

DAUGHTERS OF ISRAEL

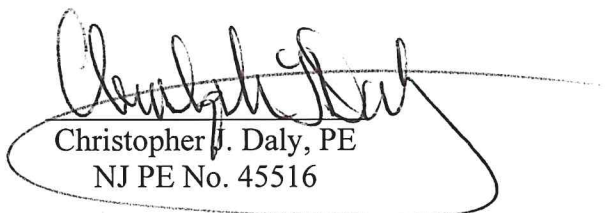
1155 PLEASANT VALLEY WAY
LOT 12, BLOCK 171
TOWNSHIP OF WEST ORANGE
ESSEX COUNTY, NEW JERSEY

RETAINING WALL CALCUATIONS

PREPARED BY:

PETRY ENGINEERING, LLC
155 PASSAIC AVENUE
FAIRFIELD, NEW JERSEY 07004

May 20, 2022


Christopher J. Daly, PE
NJ PE No. 45516



Project Title:
Engineer:
Project ID:
Project Descr:

Cantilevered Retaining Wall

Project File: Retaining Wall Design.ec6

LIC# : KW-06014278, Build:20.22.4.26

Petry Engineering, LLC

(c) ENERCALC INC 1983-2022

DESCRIPTION: Wall A: Concrete Retaining Wall - 5 feet w/ roadway

Code Reference:

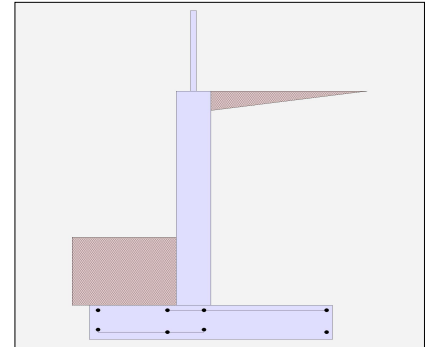
Calculations per IBC 2018 1807.3, CBC 2019, ASCE 7-16

Criteria

Retained Height	=	7.33 ft
Wall height above soil	=	2.75 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	28.00 in
Water height over heel	=	0.0 ft

Soil Data

Allow Soil Bearing	=	4,000.0 psf
Coulomb Soil Pressure calculation		
Soil Friction Angle	=	30.0 deg
Active Pressure:		
Ka*Gamma (horiz)	=	30.9 psf/ft
Passive Pressure:Kp*Gar	=	576.8 psf/ft
Soil Density, Heel	=	120.00 pcf
Soil Density, Toe	=	120.00 pcf
Footing Soil Friction	=	0.400
Soil height to ignore for passive pressure	=	12.00 in



Surcharge Loads

Surcharge Over Heel	=	250.0 psf
Used To Resist Sliding & Overturning		
Surcharge Over Toe	=	0.0 psf
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	=	1,200.0 #/ft
...Height to Top	=	10.08 ft
...Height to Bottom	=	9.08 ft
Load Type	=	Live Load (L) (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

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DESCRIPTION: Wall A: Concrete Retaining Wall - 5 feet w/ roadway

Design Summary			Stem Construction		2nd	Bottom	
Wall Stability Ratios			Design Height Above Ftg	ft =	7.33	Stem OK	
Overtuning	=	1.59 OK	Wall Material Above "Ht"	=	Fence	Concrete	
Sliding	=	2.11 OK	Design Method	=		SD	SD
Global Stability	=	2.99	Thickness	=		12.00	
			Rebar Size	=		# 6	
			Rebar Spacing	=		8.00	
			Rebar Placed at	=		Edge	
Total Bearing Load	=	6,980 lbs	Design Data				
...resultant ecc.	=	23.36 in	fb/FB + fa/Fa	=		0.899	
Eccentricity outside middle third			Total Force @ Section				
Soil Pressure @ Toe	=	2,996 psf OK	Service Level	lbs =			
Soil Pressure @ Heel	=	0 psf OK	Strength Level	lbs =		4,003.4	
Allowable	=	4,000 psf	Moment....Actual				
Soil Pressure Less Than Allowable			Service Level	ft-# =			
ACI Factored @ Toe	=	4,194 psf	Strength Level	ft-# =		24,414.5	
ACI Factored @ Heel	=	0 psf	Moment.....Allowable	ft-# =		27,140.6	
Footing Shear @ Toe	=	36.2 psi OK	Shear.....Actual				
Footing Shear @ Hee	=	37.9 psi OK	Service Level	psi =			
Allowable	=	94.9 psi	Strength Level	psi =		34.7	
Sliding Calcs			Shear.....Allowable	=		94.9	
Lateral Sliding Force	=	2,862.4 lbs	Anet (Masonry)	in2 =			
less 100% Passive Force	-	3,244.7 lbs	Wall Weight	psf =		150.0	
less 100% Friction Force	= -	2,791.9 lbs	Rebar Depth 'd'	in =		9.63	
Added Force Req'd	=	0.0 lbs OK	Masonry Data				
....for 1.5 Stability	=	0.0 lbs OK	f'm	psi =			
Vertical component of active lateral soil pressure IS NOT considered in the calculation of soil bearing			Fs	psi =			
Load Factors			Solid Grouting	=			
Building Code			Modular Ratio 'n'	=			
Dead Load		1.200	Equiv. Solid Thick.	=			
Live Load		1.600	Masonry Block Type	=			
Earth, H		1.600	Masonry Design Method	=	ASD		
Wind, W		1.600	Concrete Data				
Seismic, E		1.000	f'c	psi =		4,000.0	
			Fy	psi =		60,000.0	

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DESCRIPTION: Wall A: Concrete Retaining Wall - 5 feet w/ roadway

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.583 in2/ft	
(4/3) * As :	0.7773 in2/ft	Min Stem T&S Reinf Area 2.112 in2
200bd/fy : 200(12)(9.625)/60000 :	0.385 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 :	0.583 in2/ft	#4@ 8.33 in #4@ 16.67 in
Provided Area :	0.66 in2/ft	#5@ 12.92 in #5@ 25.83 in
Maximum Area :	2.0862 in2/ft	#6@ 18.33 in #6@ 36.67 in

Footing Data

Toe Width	=	2.50 ft
Heel Width	=	4.50
Total Footing Width	=	7.00
Footing Thickness	=	14.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft
f'c = 4,000 psi	Fy = 60,000 psi	
Footing Concrete Density = 150.00 pcf		
Min. As % = 0.0018		
Cover @ Top 2.00	@ Btm.= 3.00 in	

Footing Design Results

	Toe	Heel
Factored Pressure	= 4,194	0 psf
Mu' : Upward	= 10,763	234 ft-#
Mu' : Downward	= 1,706	10,204 ft-#
Mu: Design	= 9,057 OK	9,970 ft-# OK
phiMn	= 20,397	22,377 ft-#
Actual 1-Way Shear	= 36.17	37.87 psi
Allow 1-Way Shear	= 94.87	94.87 psi
Toe Reinforcing	= # 6 @ 12.00 in	
Heel Reinforcing	= # 6 @ 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:
Heel:
Key:

Min footing T&S reinf Area	2.12 in2
Min footing T&S reinf Area per foot	0.30 in2 /ft
If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 7.94 in	#4@ 15.87 in
#5@ 12.30 in	#5@ 24.60 in
#6@ 17.46 in	#6@ 34.92 in

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DESCRIPTION: Wall A: Concrete Retaining Wall - 5 feet w/ roadway

Summary of Overturning & Resisting Forces & Moments

.....OVERTURNING.....				RESISTING.....			
Item	Force lbs	Distance ft	Moment ft-#		Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	1,115.6	2.83	3,160.6	Soil Over HL (ab. water tbl)	3,079.9	5.25	16,169.3
HL Act Pres (be water tbl)				Soil Over HL (bel. water tbl)		5.25	16,169.3
Hydrostatic Force				Watre Table			
Buoyant Force =				Sloped Soil Over Hee =			
Surcharge over Heel =	546.9	4.25	2,324.1	Surcharge Over Heel =	875.0	5.25	4,593.8
Surcharge Over Toe =				Adjacent Footing Load =			
Adjacent Footing Load =				Axial Dead Load on Stem =			
Added Lateral Load =	1,200.0	10.75	12,899.6	* Axial Live Load on Stem =			
Load @ Stem Above Soil =				Soil Over Toe =	700.0	1.25	875.0
=				Surcharge Over Toe =			
				Stem Weight(s) =	1,100.0	3.00	3,299.9
				Earth @ Stem Transitions =			
Total =	2,862.4	O.T.M. =	18,384.3	Footing Weighl =	1,225.0	3.50	4,287.5
				Key Weight =			
				Vert. Component =			
Resisting/Overturning Ratio		=	1.59	Total =	6,979.8 lbs	R.M.=	29,225.4
Vertical Loads used for Soil Pressure =		6,979.8	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)	0.120 in
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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.

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DESCRIPTION: Wall A: Concrete Retaining Wall - 5 feet w/ roadway

Rebar Lap & Embedment Lengths Information

Stem Design Segment: Bottom

Stem Design Height: 0.00 ft above top of footing

Lap Splice length for #6 bar specified in this stem design segment = 22.20 in

Development length for #6 bar specified in this stem design segment = 17.08 in

Hooked embedment length into footing for #6 bar specified in this stem design segment = 9.96 in

As Provided = 0.6600 in²/ft

As Required = 0.5830 in²/ft

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Cantilevered Retaining Wall

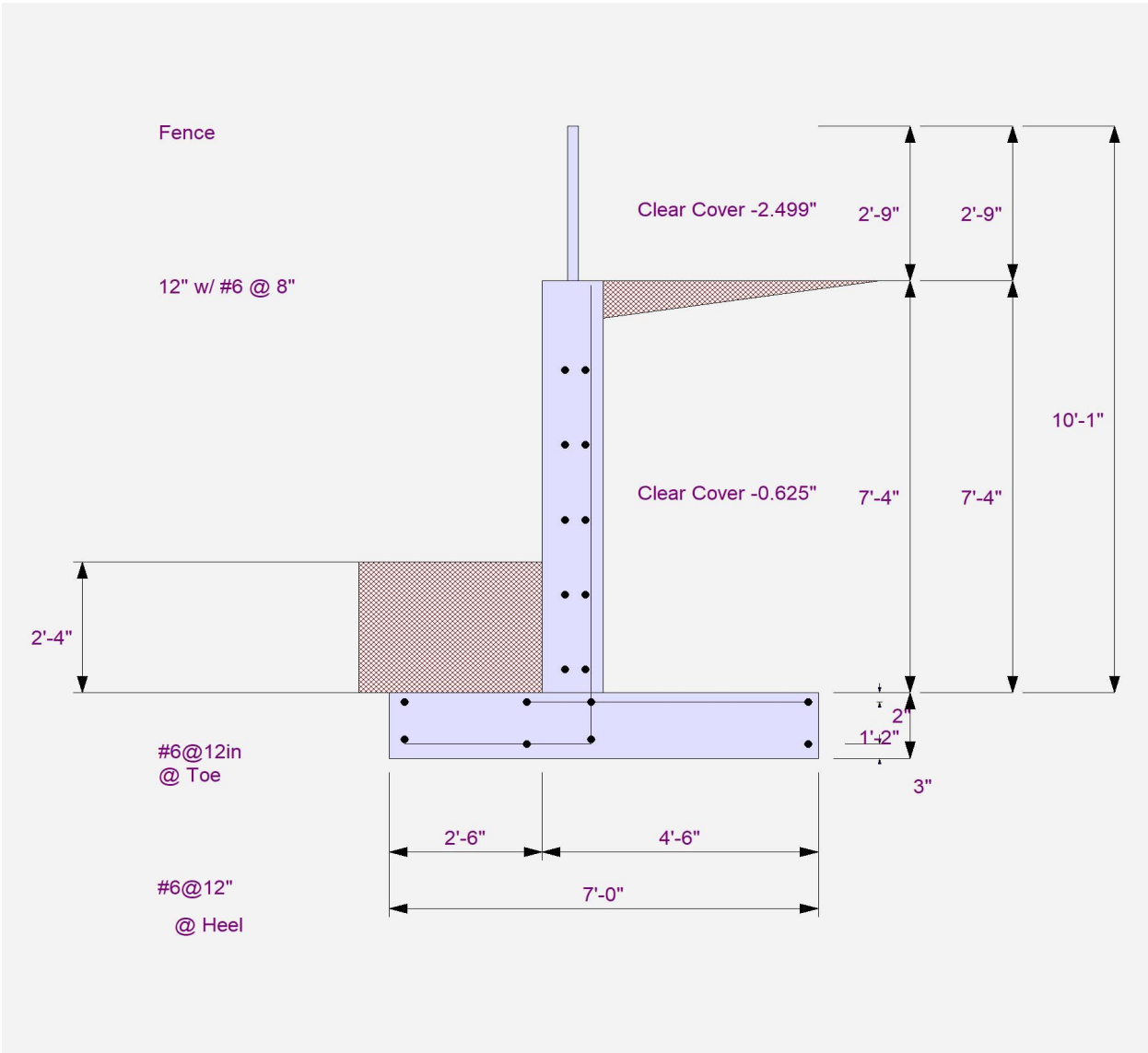
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DESCRIPTION: Wall A: Concrete Retaining Wall - 5 feet w/ roadway



Cantilevered Retaining Wall

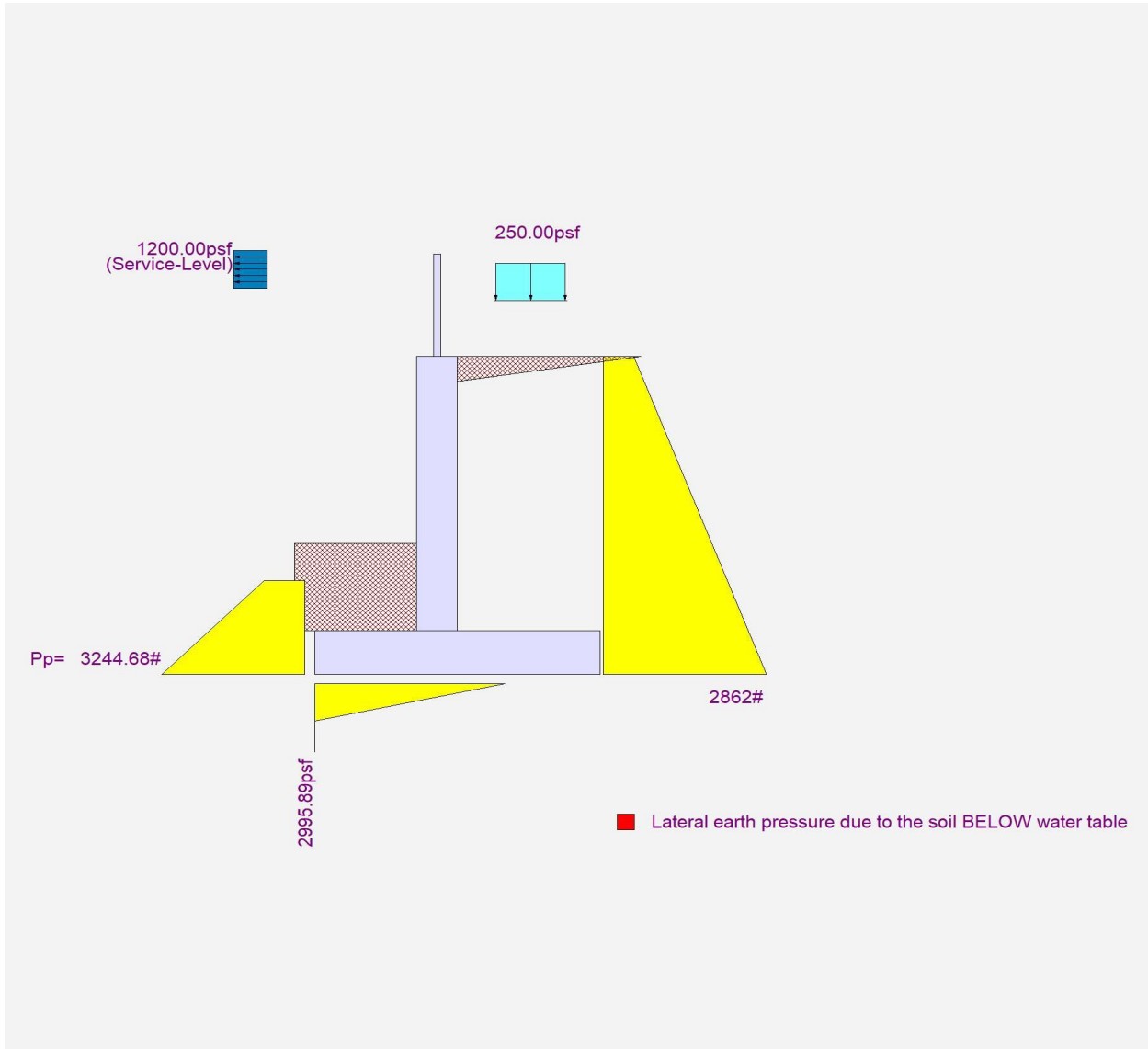
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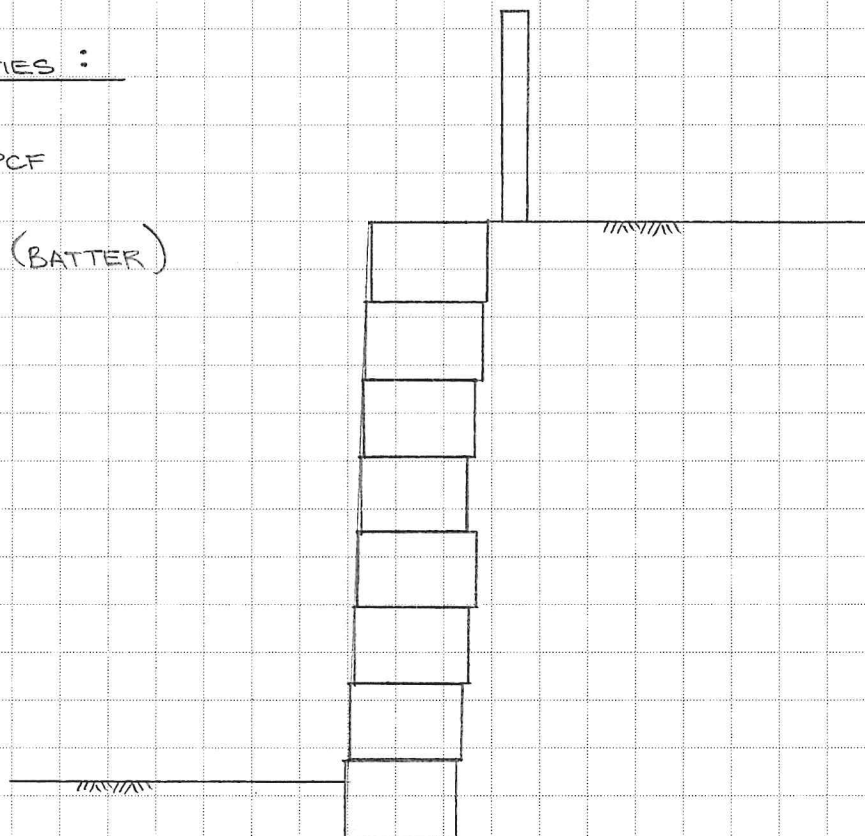
DESIGN RETAINING WALL (A) (5'-0")

SOIL PROPERTIES :

$$\gamma = 120 \text{ PCF}$$

$$\phi = 30^\circ$$

$$\alpha = 0^\circ \text{ (BATTER)}$$



SECTION

N.T.S.

CALCULATE ACTIVE & PASSIVE PRESSURE COEFF., K_a & K_p :

$$K_p^a = \cos \alpha \cdot \frac{\cos \alpha + \sqrt{\cos^2 \alpha - \cos^2 \phi}}{\cos \alpha - \sqrt{\cos^2 \alpha - \cos^2 \phi}}$$

$$K_p^a = \cos 0 \cdot \frac{\cos 0^\circ + \sqrt{\cos^2 0^\circ - \cos^2 30^\circ}}{\cos 0^\circ - \sqrt{\cos^2 0^\circ - \cos^2 30^\circ}}$$

$$K_p^a = (1) \cdot \left[\frac{(1) + \sqrt{0.25}}{(1) - \sqrt{0.25}} \right]$$

$$K_a = 0.33$$

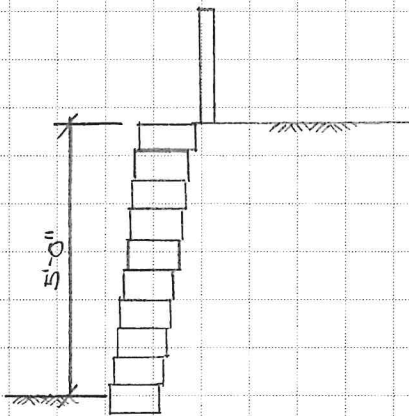
$$K_p = 3.0$$

DESIGN RETAINING WALL (A) (5'-0")

SOIL

SURCHARGE

GUIDERAIL



$$F_{SOIL} = \frac{1}{2} K_a \gamma (H)^2 = \frac{1}{2} (0.33) (120) (5.5)^2 = 599 \#$$

$$F_{SOIL_v} = F_{SOIL} \sin \phi = 599 \sin (30^\circ) = 300 \#$$

$$F_{SOIL_H} = F_{SOIL} \cos \phi = 599 \cos (30^\circ) = 519 \#$$

$$F_{SURCHARGE} = q_o (K_a) (H) = (250 \text{ PSF}) (0.33) (5.5) = 454 \#$$

$$F_{RAIL} = 1200 \# / \text{FT} \text{ (ASCE 7-10, 4.5.3)}$$

DESIGN RETAINING WALL (A) (5'-0")

A. STABILITY ANALYSIS - SLIDING :

CALCULATE SLIDING FORCE :

$$P_{SLIDING} = F_{SOIL_H} + F_{SURCHARGE} + F_{RAIL} = 519 + 454 + 1200 = 2173 \#$$

CALCULATE RESISTING FORCE :

$$R_{SLIDING} = (WEIGHT)(\mu)$$

$$WEIGHT = (5.5') \underset{\substack{\uparrow \\ \text{GEOGRID}}}{(7')} (120 \text{ PCF}) + \overset{\substack{\text{SURCHARGE}}}{(7') (250)} \\ = 6370 \#$$

$$R_{SLIDING} = 6370(0.58) \\ = 3695 \#$$

$$F.S._{SLIDING} = \frac{R_{SLIDING}}{P_{SLIDING}} = \frac{3695}{2173} = 1.7 > 1.5 \checkmark$$

WHERE :

WEIGHT = WEIGHT OF WALL

μ = COEFF. OF FRICTION

$\mu = \tan \phi = 0.58$

B. STABILITY ANALYSIS - OVERTURNING :

CALCULATE OVERTURNING MOMENT, MOT :

$$MOT = F_{SOIL_H} \left(\frac{5.5}{3} \right) + F_{SUR} \left(\frac{5.5}{2} \right) + F_{RAIL} (7.75') = 519 \left(\frac{5.5}{3} \right) + 454 \left(\frac{5.5}{2} \right) + 1200 (7.75)$$

$$MOT = 11500 \# \cdot FT$$

CALCULATE RESISTING MOMENT, MR :

$$MR = (120)(5.5)(7)(\frac{1}{2}) + (250)(7)(\frac{1}{2})$$

$$MR = 22295 \# \cdot FT$$

$$F.S._{OVERTURNING} = \frac{MR}{MOT} = \frac{22295}{11500} = 1.9 > 1.5 \text{ OK } \checkmark$$

DESIGN RETAINING WALL (A) (5'-0")

C. STABILITY ANALYSIS - BEARING :

CALCULATE ECCENTRICITY :

$$e = B/2 - \frac{M_R - M_{OT}}{WEIGHT} = 7/2 - \frac{22295 - 11500}{6370}$$

$$e = 1.8' \therefore \text{RESULTANT LIES OUTSIDE MIDDLE THIRD}$$

$$R = \frac{1}{2} p_{max} (3x_2) ; x_2 = \frac{1}{2} - e = 7/2 - 1.8 = 1.7'$$

$$p_{max} = \frac{2R}{3x_2} = \frac{2(6370)}{3(1.7)} = 2498 \text{ PSF} < 4000 \text{ PSF OK} \checkmark$$

Project Title: Daughters of Israel
 Engineer: Jorge Lopez, PE
 Project ID: 19-265
 Project Descr: Retaining Wall Design

Cantilevered Retaining Wall

Project File: Retaining Wall Design.ec6

LIC# : KW-06014278, Build:20.22.4.26

Petry Engineering, LLC

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DESCRIPTION: Wall B: 4'-0" Concrete Retaining Wall

Code Reference:

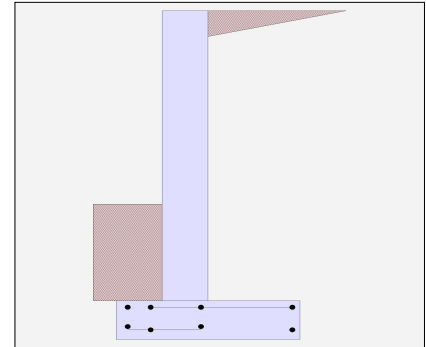
Calculations per IBC 2018 1807.3, CBC 2019, ASCE 7-16

Criteria

Retained Height	=	7.50 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	30.00 in
Water height over heel	=	0.0 ft

Soil Data

Allow Soil Bearing	=	4,000.0 psf
Coulomb Soil Pressure calculation		
Soil Friction Angle	=	30.0 deg
Active Pressure:		
Ka*Gamma (horiz)	=	30.9 psf/ft
Passive Pressure:Kp*Gar	=	576.8 psf/ft
Soil Density, Heel	=	120.00 pcf
Soil Density, Toe	=	120.00 pcf
Footing Soil Friction	=	0.400
Soil height to ignore for passive pressure	=	12.00 in



Surcharge Loads

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

Axial Load Applied to Stem

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

Lateral Load Applied to Stem

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

Adjacent Footing Load

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

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DESCRIPTION: Wall B: 4'-0" Concrete Retaining Wall

Design Summary

Wall Stability Ratios

Overturing	=	2.67	OK
Sliding	=	4.28	OK
Global Stability	=	2.52	

Total Bearing Load	=	3,825 lbs	
...resultant ecc.	=	7.45 in	

Eccentricity within middle third

Soil Pressure @ Toe	=	1,846 psf	OK
Soil Pressure @ Heel	=	66 psf	OK
Allowable	=	4,000 psf	

Soil Pressure Less Than Allowable

ACI Factored @ Toe	=	2,585 psf	
ACI Factored @ Heel	=	93 psf	
Footing Shear @ Toe	=	5.2 psi	OK
Footing Shear @ Heel	=	9.5 psi	OK
Allowable	=	94.9 psi	

Sliding Calcs

Lateral Sliding Force	=	1,115.7 lbs	
less 100% Passive Force	=	3,244.7 lbs	
less 100% Friction Force	=	1,530.0 lbs	
Added Force Req'd	=	0.0 lbs	OK
....for 1.5 Stability	=	0.0 lbs	OK

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

Load Factors

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

Stem Construction

Design Height Above Ftg

ft =	0.00		
Wall Material Above "Ht"	=	Concrete	
Design Method	=	SD	SD
Thickness	=	12.00	
Rebar Size	=	# 5	
Rebar Spacing	=	12.00	
Rebar Placed at	=	Edge	

Design Data

fb/FB + fa/Fa	=	0.250	
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Total Force @ Section

Service Level	lbs =	
Strength Level	lbs =	1,389.7

Moment....Actual

Service Level	ft-# =	
Strength Level	ft-# =	3,474.4

Moment.....Allowable	=	13,892.6	
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Shear.....Actual

Service Level	psi =	
Strength Level	psi =	11.4

Shear.....Allowable	psi =	94.9	
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Anet (Masonry)	in2 =		
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Wall Weight	psf =	150.0	
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Rebar Depth 'd'	in =	10.19	
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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 =	4,000.0	
Fy	psi =	60,000.0	

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DESCRIPTION: Wall B: 4'-0" Concrete Retaining Wall

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.0782 in ² /ft	
(4/3) * As :	0.1043 in ² /ft	Min Stem T&S Reinf Area 2.160 in ²
200bd/fy : 200(12)(10.1875)/60000 :	0.4075 in ² /ft	Min Stem T&S Reinf Area per ft of stem Height : 0.288 in ² /ft
0.0018bh : 0.0018(12)(12) :	0.2592 in ² /ft	Horizontal Reinforcing Options :
	=====	One layer of : Two layers of :
Required Area :	0.2592 in ² /ft	#4@ 8.33 in #4@ 16.67 in
Provided Area :	0.31 in ² /ft	#5@ 12.92 in #5@ 25.83 in
Maximum Area :	2.2081 in ² /ft	#6@ 18.33 in #6@ 36.67 in

Footing Data

Toe Width	=	1.00 ft
Heel Width	=	3.00
Total Footing Width	=	4.00
Footing Thickness	=	12.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft
f'c =	4,000 psi	Fy = 60,000 psi
Footing Concrete Density	=	150.00 pcf
Min. As %	=	0.0018
Cover @ Top	2.00	@ Btm.= 3.00 in

Footing Design Results

	Toe	Heel
Factored Pressure	= 2,585	93 psf
Mu' : Upward	= 1,189	1,016 ft-#
Mu' : Downward	= 270	2,520 ft-#
Mu: Design	= 919 OK	1,504 ft-# OK
phiMn	= 11,801	13,196 ft-#
Actual 1-Way Shear	= 5.24	9.55 psi
Allow 1-Way Shear	= 94.87	94.87 psi
Toe Reinforcing	= # 5 @ 12.00 in	
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:
 Heel:
 Key:

Min footing T&S reinf Area	1.04 in ²
Min footing T&S reinf Area per foot	0.26 in ² /ft
If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 9.26 in	#4@ 18.52 in
#5@ 14.35 in	#5@ 28.70 in
#6@ 20.37 in	#6@ 40.74 in

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 Project ID: 19-265
 Project Descr: Retaining Wall Design

Cantilevered Retaining Wall

Project File: Retaining Wall Design.ec6

LIC# : KW-06014278, Build:20.22.4.26

Petry Engineering, LLC

(c) ENERCALC INC 1983-2022

DESCRIPTION: Wall B: 4'-0" Concrete Retaining Wall

Summary of Overturning & Resisting Forces & Moments

.....OVERTURNING.....				RESISTING.....			
Item	Force lbs	Distance ft	Moment ft-#		Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	1,115.7	2.83	3,161.0	Soil Over HL (ab. water tbl)	1,800.0	3.00	5,400.0
HL Act Pres (be water tbl)				Soil Over HL (bel. water tbl)		3.00	5,400.0
Hydrostatic Force				Watre Table			
Buoyant Force =				Sloped Soil Over Hee =			
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 =	300.0	0.50	150.0
				Surcharge Over Toe =			
				Stem Weight(s) =	1,125.0	1.50	1,687.5
				Earth @ Stem Transitions =			
				Footing Weighl =	600.0	2.00	1,200.0
				Key Weight =			
				Vert. Component =			
Total	= 1,115.7	O.T.M. =	3,161.0	Total =	3,825.0 lbs	R.M.=	8,437.5
Resisting/Overturning Ratio		= 2.67		* Axial live load NOT included in total displayed, or used for overturning resistance, but is included for soil pressure calculation.			
Vertical Loads used for Soil Pressure =		3,825.0	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) 0.096 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: Daughters of Israel
Engineer: Jorge Lopez, PE
Project ID: 19-265
Project Descr: Retaining Wall Design

Cantilevered Retaining Wall

Project File: Retaining Wall Design.ec6

LIC# : KW-06014278, Build:20.22.4.26

Petry Engineering, LLC

(c) ENERCALC INC 1983-2022

DESCRIPTION: Wall B: 4'-0" Concrete Retaining Wall

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 = 18.50 in

Development length for #5 bar specified in this stem design segment = 14.23 in

Hooked embedment length into footing for #5 bar specified in this stem design segment = 8.30 in

As Provided = 0.3100 in2/ft

As Required = 0.2592 in2/ft

Cantilevered Retaining Wall

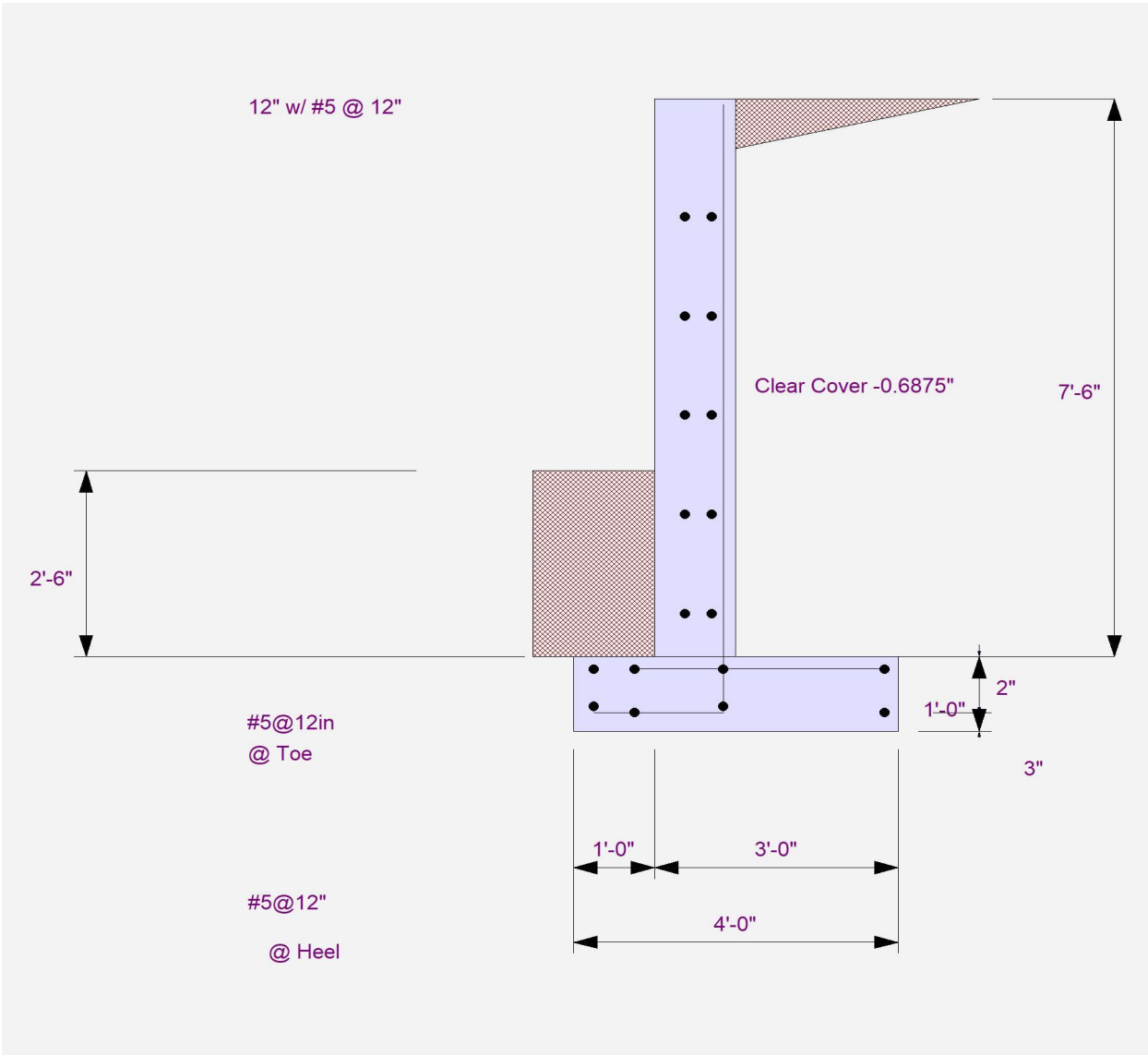
Project File: Retaining Wall Design.ec6

LIC# : KW-06014278, Build:20.22.4.26

Petry Engineering, LLC

(c) ENERCALC INC 1983-2022

DESCRIPTION: Wall B: 4'-0" Concrete Retaining Wall

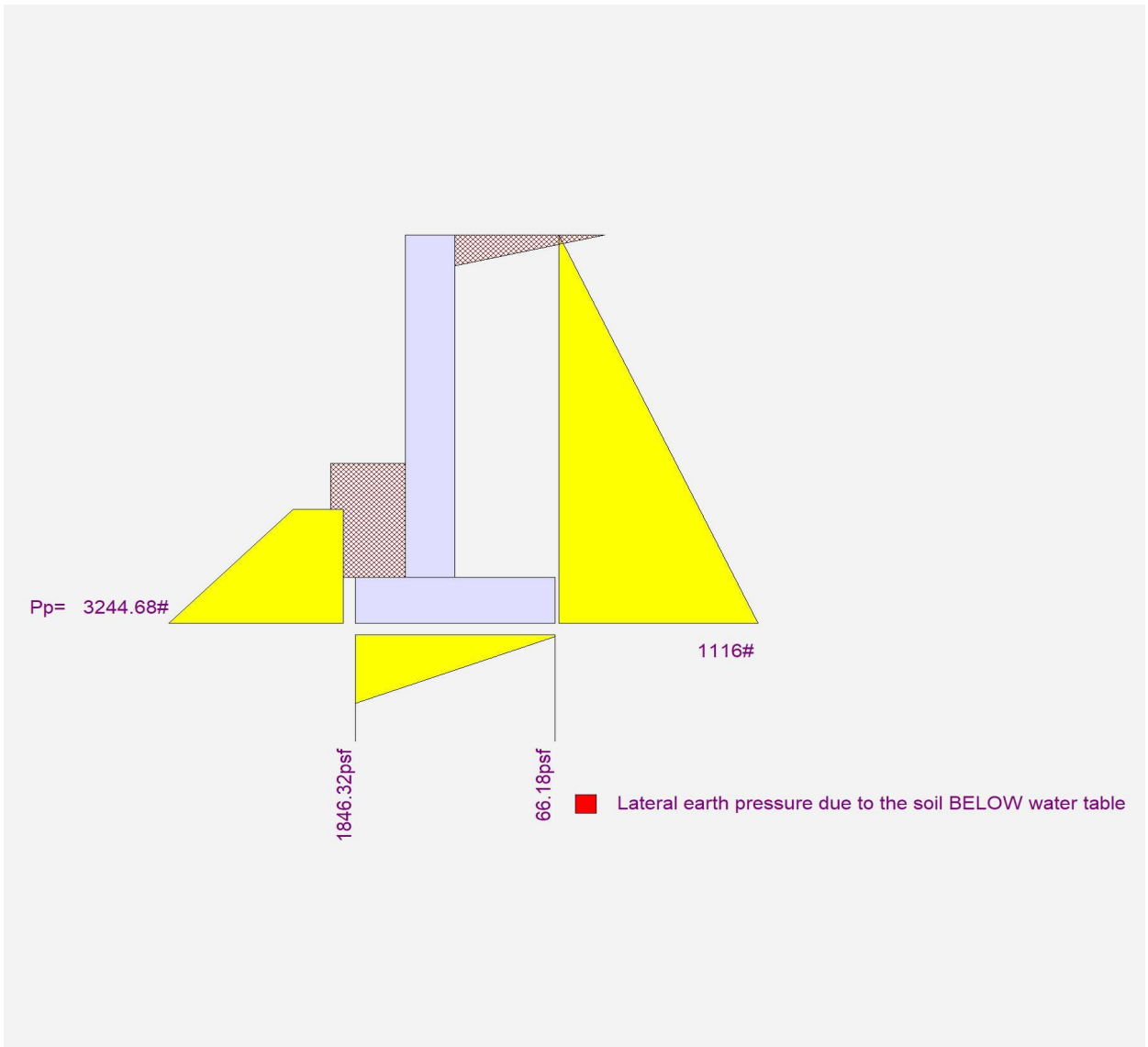


Cantilevered Retaining Wall

Project File: Retaining Wall Design.ec6

LIC# : KW-06014278, Build:20.22.4.26 Petry Engineering, LLC (c) ENERCALC INC 1983-2022

DESCRIPTION: Wall B: 4'-0" Concrete Retaining Wall



Project Title: Daughters of Israel
 Engineer: Jorge Lopez, PE
 Project ID: 19-265
 Project Descr: Retaining Wall Design

Segmental Retaining Wall

Project File: Retaining Wall Design.ec6

LIC# : KW-06014278, Build:20.22.4.26

Petry Engineering, LLC

(c) ENERCALC INC 1983-2022

DESCRIPTION: Wall B: 4'-0" Modular Block Wall

Criteria

Wall height (retained height)	6.00 ft
Backfill slope	Level
Backfill angle	0.0 deg
Embedment	1.8 ft

Soil data

External Soil, Phi_e	30 deg
External soil density (In situ)	120 pcf
Internal Soil, Phi_i	30 deg
Internal soil density	120 pcf
Wall Soil Friction Angle	0 deg
K_a(Horiz)	0.28

Loading

Dead load	0 psf
Live load	0 psf
Seismic Factor, A	0.00
d_seismic	0.00 in

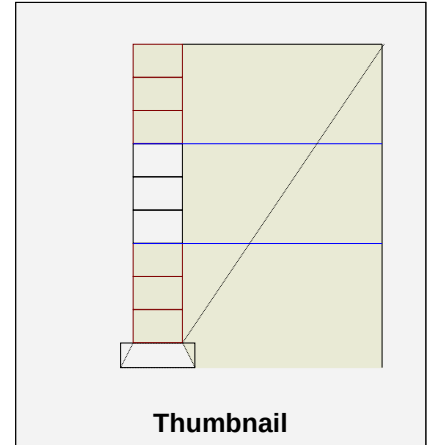
Stability

Base length	5.00 ft
Base Sliding Force (w/o Seismic)	555.90 lb
Base Resisting Force (w/o Seismic)	1,848.07 lb
Base Sliding (w/o Seismic) FS	3.32

Overturning Moment (w/o Seismic)	1,111.79 ft lb
Resisting Moment (w/o Seismic)	8,804.73 ft lb
Overturning (w/o Seismic) FS	7.92

Applied Bearing Pressure (w/o Seismic)	665.94 psf
Allowable Bearing Pressure (w/o Seismic)	4,000.00 psf
Bearing (w/o Seismic) FS	6.01

Eccentricity of Vert. Force (w/o Seismic)	0.10 ft
Effective Base Width (w/o Seismic)	4.81 ft



Segmental block data

Vendor selection	Keystone Retaining Wall		
Vendor ESR	ICC ESR-2113E	Valid through	08/31/21
Block selection type	Compac II		
Block height	8.00 in	alpha(u_1)	1376.00 lb
Block depth	12.00 in	tan(lambda_u1)	0.14
Offset per block	0.00 in	Max_1	1783.00 lb
Batter angle	0.00 deg	alpha(u_2)	1376.00 lb
Wall weight	120.00 psf	tan(lambda_u2)	0.14
		Max_2	1783.00 lb

Geogrid material

Vendor Selection			
Geogrid type			
LTDS	0.00 lb/ft		
Ci	0.90		
RF_CR	1.55		
alpha_u	1,031.00 lb		
tan(lambda_u)	0.53		
Max	3,942.00 lb		
alpha_cs1	1,713.00 lb	alpha_cs2	1,713.00 lb
tan(lambda_cs1)	0.36	tan(lambda_cs2)	0.36
Max_1	3,700.00 lb	Max_2	3,700.00 lb

Factors of Safety

Failure Mode	Static Condition			
	Min			
	Acceptable	Actual	Status	Acceptable
Base Sliding	1.50	3.32	OK	
Overturning	1.50	7.92	OK	
Bearing	1.00	6.01	OK	
Internal Sliding	1.50	8.58	OK	
Tensile Overstress	0.00	0.00	OK	
Pullout	1.50	3.76	OK	
Connection	1.50	4.69	OK	

Project Title: Daughters of Israel
 Engineer: Jorge Lopez, PE
 Project ID: 19-265
 Project Descr: Retaining Wall Design

Segmental Retaining Wall

Project File: Retaining Wall Design.ec6

LIC# : KW-06014278, Build:20.22.4.26

Petry Engineering, LLC

(c) ENERCALC INC 1983-2022

DESCRIPTION: Wall B: 4'-0" Modular Block Wall

Wall Analysis Table:

Layer	Height ft	Trib Height	Depth to Midpoint	Tension From Surcharge			Static Total Fg	LTDS	LTDS (Seismic)	Total Tension (W/seismic), Fi	FS Tensile Overstress	
				Soil	DL	LL					(Static)	w/Seismic)
2	4.00	3.00	2.00	201.2	0.0	0.0	201.2	0.0	0.0	201.2	0.00	0.00
1	2.00	3.00	4.00	402.3	0.0	0.0	402.3	0.0	0.0	402.3	0.00	0.00

Wall Analysis Table Continued:

Layer	Pullout Strength	FS Pullout		Connection Strength	FS Conn		Internal Sliding Force (Static)	FS Internal Sliding (Static)	Internal Sliding Force (Seismic)	FS Internal Sliding (Seismic)
		(Static)	(Seismic)		(Static)	(Seismic)				
2	756.8	3.76	0.00	1,799.4	8.95	8.95	61.8	25.27	61.8	25.27
1	1,542.3	3.83	0.00	1,885.8	4.69	4.69	247.1	8.58	247.1	8.58

ASSUMPTIONS AND CRITERIA USED

- References used include *Design Manual for Segmental Retaining Walls, 3rd Edition*, by NCMA.
- Blocks are all same size and uniform offsets (batter) for full wall height.
- Coulomb earth pressure theory used for earth pressures and failure plane angle.
- Refer to geotechnical report for backfill material, compaction, and other design data and recommendations.
- Cap blocks if used are above the retained height and are neglected in this design.
- Geogrid LTDS and connection values for block vendors obtained from ICC Evaluation Service (ES Legacy Reports) or as provided by vendors. Since these may change or be updated, verification of values is recommended.
- Block sizes obtained from vendors' literature and may vary with locality.
- Geogrid layers are equally spaced vertically, all same length, and laid horizontally.
- Average weight of block and cell infill assumed to be 120 pcf.
- See vendor web sites (on input screen) for more information and specifications.
- Vendor specifications or project specifications, whichever is most restrictive, to be followed for construction procedures.
- Add notes and details for proper drainage.
- See *User's Manual* Design Example #10 for methodology and sample verification calculations.
- Final design responsibility is with the project Engineer-of-Record.

Project Title: Daughters of Israel
Engineer: Jorge Lopez, PE
Project ID: 19-265
Project Descr: Retaining Wall Design

Cantilevered Retaining Wall

Project File: Retaining Wall Design.ec6

LIC# : KW-06014278, Build:20.22.4.26

Petry Engineering, LLC

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DESCRIPTION: Wall B: 10'-0" Concrete Retaining Wall

Code Reference:

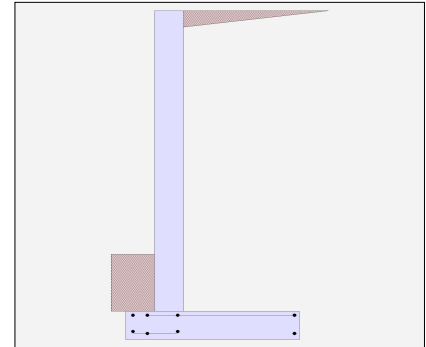
Calculations per IBC 2018 1807.3, CBC 2019, ASCE 7-16

Criteria

Retained Height	=	12.33 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	28.00 in
Water height over heel	=	0.0 ft

Soil Data

Allow Soil Bearing	=	4,000.0 psf
Coulomb Soil Pressure calculation		
Soil Friction Angle	=	30.0 deg
Active Pressure:		
Ka*Gamma (horiz)	=	30.9 psf/ft
Passive Pressure:Kp*Gar	=	576.8 psf/ft
Soil Density, Heel	=	120.00 pcf
Soil Density, Toe	=	120.00 pcf
Footing Soil Friction	=	0.400
Soil height to ignore for passive pressure	=	12.00 in



Surcharge Loads

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

Axial Load Applied to Stem

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

Lateral Load Applied to Stem

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

Adjacent Footing Load

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

Project Title: Daughters of Israel
 Engineer: Jorge Lopez, PE
 Project ID: 19-265
 Project Descr: Retaining Wall Design

Cantilevered Retaining Wall

Project File: Retaining Wall Design.ec6

LIC# : KW-06014278, Build:20.22.4.26

Petry Engineering, LLC

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DESCRIPTION: Wall B: 10'-0" Concrete Retaining Wall

Design Summary

Wall Stability Ratios

Overturing	=	2.40	OK
Sliding	=	2.45	OK
Global Stability	=	1.89	

Total Bearing Load	=	9,100 lbs	
...resultant ecc.	=	13.47 in	

Eccentricity outside middle third

Soil Pressure @ Toe	=	3,232 psf	OK
Soil Pressure @ Heel	=	0 psf	OK
Allowable	=	4,000 psf	

Soil Pressure Less Than Allowable

ACI Factored @ Toe	=	4,525 psf	
ACI Factored @ Heel	=	0 psf	
Footing Shear @ Toe	=	3.8 psi	OK
Footing Shear @ Hee	=	19.2 psi	OK
Allowable	=	94.9 psi	

Sliding Calcs

Lateral Sliding Force	=	2,814.1 lbs	
less 100% Passive Force	-	3,244.7 lbs	
less 100% Friction Force	=	3,639.9 lbs	
Added Force Req'd	=	0.0 lbs	OK
....for 1.5 Stability	=	0.0 lbs	OK

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

Load Factors

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

Stem Construction

Design Height Above Ftg

ft =	Stem OK	0.00
Wall Material Above "Ht"	=	Concrete
Design Method	=	SD
Thickness	=	12.00
Rebar Size	=	# 6
Rebar Spacing	=	12.00
Rebar Placed at	=	Edge

Design Data

fb/FB + fa/Fa	=	0.838
---------------	---	-------

Total Force @ Section

Service Level	lbs =	
Strength Level	lbs =	3,757.9

Moment....Actual

Service Level	ft-# =	
Strength Level	ft-# =	15,448.8

Moment.....Allowable

=	18,415.0
---	----------

Shear.....Actual

Service Level	psi =	
Strength Level	psi =	32.5

Shear.....Allowable

psi =	94.9
-------	------

Anet (Masonry)

in2 =	
-------	--

Wall Weight

psf =	150.0
-------	-------

Rebar Depth 'd'

in =	9.63
------	------

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 =	4,000.0
Fy	psi =	60,000.0

Project Title: Daughters of Israel
 Engineer: Jorge Lopez, PE
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Cantilevered Retaining Wall

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LIC# : KW-06014278, Build:20.22.4.26

Petry Engineering, LLC

(c) ENERCALC INC 1983-2022

DESCRIPTION: Wall B: 10'-0" Concrete Retaining Wall

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.3689 in2/ft	
(4/3) * As :	0.4919 in2/ft	Min Stem T&S Reinf Area 3.552 in2
200bd/fy : 200(12)(9.625)/60000 :	0.385 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 :	0.385 in2/ft	#4@ 8.33 in #4@ 16.67 in
Provided Area :	0.44 in2/ft	#5@ 12.92 in #5@ 25.83 in
Maximum Area :	2.0862 in2/ft	#6@ 18.33 in #6@ 36.67 in

Footing Data

Toe Width	=	1.00 ft
Heel Width	=	5.00
Total Footing Width	=	6.00
Footing Thickness	=	14.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft
f'c = 4,000 psi	Fy = 60,000 psi	
Footing Concrete Density = 150.00 pcf		
Min. As % = 0.0018		
Cover @ Top 2.00	@ Btm.= 3.00 in	

Footing Design Results

	Toe	Heel
Factored Pressure	= 4,525	0 psf
Mu' : Upward	= 2,128	6,412 ft-#
Mu' : Downward	= 273	15,888 ft-#
Mu: Design	= 1,855 OK	9,475 ft-# OK
phiMn	= 20,397	22,377 ft-#
Actual 1-Way Shear	= 3.79	19.18 psi
Allow 1-Way Shear	= 94.87	94.87 psi
Toe Reinforcing	= # 6 @ 12.00 in	
Heel Reinforcing	= # 6 @ 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:
 Heel:
 Key:

Min footing T&S reinf Area	1.81 in2
Min footing T&S reinf Area per foot	0.30 in2 /ft
If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 7.94 in	#4@ 15.87 in
#5@ 12.30 in	#5@ 24.60 in
#6@ 17.46 in	#6@ 34.92 in

Project Title: Daughters of Israel
 Engineer: Jorge Lopez, PE
 Project ID: 19-265
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Cantilevered Retaining Wall

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LIC# : KW-06014278, Build:20.22.4.26

Petry Engineering, LLC

(c) ENERCALC INC 1983-2022

DESCRIPTION: Wall B: 10'-0" Concrete Retaining 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)	2,814.1	4.50	12,663.1	Soil Over HL (ab. water tbl)	5,919.8	4.00	23,679.4
HL Act Pres (be water tbl)				Soil Over HL (bel. water tbl)		4.00	23,679.4
Hydrostatic Force				Watre Table			
Buoyant Force =				Sloped Soil Over Hee =			
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 =	280.0	0.50	140.0
				Surcharge Over Toe =			
				Stem Weight(s) =	1,850.0	1.50	2,774.9
				Earth @ Stem Transitions =			
				Footing Weight =	1,050.0	3.00	3,150.0
				Key Weight =			
				Vert. Component =			
Total	= 2,814.1	O.T.M. =	12,663.1	Total =	9,099.8 lbs	R.M. =	30,368.3
Resisting/Overturning Ratio	= 2.40			* Axial live load NOT included in total displayed, or used for overturning resistance, but is included for soil pressure calculation.			
Vertical Loads used for Soil Pressure =		9,099.8 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) 0.185 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: Daughters of Israel
Engineer: Jorge Lopez, PE
Project ID: 19-265
Project Descr: Retaining Wall Design

Cantilevered Retaining Wall

Project File: Retaining Wall Design.ec6

LIC# : KW-06014278, Build:20.22.4.26

Petry Engineering, LLC

(c) ENERCALC INC 1983-2022

DESCRIPTION: Wall B: 10'-0" Concrete Retaining Wall

Rebar Lap & Embedment Lengths Information

Stem Design Segment: Bottom

Stem Design Height: 0.00 ft above top of footing

Lap Splice length for #6 bar specified in this stem design segment = 22.20 in

Development length for #6 bar specified in this stem design segment = 17.08 in

Hooked embedment length into footing for #6 bar specified in this stem design segment = 9.96 in

As Provided = 0.4400 in2/ft

As Required = 0.3850 in2/ft

Cantilevered Retaining Wall

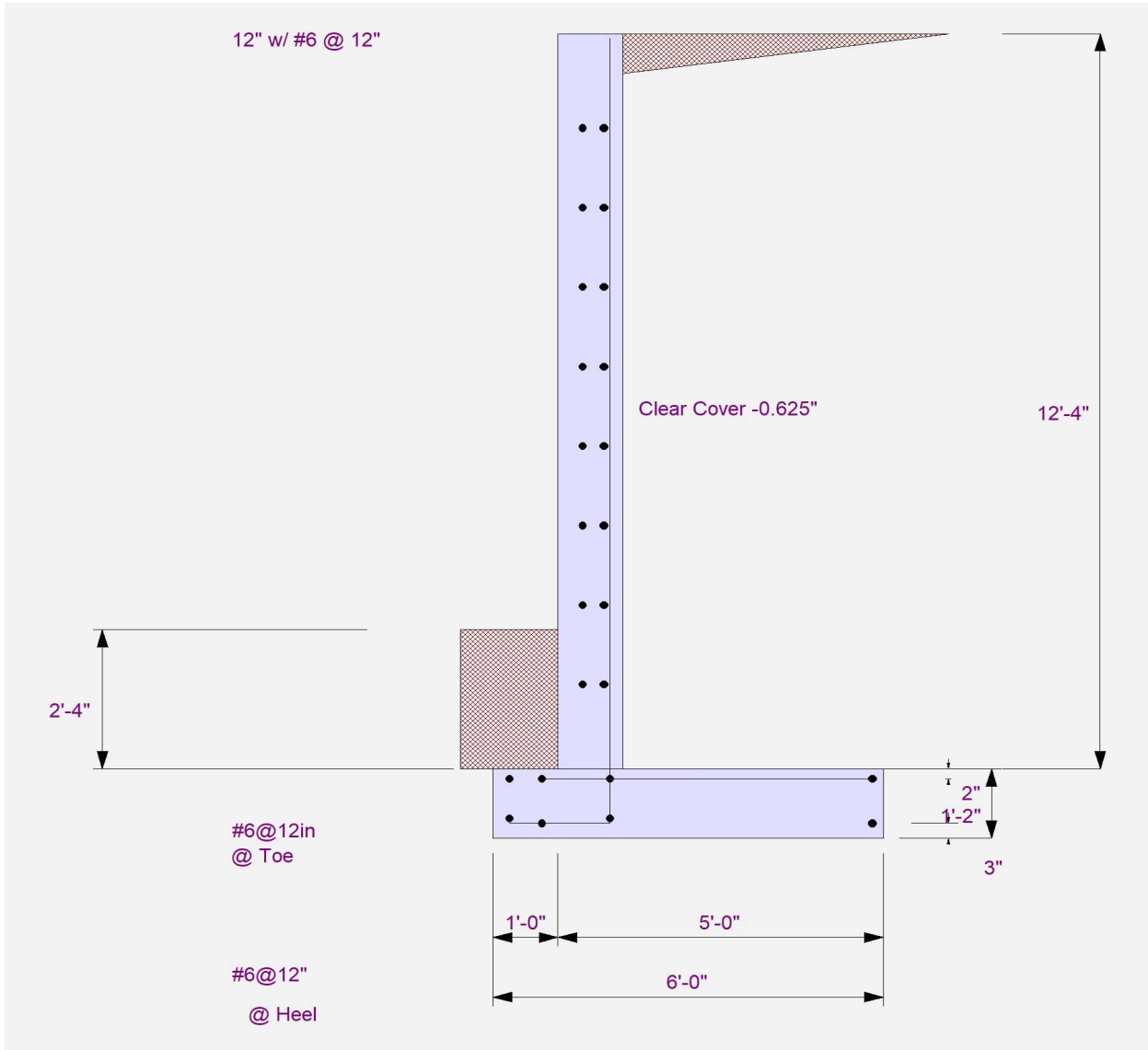
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LIC# : KW-06014278, Build:20.22.4.26

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DESCRIPTION: Wall B: 10'-0" Concrete Retaining Wall

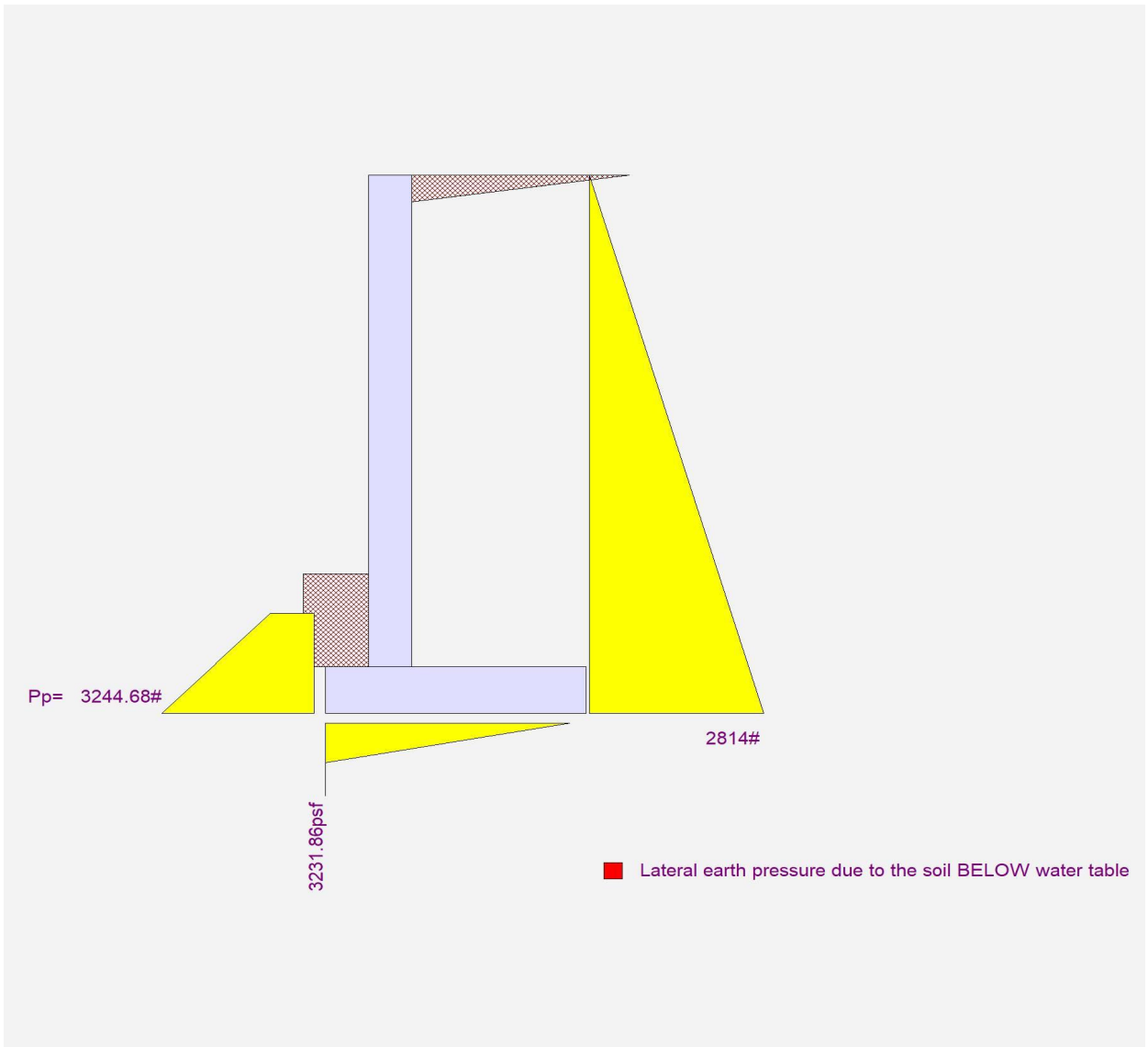


Cantilevered Retaining Wall

Project File: Retaining Wall Design.ec6

LIC# : KW-06014278, Build:20.22.4.26 Petry Engineering, LLC (c) ENERCALC INC 1983-2022

DESCRIPTION: Wall B: 10'-0" Concrete Retaining Wall



Project Title: Daughters of Israel
 Engineer: Jorge Lopez, PE
 Project ID: 19-265
 Project Descr: Retaining Wall Design

Segmental Retaining Wall

Project File: Retaining Wall Design.ec6

LIC# : KW-06014278, Build:20.22.4.26

Petry Engineering, LLC

(c) ENERCALC INC 1983-2022

DESCRIPTION: Wall B: 10'-0" Modular Block Wall

Criteria

Wall height (retained height)	12.00 ft
Backfill slope	Level
Backfill angle	0.0 deg
Embedment	2.3 ft

Soil data

External Soil, Phi_e	30 deg
External soil density (In situ)	120 pcf
Internal Soil, Phi_i	30 deg
Internal soil density	120 pcf
Wall Soil Friction Angle	0 deg
K_a(Horiz)	0.28

Loading

Dead load	0 psf
Live load	0 psf
Seismic Factor, A	0.00
d_seismic	0.00 in

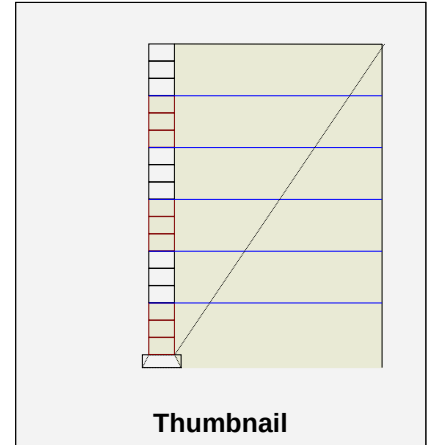
Stability

Base length	9.00 ft
Base Sliding Force (w/o Seismic)	2,223.58 lb
Base Resisting Force (w/o Seismic)	7,392.27 lb
Base Sliding (w/o Seismic) FS	3.32

Overturning Moment (w/o Seismic)	8,894.34 ft lb
Resisting Moment (w/o Seismic)	63,394.08 ft lb
Overturning (w/o Seismic) FS	7.13

Applied Bearing Pressure (w/o Seismic)	1,504.02 psf
Allowable Bearing Pressure (w/o Seismic)	4,000.00 psf
Bearing (w/o Seismic) FS	2.66

Eccentricity of Vert. Force (w/o Seismic)	0.24 ft
Effective Base Width (w/o Seismic)	8.51 ft



Segmental block data

Vendor selection	Keystone Retaining Wall		
Vendor ESR	ICC ESR-2113E	Valid through	08/31/21
Block selection type	Compac II		
Block height	8.00 in	alpha(u_1)	1376.00 lb
Block depth	12.00 in	tan(lambda_u1)	0.14
Offset per block	0.00 in	Max_1	1783.00 lb
Batter angle	0.00 deg	alpha(u_2)	1376.00 lb
Wall weight	120.00 psf	tan(lambda_u2)	0.14
		Max_2	1783.00 lb

Geogrid material

Vendor Selection			
Geogrid type			
LTDS	0.00 lb/ft		
Ci	0.90		
RF_CR	1.55		
alpha_u	1,031.00 lb		
tan(lambda_u)	0.53		
Max	3,942.00 lb		
alpha_cs1	1,713.00 lb	alpha_cs2	1,713.00 lb
tan(lambda_cs1)	0.36	tan(lambda_cs2)	0.36
Max_1	3,700.00 lb	Max_2	3,700.00 lb

Factors of Safety

Failure Mode	Static Condition			
	Min			
	Acceptable	Actual	Status	Acceptable
Base Sliding	1.50	3.32	OK	
Overturning	1.50	7.13	OK	
Bearing	1.00	2.66	OK	
Internal Sliding	1.50	3.83	OK	
Tensile Overstress	0.00	0.00	OK	
Pullout	1.50	7.24	OK	
Connection	1.50	2.13	OK	

Project Title: Daughters of Israel
 Engineer: Jorge Lopez, PE
 Project ID: 19-265
 Project Descr: Retaining Wall Design

Segmental Retaining Wall

Project File: Retaining Wall Design.ec6

LIC# : KW-06014278, Build:20.22.4.26

Petry Engineering, LLC

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DESCRIPTION: Wall B: 10'-0" Modular Block Wall

Wall Analysis Table:

Layer	Height ft	Trib Height	Depth to Midpoint	Tension From Surcharge			Static Total Fg	LTDS	LTDS (Seismic)	Total Tension (W/seismic), Fi	FS Tensile Overstress	
				Soil	DL	LL					(Static)	w/Seismic)
5	10.00	3.00	2.00	201.2	0.0	0.0	201.2	0.0	0.0	201.2	0.00	0.00
4	8.00	2.00	4.00	268.2	0.0	0.0	268.2	0.0	0.0	268.2	0.00	0.00
3	6.00	2.00	6.00	402.3	0.0	0.0	402.3	0.0	0.0	402.3	0.00	0.00
2	4.00	2.00	8.00	536.4	0.0	0.0	536.4	0.0	0.0	536.4	0.00	0.00
1	2.00	3.00	10.00	1,005.8	0.0	0.0	1,005.8	0.0	0.0	1,005.8	0.00	0.00

Wall Analysis Table Continued:

Layer	Pullout Strength	FS Pullout		Connection Strength	FS Conn		Internal Sliding Force (Static)	FS Internal Sliding (Static)	Internal Sliding Force (Seismic)	FS Internal Sliding (Seismic)
		(Static)	(Seismic)		(Static)	(Seismic)				
5	1,455.9	7.24	0.00	1,799.4	8.95	8.95	61.8	31.55	61.8	31.55
4	3,027.0	11.29	0.00	1,885.8	7.03	7.03	247.1	11.72	247.1	11.72
3	4,598.1	11.43	0.00	1,972.2	4.90	4.90	555.9	6.96	555.9	6.96
2	6,169.3	11.50	0.00	2,058.6	3.84	3.84	988.3	4.93	988.3	4.93
1	7,740.4	7.70	0.00	2,145.0	2.13	2.13	1,544.2	3.83	1,544.2	3.83

ASSUMPTIONS AND CRITERIA USED

- References used include *Design Manual for Segmental Retaining Walls, 3rd Edition*, by NCMA.
- Blocks are all same size and uniform offsets (batter) for full wall height.
- Coulomb earth pressure theory used for earth pressures and failure plane angle.
- Refer to geotechnical report for backfill material, compaction, and other design data and recommendations.
- Cap blocks if used are above the retained height and are neglected in this design.
- Geogrid LTDS and connection values for block vendors obtained from ICC Evaluation Service (ES Legacy Reports) or as provided by vendors. Since these may change or be updated, verification of values is recommended.
- Block sizes obtained from vendors' literature and may vary with locality.
- Geogrid layers are equally spaced vertically, all same length, and laid horizontally.
- Average weight of block and cell infill assumed to be 120 pcf.
- See vendor web sites (on input screen) for more information and specifications.
- Vendor specifications or project specifications, whichever is most restrictive, to be followed for construction procedures.
- Add notes and details for proper drainage.
- See *User's Manual* Design Example #10 for methodology and sample verification calculations.
- Final design responsibility is with the project Engineer-of-Record.

Project Title: Daughters of Israel
 Engineer: Jorge Lopez, PE
 Project ID: 19-265
 Project Descr: Retaining Wall Design

Cantilevered Retaining Wall

Project File: Retaining Wall Design.ec6

LIC# : KW-06014278, Build:20.22.4.26

Petry Engineering, LLC

(c) ENERCALC INC 1983-2022

DESCRIPTION: Wall C: 4'-6" Concrete Retaining Wall

Code Reference:

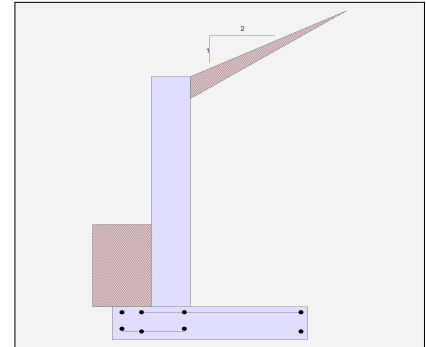
Calculations per IBC 2018 1807.3, CBC 2019, ASCE 7-16

Criteria

Retained Height	=	7.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	2.00
Height of Soil over Toe	=	30.00 in
Water height over heel	=	0.0 ft

Soil Data

Allow Soil Bearing	=	4,000.0 psf
Coulomb Soil Pressure calculation		
Soil Friction Angle	=	30.0 deg
Active Pressure:		
Ka*Gamma (horiz)	=	56.8 psf/ft
Passive Pressure:Kp*Gar	=	576.8 psf/ft
Soil Density, Heel	=	120.00 pcf
Soil Density, Toe	=	120.00 pcf
Footing Soil Friction	=	0.400
Soil height to ignore for passive pressure	=	12.00 in



Surcharge Loads

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

Axial Load Applied to Stem

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

Lateral Load Applied to Stem

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

Adjacent Footing Load

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

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DESCRIPTION: Wall C: 4'-6" Concrete Retaining Wall

Design Summary

Wall Stability Ratios

Overturing	=	1.66	OK
Sliding	=	2.03	OK
Global Stability	=	1.73	

Total Bearing Load	=	4,890 lbs	
...resultant ecc.	=	16.79 in	

Eccentricity outside middle third

Soil Pressure @ Toe	=	2,961 psf	OK
Soil Pressure @ Heel	=	0 psf	OK
Allowable	=	4,000 psf	

Soil Pressure Less Than Allowable

ACI Factored @ Toe	=	4,145 psf	
ACI Factored @ Heel	=	0 psf	
Footing Shear @ Toe	=	9.4 psi	OK
Footing Shear @ Heel	=	24.8 psi	OK
Allowable	=	94.9 psi	

Sliding Calcs

Lateral Sliding Force	=	2,562.9 lbs	
less 100% Passive Force	=	3,244.7 lbs	
less 100% Friction Force	=	1,956.0 lbs	
Added Force Req'd	=	0.0 lbs	OK
....for 1.5 Stability	=	0.0 lbs	OK

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

Load Factors

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

Stem Construction

Design Height Above Ftg

ft =	0.00		
Wall Material Above "Ht"	=	Concrete	
Design Method	=	SD	SD
Thickness	=	12.00	
Rebar Size	=	# 5	
Rebar Spacing	=	12.00	
Rebar Placed at	=	Edge	

Design Data

fb/FB + fa/Fa	=	0.373	
---------------	---	-------	--

Total Force @ Section

Service Level	lbs =	
Strength Level	lbs =	2,226.4

Moment....Actual

Service Level	ft-# =	
Strength Level	ft-# =	5,194.9

Moment.....Allowable	=	13,892.6	
----------------------	---	----------	--

Shear.....Actual

Service Level	psi =	
Strength Level	psi =	18.2

Shear.....Allowable	psi =	94.9	
---------------------	-------	------	--

Anet (Masonry)	in2 =		
----------------	-------	--	--

Wall Weight	psf =	150.0	
-------------	-------	-------	--

Rebar Depth 'd'	in =	10.19	
-----------------	------	-------	--

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 =	4,000.0	
Fy	psi =	60,000.0	

Project Title: Daughters of Israel
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LIC# : KW-06014278, Build:20.22.4.26

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(c) ENERCALC INC 1983-2022

DESCRIPTION: Wall C: 4'-6" Concrete Retaining Wall

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.117 in ² /ft	
(4/3) * As :	0.156 in ² /ft	Min Stem T&S Reinf Area 2.016 in ²
200bd/fy : 200(12)(10.1875)/60000 :	0.4075 in ² /ft	Min Stem T&S Reinf Area per ft of stem Height : 0.288 in ² /ft
0.0018bh : 0.0018(12)(12) :	0.2592 in ² /ft	Horizontal Reinforcing Options :
	=====	One layer of : Two layers of :
Required Area :	0.2592 in ² /ft	#4@ 8.33 in #4@ 16.67 in
Provided Area :	0.31 in ² /ft	#5@ 12.92 in #5@ 25.83 in
Maximum Area :	2.2081 in ² /ft	#6@ 18.33 in #6@ 36.67 in

Footing Data

Toe Width	=	1.00 ft
Heel Width	=	4.00
Total Footing Width	=	5.00
Footing Thickness	=	12.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft
f'c =	4,000 psi	Fy = 60,000 psi
Footing Concrete Density	=	150.00 pcf
Min. As %	=	0.0018
Cover @ Top	2.00	@ Btm.= 3.00 in

Footing Design Results

	Toe	Heel
Factored Pressure	= 4,145	0 psf
Mu' : Upward	= 1,863	463 ft-#
Mu' : Downward	= 270	5,994 ft-#
Mu: Design	= 1,593 OK	5,531 ft-# OK
phiMn	= 11,801	13,196 ft-#
Actual 1-Way Shear	= 9.44	24.76 psi
Allow 1-Way Shear	= 94.87	94.87 psi
Toe Reinforcing	= # 5 @ 12.00 in	
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:
 Heel:
 Key:

Min footing T&S reinf Area	1.30 in ²
Min footing T&S reinf Area per foot	0.26 in ² /ft
If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 9.26 in	#4@ 18.52 in
#5@ 14.35 in	#5@ 28.70 in
#6@ 20.37 in	#6@ 40.74 in

Project Title: Daughters of Israel
 Engineer: Jorge Lopez, PE
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Cantilevered Retaining Wall

Project File: Retaining Wall Design.ec6

LIC# : KW-06014278, Build:20.22.4.26

Petry Engineering, LLC

(c) ENERCALC INC 1983-2022

DESCRIPTION: Wall C: 4'-6" Concrete Retaining Wall

Summary of Overturning & Resisting Forces & Moments

.....OVERTURNING.....				RESISTING.....			
Item	Force lbs	Distance ft	Moment ft-#		Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	2,562.9	3.17	8,115.9	Soil Over HL (ab. water tbl)	2,520.0	3.50	8,820.0
HL Act Pres (be water tbl)				Soil Over HL (bel. water tbl)		3.50	8,820.0
Hydrostatic Force				Watre Table			
Buoyant Force =				Sloped Soil Over Hee =	270.0	4.00	1,080.0
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 =	300.0	0.50	150.0
				Surcharge Over Toe =			
				Stem Weight(s) =	1,050.0	1.50	1,575.0
				Earth @ Stem Transitions =			
				Footing Weighl =	750.0	2.50	1,875.0
				Key Weight =			
				Vert. Component =			
Total	= 2,562.9	O.T.M.	= 8,115.9	Total	= 4,890.0 lbs	R.M.	= 13,500.0
Resisting/Overturning Ratio		=	1.66	* Axial live load NOT included in total displayed, or used for overturning resistance, but is included for soil pressure calculation.			
Vertical Loads used for Soil Pressure =		4,890.0	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) 0.115 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: Daughters of Israel
Engineer: Jorge Lopez, PE
Project ID: 19-265
Project Descr: Retaining Wall Design

Cantilevered Retaining Wall

Project File: Retaining Wall Design.ec6

LIC# : KW-06014278, Build:20.22.4.26

Petry Engineering, LLC

(c) ENERCALC INC 1983-2022

DESCRIPTION: Wall C: 4'-6" Concrete Retaining Wall

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 = 18.50 in

Development length for #5 bar specified in this stem design segment = 14.23 in

Hooked embedment length into footing for #5 bar specified in this stem design segment = 8.30 in

As Provided = 0.3100 in2/ft

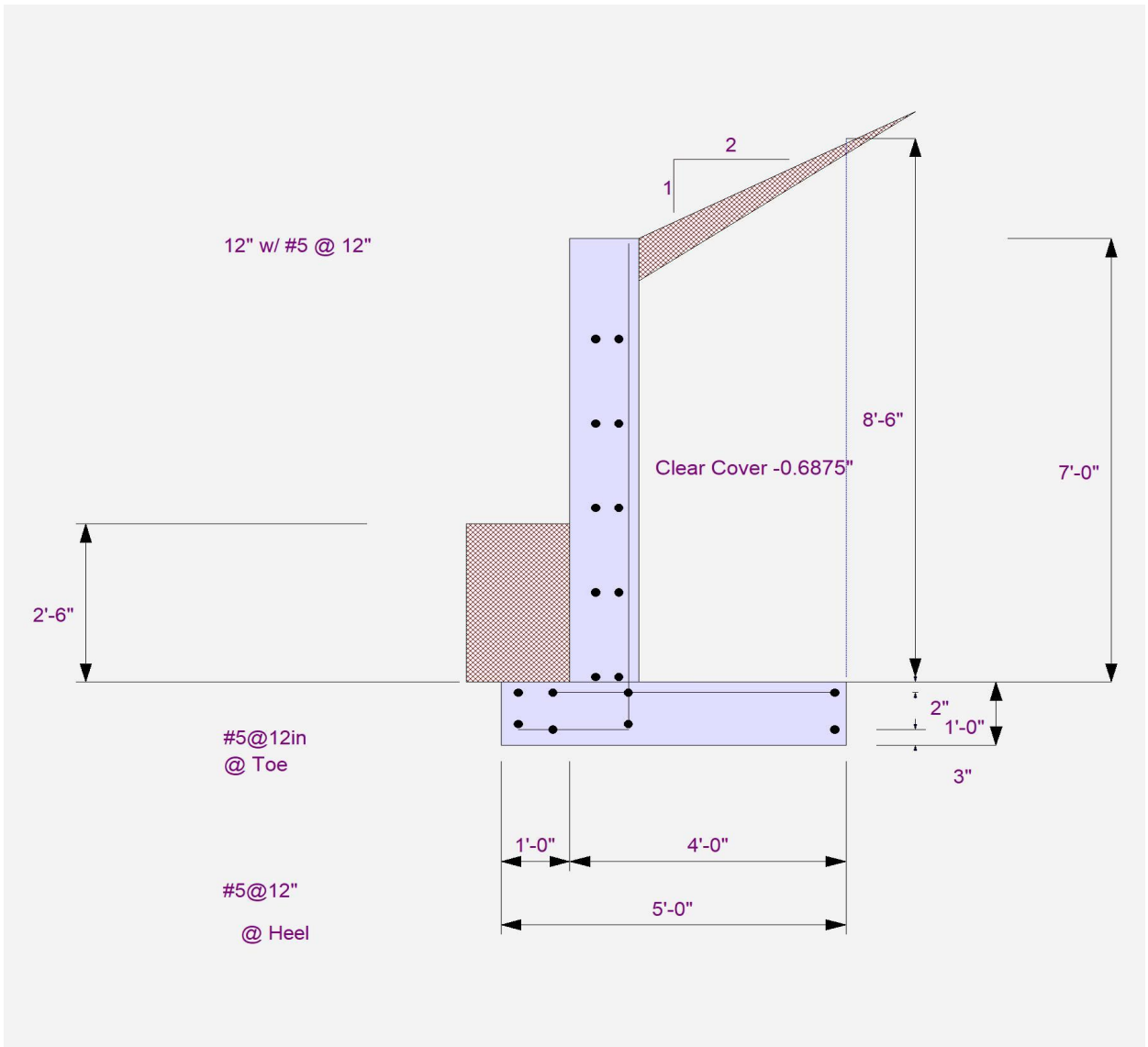
As Required = 0.2592 in2/ft

Cantilevered Retaining Wall

Project File: Retaining Wall Design.ec6

LIC# : KW-06014278, Build:20.22.4.26 Petry Engineering, LLC (c) ENERCALC INC 1983-2022

DESCRIPTION: Wall C: 4'-6" Concrete Retaining Wall

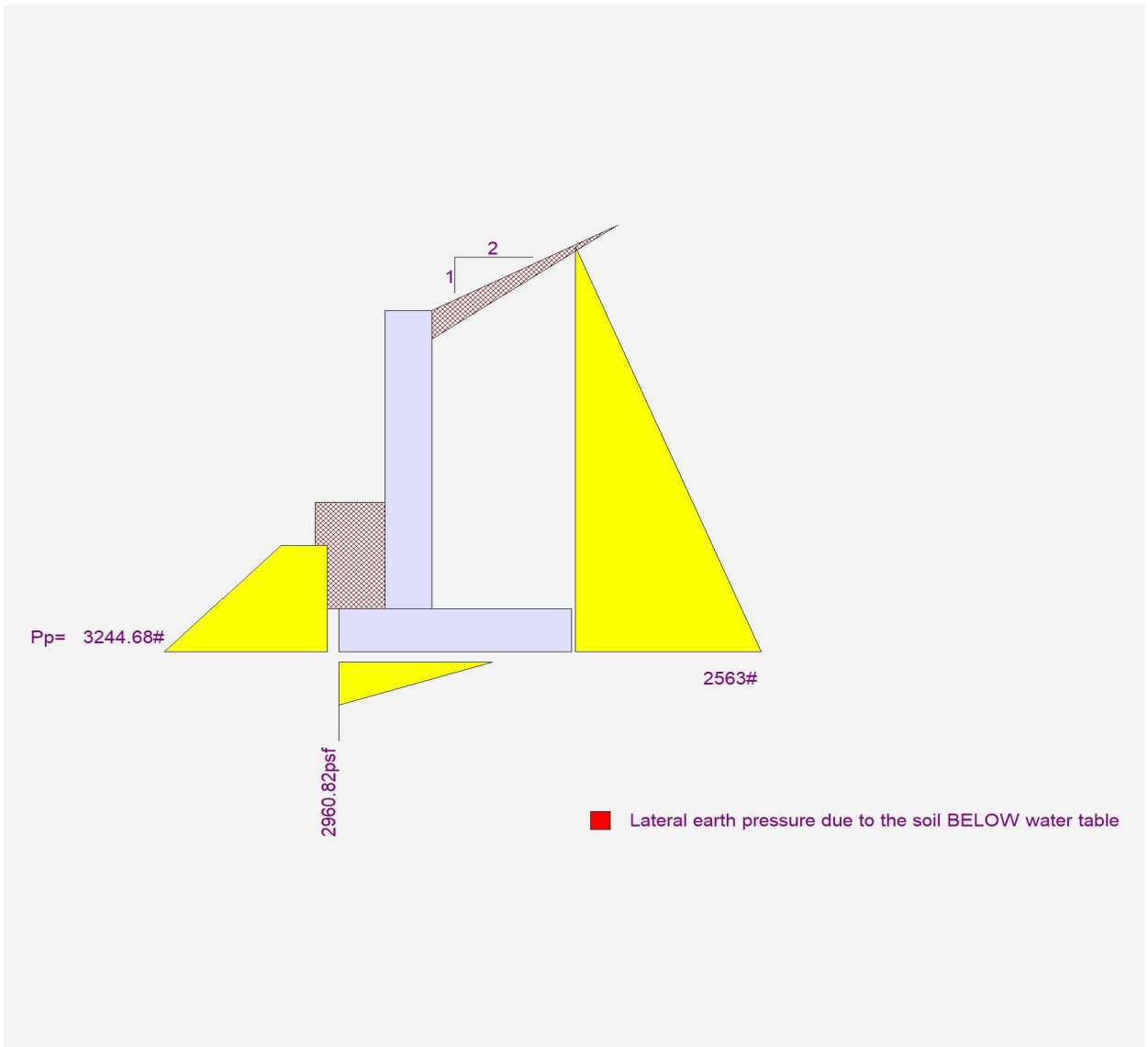


Cantilevered Retaining Wall

Project File: Retaining Wall Design.ec6

LIC# : KW-06014278, Build:20.22.4.26 Petry Engineering, LLC (c) ENERCALC INC 1983-2022

DESCRIPTION: Wall C: 4'-6" Concrete Retaining Wall



Project Title: Daughters of Israel
 Engineer: Jorge Lopez, PE
 Project ID: 19-265
 Project Descr: Retaining Wall Design

Segmental Retaining Wall

Project File: Retaining Wall Design.ec6

LIC# : KW-06014278, Build:20.22.4.26

Petry Engineering, LLC

(c) ENERCALC INC 1983-2022

DESCRIPTION: Wall C: 4'-6" Modular Block Wall

Criteria

Wall height (retained height)	5.33 ft
Backfill slope	2:1
Backfill angle	26.6 deg
Embedment	0.5 ft

Soil data

External Soil, Phi_e	30 deg
External soil density (In situ)	120 pcf
Internal Soil, Phi_i	30 deg
Internal soil density	120 pcf
Wall Soil Friction Angle	0 deg
K_a(Horiz)	0.49

Loading

Dead load	0 psf
Live load	0 psf
Seismic Factor, A	0.00
d_seismic	0.00 in

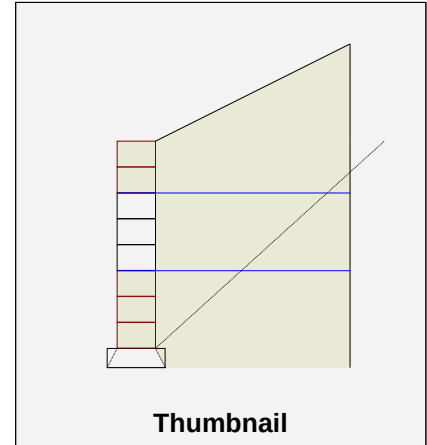
Stability

Base length	6.00 ft
Base Sliding Force (w/o Seismic)	1,747.62 lb
Base Resisting Force (w/o Seismic)	2,863.62 lb
Base Sliding (w/o Seismic) FS	1.64

Overturning Moment (w/o Seismic)	4,565.27 ft lb
Resisting Moment (w/o Seismic)	18,908.30 ft lb
Overturning (w/o Seismic) FS	4.14

Applied Bearing Pressure (w/o Seismic)	857.59 psf
Allowable Bearing Pressure (w/o Seismic)	4,000.00 psf
Bearing (w/o Seismic) FS	4.66

Eccentricity of Vert. Force (w/o Seismic)	0.11 ft
Effective Base Width (w/o Seismic)	5.78 ft



Segmental block data

Vendor selection	Keystone Retaining Wall		
Vendor ESR	ICC ESR-2113E	Valid through	08/31/21
Block selection type	Compac II		
Block height	8.00 in	alpha(u_1)	1376.00 lb
Block depth	12.00 in	tan(lambda_u1)	0.14
Offset per block	0.00 in	Max_1	1783.00 lb
Batter angle	0.00 deg	alpha(u_2)	1376.00 lb
Wall weight	120.00 psf	tan(lambda_u2)	0.14
		Max_2	1783.00 lb

Geogrid material

Vendor Selection			
Geogrid type			
LTDS	0.00 lb/ft		
Ci	0.90		
RF_CR	1.55		
alpha_u	1,031.00 lb		
tan(lambda_u)	0.53		
Max	3,942.00 lb		
alpha_cs1	1,713.00 lb	alpha_cs2	1,713.00 lb
tan(lambda_cs1)	0.36	tan(lambda_cs2)	0.36
Max_1	3,700.00 lb	Max_2	3,700.00 lb

Factors of Safety

Failure Mode	Static Condition			
	Min			
	Acceptable	Actual	Status	Acceptable
Base Sliding	1.50	1.64	OK	
Overturning	1.50	4.14	OK	
Bearing	1.00	4.66	OK	
Internal Sliding	1.50	2.66	OK	
Tensile Overstress	0.00	0.00	OK	
Pullout	1.50	1.65	OK	
Connection	1.50	3.13	OK	

Project Title: Daughters of Israel
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Segmental Retaining Wall

Project File: Retaining Wall Design.ec6

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DESCRIPTION: Wall C: 4'-6" Modular Block Wall

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				Soil	DL	LL					(Static)	w/Seismic)
2	4.00	2.33	1.33	184.3	0.0	0.0	184.3	0.0	0.0	184.3	0.00	0.00
1	2.00	3.00	3.33	592.4	0.0	0.0	592.4	0.0	0.0	592.4	0.00	0.00

Wall Analysis Table Continued:

Layer	Pullout Strength	FS Pullout		Connection Strength	FS Conn		Internal Sliding Force (Static)	FS Internal Sliding (Static)	Internal Sliding Force (Seismic)	FS Internal Sliding (Seismic)
		(Static)	(Seismic)		(Static)	(Seismic)				
2	304.6	1.65	0.00	1,770.6	9.61	9.61	419.0	4.39	419.0	3.75
1	1,445.6	2.44	0.00	1,857.0	3.13	3.13	969.6	2.66	969.6	2.38

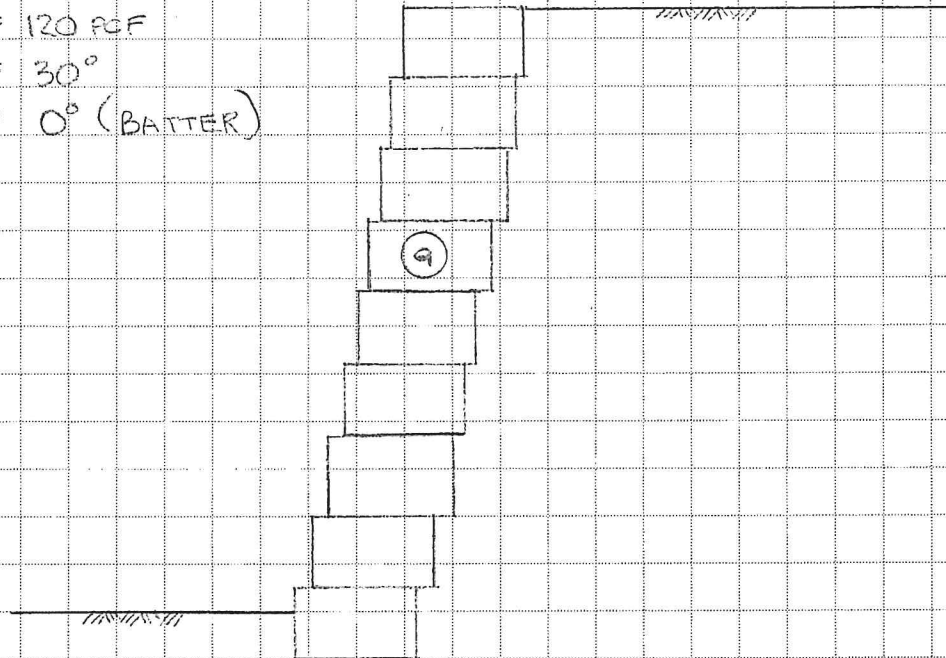
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- Refer to geotechnical report for backfill material, compaction, and other design data and recommendations.
- Cap blocks if used are above the retained height and are neglected in this design.
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- Block sizes obtained from vendors' literature and may vary with locality.
- Geogrid layers are equally spaced vertically, all same length, and laid horizontally.
- Average weight of block and cell infill assumed to be 120 pcf.
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- Vendor specifications or project specifications, whichever is most restrictive, to be followed for construction procedures.
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DESIGNED RETAINING WALL (G) (5'0")

SOIL PROPERTIES:

$\gamma = 120 \text{ PCF}$
 $\phi = 30^\circ$
 $\alpha = 0^\circ \text{ (BATTER)}$



CALCULATE ACTIVE & PASSIVE PRESSURE COEFF. K_a & K_p :

$$K_p^a = \cos \alpha \cdot \frac{\cos \alpha + \sqrt{\cos^2 \alpha - \cos^2 \phi}}{\cos \alpha - \sqrt{\cos^2 \alpha - \cos^2 \phi}}$$

$$K_p^a = \cos 0^\circ \cdot \frac{\cos 0^\circ + \sqrt{\cos^2 0^\circ - \cos^2 30^\circ}}{\cos 0^\circ - \sqrt{\cos^2 0^\circ - \cos^2 30^\circ}}$$

$$K_p^a = (1) \cdot \left[\frac{(1) + \sqrt{0.25}}{(1) - \sqrt{0.25}} \right]$$

$K_a = 0.33$

$K_p = 3.0$

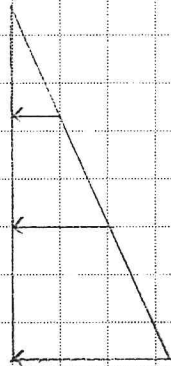
DESIGN RETAINING WALL (G) (5'-0")

SOIL

GROUND WATER



SECTION
NTS



$$F_{\text{soil}} = \frac{1}{2} K_a \gamma (H)^2 = \frac{1}{2} (0.33) (120) (5.5)^2 = 599 \text{ \#}$$

$$F_{\text{soil}_v} = F_{\text{soil}} \sin \phi = 599 \sin (30^\circ) = 300 \text{ \#}$$

$$F_{\text{soil}_h} = F_{\text{soil}} \cos \phi = 599 \cos (30^\circ) = 519 \text{ \#}$$

$$F_{\text{H}_2\text{O}} = \frac{1}{2} \gamma_w (H)^2 = \frac{1}{2} (62.4) (5)^2 = 780 \text{ \#}$$

$$F_{\text{H}_2\text{O}_v} = F_{\text{H}_2\text{O}} \sin \phi = 780 \sin (30^\circ) = 390 \text{ \#}$$

$$F_{\text{H}_2\text{O}_h} = F_{\text{H}_2\text{O}} \cos \phi = 780 \cos (30^\circ) = 676 \text{ \#}$$

DESIGN RETAINING WALL (C) (5'-0")

A. STABILITY ANALYSIS - SLIDING:

CALCULATE SLIDING FORCE:

$$P_{SLIDING} = F_{SOIL} + F_{H2O} = 519 \# + 676 \# = 1195 \#$$

CALCULATE RESISTING FORCE:

$$R_{SLIDING} = (WEIGHT)(\mu)$$

$$\begin{aligned} WEIGHT &= (5.5)(8)(120 \text{ PCF}) \\ &= 3960 \# \end{aligned}$$

$$\begin{aligned} R_{SLIDING} &= 3960 \# (0.58) \\ &= 2297 \# \end{aligned}$$

WEIGHT:

$$\begin{aligned} WEIGHT &= \text{WEIGHT OF WALL} \\ \mu &= \text{COEFF. OF FRICTION} \\ \mu &= \tan \phi = 0.58 \end{aligned}$$

$$F.S. \text{ SLIDING} = \frac{R_{SLIDING}}{P_{SLIDING}} = \frac{2297}{1195} = 1.9 > 1.5 \text{ OK!}$$

B. STABILITY ANALYSIS - OVERTURNING:

CALCULATE OVERTURNING MOMENT, MOT:

$$MOT = F_{SOIL} \left(\frac{5.5}{3} \right) + F_{H2O} \left(\frac{5}{3} \right) = 519 \left(\frac{5.5}{3} \right) + 676 \left(\frac{5}{3} \right)$$

$$MOT = 2079 \# \cdot \text{FT}$$

CALCULATE RESISTING MOMENT, MR:

$$MR = (120 \text{ PCF})(5.5)(8) \left(\frac{6}{2} \right)$$

$$MR = 11880 \# \cdot \text{FT}$$

$$F.S. \text{ OVERTURNING} = \frac{MR}{MOT} = \frac{11880}{2079} = 5.7 > 1.5 \text{ OK!}$$

PETRY ENGINEERING, LLC
155 Passaic Ave
Fairfield, NJ 07004
Phone (973) 227-7004 Fax (973) 227-7074

JOB 19-265 DAUGHTERS OF ISRAEL

SHEET NO. _____ OF _____

CALCULATED BY [Signature] DATE 5/6/2022

CHECKED BY _____ DATE _____

SCALE _____

DESIGN RETAINING WALL @ (0'-0")

C. STABILITY ANALYSIS - BEARING :

CALCULATE ECCENTRICITY :

$$e = B/2 - \frac{MR - M_{OT}}{WEIGHT} = \frac{6}{2} - \frac{11880 - 2079}{3960}$$

$$e = 0.52' \therefore \text{RESULTANT LIES WITHIN MIDDLE THIRD}$$

$$R = WEIGHT = 3960 \#$$

$$p_{\max/\min} = \frac{R}{B} \left(1 \pm \frac{6e}{B} \right)$$

$$p_{\max/\min} = \frac{3960}{6} \left(1 \pm \frac{6(0.52)}{6} \right)$$

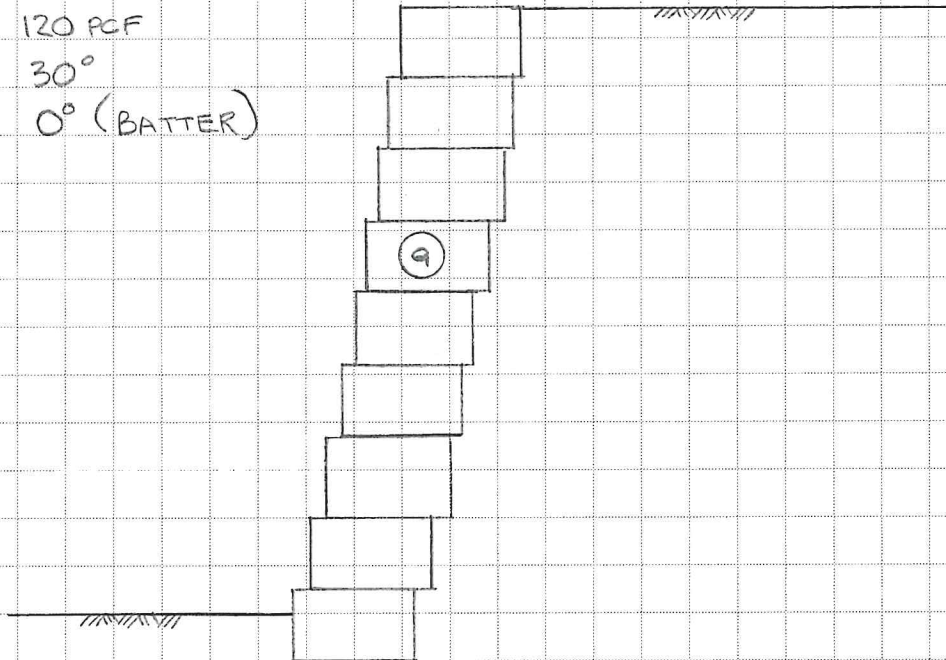
$$p_{\max} = \underline{\underline{1004 \text{ PSF}}}$$

$$p_{\min} = \underline{\underline{317 \text{ PSF}}}$$

DESIGN RETAINING WALL (8'0")

SOIL PROPERTIES :

$\gamma = 120 \text{ PCF}$
 $\phi = 30^\circ$
 $\alpha = 0^\circ \text{ (BATTER)}$



CALCULATE ACTIVE & PASSIVE PRESSURE COEFF., K_a & K_p :

$$K_p^a = \cos \alpha \cdot \frac{\cos \alpha + \sqrt{\cos^2 \alpha - \cos^2 \phi}}{\cos \alpha - \sqrt{\cos^2 \alpha - \cos^2 \phi}}$$

$$K_p^a = \cos 0 \cdot \frac{\cos 0^\circ + \sqrt{\cos^2 0^\circ - \cos^2 30^\circ}}{\cos 0^\circ - \sqrt{\cos^2 0^\circ - \cos^2 30^\circ}}$$

$$K_p^a = (1) \cdot \left[\frac{(1) + \sqrt{0.25}}{(1) - \sqrt{0.25}} \right]$$

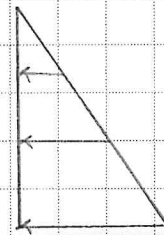
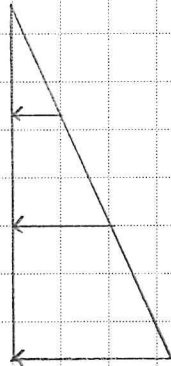
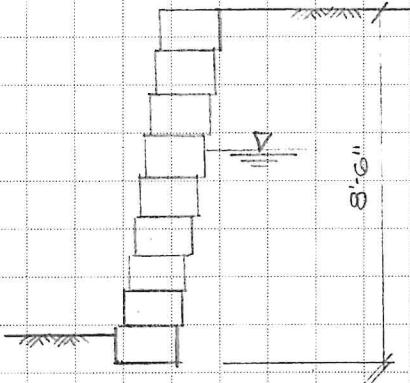
$K_a = 0.33$

$K_p = 3.0$

DESIGN RETAINING WALL (G) (8'-0")

SOIL

GROUND WATER



SECTION
NTS

$$F_{SOIL} = \frac{1}{2} K_a \gamma (H)^2 = \frac{1}{2} (0.33) (120) (8.5')^2 = 1430.55 \#$$

$$F_{SOIL_v} = F_{SOIL} \sin \phi = 1430.55 \sin (30^\circ) = 716 \#$$

$$F_{SOIL_H} = F_{SOIL} \cos \phi = 1430.55 \cos (30^\circ) = 1239 \#$$

$$F_{H2O} = \frac{1}{2} \gamma_{ws} (H)^2 = \frac{1}{2} (62.4) (5')^2 = 780 \#$$

$$F_{H2O_v} = F_{H2O} \sin \phi = 780 \sin (30^\circ) = 390 \#$$

$$F_{H2O_H} = F_{H2O} \cos \phi = 780 \cos (30^\circ) = 676 \#$$

DESIGN RETAINING WALL (C) (8'-0")

A. STABILITY ANALYSIS - SLIDING :

CALCULATE SLIDING FORCE :

$$P_{SLIDING} = F_{SOIL} + F_{H2O} = 1239^{\#} + 676^{\#} = 1915^{\#}$$

CALCULATE RESISTING FORCE :

$$R_{SLIDING} = (WEIGHT)(\mu)$$

$$\begin{aligned} \text{WEIGHT} &= (8.5)(10)(120 \text{ PCF}) \\ &= 10200^{\#} \end{aligned}$$

WHERE :

WEIGHT = WEIGHT OF WALL
 μ = COEFF. OF FRICTION
 $\mu = \tan \phi = 0.58$

$$\begin{aligned} R_{SLIDING} &= 10200^{\#}(0.58) \\ &= 5916^{\#} \end{aligned}$$

$$F.S. \text{ SLIDING} = \frac{R_{SLIDING}}{P_{SLIDING}} = \frac{5916}{1915} = 3.0 > 1.5 \text{ OK} \checkmark$$

B. STABILITY ANALYSIS - OVERTURNING :

CALCULATE OVERTURNING MOMENT, MOT :

$$MOT = F_{SOIL} \left(\frac{8.5}{3} \right) + F_{H2O} \left(\frac{5}{3} \right) = 1239 \left(\frac{8.5}{3} \right) + 676 \left(\frac{5}{3} \right)$$

$$MOT = 4638^{\#} \cdot \text{FT}$$

CALCULATE RESISTING MOMENT, MR :

$$MR = (120 \text{ PCF})(8.5)(10) \left(\frac{10}{2} \right)$$

$$MR = 51000^{\#} \cdot \text{FT}$$

$$F.S. \text{ OVERTURNING} = \frac{MR}{MOT} = \frac{51000}{4638} = 11 > 1.5 \text{ OK} \checkmark$$

PETRY ENGINEERING, LLC
155 Passaic Ave
Fairfield, NJ 07004
Phone (973) 227-7004 Fax (973) 227-7074

JOB 19-265 DAUGHTERS OF ISRAEL

SHEET NO. _____ OF _____

CALCULATED BY DATE 5/6/2022

CHECKED BY DATE

SCALE

DESIGN RETAINING WALL @ (8'-0")

C. STABILITY ANALYSIS - BEARING :

CALCULATE ECCENTRICITY :

$$e = B/2 - \frac{MR - M_{OT}}{WEIGHT} = 10/2 - \frac{51000 - 4638}{10200}$$

$$e = 0.45' \therefore \text{RESULTANT LIES WITHIN MIDDLE THIRD}$$

$$R = WEIGHT = 10200 \#$$

$$p_{\min}^{\max} = R/B \left(1 \pm \frac{6e}{B} \right)$$

$$p_{\min}^{\max} = \frac{10200}{10} \left(1 \pm \frac{6(0.45)}{10} \right)$$

$$p_{\max} = \underline{\underline{1296 \text{ PSF}}}$$

$$p_{\min} = \underline{\underline{745 \text{ PSF}}}$$