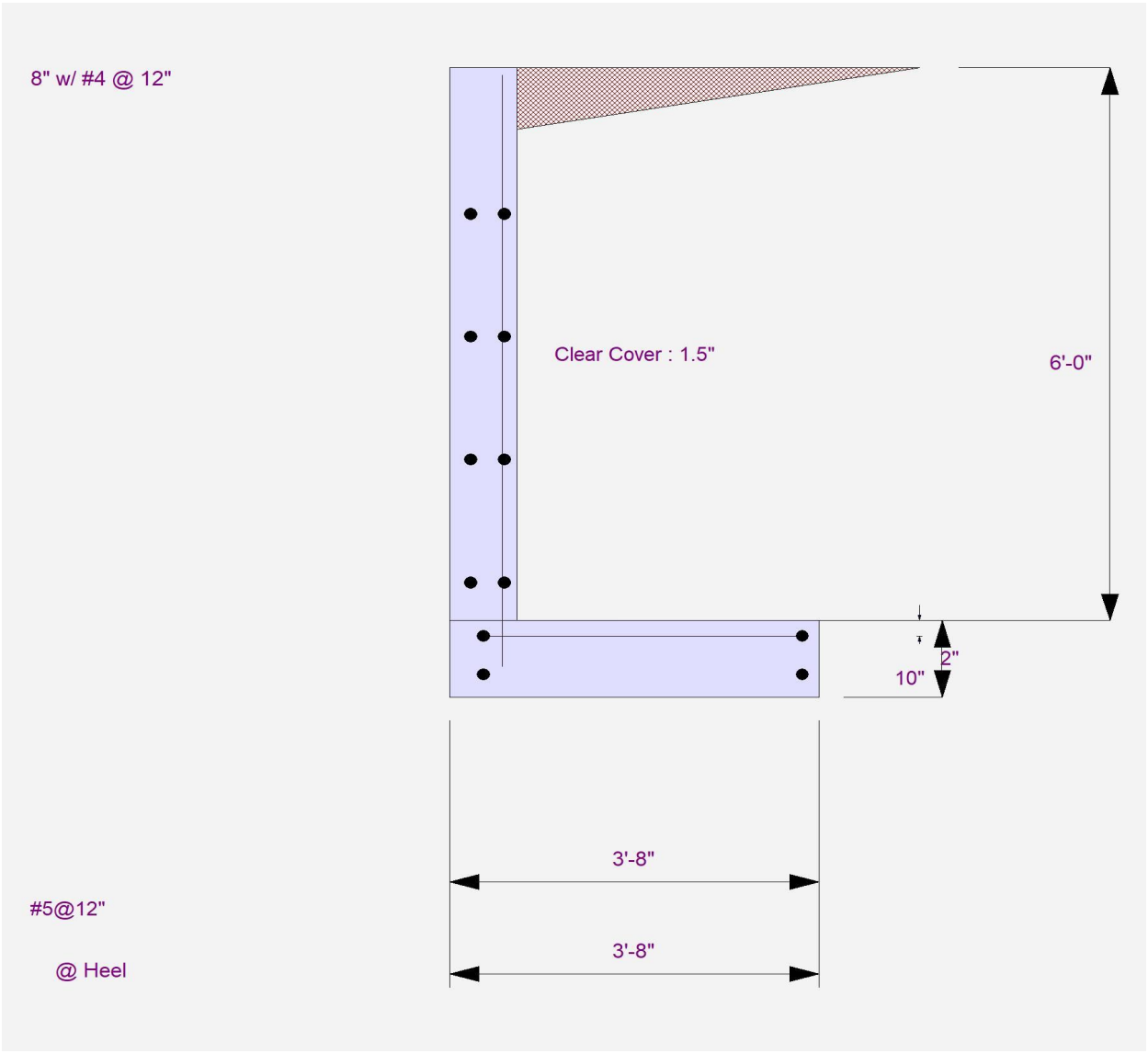

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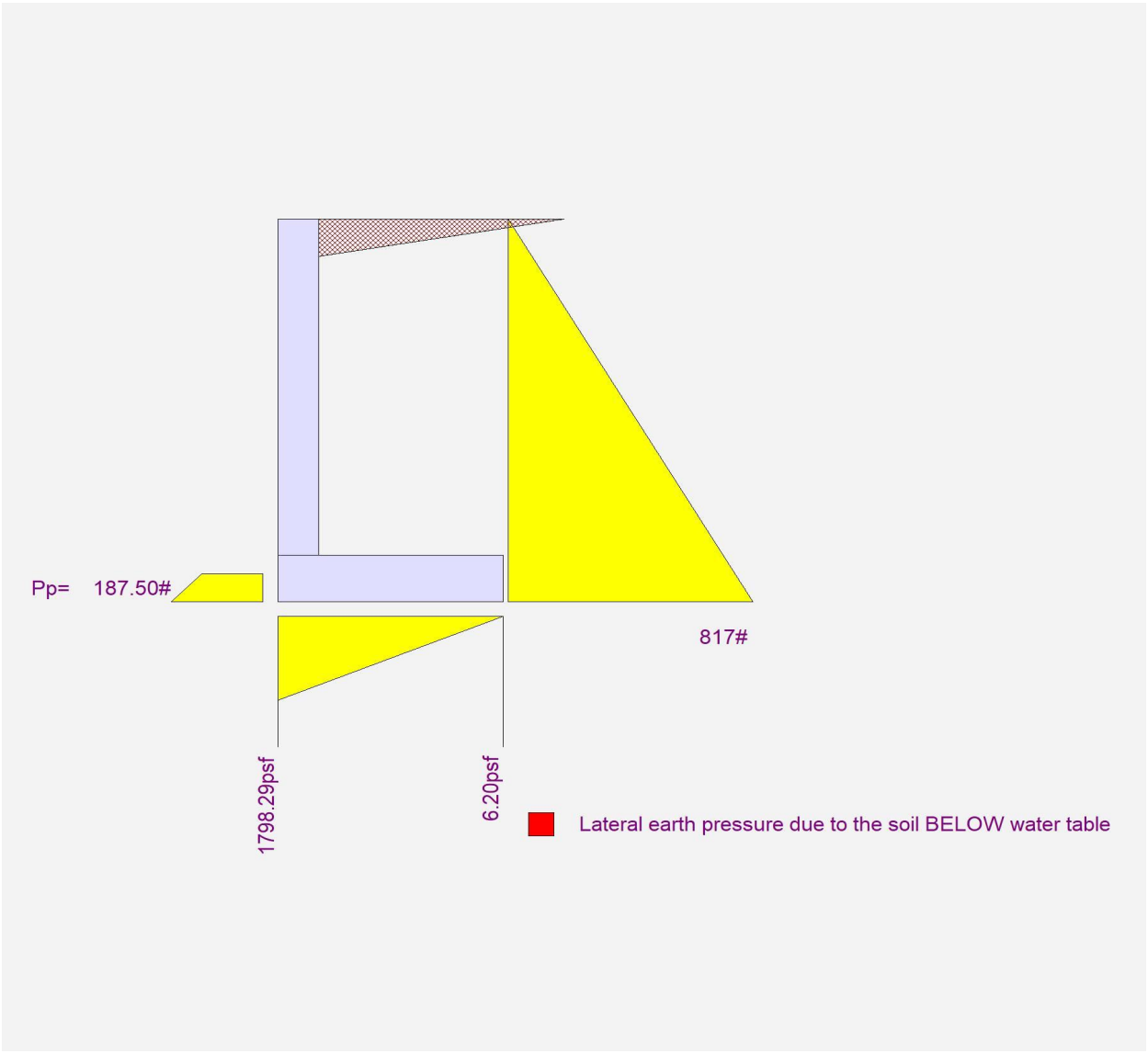
DESCRIPTION: Property Line - 6 ft



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Engineer: ETC/RJA
Project ID: 13271-2023-01
Project Descr: Site Retaining Walls

Cantilevered Retaining Wall

Project File: arvind.ec6

DESCRIPTION: Property Line - Seismic - 6 ft

Code Reference

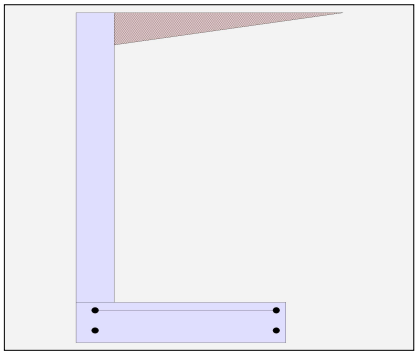
Calculations per IBC 2018 1807.3, CBC 2019, ASCE 7-16

Criteria

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

Soil Data

Allow Soil Bearing	=	2,667.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	300.0 psf/ft
Soil Density, Heel	=	125.00 pcf
Soil Density, Toe	=	125.00 pcf
Footing||Soil Friction	=	0.450
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		

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 (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

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	=	11.000
(Multiplier used on soil density)		
Uniform Seismic Force	=	75.167
Total Seismic Force	=	513.639

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DESCRIPTION: Property Line - Seismic - 6 ft

Design Summary

Wall Stability Ratios

Overturning	=	1.92	OK
Sliding	=	1.43	Ratio < 1.5!
Global Stability	=	2.53	

Total Bearing Load	=	3,311	lbs
...resultant ecc.	=	11.74	in
Eccentricity outside middle third			
Soil Pressure @ Toe	=	2,577	psf OK
Soil Pressure @ Heel	=	0	psf OK
Allowable	=	2,667	psf
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	3,608	psf
ACI Factored @ Heel	=	0	psf
Footing Shear @ Toe	=	0.0	psi OK
Footing Shear @ Heel	=	6.8	psi OK
Allowable	=	75.0	psi

Sliding Calcs

Lateral Sliding Force	=	1,176.7	lbs
less 100% Passive Force	-	187.5	lbs
less 100% Friction Force	-	1,490.1	lbs
Added Force Req'd	=	0.0	lbs OK
....for 1.5 Stability	=	87.5	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

Stem Construction

		Bottom		
		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	=	Edge		
Design Data				
fb/FB + fa/Fa	=	**0.622**		
Total Force @ Section				
Service Level	lbs =			
Strength Level	lbs =	1,459.0		
Moment....Actual				
Service Level	ft-# =			
Strength Level	ft-# =	3,369.0		
Moment.....Allowable	=	5,412.6		
Shear.....Actual				
Service Level	psi =			
Strength Level	psi =	19.5		
Shear.....Allowable	psi =	75.0		
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 =	60,000.0

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DESCRIPTION: Property Line - Seismic - 6 ft

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.1262 in2/ft		
(4/3) * As :	0.1683 in2/ft	Min Stem T&S Reinf Area 1.152 in2	
200bd/fy : 200(12)(6.25)/60000 :	0.25 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in2/ft	
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :	
	==========	One layer of :	Two layers of :
Required Area :	0.1728 in2/ft	#4@ 12.50 in	#4@ 25.00 in
Provided Area :	0.2 in2/ft	#5@ 19.38 in	#5@ 38.75 in
Maximum Area :	0.8467 in2/ft	#6@ 27.50 in	#6@ 55.00 in

Footing Data

Toe Width	=	0.00 ft
Heel Width	=	3.67
Total Footing Width	=	3.67
Footing Thickness	=	10.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft

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

Footing Design Results

		Toe		Heel	
Factored Pressure	=	3,608		0	psf
Mu' : Upward	=	0		1,613	ft-#
Mu' : Downward	=	0		4,736	ft-#
Mu: Design	=	0	OK	3,123	ft-# OK
phiMn	=	19,803		10,215	ft-#
Actual 1-Way Shear	=	0.00		6.79	psi
Allow 1-Way Shear	=	0.00		75.00	psi

Toe Reinforcing = Flush toe condition. No reinforcing required.
Heel Reinforcing = # 5 @ 12.00 in
Key Reinforcing = None Spec'd
Footing Torsion, Tu = 0.00 ft-lbs
Footing Allow. Torsion, phi Tu = 0.00 ft-lbs

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

Other Acceptable Sizes & Spacings

Toe: Flush toe condition. No reinforcing required.

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

If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 11.11 in	#4@ 22.22 in
#5@ 17.22 in	#5@ 34.44 in
#6@ 24.44 in	#6@ 48.89 in

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Cantilevered Retaining Wall

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DESCRIPTION: Property Line - Seismic - 6 ft

Summary of Overturning & Resisting Forces & Moments

Item		.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#		.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)		817.2	2.28	1,861.3	Soil Over HL (ab. water tbl)	2,252.5	2.17	4,884.2
HL Act Pres (be water tbl)					Soil Over HL (bel. water tbl)		2.17	4,884.2
Hydrostatic Force					Watre 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	=	359.5	3.42	1,228.5	Surcharge Over Toe	=		
	=				Stem Weight(s)	=	600.0	0.33	200.0
					Earth @ Stem Transitions	=			
Total	=	1,176.7	**O.T.M.** =	3,089.7	Footing Weight	=	458.8	1.84	841.8
					Key Weight	=			
					Vert. Component	=			
					Total =		3,311.3 lbs	**R.M.=**	5,926.0

Resisting/Overturning Ratio = **1.92**
Vertical Loads used for Soil Pressure = 3,311.3 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)	0.117	in

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

Cantilevered Retaining Wall

DESCRIPTION: Property Line - Seismic - 6 ft

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 =	18.72 in
Development length for #4 bar specified in this stem design segment =	14.40 in
Hooked embedment length into footing for #4 bar specified in this stem design segment =	7.26 in
As Provided =	0.2000 in2/ft
As Required =	0.1728 in2/ft

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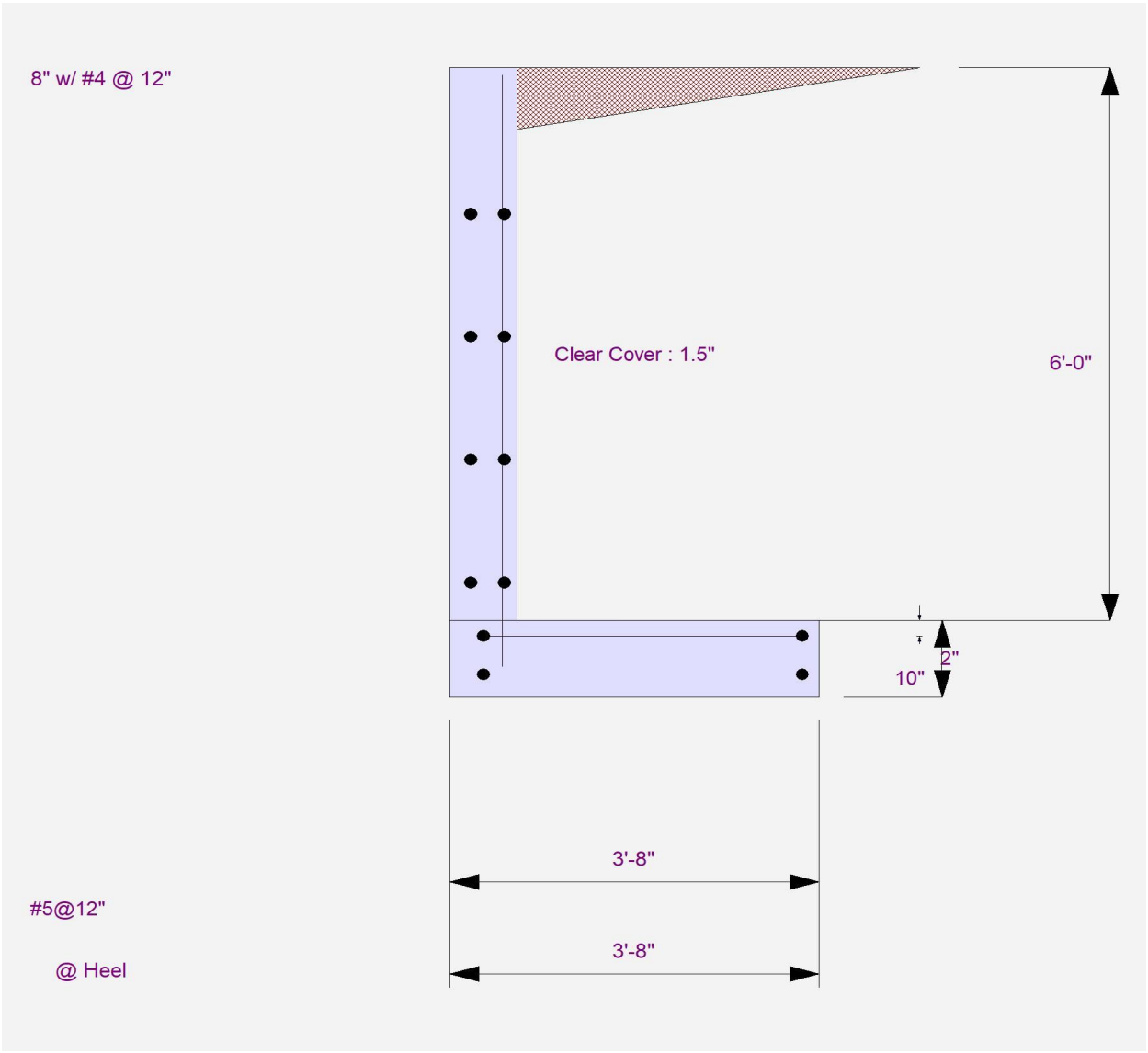

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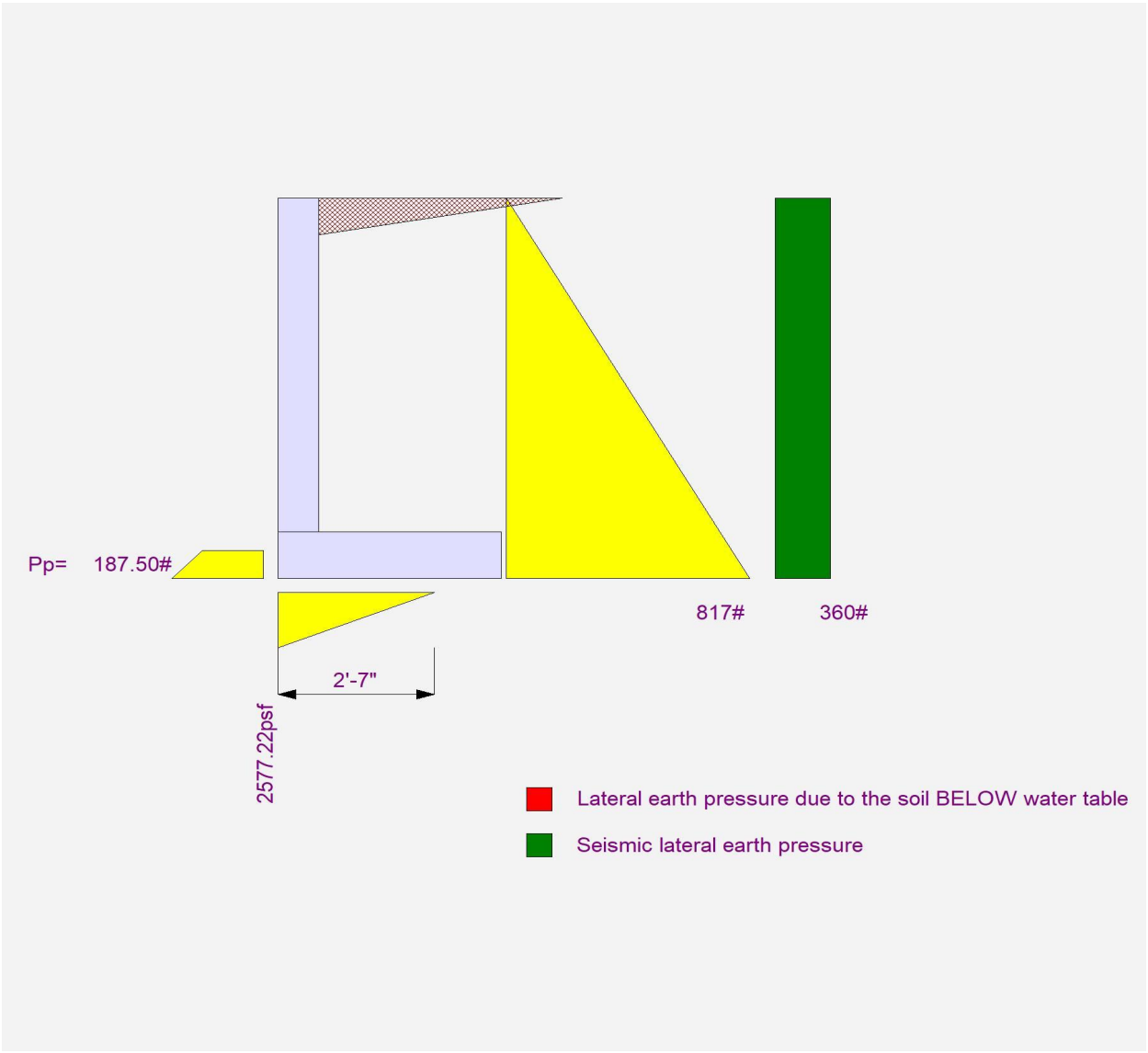

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Cantilevered Retaining Wall

Project File: arvind.ec6

DESCRIPTION: Property Line - Seismic - 4 ft

Code Reference

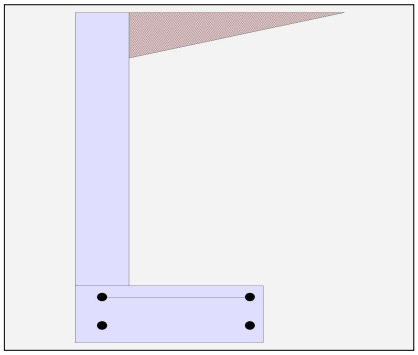
Calculations per IBC 2018 1807.3, CBC 2019, ASCE 7-16

Criteria

Retained Height	=	4.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	8.00 in
Water height over heel	=	0.0 ft

Soil Data

Allow Soil Bearing	=	2,667.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	300.0 psf/ft
Soil Density, Heel	=	125.00 pcf
Soil Density, Toe	=	125.00 pcf
Footing||Soil Friction	=	0.450
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		

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 (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

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	=	11.000
(Multiplier used on soil density)		
Uniform Seismic Force	=	53.167
Total Seismic Force	=	256.972

Project Title: Arvind Residence
Engineer: ETC/RJA
Project ID: 13271-2023-01
Project Descr: Site Retaining Walls

Cantilevered Retaining Wall

Project File: arvind.ec6

DESCRIPTION: Property Line - Seismic - 4 ft

Design Summary

Wall Stability Ratios

Overturning	=	1.57	OK
Sliding	=	1.48	Ratio < 1.5!
Global Stability	=	2.16	

Total Bearing Load	=	1,523	lbs
...resultant ecc.	=	9.05	in

Eccentricity outside middle third

Soil Pressure @ Toe	=	2,472	psf OK
Soil Pressure @ Heel	=	0	psf OK
Allowable	=	2,667	psf

Soil Pressure Less Than Allowable

ACI Factored @ Toe	=	3,461	psf
ACI Factored @ Heel	=	0	psf
Footing Shear @ Toe	=	0.0	psi OK
Footing Shear @ Heel	=	8.9	psi OK
Allowable	=	75.0	psi

Sliding Calcs

Lateral Sliding Force	=	588.7	lbs
less 100% Passive Force	-	187.5	lbs
less 100% Friction Force	-	685.3	lbs
Added Force Req'd	=	0.0	lbs OK
....for 1.5 Stability	=	10.2	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

Stem Construction

		Bottom		
		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	=	Edge		
Design Data				
fb/FB + fa/Fa	=	**0.188**		
Total Force @ Section				
Service Level	lbs =			
Strength Level	lbs =	660.7		
Moment....Actual				
Service Level	ft-# =			
Strength Level	ft-# =	1,022.7		
Moment.....Allowable	=	5,412.6		
Shear.....Actual				
Service Level	psi =			
Strength Level	psi =	8.8		
Shear.....Allowable	psi =	75.0		
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 =	60,000.0

Project Title: Arvind Residence
Engineer: ETC/RJA
Project ID: 13271-2023-01
Project Descr: Site Retaining Walls

Cantilevered Retaining Wall

Project File: arvind.ec6

DESCRIPTION: Property Line - Seismic - 4 ft

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.0383 in2/ft		
(4/3) * As :	0.0511 in2/ft	Min Stem T&S Reinf Area 0.768 in2	
200bd/fy : 200(12)(6.25)/60000 :	0.25 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in2/ft	
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :	
	==========	One layer of :	Two layers of :
Required Area :	0.1728 in2/ft	#4@ 12.50 in	#4@ 25.00 in
Provided Area :	0.2 in2/ft	#5@ 19.38 in	#5@ 38.75 in
Maximum Area :	0.8467 in2/ft	#6@ 27.50 in	#6@ 55.00 in

Footing Data

Toe Width	=	0.00 ft
Heel Width	=	2.33
Total Footing Width	=	2.33
Footing Thickness	=	10.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft

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

Footing Design Results

		Toe	Heel	
Factored Pressure	=	3,461	0	psf
Mu' : Upward	=	0	85	ft-#
Mu' : Downward	=	0	1,038	ft-#
Mu: Design	=	0 OK	953	ft-# OK
phiMn	=	19,803	10,215	ft-#
Actual 1-Way Shear	=	0.00	8.87	psi
Allow 1-Way Shear	=	0.00	75.00	psi

Toe Reinforcing = Flush toe condition. No reinforcing required.
Heel Reinforcing = # 5 @ 12.00 in
Key Reinforcing = None Spec'd
Footing Torsion, Tu = 0.00 ft-lbs
Footing Allow. Torsion, phi Tu = 0.00 ft-lbs

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

Other Acceptable Sizes & Spacings

Toe: Flush toe condition. No reinforcing required.

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

If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 11.11 in	#4@ 22.22 in
#5@ 17.22 in	#5@ 34.44 in
#6@ 24.44 in	#6@ 48.89 in

Project Title: Arvind Residence
Engineer: ETC/RJA
Project ID: 13271-2023-01
Project Descr: Site Retaining Walls

Cantilevered Retaining Wall

Project File: arvind.ec6

DESCRIPTION: Property Line - Seismic - 4 ft

Summary of Overturning & Resisting Forces & Moments

Item		.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#		.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)		408.8	1.61	658.7	Soil Over HL (ab. water tbl)	831.7	1.50	1,246.1
HL Act Pres (be water tbl)					Soil Over HL (bel. water tbl)		1.50	1,246.1
Hydrostatic Force					Watre 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	=	179.9	2.42	434.7	Surcharge Over Toe	=		
	=				Stem Weight(s)	=	400.0	0.33	133.3
					Earth @ Stem Transitions	=			
Total	=	588.7	**O.T.M.** =	1,093.4	Footing Weight	=	291.3	1.17	339.3
					Key Weight	=			
					Vert. Component	=			
					Total =		1,522.9 lbs	**R.M.=**	1,718.8

Resisting/Overturning Ratio = **1.57**

Vertical Loads used for Soil Pressure = 1,522.9 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)	0.118	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

DESCRIPTION: Property Line - Seismic - 4 ft

Rebar Lap & Embedment Lengths Information

Stem Design Segment: Bottom

Stem Design Height: 0.00 ft above top of footing

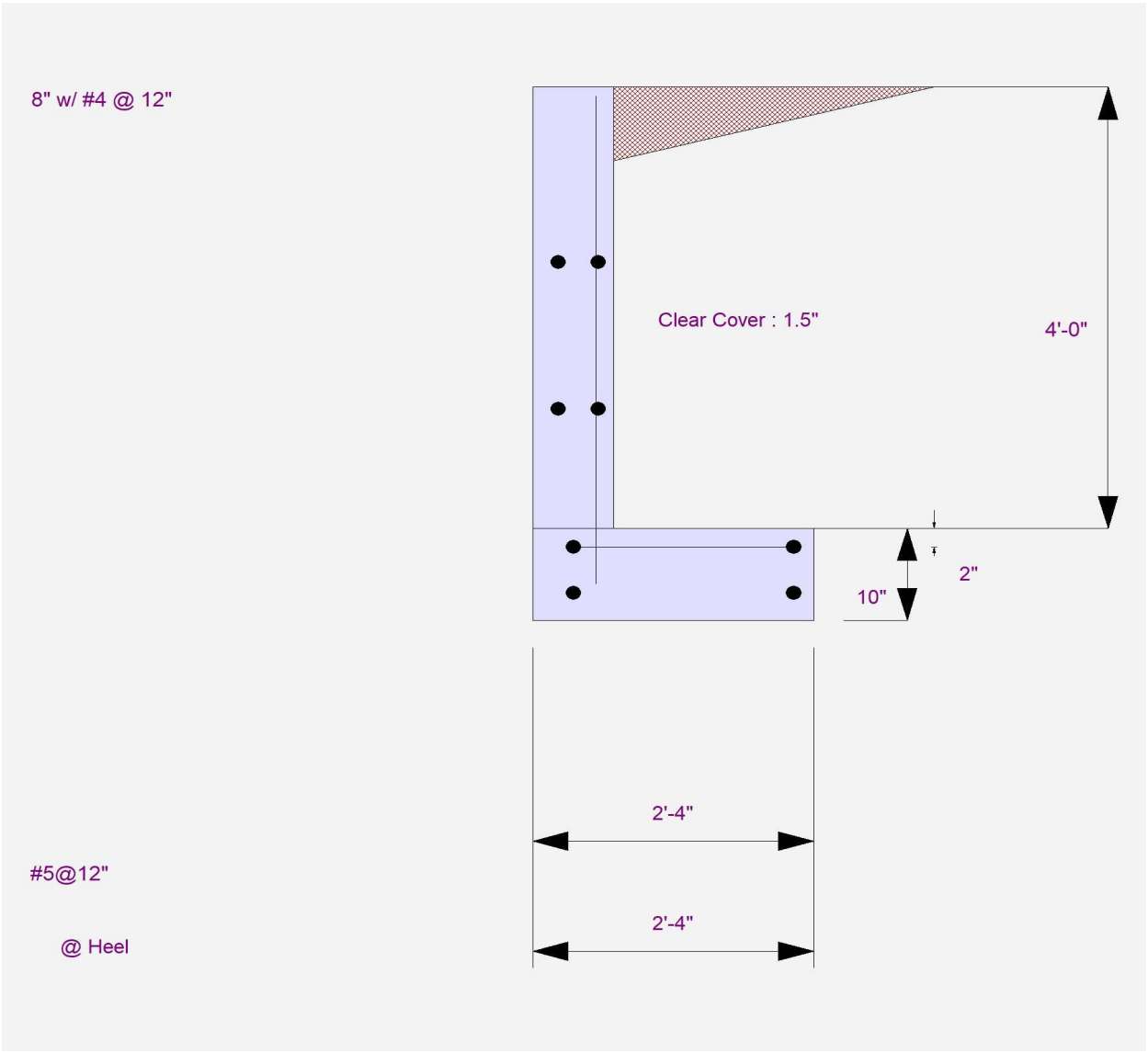
Lap Splice length for #4 bar specified in this stem design segment =	18.72 in
Development length for #4 bar specified in this stem design segment =	14.40 in
Hooked embedment length into footing for #4 bar specified in this stem design segment =	7.26 in
As Provided =	0.2000 in2/ft
As Required =	0.1728 in2/ft

Project Title: Arvind Residence
Engineer: ETC/RJA
Project ID: 13271-2023-01
Project Descr: Site Retaining Walls

Cantilevered Retaining Wall

Project File: arvind.ec6

DESCRIPTION: Property Line - Seismic - 4 ft

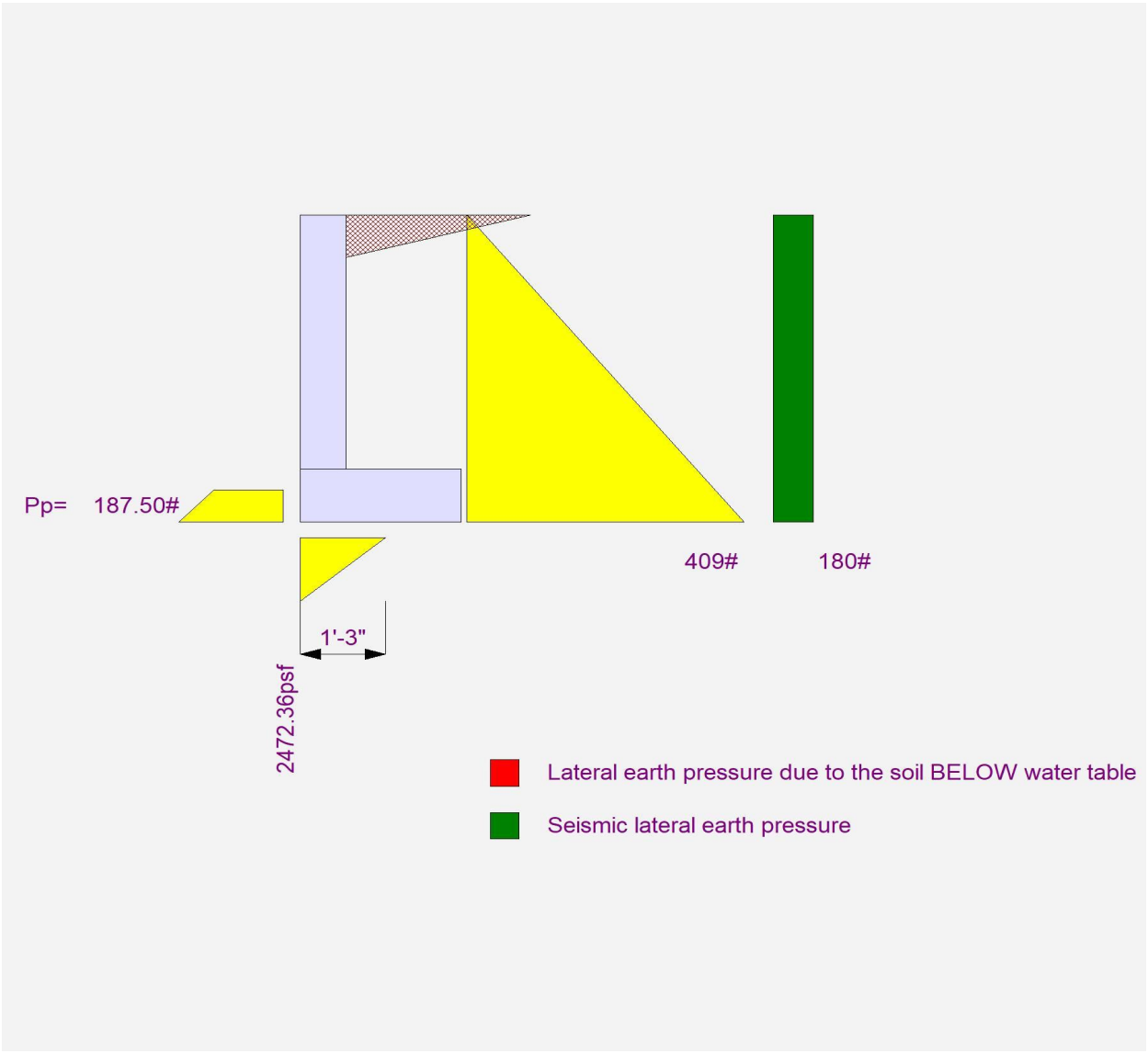


Project Title: Arvind Residence
Engineer: ETC/RJA
Project ID: 13271-2023-01
Project Descr: Site Retaining Walls

Cantilevered Retaining Wall

Project File: arvind.ec6

DESCRIPTION: Property Line - Seismic - 4 ft



Project Title: Arvind Residence
Engineer: ETC/RJA
Project ID: 13271-2023-01
Project Descr: Site Retaining Walls

Cantilevered Retaining Wall

Project File: arvind.ec6

DESCRIPTION: Property Line - 4 ft

Code Reference

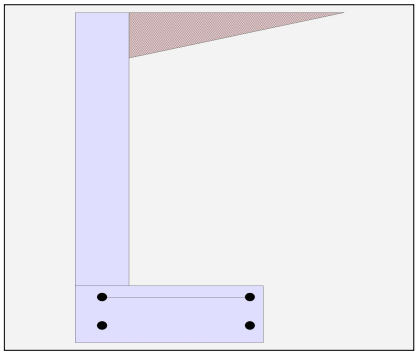
Calculations per IBC 2018 1807.3, CBC 2019, ASCE 7-16

Criteria

Retained Height	=	4.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	8.00 in
Water height over heel	=	0.0 ft

Soil Data

Allow Soil Bearing	=	2,667.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	300.0 psf/ft
Soil Density, Heel	=	125.00 pcf
Soil Density, Toe	=	125.00 pcf
Footing||Soil Friction	=	0.450
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 (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

Project Title: Arvind Residence
Engineer: ETC/RJA
Project ID: 13271-2023-01
Project Descr: Site Retaining Walls

Cantilevered Retaining Wall

Project File: arvind.ec6

DESCRIPTION: Property Line - 4 ft

Design Summary

Wall Stability Ratios

Overturning	=	2.61	OK
Sliding	=	2.13	OK
Global Stability	=	2.97	

Total Bearing Load	=	1,523	lbs
...resultant ecc.	=	5.63	in
Eccentricity outside middle third			
Soil Pressure @ Toe	=	1,459	psf OK
Soil Pressure @ Heel	=	0	psf OK
Allowable	=	2,667	psf
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	2,042	psf
ACI Factored @ Heel	=	0	psf
Footing Shear @ Toe	=	0.0	psi OK
Footing Shear @ Heel	=	2.9	psi OK
Allowable	=	75.0	psi

Sliding Calcs

Lateral Sliding Force	=	408.8	lbs
less 100% Passive Force	-	187.5	lbs
less 100% Friction Force	-	685.3	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

		Bottom		
		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	=	Edge		
Design Data				
fb/FB + fa/Fa	=	**0.110**		
Total Force @ Section				
Service Level	lbs =			
Strength Level	lbs =	448.0		
Moment....Actual				
Service Level	ft-# =			
Strength Level	ft-# =	597.3		
Moment.....Allowable	=	5,412.6		
Shear.....Actual				
Service Level	psi =			
Strength Level	psi =	6.0		
Shear.....Allowable	psi =	75.0		
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 =	60,000.0

Project Title: Arvind Residence
Engineer: ETC/RJA
Project ID: 13271-2023-01
Project Descr: Site Retaining Walls

Cantilevered Retaining Wall

Project File: arvind.ec6

DESCRIPTION: Property Line - 4 ft

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.0224 in2/ft		
(4/3) * As :	0.0298 in2/ft	Min Stem T&S Reinf Area 0.768 in2	
200bd/fy : 200(12)(6.25)/60000 :	0.25 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in2/ft	
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :	
	==========	One layer of :	Two layers of :
Required Area :	0.1728 in2/ft	#4@ 12.50 in	#4@ 25.00 in
Provided Area :	0.2 in2/ft	#5@ 19.38 in	#5@ 38.75 in
Maximum Area :	0.8467 in2/ft	#6@ 27.50 in	#6@ 55.00 in

Footing Data

Toe Width	=	0.00 ft
Heel Width	=	2.33
Total Footing Width	=	2.33
Footing Thickness	=	10.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft

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

Footing Design Results

		Toe	Heel	
Factored Pressure	=	2,042	0	psf
Mu' : Upward	=	0	468	ft-#
Mu' : Downward	=	0	1,038	ft-#
Mu: Design	=	0 OK	569	ft-# OK
phiMn	=	19,803	10,215	ft-#
Actual 1-Way Shear	=	0.00	2.88	psi
Allow 1-Way Shear	=	0.00	75.00	psi

Toe Reinforcing = Flush toe condition. No reinforcing required.
Heel Reinforcing = # 5 @ 12.00 in
Key Reinforcing = None Spec'd
Footing Torsion, Tu = 0.00 ft-lbs
Footing Allow. Torsion, phi Tu = 0.00 ft-lbs

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

Other Acceptable Sizes & Spacings

Toe: Flush toe condition. No reinforcing required.

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

If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 11.11 in	#4@ 22.22 in
#5@ 17.22 in	#5@ 34.44 in
#6@ 24.44 in	#6@ 48.89 in

Project Title: Arvind Residence
Engineer: ETC/RJA
Project ID: 13271-2023-01
Project Descr: Site Retaining Walls

Cantilevered Retaining Wall

Project File: arvind.ec6

DESCRIPTION: Property Line - 4 ft

Summary of Overturning & Resisting Forces & Moments

Item	.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#	.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	408.8	1.61	658.7			
HL Act Pres (be water tbl)						
Hydrostatic Force						
Buoyant Force =						
Surcharge over Heel =						
Surcharge Over Toe =						
Adjacent Footing Load =						
Added Lateral Load =						
Load @ Stem Above Soil =						
=						
				Soil Over HL (ab. water tbl)	831.7	1.50	1,246.1
				Soil Over HL (bel. water tbl)		1.50	1,246.1
				Watre 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 =			
				Stem Weight(s) =	400.0	0.33	133.3
				Earth @ Stem Transitions =			
				Footing Weight =	291.3	1.17	339.3
				Key Weight =			
				Vert. Component =			
Total =	408.8	**O.T.M.** =	658.7	**Total =**	1,522.9 lbs	**R.M.=**	1,718.8

Resisting/Overturning Ratio = **2.61**

Vertical Loads used for Soil Pressure = 1,522.9 lbs

* 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 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)	0.070	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.

Cantilevered Retaining Wall

DESCRIPTION: Property Line - 4 ft

Rebar Lap & Embedment Lengths Information

Stem Design Segment: Bottom
Stem Design Height: 0.00 ft above top of footing

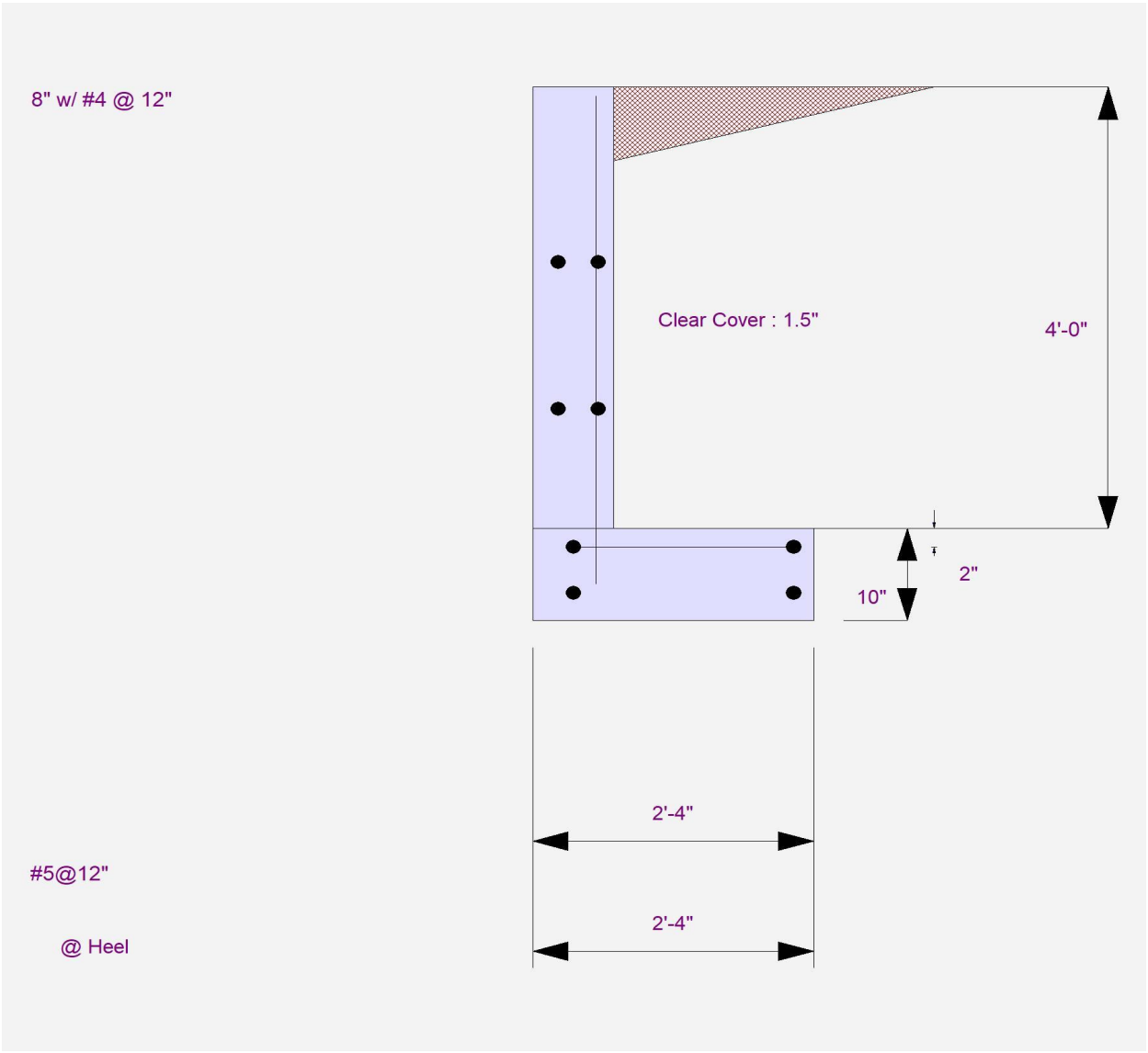
Lap Splice length for #4 bar specified in this stem design segment =	18.72 in
Development length for #4 bar specified in this stem design segment =	14.40 in
Hooked embedment length into footing for #4 bar specified in this stem design segment =	7.26 in
As Provided =	0.2000 in2/ft
As Required =	0.1728 in2/ft

Project Title: Arvind Residence
Engineer: ETC/RJA
Project ID: 13271-2023-01
Project Descr: Site Retaining Walls

Cantilevered Retaining Wall

Project File: arvind.ec6

DESCRIPTION: Property Line - 4 ft



Project Title: Arvind Residence
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Project ID: 13271-2023-01
Project Descr: Site Retaining Walls

Cantilevered Retaining Wall

Project File: arvind.ec6

DESCRIPTION: Property Line - 4 ft