NLMUSD Modernization Project for

La Mirada High School New Football Stadium Project Existing Retaining Walls

DSA #03-120586

Existing Retaining Wall

Prepared By:

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EST. 1945

November 23, 2020

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STATE OF CALIFORNIA

11/23/2020

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A. Basis of Design

SCOPE OF WORK:

The existing ramp and retaining walls were constructed without DSA approval. This project serves the purpose of obtaining DSA certification for the existing walls, as well as rehabilitating them to meet current ADA requirements. The calculations provided check the existing walls for current Code requirements.

See DSA approved 03-120586_REH Report_A rehabilitation report and the materials testing results provided.

BASIS OF DESIGN:

DESIGN CODE: STRUCTURAL DESIGN IS BASED UPON THE 2019 CALIFORNIA BUILDING CODE

DESIGN LIVE LOADS:

AREA	BASIC LIVE LOADS	COMMENTS
RAMP	100 PSF	UNREDUCIBLE

DESIGN LOAD BEARING VALUES OF SOILS

ALLOWABLE SOIL BEARING:	2000 PSF (DL+LL) BEARING ON COMPACTED OR ENGINEERED FILL. AN ADDITIONAL ONE-THIRD INCREASE IS PERMITTED FOR WIND OR SEISMIC EFFECTS.
ALLOWABLE COEFFICIENT OF FRICTION: INCREASE IS PERMITTED FOR WIND OR	0.3 AT FOUNDATIONS WITH DEAD LOAD FORCES ONLY, NO SEISMIC EFFECTS.
ALLOWABLE PASSIVE SOIL PRESSURE:	150 PSF/FT OF DEPTH ON THE SIDES OF FOUNDATIONS POURED AGAINST COMPACTED FILL. A ONE-THIRD INCREASE IS PERMITTED FOR WIND AND SEISMIC EFFECTS. (MAXIMUM 1,500 PSF)
LATERAL RESISTANCE:	PROVIDED BY FRICTION AND 80% PASSIVE EARTH PRESSURE, WHEN COMBINED REDUCE THE PASSIVE COMPONENT BY ONE-THIRD.
CANTILEVER RETAINING WALL DESIGN EQUIVALENT FLUID PRESSURE:	40 PSF/FT OF DEPTH - ACTIVE PRESSURE FOR LEVEL SOIL TRIANGULAR PRESSURE DISTRIBUTION. AN ADDITIONAL EQUIVALENT FLUID PRESSURE OF ONE (1) POUND PER CUBIC FOOT FOR EVERY TWO (2) DEGREES OF SLOPE INCLINATION. WALLS TALLER THAN 6 FEET SHOULD BE DESIGNED TO RESIST ADDITIONAL EARTH PRESSURE 25H.
RESTRAINED WALL DESIGN EQUIVALENT FLUID PRESSURE:	60 PSF / FT OF DEPTH. ACTIVE PRESSURE FOR SOIL (TRANGULAR PRESSURE DISTRUBUTION) AN ADDITIONAL EQUIVALENT FLUID PRESSURE OF ONE (1) POUND PER CUBIC FOOT FOR EVERY TWO (2) DEGREES OF SLOPE INCLINATION. WALLS TALLER THAN 6 FEET SHOULD BE DESIGNED TO RESIST ADDITIONAL EARTH PRESSURE 25H.

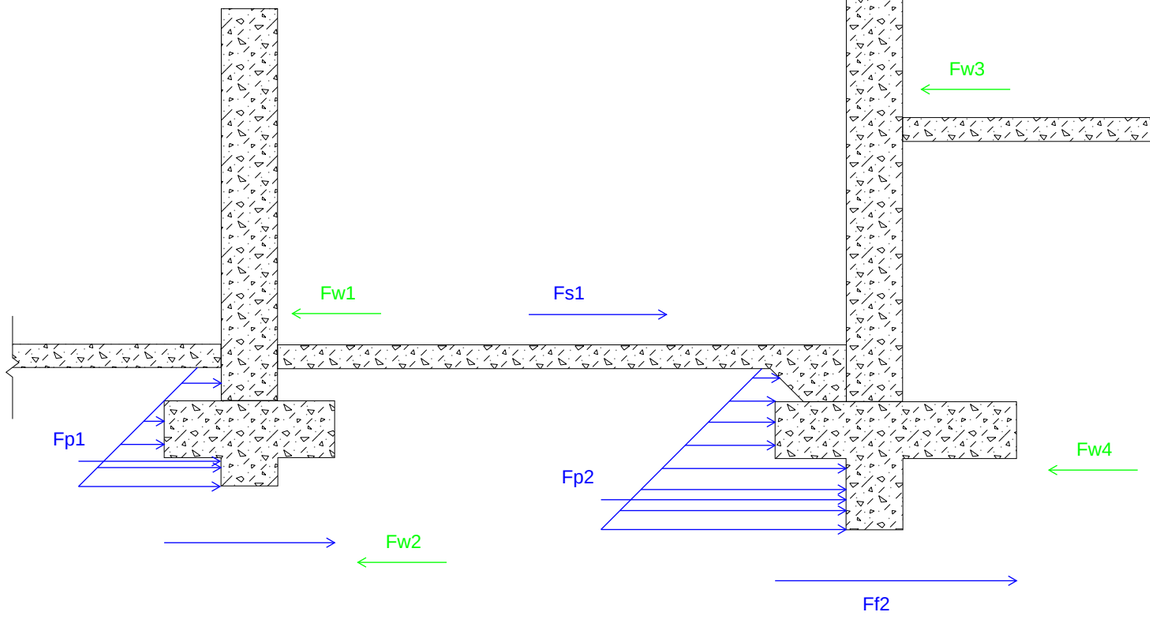
B. Sliding Calculations

Cantilevered & Restrained Case

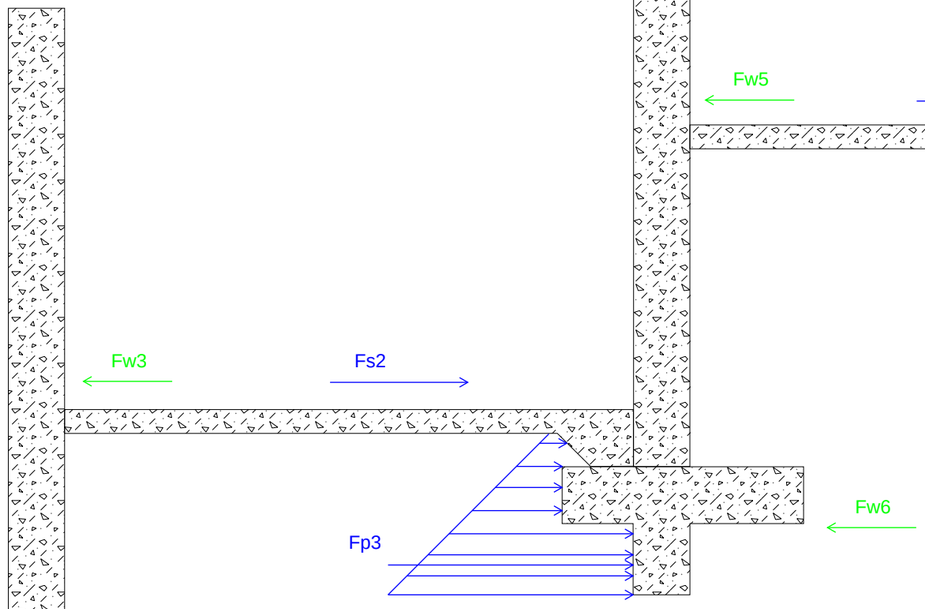
Restrained Case Only

RETAINING WALL SCHEDULE OF DIMENSIONS AND REINFORCEMENT				
DESIGN HEIGHT, H	4'-0"	6'-0"	8'-0"	9'-9"
FOOTING WIDTH, W	3'-0"	4'-3"	5'-6"	6'-9"
FOOTING TOE, C	1'-0"	1'-3"	1'-9"	2'-3"
FOOTING DEPTH, D	1'-2"	1'-2"	1'-2"	1'-4"
BAR 'A'	#5@18"	#5@18"	#5@18"	#5@18"
BAR 'B'	NONE	NONE	#5@18"	#7@18"
BAR 'F'	#5@18"	#5@18"	#7@9"	#7@9"
DIMENSION "L"	-	-	3'-6"	4'-0"
FOOTING KEY, Z	6"	1'-3"	1'-3"	1'-6"

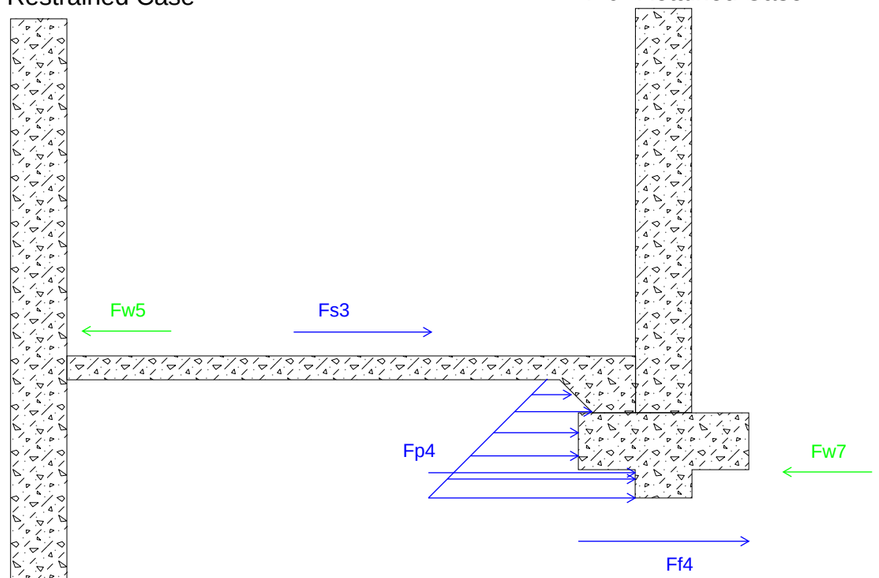
4'-0" Restrained Case



9'-9" Restrained Case

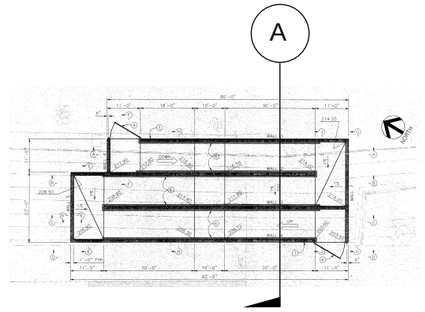


6'-0" Restrained Case



4'-0" Retained Case

SECTION A



KEY PLAN

F — Applied Force

F — Resisting Force

DRAWING TITLE: **Wall Forces Sketch**

DATE: **11/10/2020**

REFERENCE DRAWING NO.:

SCALE: **NOT TO SCALE**

PROJECT: **LMHS Existing Retaining Walls (Worst Case Condition for Sliding)**

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4'-0" Restrained Wall	
Lateral Earth Pressure	60 psf/ft
H	4.00 ft
Footing Thickness	1.167 ft
R	801 lbs/ft
H/3	1.72 ft
2H/3	3.44 ft
Fw1, Top reaction	**267 lbs/ft**
Fw2, Bottom reaction	**534 lbs/ft**
Seismic	20 psf/ft
H	4.00 ft
Footing Thickness	1.17 ft
R	267 lbs/ft
H/3	1.72 ft
2H/3	3.44 ft
Top reaction (Strength)	88.98 lbs/ft
Bottom reaction (Strength)	177.96 lbs/ft
Top reaction (Service)	62.29 lbs/ft
Bottom reaction (Service)	124.57 lbs/ft

9'-9" Restrained Wall	
Lateral Earth Pressure	60 psf/ft
H	9.75 ft
Footing Thickness	1.33 ft
R	3685 lbs/ft
H/3	3.69 ft
2H/3	7.39 ft
Fw3, Top reaction	**1228 lbs/ft**
Fw4, Bottom reaction	**2457 lbs/ft**
Seismic	20 psf/ft
H	9.75 ft
Footing Thickness	1.33 ft
R	1228 lbs/ft
H/3	3.69 ft
2H/3	7.39 ft
Top reaction (Strength)	409.47 lbs/ft
Bottom reaction (Strength)	818.94 lbs/ft
Top reaction (Service)	286.63 lbs/ft
Bottom reaction (Service)	573.25 lbs/ft

6'-0" Restrained Wall	
Lateral Earth Pressure	60 psf/ft
H	6.00 ft
Footing Thickness	1.167 ft
R	1541 lbs/ft
H/3	2.39 ft
2H/3	4.78 ft
Fw5, Top reaction	**514 lbs/ft**
Fw6, Bottom reaction	**1027 lbs/ft**
Seismic	20 psf/ft
H	6.00 ft
Footing Thickness	1.17 ft
R	514 lbs/ft
H/3	2.39 ft
2H/3	4.78 ft
Top reaction (Strength)	171.20 lbs/ft
Bottom reaction (Strength)	342.41 lbs/ft
Top reaction (Service)	119.84 lbs/ft
Bottom reaction (Service)	239.69 lbs/ft

4'-0" Cantilevered Wall	
Lateral Earth Pressure	40 psf/ft
H	4.00 ft
Footing Thickness	1.167 ft
R	534 lbs/ft
Fw7, Bottom reaction	**534 lbs/ft**
Seismic	20 psf/ft
H	4.00 ft
Footing Thickness	1.17 ft
R	267 lbs/ft
H/3	1.72 ft
2H/3	3.44 ft
Bottom reaction (Strength)	266.94 lbs/ft
Bottom reaction (Service)	186.86 lbs/ft

Passive Resistance Force	
Passive Resistance	150 psf/ft
Soil Height Above Ftg.	1.00 ft
Footing Thickness	1.17 ft
Key depth	0.50 ft
Fp1	**533 lbs/ft**

Passive Resistance Force	
Passive Resistance	150 psf/ft
Soil Height Above Ftg.	1.00 ft
Footing Thickness	1.33 ft
Key depth	1.50 ft
Fp2	**1102 lbs/ft**

Passive Resistance Force	
Passive Resistance	150 psf/ft
Soil Height Above Ftg.	1.00 ft
Footing Thickness	1.17 ft
Key depth	1.25 ft
Fp3	**876 lbs/ft**

Passive Resistance Force	
Passive Resistance	150 psf/ft
Soil Height Above Ftg.	1.00 ft
Footing Thickness	1.17 ft
Key depth	0.50 ft
Fp1	**533 lbs/ft**

-See next page for summary of forces and sliding calculations

Footing Forces Summary

Resisting Forces

Slab Friction Force, Fsi

Fs1	188 lbs/ft	5" thick slab, 10' long
Fs2	188 lbs/ft	5" thick slab, 10' long
Fs3	188 lbs/ft	5" thick slab, 10' long

Footing Friction, Ffi

Ff1	735 lbs/ft	(From RetainPro)
Ff2	2397 lbs/ft	(From RetainPro)
Ff3	1227 lbs/ft	(From RetainPro)
Ff4	672 lbs/ft	(From RetainPro)

Passive Force, Fpi

Fp1	533 lbs/ft	See "Lateral and Passive Force Calculations"
Fp2	1102 lbs/ft	See "Lateral and Passive Force Calculations"
Fp3	876 lbs/ft	See "Lateral and Passive Force Calculations"
Fp4	533 lbs/ft	See "Lateral and Passive Force Calculations"

Total Resisting Force **8638 lbs/ft**

Applied Later Force

Fw1	0 lbs/ft	Retained soil negligible
Fw2	0 lbs/ft	Retained soil negligible
Fw3	1228 lbs/ft	See "Lateral and Passive Force Calculations"
Fw4	2457 lbs/ft	See "Lateral and Passive Force Calculations"
Fw5	514 lbs/ft	See "Lateral and Passive Force Calculations"
Fw6	1027 lbs/ft	See "Lateral and Passive Force Calculations"
Fw7	534 lbs/ft	See "Lateral and Passive Force Calculations"

Total Applied Lateral Force **5760 lbs/ft**

FS **1.500** >= 1.5 (OK)

Note:

See Wall Forces Sketch on Page 6 for force locations

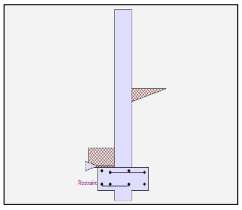
See "Lateral and Passive Force Calculations" on page 7 for lateral and passive forces

See pages 49-53 for Epoxy dowel anchorage for new slab

C. Wall Calculations

Cantilevered Retaining Wall

Code: CBC 2019,ACI 318-14,TMS 402-16



Criteria

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

Load Factors

Building Code	CBC 2019,ACI
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.000
Seismic, E	1.000

Soil Data and Lateral Earth Pressure

Allow Soil Bearing	=	2,000.0 psf	Soil Density, Heel	=	110.00 pcf
Equivalent Fluid Pressure Method			Soil Density, Toe	=	0.00 pcf
Active Heel Pressure	=	40.0 psf/ft	Footing||Soil Friction	=	0.300
	=		Soil height to ignore for passive pressure	=	12.00 in
Passive Pressure	=	150.0 psf/ft			

Surcharge Loads

Surcharge Over Heel	=	100.0 psf	Surcharge Over Toe	=	0.0
NOT Used To Resist Sliding & Overturning			NOT Used for Sliding & Overturning		

Axial Load Applied to Stem

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

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

Wind on Exposed Stem (Service Level)	=	20.0 psf

Adjacent Footing Load

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

Cantilevered Retaining Wall

Code: CBC 2019,ACI 318-14,TMS 402-16

Wall Design Summary

Stability Ratios

Overturning	=	1.92 OK
Slab Resists All Sliding !		

Soil Bearing

Total Bearing Load	=	2,240 lbs
...resultant ecc.	=	6.90 in
Soil Pressure @ Toe	=	1,615 psf OK
Soil Pressure @ Heel	=	0 psf OK
Allowable	=	2,000 psf
Soil Pressure Less Than Allowable		
ACI Factored @ Toe	=	2,361 psf
ACI Factored @ Heel	=	0 psf
Footing Shear @ Toe	=	1.9 psi OK
Footing Shear @ Heel	=	5.1 psi OK
Allowable	=	85.5 psi

Overturning

Resisting Moments

Resisting Moments	Force		Distance		Moment
Soil Over Heel (above water table, if any)	440.0	lbs	2.50	ft	1,100.0ft-#
Soil Over Heel (below water table, if any)	0.0				
Water Table	0.0				
Soil Over Heel	440.0		2.50		1,100.0
Sloped Soil Over Heel	0.0				
Surcharge Over Heel	0.0				
Adjacent Footing Load	0.0				
Axial Dead Load on Stem	0.0				
Axial Live Load on Stem *	0.0				
Soil Over Toe	0.0		0.50		
Surcharge Over Toe	0.0				
Stem Weight(s)	1,200.0		1.50		1,800.0
Earth @ Stem Transitions	0.0				
Footing Weight	525.0		1.50		787.5
Key Weight	75.0		1.50		112.5
Vert. Component	0.0				
Total Vertical Loads	2,240.0	lbs			
Resisting Moment					**3,800.0** ft-#
Eccentricity					**8.2** in

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

Overturning

Overturning Moments

Overturning Moments	Force		Distance		Moment
Heel Active Pressure (above water table, if any)	533.9	lbs	1.72	ft	919.5 ft-#
Heel Active Pressure (below water table, if any)	0.0				
Hydrostatic Force	0.0				
Buoyant Force	0.0				
Surcharge over Heel	187.9		2.58		485.4
Adjacent Footing	0.0				
Surcharge Over Toe	0.0				
Load @ Stem Above Soil	80.0		7.17		573.3
Added Lateral Load	0.0				
Seismic Load	0.0				
Seismic-Self-weight	0.0				
Totals =	801.8	lbs			
	Overturning Moment				1,978.2 ft-#

Stem Design Summary

			Bottom
			Stem OK
Design Height Above Ftg	ft	=	0.00
Wall Material Above "Ht"		=	Concrete
Design Method		=	LRFD
Thickness		=	12.00
Rebar Size		=	# 5
Rebar Spacing		=	18.00
Rebar Placed at		=	Edge
Design Data			
fb/FB + fa/Fa		=	**0.173**
Total Force @ Section			
Service Level	lbs	=	
Strength Level	lbs	=	824.7
Moment....Actual			
Service Level	ft-#	=	
Strength Level	ft-#	=	1,628.1
Moment.....Allowable		=	9,348.4
Shear.....Actual			
Service Level	psi	=	
Strength Level	psi	=	6.7
Shear.....Allowable	psi	=	100.6
Anet	in2	=	
Rebar Depth 'd'	in	=	10.19
Masonry Data			
f'm	psi	=	
Fs	psi	=	
Solid Grouting		=	
Modular Ratio 'n'		=	
Wall Weight	psf	=	150.0
Short Term Factor		=	
Equiv. Solid Thick.		=	
Masonry Block Type		=	Medium Weight
Masonry Design Method		=	ASD
Concrete Data			
f'c	psi	=	4,500.0
Fy	psi	=	60,000.0

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.0366 in2/ft	
(4/3) * As :	0.0488 in2/ft	Min Stem T&S Reinf Area 2.304 in2
3sqrt(f'c)bd/fy : 3sqrt(4500)(12)(10.1875)/60000	0.0041 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.288 in2/ft
0.0009bh : 0.0009(12)(12) :	0.1296 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.1296 in2/ft	#4@ 8.33 in #4@ 16.67 in
Provided Area :	0.2067 in2/ft	#5@ 12.92 in #5@ 25.83 in
Maximum Area :	2.4111 in2/ft	#6@ 18.33 in #6@ 36.67 in

Footing Data

Toe Width	=	1.00 ft	f'c		=	3,250	psi
Heel Width	=	2.00	Fy		=	60,000	psi
Total Footing Width	=	3.00 ft	Footing Concrete Density		=	150.00	pcf
Footing Thickness	=	14.00 in	Min. As %		=	0.0018	
Key Width	=	12.00 in	Rebar Cover	@ Top	=	3.00	in
Key Depth	=	6.00 in		@ Bottom	=	3.00	in
Key Distance from Toe	=	1.00 ft					

Footing Design Results

		Toe	Heel	
Factored Pressure	=	2,361	0	psf
Mu' : Upward	=	12,466	66	ft-#
Mu' : Downward	=	2,052	449	ft-#
Mu: Design	=	375	97	ft-#
Actual 1-Way Shear	=	1.91	5.10	psi
Allow 1-Way Shear	=	85.51	85.51	psi

Toe Reinforcing	=	# 5 @ 18.00 in
Heel Reinforcing	=	# 5 @ 18.00 in
Key Reinforcing	=	None Spec'd

Other Acceptable Sizes & Spacings

Toe: #4@ 7.93 in, #5@ 12.29 in, #6@ 17.45 in, #7@ 23.80 in, #8@ 31.34 in, #9@ 39

Heel: #4@ 7.93 in, #5@ 12.29 in, #6@ 17.45 in, #7@ 23.80 in, #8@ 31.34 in, #9@ 39

Key: Slab Resists Sliding - No Force on Key

Min footing T&S reinf Area	0.91	in2
Min footing T&S reinf Area per fo	0.30	in2 /ft

If one layer of horizontal bars:
#4@ 7.94 in
#5@ 12.30 in
#6@ 17.46 in

If two layers of horizontal bars:
#4@ 15.87 in
#5@ 24.60 in
#6@ 34.92 in

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.

Tilt

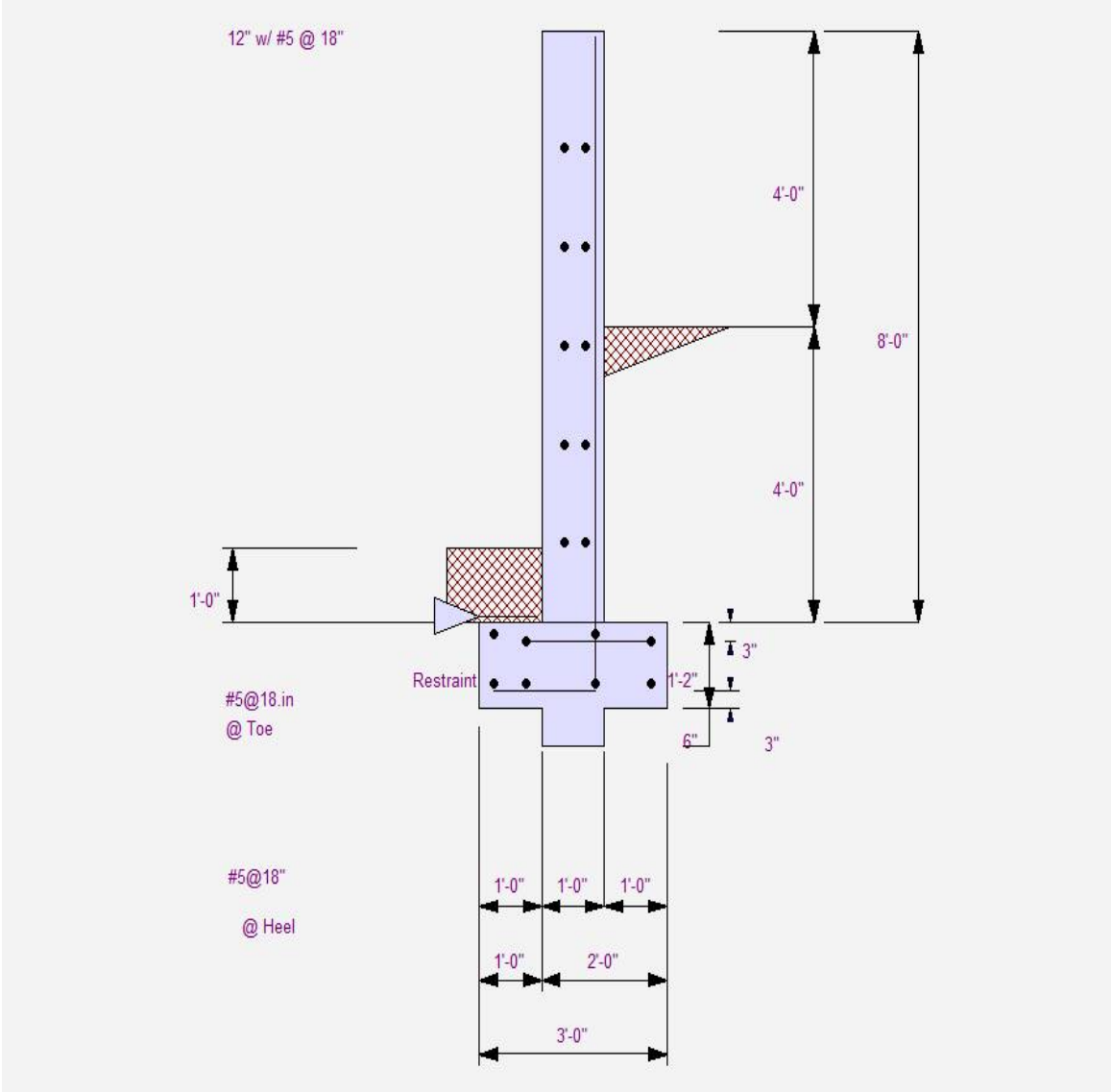
Horizontal Deflection at Top of Wall due to settlement of soil

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus	250.0	pci
Horizontal Defl @ Top of Wall (approximate only)	0.120	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.

4'-0" Cantilevered Condition

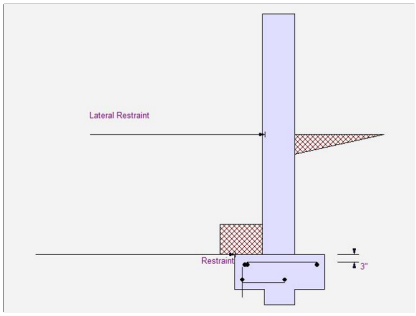


Restrained Retaining Wall

Code: CBC 2019,ACI 318-14,TMS 402-16

Criteria

Retained Height	=	4.00	ft
Wall height above soil	=	4.00	ft
Total Wall Height	=	8.00	ft
Top Support Height	=	4.00	ft
Slope Behind Wall	=	0.00	
Height of Soil over Toe	=	12.00	in



Load Factors

Building Code	CBC 2019,ACI 318-14,TMS 402-16
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.000
Seismic, E	1.000

Soil Data

Allow Soil Bearing	=	2,000.0	psf
Equivalent Fluid Pressure Method			
At-Rest Heel Pressure	=	60.0	psf/ft
	=		
Passive Pressure	=	150.0	psf/ft
Soil Density	=	110.00	pcf
Footing||Soil Frictior	=	0.300	
Soil height to ignore for passive pressure	=	12.00	in

Surcharge Loads

Surcharge Over Heel	=	100.0	psf
>>>NOT Used To Resist Sliding & Overturn			
Surcharge Over Toe	=	0.0	psf
NOT Used for Sliding & Overturning			

Axial Load Applied to Stem

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

Uniform Lateral Load Applied to Stem

Lateral Load	=	0.0	#/ft
...Height to Top	=	0.00	ft
...Height to Bottom	=	0.00	ft
Load Type	=	Seismic (E) (Service Level)	
Wind on Exposed Stem	=	12.0	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	Line Load		
Base Above/Below Soil at Back of Wall	=	0.0	ft
Poisson's Ratio	=	0.300	

Earth Pressure Seismic Load

K_h Soil Density Multiplier	=	0.200	g
Added seismic per unit area	=	0.0	psf

Design Summary

Total Bearing Load	=	2,450	lbs	
...resultant ecc.	=	0.00	in	
Soil Pressure @ Toe	=	817	psf	OK
Soil Pressure @ Heel	=	817	psf	OK
Allowable	=	2,000	psf	
Soil Pressure Less Than Allowable				
ACI Factored @ Toe	=	980	psf	
ACI Factored @ Heel	=	980	psf	
Footing Shear @ Toe	=	0.6	psi	OK
Footing Shear @ Heel	=	0.7	psi	OK
Allowable	=	75.0	psi	
Reaction at Top	=	316.8	lbs	
Reaction at Bottom	=	844.8	lbs	

Sliding Calcs

Lateral Sliding Force = 844.8 lbs

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

Restrained Retaining Wall

Code: CBC 2019,ACI 318-14,TMS 402-16

Concrete Stem Construction

Thickness = 12.00 in
Wall Weight = 150.0 psf
Stem is FIXED to top of footing

Fy = 60,000 psi
f'c = 4,500 psi

'OK' SEE COMMENTS ON NEXT PAGE

		@ Top Support	Mmax Between Top & Base	@ Base of Wall
		As < Min %	As < Min %	As < Min %
Design Height Above Ftg	=	4.00 ft	2.09 ft	0.00 ft
Rebar Size	=	# 5	# 5	# 5
Rebar Spacing	=	18.00 in	18.00 in	18.00 in
Rebar Placed at	=	Edge	Edge	Edge
Rebar Depth 'd'	=	9.50 in	9.50 in	9.50 in
Design Data				
fb/FB + fa/Fa	=	1.000	1.000	1.000
Mu....Actual	=	160.0 ft-#	224.4 ft-#	504.2 ft-#
Mn * Phi.....Allowable	=	8,709.0 ft-#	8,709.0 ft-#	8,709.0 ft-#
Shear Force @ this height	=	345.9 lbs		772.6 lbs
Shear.....Actual	=	3.03 psi		6.78 psi
Shear.....Allowable	=	100.62 psi		100.62 psi

Other Acceptable Sizes & Spacings:

Toe: # 5 @ 18.00 in	-or-	Not req'd: Mu < phi*5*lambda*sqrt(f'c)*Sm
Heel:# 5 @ 18.00 in	-or-	Not req'd: Mu < phi*5*lambda*sqrt(f'c)*Sm
Key: Slab Resists Sliding	-or-	Slab Resists Sliding - No Force on

Concrete Stem Rebar Area Details

Top Support	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.0039 in2/ft	
(4/3) * As :	0.0052 in2/ft	Min Stem T&S Reinf Area 1.152 in2
3sqrt(f'c)bd/fy : 3sqrt(4500)(12)(9.5)/60000 :	0.3824 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.288 in2/ft
0.0018bh : 0.0018(12)(12) :	0.2592 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.2592 in2/ft	#4@ 8.33 in #4@ 16.67 in
Provided Area :	0.2067 in2/ft	#5@ 12.92 in #5@ 25.83 in
Maximum Area :	2.2484 in2/ft	#6@ 18.33 in #6@ 36.67 in

Mmax Between Ends	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.0054 in2/ft	
(4/3) * As :	0.0072 in2/ft	Min Stem T&S Reinf Area 0.551 in2
3sqrt(f'c)bd/fy : 3sqrt(4500)(12)(9.5)/60000 :	0.3824 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.288 in2/ft
0.0018bh : 0.0018(12)(12) :	0.2592 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.2592 in2/ft	#4@ 8.33 in #4@ 16.67 in
Provided Area :	0.2067 in2/ft	#5@ 12.92 in #5@ 25.83 in
Maximum Area :	2.2484 in2/ft	#6@ 18.33 in #6@ 36.67 in

Base Support	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.0122 in2/ft	
(4/3) * As :	0.0163 in2/ft	Min Stem T&S Reinf Area 0.601 in2
3sqrt(f'c)bd/fy : 3sqrt(4500)(12)(9.5)/60000 :	0.3824 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.288 in2/ft
0.0018bh : 0.0018(12)(12) :	0.2592 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.2592 in2/ft	#4@ 8.33 in #4@ 16.67 in
Provided Area :	0.2067 in2/ft	#5@ 12.92 in #5@ 25.83 in
Maximum Area :	2.2484 in2/ft	#6@ 18.33 in #6@ 36.67 in

'OK' SEE COMMENTS BELOW

Footing Strengths & Dimensions

Toe Width	=	1.00	ft
Heel Width	=	2.00	
Total Footing Width	=	3.00	
Footing Thickness	=	14.00	in
Key Width	=	12.00	in
Key Depth	=	6.00	in
Key Distance from Toe	=	1.00	ft
f'c	=	2,500	psi
Fy	=	60,000	psi
Footing Concrete Density	=	150.00	pcf
Min. As %	=	0.0018	

Cover @ Top = 3.00 in @ Btm.= 3.00 in

PROGRAM MINIMUM AREA IS ONLY CONSIDERING ONE LAYER OF REINFORCEMENT. TWO PROVIDE 2 LAYERS 0F #5'S @ 18" O.C.
As, actual=(2)*0.31 in^2*(12"/18")=0.413 in^2 > 0.2592 in^2 (OK)

Footing Design Results

		Toe	Heel
Factored Pressure	=	980	980 psf
Mu' : Upward	=	490	490 ft-#
Mu' : Downward	=	171	449 ft-#
Mu: Design	=	319	-41 ft-#
Actual 1-Way Shear	=	0.63	0.65 psi
Allow 1-Way Shear	=	75.00	75.00 psi

Min footing T&S reinf Area 0.91 in2
Min footing T&S reinf Area per fo 0.30 in2 /ft

If one layer of horizontal bars: If two layers of horizontal bars:
#4@ 7.94 in
#5@ 12.30 in
#6@ 17.46 in

Summary of Forces on Footing : Slab RESISTS sliding, stem is FIXED at footing

Forces acting on footing for soil pressure **>>> Sliding Forces are restrained by the adjacent slab**

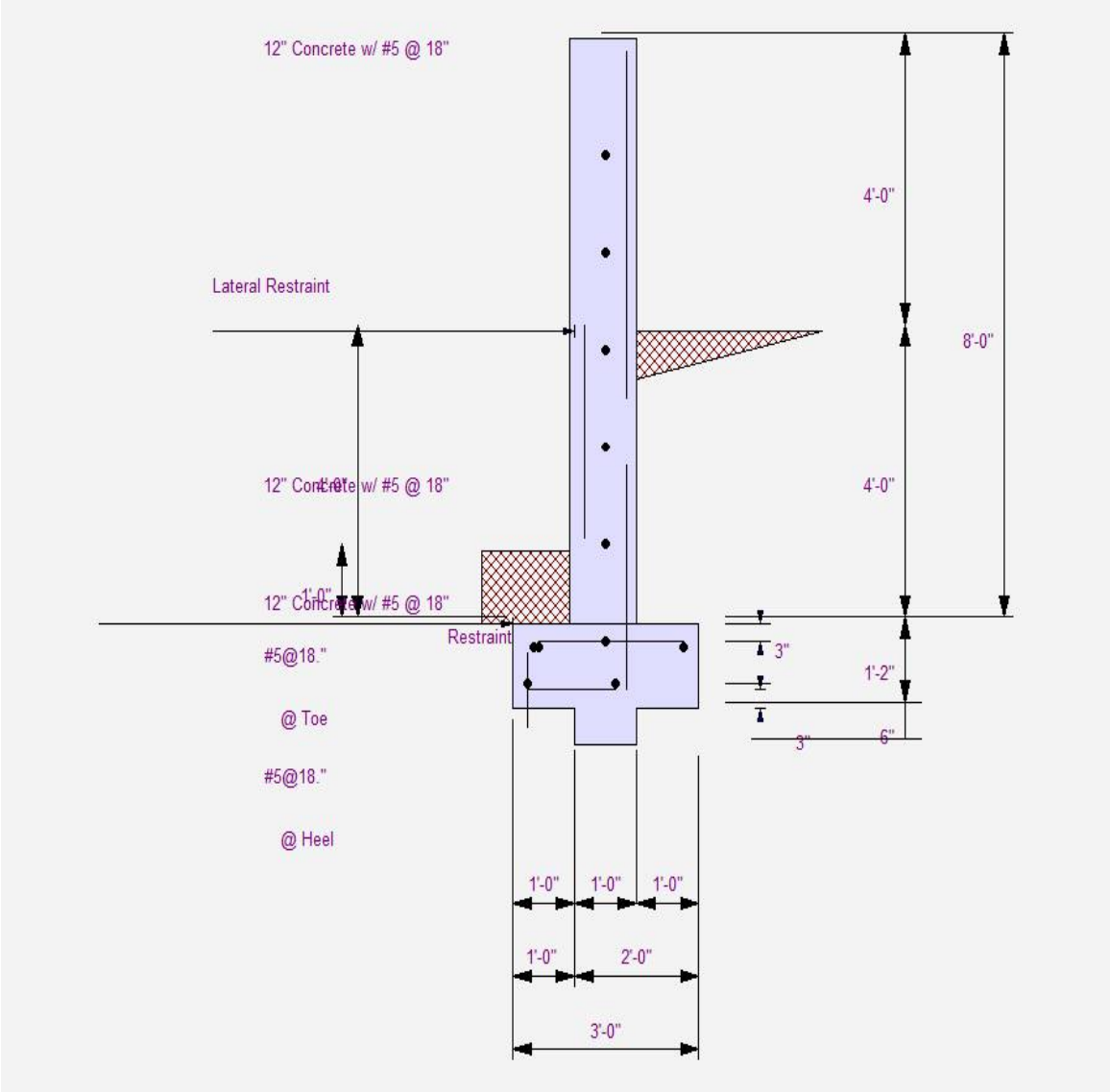
Load & Moment Summary For Footing : For Soil Pressure Calcs

Moment @ Top of Footing Applied from Stem	=					-285.1	ft-#
Surcharge Over Heel	=		lbs		ft		ft-#
Adjacent Footing Load	=		lbs		ft		ft-#
Axial Dead Load on Stem	=		lbs		ft		ft-#
Soil Over Toe	=	110.0	lbs	0.50	ft	55.0	ft-#
Surcharge Over Toe	=		lbs		ft		ft-#
Stem Weight	=	1,200.0	lbs	1.50	ft	1,800.0	ft-#
Soil Over Heel	=	440.0	lbs	2.50	ft	1,100.0	ft-#
Footing Weight	=	600.0	lbs	1.44	ft	863.0	ft-#
Total Vertical Force	=	2,450.0	lbs	Base Moment	=	3,532.9	ft-#

Soil Pressure Resulting Moment = 0.0 ft-#

Vertical component of active lateral soil pressure IS NOT considered in the calculation of soil bearing pressures.

4'-0" Restrained Condition



6'-0" Cantilevered Condition

Use menu item Settings > Printing & Title Block to set these five lines of information for your program.

Project Name/Number : Existing Reta
Title **6'-0" Cantilevered**
Dsgnr: **NM**
Description....

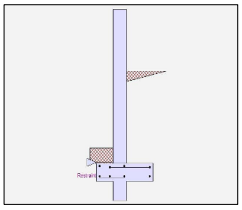
Date: 7 FEB 2020

This Wall in File: G:\19\S19-0231 - NAC La Mirada HS Athletic Field & Stadium\Eng\Calcs\Retaining Wa

Cantilevered Retaining Wall

Code: CBC 2019,ACI 318-14,TMS 402-16

Criteria



Retained Height	=	6.00 ft
Wall height above soil	=	4.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	12.00 in
Water height over heel	=	0.0 ft

Load Factors

Building Code	CBC 2019,ACI
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.000
Seismic, E	1.000

Soil Data and Lateral Earth Pressure

Allow Soil Bearing	=	2,667.0 psf	Soil Density, Heel	=	110.00 pcf
Equivalent Fluid Pressure Method			Soil Density, Toe	=	0.00 pcf
Active Heel Pressure	=	40.0 psf/ft	Footing||Soil Friction	=	0.300
	=		Soil height to ignore for passive pressure	=	12.00 in
Passive Pressure	=	150.0 psf/ft			

Surcharge Loads

Surcharge Over Heel	=	100.0 psf	Surcharge Over Toe	=	0.0
NOT Used To Resist Sliding & Overturning			NOT Used for Sliding & Overturning		

Axial Load Applied to Stem

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

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

Wind on Exposed Stem (Service Level)	=	20.0 psf

Adjacent Footing Load

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

Earth Pressure Seismic Load

Method : Triangular

Load at bottom of Triangular Distribution	=	144.000 psf	Total Strength-Level Seismic Load.	=	516.000 lbs
Strength-Level)			Total Service-Level Seismic Load.	=	361.200 lbs

Cantilevered Retaining Wall

Code: CBC 2019,ACI 318-14,TMS 402-16

Wall Design Summary

Stability Ratios

Overturning	=	1.77 OK
Slab Resists All Sliding !		

Soil Bearing

Total Bearing Load	=	3,751 lbs
...resultant ecc.	=	11.14 in
Soil Pressure @ Toe	=	2,090 psf OK
Soil Pressure @ Heel	=	0 psf OK
Allowable	=	2,667 psf
Soil Pressure Less Than Allowable		
ACI Factored @ Toe	=	3,081 psf
ACI Factored @ Heel	=	0 psf
Footing Shear @ Toe	=	7.5 psi OK
Footing Shear @ Heel	=	12.3 psi OK
Allowable	=	85.5 psi

Overturning

Resisting Moments

Resisting Moments	Force		Distance	Moment
Soil Over Heel (above water table, if any)	1,320.0	lbs	3.25 ft	4,290.0ft-#
Soil Over Heel (below water table, if any)	0.0			
Water Table	0.0			
Soil Over Heel	1,320.0		3.25	4,290.0
Sloped Soil Over Heel	0.0			
Surcharge Over Heel	0.0			
Adjacent Footing Load	0.0			
Axial Dead Load on Stem	0.0			
Axial Live Load on Stem *	0.0			
Soil Over Toe	0.0		0.63	
Surcharge Over Toe	0.0			
Stem Weight(s)	1,500.0		1.75	2,625.0
Earth @ Stem Transitions	0.0			
Footing Weight	743.8		2.13	1,580.5
Key Weight	187.5		1.75	328.1
Vert. Component	0.0			
Total Vertical Loads	3,751.3	lbs		
Resisting Moment				**8,823.6** ft-#
Eccentricity				**13.2** in

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

Overturning

Overturning Moments

Overturning Moments	Force		Distance		Moment	
Heel Active Pressure (above water table, if any)	1,027.2	lbs	2.39	ft	2,453.9	ft-#
Heel Active Pressure (below water table, if any)	0.0					
Hydrostatic Force	0.0					
Buoyant Force	0.0					
Surcharge over Heel	260.6		3.58		933.8	
Adjacent Footing	0.0					
Surcharge Over Toe	0.0					
Load @ Stem Above Soil	80.0		9.17		733.3	
Added Lateral Load	0.0					
Seismic Load	361.2		2.39		862.9	
Seismic-Self-weight	0.0					
Totals =	1,729.0	lbs				
	Overturning Moment				4,984.0	ft-#

Stem Design Summary

			Bottom
			Stem OK
Design Height Above Ftg	ft	=	0.00
Wall Material Above "Ht"		=	Concrete
Design Method		=	LRFD
Thickness		=	12.00
Rebar Size		=	# 5
Rebar Spacing		=	18.00
Rebar Placed at		=	Edge
Design Data			
fb/FB + fa/Fa		=	**0.503**
Total Force @ Section			
Service Level	lbs	=	
Strength Level	lbs	=	1,942.8
Moment....Actual			
Service Level	ft-#	=	
Strength Level	ft-#	=	4,714.6
Moment.....Allowable		=	9,348.4
Shear.....Actual			
Service Level	psi	=	
Strength Level	psi	=	15.9
Shear.....Allowable	psi	=	100.6
Anet	in2	=	
Rebar Depth 'd'	in	=	10.19
Masonry Data			
f'm	psi	=	
Fs	psi	=	
Solid Grouting		=	
Modular Ratio 'n'		=	
Wall Weight	psf	=	150.0
Short Term Factor		=	
Equiv. Solid Thick.		=	
Masonry Block Type		=	Medium Weight
Masonry Design Method		=	ASD
Concrete Data			
f'c	psi	=	4,500.0
Fy	psi	=	60,000.0

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.1061 in2/ft	
(4/3) * As :	0.1414 in2/ft	Min Stem T&S Reinf Area 2.880 in2
3sqrt(f'c)bd/fy : 3sqrt(4500)(12)(10.1875)/60000	0.1141 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.288 in2/ft
0.0009bh : 0.0009(12)(12) :	0.1296 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.1414 in2/ft	#4@ 8.33 in #4@ 16.67 in
Provided Area :	0.2067 in2/ft	#5@ 12.92 in #5@ 25.83 in
Maximum Area :	2.4111 in2/ft	#6@ 18.33 in #6@ 36.67 in

Footing Data

Toe Width	=	1.25 ft	f'c	=	3,250	psi
Heel Width	=	3.00	Fy	=	60,000	psi
Total Footing Width	=	4.25 ft	Footing Concrete Density	=	150.00	pcf
Footing Thickness	=	14.00 in	Min. As %	=	0.0018	
Key Width	=	12.00 in	Rebar Cover @ Top	=	3.00	in
Key Depth	=	15.00 in	@ Bottom	=	3.00	in
Key Distance from Toe	=	1.25 ft				

Footing Design Results

		Toe	Heel	
Factored Pressure	=	3,081	0	psf
Mu' : Upward	=	25,535	345	ft-#
Mu' : Downward	=	3,206	2,324	ft-#
Mu: Design	=	750	279	ft-#
Actual 1-Way Shear	=	7.54	12.32	psi
Allow 1-Way Shear	=	85.51	85.51	psi

Toe Reinforcing	=	# 5 @ 18.00 in
Heel Reinforcing	=	# 5 @ 18.00 in
Key Reinforcing	=	None Spec'd

Other Acceptable Sizes & Spacings

Toe: #4@ 7.93 in, #5@ 12.29 in, #6@ 17.45 in, #7@ 23.80 in, #8@ 31.34 in, #9@ 39

Heel: #4@ 7.93 in, #5@ 12.29 in, #6@ 17.45 in, #7@ 23.80 in, #8@ 31.34 in, #9@ 39

Key: Slab Resists Sliding - No Force on Key

Min footing T&S reinf Area	1.29	in2
Min footing T&S reinf Area per fo	0.30	in2 /ft

If one layer of horizontal bars:
#4@ 7.94 in
#5@ 12.30 in
#6@ 17.46 in

If two layers of horizontal bars:
#4@ 15.87 in
#5@ 24.60 in
#6@ 34.92 in

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.

Tilt

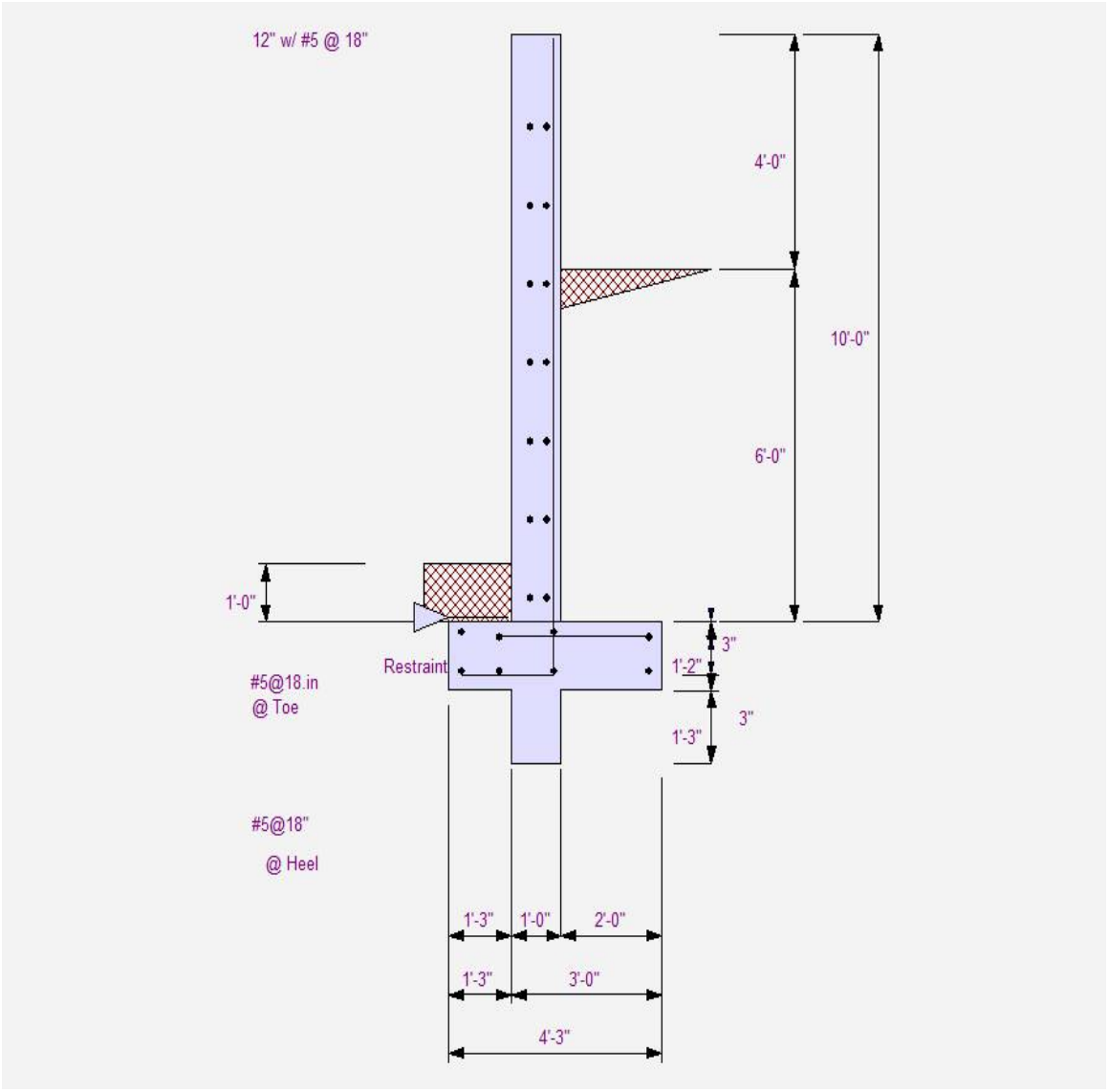
Horizontal Deflection at Top of Wall due to settlement of soil

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus	250.0	pci
Horizontal Defl @ Top of Wall (approximate only)	0.137	in

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

6'-0" Cantilevered Condition

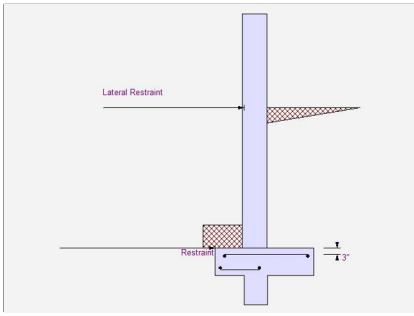


Restrained Retaining Wall

Code: CBC 2019,ACI 318-14,TMS 402-16

Criteria

Retained Height	=	6.00	ft
Wall height above soil	=	4.00	ft
Total Wall Height	=	10.00	ft
Top Support Height	=	6.00	ft
Slope Behind Wall	=	0.00	
Height of Soil over Toe	=	12.00	in



Load Factors

Building Code	CBC 2019,ACI 318-14,TMS 402-16
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.000
Seismic, E	1.000

Soil Data

Allow Soil Bearing	=	2,000.0	psf
Equivalent Fluid Pressure Method			
At-Rest Heel Pressure	=	60.0	psf/ft
	=		
Passive Pressure	=	150.0	psf/ft
Soil Density	=	110.00	pcf
Footing||Soil Frictior	=	0.300	
Soil height to ignore for passive pressure	=	12.00	in

Surcharge Loads

Surcharge Over Heel	=	100.0	psf
>>>NOT Used To Resist Sliding & Overturn			
Surcharge Over Toe	=	0.0	psf
NOT Used for Sliding & Overturning			

Axial Load Applied to Stem

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

Uniform Lateral Load Applied to Stem

Lateral Load	=	0.0	#/ft
...Height to Top	=	0.00	ft
...Height to Bottom	=	0.00	ft
Load Type	=	Seismic (E) (Service Level)	
Wind on Exposed Stem	=	12.0	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	Line Load		
Base Above/Below Soil at Back of Wall	=	0.0	ft
Poisson's Ratio	=	0.300	

Earth Pressure Seismic Load

K_h Soil Density Multiplier	=	0.200	g
Added seismic per unit area	=	92.4	psf

Design Summary

Total Bearing Load	=	4,089	lbs	
...resultant ecc.	=	0.00	in	
Soil Pressure @ Toe	=	962	psf	OK
Soil Pressure @ Heel	=	962	psf	OK
Allowable	=	2,000	psf	
Soil Pressure Less Than Allowable				
ACI Factored @ Toe	=	1,154	psf	
ACI Factored @ Heel	=	1,154	psf	
Footing Shear @ Toe	=	2.4	psi	OK
Footing Shear @ Heel	=	0.1	psi	OK
Allowable	=	75.0	psi	
Reaction at Top	=	663.4	lbs	
Reaction at Bottom	=	1,899.5	lbs	

Sliding Calcs

Lateral Sliding Force = 1,899.5 lbs

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

Restrained Retaining Wall

Code: CBC 2019,ACI 318-14,TMS 402-16

Concrete Stem Construction

Thickness = 12.00 in
Wall Weight = 150.0 psf
Stem is FIXED to top of footing

Fy = 60,000 psi
f'c = 4,500 psi

'OK' SEE COMMENTS ON NEXT PAGE

		@ Top Support	Mmax Between Top & Base	@ Base of Wall
		As < Min %	As < Min %	As < Min %
Design Height Above Ftg	=	6.00 ft	3.45 ft	0.00 ft
Rebar Size	=	# 5	# 5	# 5
Rebar Spacing	=	18.00 in	18.00 in	18.00 in
Rebar Placed at	=	Edge	Edge	Edge
Rebar Depth 'd'	=	9.50 in	9.50 in	9.50 in
Design Data				
fb/FB + fa/Fa	=	1.000	1.000	1.000
Mu....Actual	=	160.0 ft-#	1,096.0 ft-#	2,289.2 ft-#
Mn * Phi.....Allowable	=	8,709.0 ft-#	8,709.0 ft-#	8,709.0 ft-#
Shear Force @ this height	=	881.1 lbs		2,164.7 lbs
Shear.....Actual	=	7.73 psi		18.99 psi
Shear.....Allowable	=	100.62 psi		100.62 psi

Other Acceptable Sizes & Spacings:

Toe: # 5 @ 18.00 in	-or-	Not req'd: Mu < phi*5*lambda*sqrt(f'c)*Sm
Heel:# 5 @ 18.00 in	-or-	Not req'd: Mu < phi*5*lambda*sqrt(f'c)*Sm
Key: Slab Resists Sliding	-or-	Slab Resists Sliding - No Force on

Concrete Stem Rebar Area Details

Top Support	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.0039 in2/ft	
(4/3) * As :	0.0052 in2/ft	Min Stem T&S Reinf Area 1.728 in2
3sqrt(f'c)bd/fy : 3sqrt(4500)(12)(9.5)/60000 :	0.3824 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.288 in2/ft
0.0018bh : 0.0018(12)(12) :	0.2592 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.2592 in2/ft	#4@ 8.33 in #4@ 16.67 in
Provided Area :	0.2067 in2/ft	#5@ 12.92 in #5@ 25.83 in
Maximum Area :	2.2484 in2/ft	#6@ 18.33 in #6@ 36.67 in

Mmax Between Ends	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.0265 in2/ft	
(4/3) * As :	0.0353 in2/ft	Min Stem T&S Reinf Area 0.736 in2
3sqrt(f'c)bd/fy : 3sqrt(4500)(12)(9.5)/60000 :	0.3824 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.288 in2/ft
0.0018bh : 0.0018(12)(12) :	0.2592 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.2592 in2/ft	#4@ 8.33 in #4@ 16.67 in
Provided Area :	0.2067 in2/ft	#5@ 12.92 in #5@ 25.83 in
Maximum Area :	2.2484 in2/ft	#6@ 18.33 in #6@ 36.67 in

Base Support	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.0554 in2/ft	
(4/3) * As :	0.0738 in2/ft	Min Stem T&S Reinf Area 0.992 in2
3sqrt(f'c)bd/fy : 3sqrt(4500)(12)(9.5)/60000 :	0.3824 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.288 in2/ft
0.0018bh : 0.0018(12)(12) :	0.2592 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.2592 in2/ft	#4@ 8.33 in #4@ 16.67 in
Provided Area :	0.2067 in2/ft	#5@ 12.92 in #5@ 25.83 in
Maximum Area :	2.2484 in2/ft	#6@ 18.33 in #6@ 36.67 in

'OK' SEE COMMENTS BELOW

Footing Strengths & Dimensions

Toe Width	=	1.25	ft
Heel Width	=	3.00	
Total Footing Width	=	4.25	
Footing Thickness	=	14.00	in
Key Width	=	12.00	in
Key Depth	=	15.00	in
Key Distance from Toe	=	1.25	ft
f'c	=	2,500	psi
Fy	=	60,000	psi
Footing Concrete Density	=	150.00	pcf
Min. As %	=	0.0018	

Cover @ Top = 3.00 in @ Btm.= 3.00 in

PROGRAM MINIMUM AREA IS ONLY CONSIDERING ONE LAYER OF REINFORCEMENT. TWO PROVIDE 2 LAYERS 0F #5'S @ 18" O.C.
As, actual=(2)*0.31 in^2*(12"/18")=0.413 in^2 > 0.2592 in^2 (OK)

Restrained Retaining Wall

Code: CBC 2019,ACI 318-14,TMS 402-16

Footing Design Results

		Toe	Heel
Factored Pressure	=	1,154	1,154 psf
Mu' : Upward	=	902	2,309 ft-#
Mu' : Downward	=	267	2,324 ft-#
Mu: Design	=	635	15 ft-#
Actual 1-Way Shear	=	2.42	0.12 psi
Allow 1-Way Shear	=	75.00	75.00 psi

Min footing T&S reinf Area 1.29 in2
Min footing T&S reinf Area per fo 0.30 in2 /ft

If one layer of horizontal bars: If two layers of horizontal bars:
#4@ 7.94 in
#5@ 12.30 in
#6@ 17.46 in

Summary of Forces on Footing : Slab RESISTS sliding, stem is FIXED at footing

Forces acting on footing for soil pressure **>>> Sliding Forces are restrained by the adjacent slab**

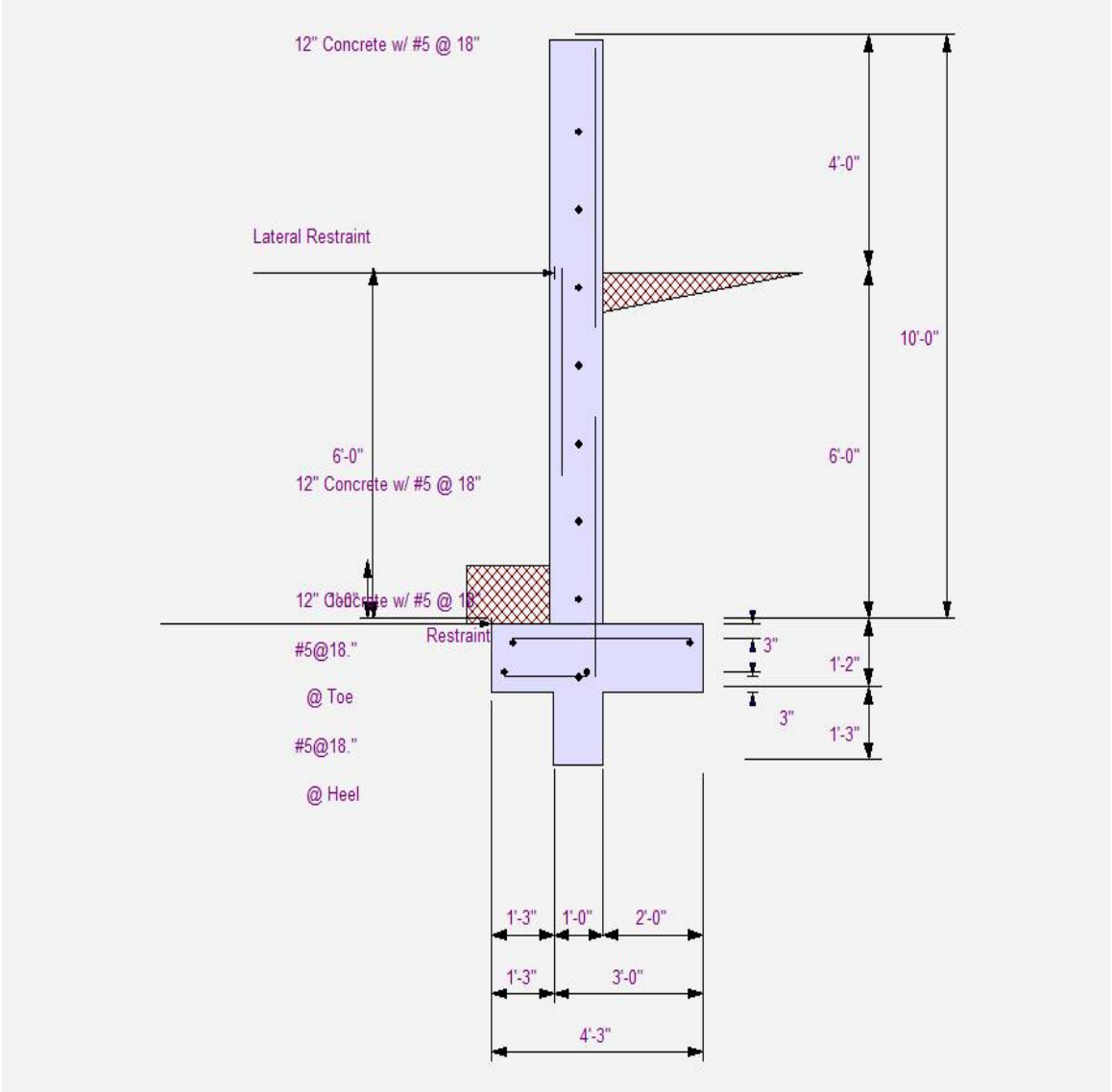
Load & Moment Summary For Footing : For Soil Pressure Calcs

Moment @ Top of Footing Applied from Stem	=					-1,445.3	ft-#
Surcharge Over Heel	=		lbs		ft		ft-#
Adjacent Footing Load	=		lbs		ft		ft-#
Axial Dead Load on Stem	=		lbs		ft		ft-#
Soil Over Toe	=	137.5	lbs	0.63	ft	85.9	ft-#
Surcharge Over Toe	=		lbs		ft		ft-#
Stem Weight	=	1,500.0	lbs	1.75	ft	2,625.0	ft-#
Soil Over Heel	=	1,320.0	lbs	3.25	ft	4,290.0	ft-#
Footing Weight	=	931.3	lbs	1.95	ft	1,815.3	ft-#
Total Vertical Force	=	4,088.8	lbs	Base Moment	=	7,371.0	ft-#

Soil Pressure Resulting Moment = 0.0 ft-#

Vertical component of active lateral soil pressure IS NOT considered in the calculation of soil bearing pressures.

6'-0" Restrained Condition



8'-0" Restrained Condition

Use menu item Settings > Printing & Title Block to set these five lines of information for your program.

Project Name/Number : Existing Reta
Title **8'-0" Restrained**
Dsgnr: **NM**
Description....

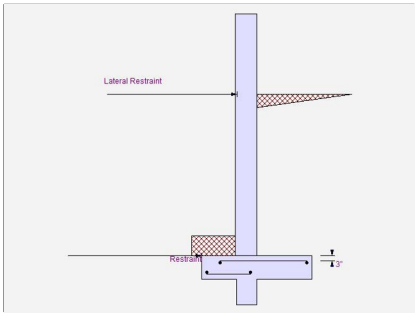
Date: 7 FEB 2020

This Wall in File: G:\19\S19-0231 - NAC La Mirada HS Athletic Field & Stadium\Eng\Calcs\Retaining Wa

Restrained Retaining Wall

Code: CBC 2019,ACI 318-14,TMS 402-16

Criteria



Retained Height	=	8.00	ft
Wall height above soil	=	4.00	ft
Total Wall Height	=	12.00	ft
Top Support Height	=	8.00	ft
Slope Behind Wall	=	0.00	
Height of Soil over Toe	=	12.00	in

Load Factors

Building Code	CBC 2019,ACI 318-14,TMS 402-16
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.000
Seismic, E	1.000

Soil Data

Allow Soil Bearing	=	2,000.0	psf
Equivalent Fluid Pressure Method			
At-Rest Heel Pressure =		60.0	psf/ft
=			
Passive Pressure =		150.0	psf/ft
Soil Density	=	110.00	pcf
Footing||Soil Frictior	=	0.300	
Soil height to ignore for passive pressure	=	12.00	in

Surcharge Loads

Surcharge Over Heel	=	100.0	psf
>>>NOT Used To Resist Sliding & Overturn			
Surcharge Over Toe	=	0.0	psf
NOT Used for Sliding & Overturning			

Axial Load Applied to Stem

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

Uniform Lateral Load Applied to Stem

Lateral Load	=	0.0	#/ft
...Height to Top	=	0.00	ft
...Height to Bottom	=	0.00	ft
Load Type	=	Seismic (E) (Service Level)	
Wind on Exposed Stem	=	12.0	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	Line Load		
Base Above/Below Soil at Back of Wall	=	0.0	ft
Poisson's Ratio	=	0.300	

Earth Pressure Seismic Load

K_h Soil Density Multiplier	=	0.200	g
Added seismic per unit area	=	123.2	psf

Design Summary

Total Bearing Load	=	5,838	lbs	
...resultant ecc.	=	0.00	in	
Soil Pressure @ Toe	=	1,061	psf	OK
Soil Pressure @ Heel	=	1,061	psf	OK
Allowable	=	2,000	psf	
Soil Pressure Less Than Allowable				
ACI Factored @ Toe	=	1,274	psf	
ACI Factored @ Heel	=	1,274	psf	
Footing Shear @ Toe	=	6.5	psi	OK
Footing Shear @ Heel	=	3.3	psi	OK
Allowable	=	75.0	psi	
Reaction at Top	=	1,022.2	lbs	
Reaction at Bottom	=	3,059.2	lbs	

Sliding Calcs
Lateral Sliding Force = 3,059.2 lbs

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

Restrained Retaining Wall

Code: CBC 2019,ACI 318-14,TMS 402-16

Concrete Stem Construction

Thickness = 12.00 in
Wall Weight = 150.0 psf
Stem is FIXED to top of footing

Fy = 60,000 psi
f'c = 4,500 psi

'OK' SEE COMMENTS ON NEXT PAGE

		@ Top Support	Mmax Between Top & Base	@ Base of Wall
		As < Min %	As < Min %	As < Min %
Design Height Above Ftg	=	8.00 ft	4.66 ft	0.00 ft
Rebar Size	=	# 5	# 5	# 5
Rebar Spacing	=	18.00 in	18.00 in	18.00 in
Rebar Placed at	=	Edge	Edge	Edge
Rebar Depth 'd'	=	9.50 in	9.50 in	9.50 in
Design Data				
fb/FB + fa/Fa	=	1.000	1.000	1.000
Mu....Actual	=	160.0 ft-#	2,553.1 ft-#	5,303.1 ft-#
Mn * Phi.....Allowable	=	8,709.0 ft-#	8,709.0 ft-#	8,709.0 ft-#
Shear Force @ this height	=	1,437.0 lbs		3,744.0 lbs
Shear.....Actual	=	12.61 psi		32.84 psi
Shear.....Allowable	=	100.62 psi		100.62 psi

Other Acceptable Sizes & Spacings:

Toe: # 5 @ 18.00 in	-or-	Not req'd: Mu < phi*5*lambda*sqrt(f'c)*Sm
Heel:# 5 @ 18.00 in	-or-	Not req'd: Mu < phi*5*lambda*sqrt(f'c)*Sm
Key: Slab Resists Sliding	-or-	Slab Resists Sliding - No Force on

Concrete Stem Rebar Area Details

Top Support	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.0039 in2/ft	
(4/3) * As :	0.0052 in2/ft	Min Stem T&S Reinf Area 2.304 in2
3sqrt(f'c)bd/fy : 3sqrt(4500)(12)(9.5)/60000 :	0.3824 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.288 in2/ft
0.0018bh : 0.0018(12)(12) :	0.2592 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.2592 in2/ft	#4@ 8.33 in #4@ 16.67 in
Provided Area :	0.2067 in2/ft	#5@ 12.92 in #5@ 25.83 in
Maximum Area :	2.2484 in2/ft	#6@ 18.33 in #6@ 36.67 in

Mmax Between Ends	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.0617 in2/ft	
(4/3) * As :	0.0823 in2/ft	Min Stem T&S Reinf Area 0.962 in2
3sqrt(f'c)bd/fy : 3sqrt(4500)(12)(9.5)/60000 :	0.3824 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.288 in2/ft
0.0018bh : 0.0018(12)(12) :	0.2592 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.2592 in2/ft	#4@ 8.33 in #4@ 16.67 in
Provided Area :	0.2067 in2/ft	#5@ 12.92 in #5@ 25.83 in
Maximum Area :	2.2484 in2/ft	#6@ 18.33 in #6@ 36.67 in

Base Support	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.1282 in2/ft	
(4/3) * As :	0.171 in2/ft	Min Stem T&S Reinf Area 1.342 in2
3sqrt(f'c)bd/fy : 3sqrt(4500)(12)(9.5)/60000 :	0.3824 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.288 in2/ft
0.0018bh : 0.0018(12)(12) :	0.2592 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.2592 in2/ft	#4@ 8.33 in #4@ 16.67 in
Provided Area :	0.2067 in2/ft	#5@ 12.92 in #5@ 25.83 in
Maximum Area :	2.2484 in2/ft	#6@ 18.33 in #6@ 36.67 in

'OK' SEE COMMENTS BELOW

Footing Strengths & Dimensions

Toe Width	=	1.75	ft
Heel Width	=	3.75	
Total Footing Width	=	5.50	
Footing Thickness	=	14.00	in
Key Width	=	12.00	in
Key Depth	=	15.00	in
Key Distance from Toe	=	1.75	ft
f'c	=	2,500	psi
Fy	=	60,000	psi
Footing Concrete Density	=	150.00	pcf
Min. As %	=	0.0018	

Cover @ Top = 3.00 in @ Btm.= 3.00 in

PROGRAM MINIMUM AREA IS ONLY CONSIDERING ONE LAYER OF REINFORCEMENT. TWO PROVIDE 2 LAYERS 0F #5'S @ 18" O.C.
As, actual=(2)*0.31 in^2*(12"/18")=0.413 in^2 > 0.2592 in^2 (OK)

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Restrained Retaining Wall

Code: CBC 2019,ACI 318-14,TMS 402-16

Footing Design Results

		Toe	Heel
Factored Pressure	=	1,274	1,274 psf
Mu' : Upward	=	1,950	4,816 ft-#
Mu' : Downward	=	524	5,392 ft-#
Mu: Design	=	1,427	576 ft-#
Actual 1-Way Shear	=	6.47	3.33 psi
Allow 1-Way Shear	=	75.00	75.00 psi

Min footing T&S reinf Area 1.66 in2
Min footing T&S reinf Area per fo 0.30 in2 /ft

If one layer of horizontal bars: If two layers of horizontal bars:
#4@ 7.94 in
#5@ 12.30 in
#6@ 17.46 in

Summary of Forces on Footing : Slab RESISTS sliding, stem is FIXED at footing

Forces acting on footing for soil pressure **>>> Sliding Forces are restrained by the adjacent slab**

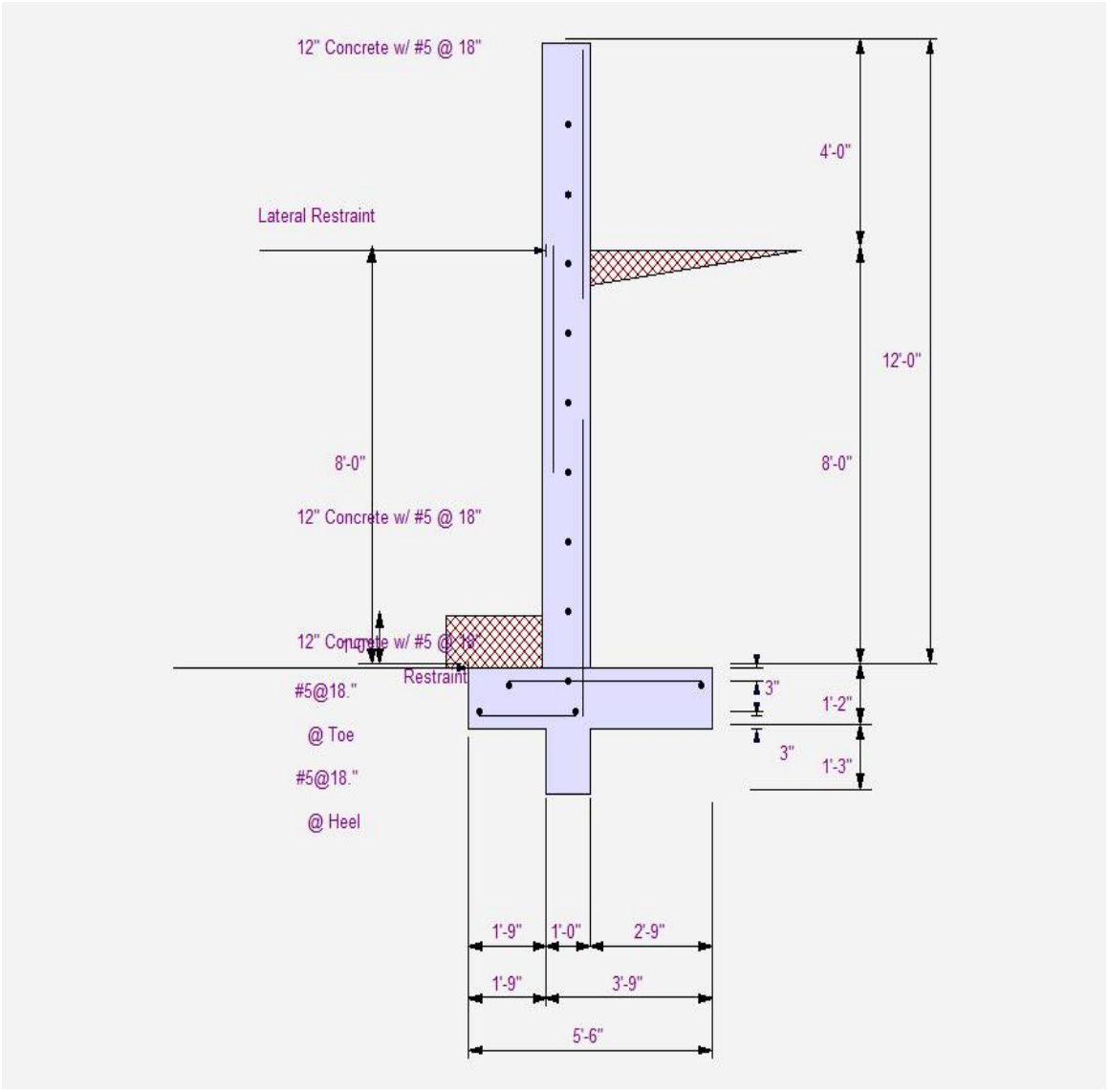
Load & Moment Summary For Footing : For Soil Pressure Calcs

Moment @ Top of Footing Applied from Stem	=					-3,390.0	ft-#
Surcharge Over Heel	=		lbs		ft		ft-#
Adjacent Footing Load	=		lbs		ft		ft-#
Axial Dead Load on Stem	=		lbs		ft		ft-#
Soil Over Toe	=	192.5	lbs	0.88	ft	168.4	ft-#
Surcharge Over Toe	=		lbs		ft		ft-#
Stem Weight	=	1,800.0	lbs	2.25	ft	4,050.0	ft-#
Soil Over Heel	=	2,420.0	lbs	4.13	ft	9,982.5	ft-#
Footing Weight	=	1,150.0	lbs	2.59	ft	2,975.5	ft-#
Total Vertical Force	=	5,837.5	lbs	Base Moment	=	13,786.4	ft-#

Soil Pressure Resulting Moment = 0.0 ft-#

Vertical component of active lateral soil pressure IS NOT considered in the calculation of soil bearing pressures.

8'-0" Restrained Condition

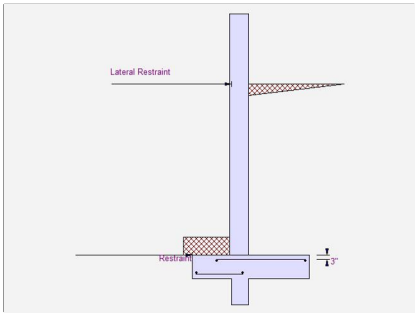


Restrained Retaining Wall

Code: CBC 2019,ACI 318-14,TMS 402-16

Criteria

Retained Height	=	9.75	ft
Wall height above soil	=	4.00	ft
Total Wall Height	=	13.75	ft
Top Support Height	=	9.75	ft
Slope Behind Wall	=	0.00	
Height of Soil over Toe	=	12.00	in



Load Factors

Building Code	CBC 2019,ACI 318-14,TMS 402-16
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.000
Seismic, E	1.000

Soil Data

Allow Soil Bearing	=	2,000.0	psf
Equivalent Fluid Pressure Method			
At-Rest Heel Pressure	=	60.0	psf/ft
	=		
Passive Pressure	=	150.0	psf/ft
Soil Density	=	110.00	pcf
Footing||Soil Frictior	=	0.300	
Soil height to ignore for passive pressure	=	12.00	in

Surcharge Loads

Surcharge Over Heel	=	100.0	psf
>>>NOT Used To Resist Sliding & Overturn			
Surcharge Over Toe	=	0.0	psf
NOT Used for Sliding & Overturning			

Axial Load Applied to Stem

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

Uniform Lateral Load Applied to Stem

Lateral Load	=	0.0	#/ft
...Height to Top	=	0.00	ft
...Height to Bottom	=	0.00	ft
Load Type	=	Seismic (E) (Service Level)	
Wind on Exposed Stem	=	12.0	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	Line Load		
Base Above/Below Soil at Back of Wall	=	0.0	ft
Poisson's Ratio	=	0.300	

Earth Pressure Seismic Load

K_h Soil Density Multiplier	=	0.200	g
Added seismic per unit area	=	150.2	psf

Design Summary

Total Bearing Load	=	7,989	lbs	
...resultant ecc.	=	4.24	in	
Soil Pressure @ Toe	=	812	psf	OK
Soil Pressure @ Heel	=	1,555	psf	OK
Allowable	=	2,000	psf	
Soil Pressure Less Than Allowable				
ACI Factored @ Toe	=	975	psf	
ACI Factored @ Heel	=	1,866	psf	
Footing Shear @ Toe	=	5.5	psi	OK
Footing Shear @ Heel	=	1.2	psi	OK
Allowable	=	75.0	psi	
Reaction at Top	=	2,038.0	lbs	
Reaction at Bottom	=	3,788.8	lbs	

Sliding Calcs

Lateral Sliding Force = 3,788.8 lbs

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

Restrained Retaining Wall

Code: CBC 2019,ACI 318-14,TMS 402-16

Concrete Stem Construction

Thickness = 12.00 in
Wall Weight = 150.0 psf
Stem is FREE to rotate at top of footing

Fy = 60,000 psi
f'c = 4,500 psi

		@ Top Support	Mmax Between Top & Base	@ Base of Wall
		As < Min %	As < Min %	As < Min %
Design Height Above Ftg	=	9.75 ft	4.42 ft	0.00 ft
Rebar Size	=	# 5	# 5	# 5
Rebar Spacing	=	18.00 in	18.00 in	18.00 in
Rebar Placed at	=	Edge	Edge	Edge
Rebar Depth 'd'	=	9.50 in	9.50 in	9.50 in
Design Data				
fb/FB + fa/Fa	=	1.000	1.000	1.000
Mu....Actual	=	160.0 ft-#	9,152.3 ft-#	0.0 ft-#
Mn * Phi.....Allowable	=	8,709.0 ft-#	8,709.0 ft-#	8,709.0 ft-#
Shear Force @ this height	=	3,012.0 lbs		4,496.7 lbs
Shear.....Actual	=	26.42 psi		39.45 psi
Shear.....Allowable	=	100.62 psi		100.62 psi

DCR=1.05
WITHIN 5% (OK)

Other Acceptable Sizes & Spacings:

Toe: # 5 @ 18.00 in	-or-	Not req'd: Mu < phi*5*lambda*sqrt(f'c)*Sm
Heel:# 5 @ 18.00 in	-or-	Not req'd: Mu < phi*5*lambda*sqrt(f'c)*Sm
Key: Slab Resists Sliding	-or-	Slab Resists Sliding - No Force on

Concrete Stem Rebar Area Details

Top Support	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.0039 in2/ft		
(4/3) * As :	0.0052 in2/ft	Min Stem T&S Reinf Area 2.808 in2	
3sqrt(f'c)bd/fy : 3sqrt(4500)(12)(9.5)/60000 :	0.3824 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.288 in2/ft	
0.0018bh : 0.0018(12)(12) :	0.2592 in2/ft	Horizontal Reinforcing Options :	
	==========	One layer of :	Two layers of :
Required Area :	0.2592 in2/ft	#4@ 8.33 in	#4@ 16.67 in
Provided Area :	0.2067 in2/ft	#5@ 12.92 in	#5@ 25.83 in
Maximum Area :	2.2484 in2/ft	#6@ 18.33 in	#6@ 36.67 in

Mmax Between Ends	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.2213 in2/ft		
(4/3) * As :	0.2951 in2/ft	Min Stem T&S Reinf Area 1.534 in2	
3sqrt(f'c)bd/fy : 3sqrt(4500)(12)(9.5)/60000 :	0.3824 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.288 in2/ft	
0.0018bh : 0.0018(12)(12) :	0.2592 in2/ft	Horizontal Reinforcing Options :	
	==========	One layer of :	Two layers of :
Required Area :	0.2951 in2/ft	#4@ 8.33 in	#4@ 16.67 in
Provided Area :	0.2067 in2/ft	#5@ 12.92 in	#5@ 25.83 in
Maximum Area :	2.2484 in2/ft	#6@ 18.33 in	#6@ 36.67 in

Base Support	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0 in2/ft		
(4/3) * As :	0 in2/ft	Min Stem T&S Reinf Area 1.274 in2	
3sqrt(f'c)bd/fy : 3sqrt(4500)(12)(9.5)/60000 :	0.3824 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.288 in2/ft	
0.0018bh : 0.0018(12)(12) :	0.2592 in2/ft	Horizontal Reinforcing Options :	
	==========	One layer of :	Two layers of :
Required Area :	0.2592 in2/ft	#4@ 8.33 in	#4@ 16.67 in
Provided Area :	0.2067 in2/ft	#5@ 12.92 in	#5@ 25.83 in
Maximum Area :	2.2484 in2/ft	#6@ 18.33 in	#6@ 36.67 in

Footing Strengths & Dimensions

Toe Width	=	2.25	ft
Heel Width	=	4.50	
Total Footing Width	=	6.75	
Footing Thickness	=	16.00	in
Key Width	=	12.00	in
Key Depth	=	18.00	in
Key Distance from Toe	=	2.25	ft
f'c	=	2,500	psi
Fy	=	60,000	psi
Footing Concrete Density	=	150.00	pcf
Min. As %	=	0.0018	

Cover @ Top = 3.00 in @ Btm.= 3.00 in

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Restrained Retaining Wall

Code: CBC 2019,ACI 318-14,TMS 402-16

Footing Design Results

		Toe	Heel
Factored Pressure	=	975	1,866 psf
Mu' : Upward	=	0	9,811 ft-#
Mu' : Downward	=	0	10,333 ft-#
Mu: Design	=	1,628	522 ft-#
Actual 1-Way Shear	=	5.50	1.22 psi
Allow 1-Way Shear	=	75.00	75.00 psi

Min footing T&S reinf Area 2.33 in2
Min footing T&S reinf Area per fo 0.35 in2 /ft

If one layer of horizontal bars: If two layers of horizontal bars:
#4@ 6.94 in
#5@ 10.76 in
#6@ 15.28 in

Summary of Forces on Footing : Slab RESISTS sliding, stem is PINNED at footing

Forces acting on footing soil pressure

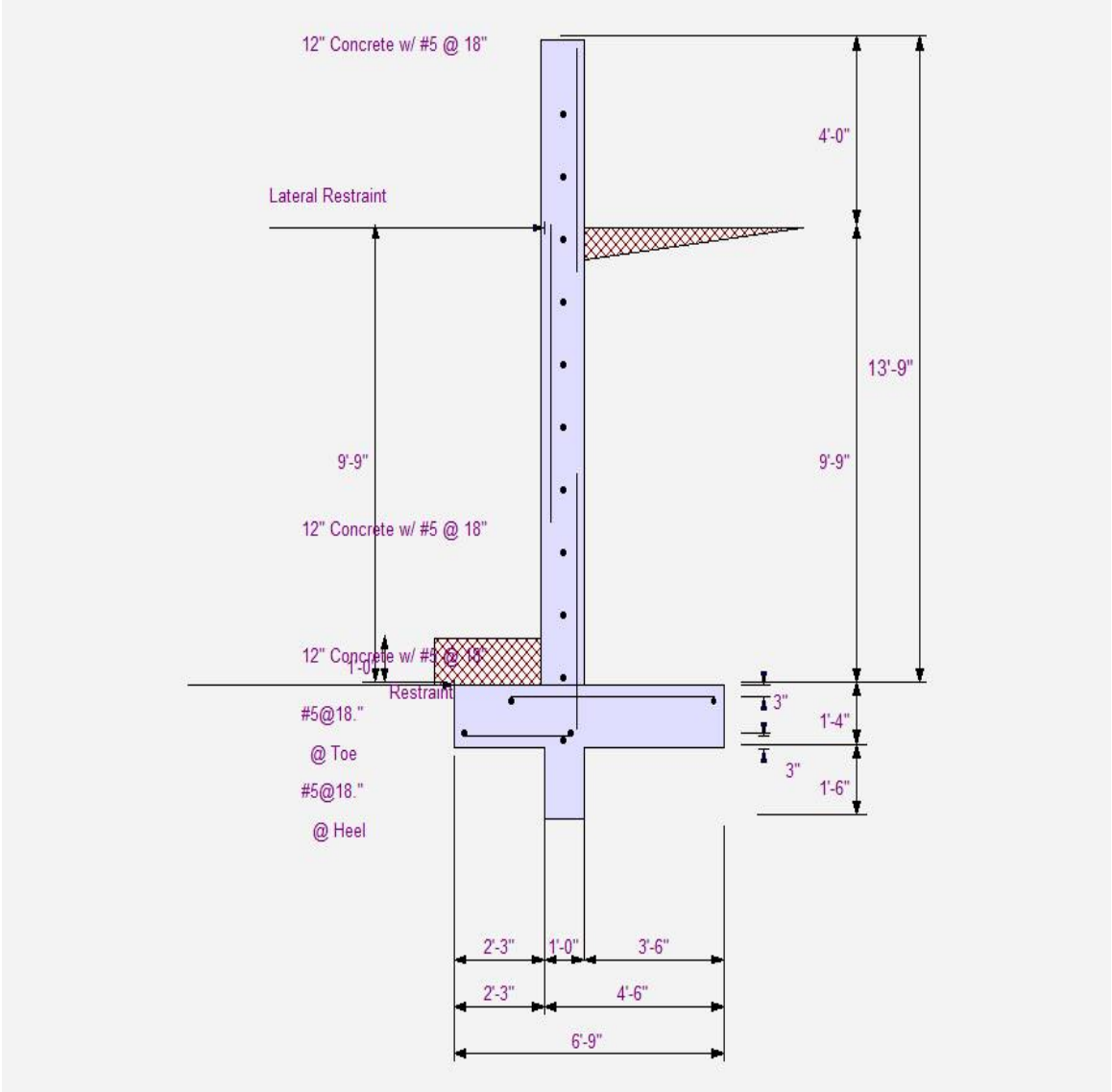
(taking moments about front of footing to find eccentricity)

Surcharge Over Heel	=		lbs		ft	ft-#
Axial Dead Load on Stem	=		lbs		ft	ft-#
Soil Over Toe	=	247.5	lbs	1.13	ft	278.4 ft-#
Adjacent Footing Load	=		lbs		ft	ft-#
Surcharge Over Toe	=		lbs		ft	ft-#
Stem Weight	=	2,062.5	lbs	2.75	ft	5,671.9 ft-#
Soil Over Heel	=	3,753.8	lbs	5.00	ft	18,768.8 ft-#
Footing Weight	=	1,575.0	lbs	3.21	ft	5,063.0 ft-#
Total Vertical Force	=	7,988.8	lbs	Moment	=	29,782.1 ft-#

Net Mom. at Stem/Ftg Interface =	**-2,820.0**	**ft-#**
Allow. Mom. @ Stem/Ftg Interface =	**5,443.1**	**ft-#**
Allow. Mom. Exceeds Applied Mom.?	**Yes**	

Vertical component of active lateral soil pressure IS NOT considered in the calculation of soil bearing pressures.

9'-9" Restrained Condition



D. New Slab Anchorage

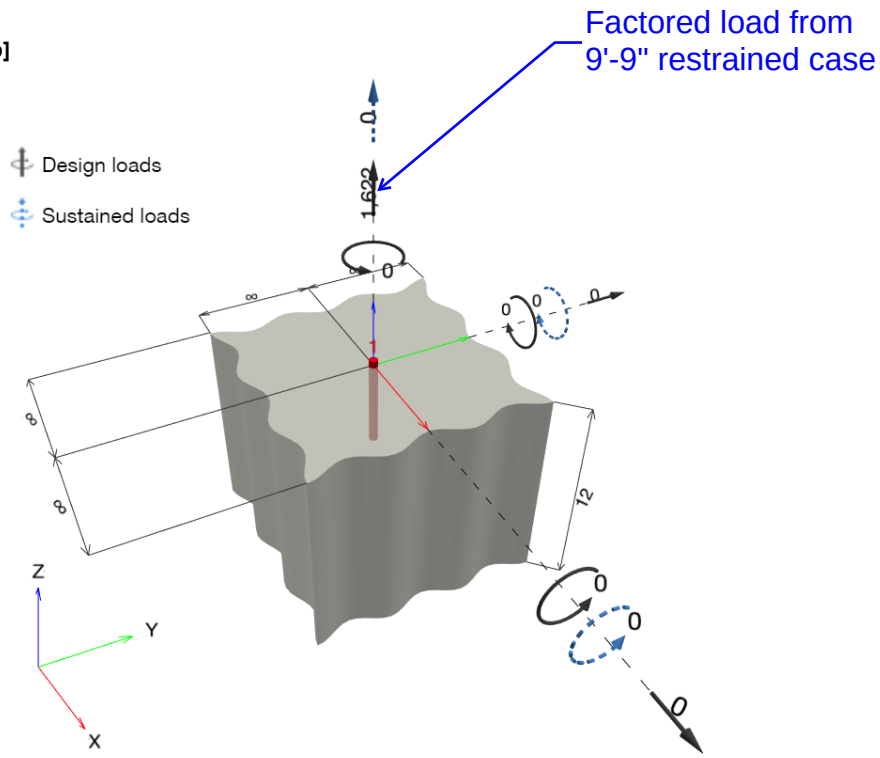
Company:		Page:	1
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	Concrete - Oct 9, 2020	Date:	10/9/2020
Fastening point:			

Specifier's comments:

1 Input data

Anchor type and diameter:	**HIT-RE 500 V3 + Rebar A706 Gr.60 #4**
Item number:	not available (element) / 2123401 HIT-RE 500 V3 (adhesive)
Effective embedment depth:	$h_{ef,act}$ = 5.000 in. ($h_{ef,limit}$ = - in.)
Material:	ASTM A 706 Gr.60
Evaluation Service Report:	ESR-3814
Issued I Valid:	1/1/2020 | 1/1/2021
Proof:	Design Method ACI 318-08 / Chem
Stand-off installation:	
Profile:	
Base material:	cracked concrete, 2500, f_c' = 2,500 psi; h = 12.000 in., Temp. short/long: 32/32 °F
Installation:	**hammer drilled hole, Installation condition: Dry**
Reinforcement:	tension: condition B, shear: condition B; no supplemental splitting reinforcement present edge reinforcement: none or < No. 4 bar
Seismic loads (cat. C, D, E, or F)	no

Geometry [in.] & Loading [lb, in.lb]



Company:		Page:	2
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	Concrete - Oct 9, 2020	Date:	10/9/2020
Fastening point:			

1.1 Design results

Case	Description	Forces [lb] / Moments [in.lb]	Seismic	Max. Util. Anchor [%]
1	Combination 1	N = 1,622; V_x = 0; V_y = 0; M_x = 0; M_y = 0; M_z = 0; N_{sus} = 0; $M_{x,sus}$ = 0; $M_{y,sus}$ = 0;	no	27

Company:		Page:	3
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	Concrete - Oct 9, 2020	Date:	10/9/2020
Fastening point:			

2 Proof I Utilization (Governing Cases)

		Design values [lb]		Utilization	
Loading	**Proof**	**Load**	**Capacity**	**β_N / β_V [%]**	**Status**
Tension	Concrete Breakout Failure	1,622	6,177	27 / -	OK
Shear	-	-	-	- / -	N/A

Loading	**β_N**	**β_V**	**ζ**	**Utilization $\beta_{N,V}$ [%]**	**Status**
Combined tension and shear loads	-	-	-	-	N/A

3 Warnings

- Please consider all details and hints/warnings given in the detailed report!

Fastening meets the design criteria!

4 Remarks; Your Cooperation Duties

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