

DAUGHTERS OF ISRAEL

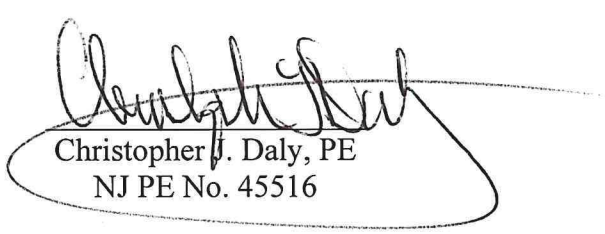
1155 PLEASANT VALLEY WAY
LOT 12, BLOCK 171
TOWNSHIP OF WEST ORANGE
ESSEX COUNTY, NEW JERSEY

RETAINING WALL CALCUATIONS

PREPARED BY:

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

October 13, 2023


Christopher J. Daly, PE
NJ PE No. 45516



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:20.23.08.30

Petry Engineering, LLC

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DESCRIPTION: Wall A: Concrete Retaining Wall - 3 feet w/ roadway

Code Reference:

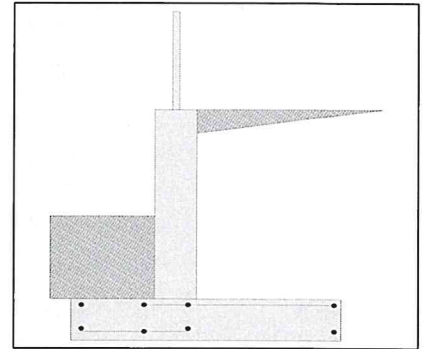
Calculations per IBC 2018 1807.3, CBC 2019, ASCE 7-16

Criteria

Retained Height	=	5.33 ft
Wall height above soil	=	2.75 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	28.00 in
Water table above bottom of footing	=	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	=	8.08 ft
...Height to Bottom	=	7.08 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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Design Summary		Stem Construction		2nd	Bottom
Wall Stability Ratios		Design Height Above Ftc	ft =	5.33	Stem OK 0.00
Overturning	= 1.59 OK	Wall Material Above "Ht"	=	Fence	Concrete
Sliding	= 2.42 OK	Design Method	=		SD
Global Stability	= 4.32	Thickness	=		12.00
		Rebar Size	=		# 6
		Rebar Spacing	=		8.00
		Rebar Placed at	=		Edge
Total Bearing Load		Design Data			
...resultant ecc.	= 5,612 lbs	fb/FB + fa/Fa	=		0.636
Eccentricity outside middle third	= 22.36 in	Total Force @ Section			
Soil Pressure @ Toe	= 2,699 psf OK	Service Level	lbs =		
Soil Pressure @ Heel	= 0 psf OK	Strength Level	lbs =		3,171.7
Allowable	= 4,000 psf	Moment.....Actual			
Soil Pressure Less Than Allowable		Service Level	ft-# =		
ACI Factored @ Toe	= 3,778 psf	Strength Level	ft-# =		17,272.4
ACI Factored @ Heel	= 0 psf	Moment.....Allowable	ft-# =		27,140.6
Footing Shear @ Toe	= 23.3 psi OK	Shear.....Actual			
Footing Shear @ Heel	= 30.5 psi OK	Service Level	psi =		
Allowable	= 94.9 psi	Strength Level	psi =		27.5
Sliding Calcs		Shear.....Allowable	=		94.9
Lateral Sliding Force	= 2,270.5 lbs	Anet (Masonry)	in2 =		
less 100% Passive Force	= - 3,244.7 lbs	Wall Weight	psf =		150.0
less 100% Friction Force	= - 2,244.9 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 - 3 feet w/ roadway

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.4124 in ² /ft	
(4/3) * As :	0.5499 in ² /ft	Min Stem T&S Reinf Area 1.535 in ²
200bd/fy : 200(12)(9.625)/60000 :	0.385 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 :
	=====	<u>One layer of :</u> <u>Two layers of :</u>
Required Area :	0.4124 in ² /ft	#4@ 8.33 in #4@ 16.67 in
Provided Area :	0.66 in ² /ft	#5@ 12.92 in #5@ 25.83 in
Maximum Area :	2.0862 in ² /ft	#6@ 18.33 in #6@ 36.67 in

Footing Data

Toe Width	=	2.00 ft
Heel Width	=	4.50
Total Footing Width	=	6.50
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	F _y = 60,000 psi
Footing Concrete Density	=	150.00 pcf
Min. As %	=	0.0018
Cover @ Top	2.00	@ Btm.= 3.00 in

Footing Design Results

	Toe	Heel
Factored Pressure	= 3,778	0 psf
Mu' : Upward	= 6,346	236 ft-#
Mu' : Downward	= 1,092	8,440 ft-#
Mu: Design	= 5,254 OK	8,204 ft-# OK
phiMn	= 20,397	22,377 ft-#
Actual 1-Way Shear	= 23.30	30.53 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: #4@ 7.93 in, #5@ 12.30 in, #6@ 17.46 in, #7@ 23.80 in, #8@ 31.34 in, #9@ 39.68 in, #10@ 50.39 in

Heel: #4@ 7.93 in, #5@ 12.30 in, #6@ 17.46 in, #7@ 23.80 in, #8@ 31.34 in, #9@ 39.68 in, #10@ 50.39 in

Key: No key defined

Min footing T&S reinf Area 1.97 in²
 Min footing T&S reinf Area per foot 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

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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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 (25.4.2.3a) = 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 = 0.4124 in²/ft

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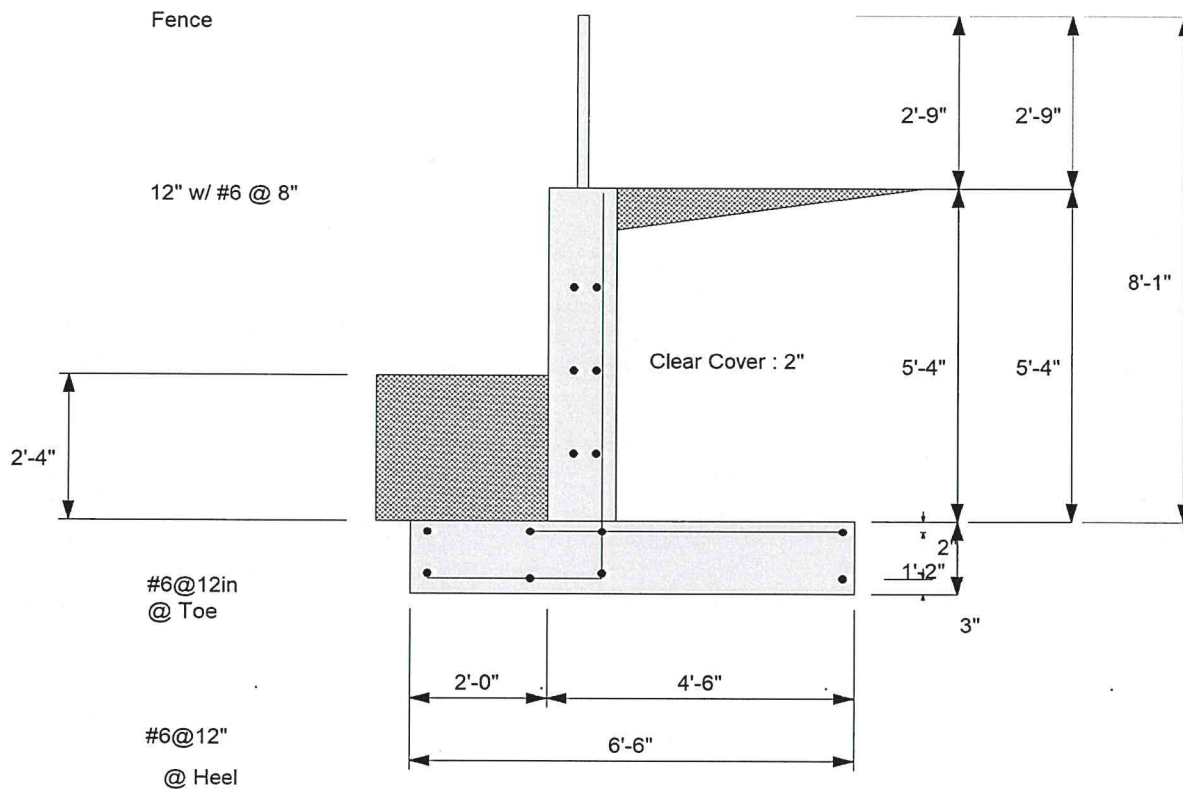
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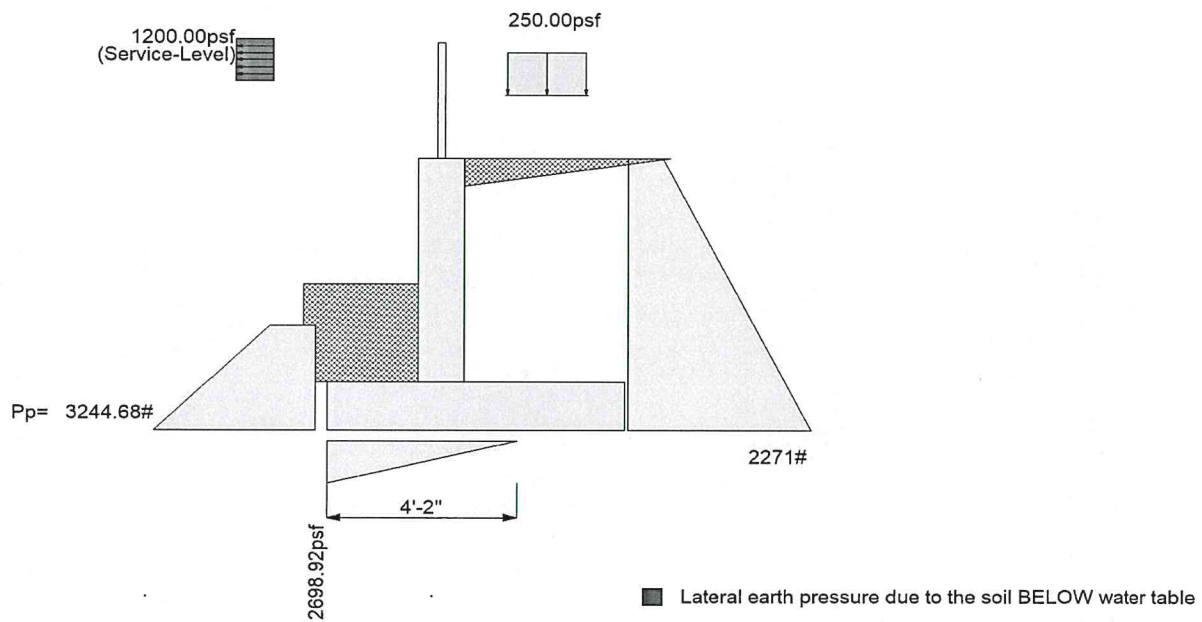
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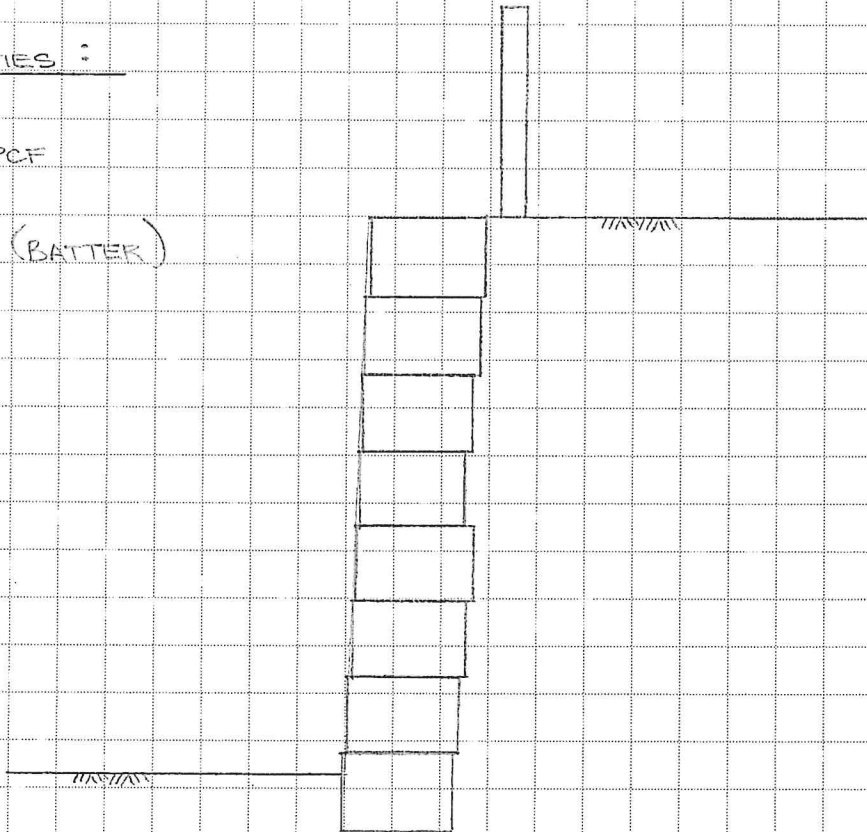
DESIGN RETAINING WALL (A) (3'-0")

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 :

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

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

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

$$K_a = 0.33$$

$$K_p = 3.0$$

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155 Passaic Ave
Fairfield, NJ 07004
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JOB 19-265 DAUGHTERS OF ISRAEL

SHEET NO. _____ OF _____

CALCULATED BY CJD DATE 10/10/2023

CHECKED BY _____ DATE _____

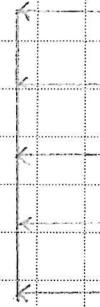
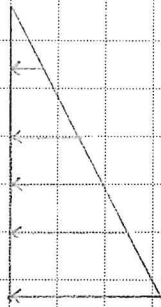
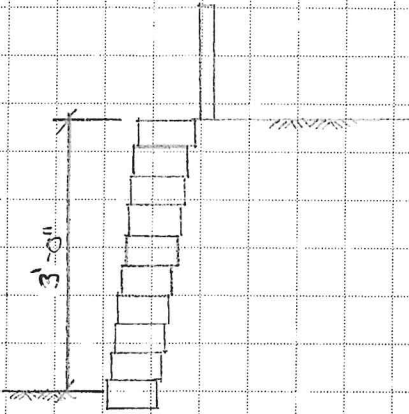
SCALE _____

DESIGN RETAINING WALL (A) (3'-0")

SOIL

SURCHARGE

GUIDE RAIL



$$F_{SOIL} = \frac{1}{2} K_a \gamma (H)^2 = \frac{1}{2} (0.33) (120) (3.5)^2 = 243 \text{ \#}$$

$$F_{SOIL_v} = F_{SOIL} \sin \phi = 243 \sin (30^\circ) = 121 \text{ \#}$$

$$F_{SOIL_H} = F_{SOIL} \cos \phi = 243 \cos (30^\circ) = 211 \text{ \#}$$

$$F_{SURCHARGE} = q_o (K_a) (H) = (250 \text{ PSF}) (0.33) (3.5) = 289 \text{ \#}$$

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

DESIGN RETAINING WALL (A) (3'-0")

A. STABILITY ANALYSIS - SLIDING :

CALCULATE SLIDING FORCE :

$$P_{SLIDING} = F_{SOIL_H} + F_{SURCHARGE} + F_{RAIL} = 211 + 289 + 1200 = 1700 \#$$

CALCULATE RESISTING FORCE :

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

$$WEIGHT = (3.5) \overset{\substack{\uparrow \\ \text{GEOGRID}}}{(7')} (120 \text{ PCF}) + \overset{\substack{\uparrow \\ \text{SURCHARGE}}}{(1)} (250) \\ = 4690 \#$$

$$R_{SLIDING} = 4690(0.58) \\ = 2720 \#$$

$$F.S._{SLIDING} = \frac{R_{SLIDING}}{P_{SLIDING}} = \frac{2720}{1700} = 1.6 > 1.5 \checkmark$$

WHERE :

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

B. STABILITY ANALYSIS - OVERTURNING :

CALCULATE OVERTURNING MOMENT, MOT :

$$MOT = F_{SOIL_H} \left(\frac{3.5}{3} \right) + F_{SUR} \left(\frac{3.5}{2} \right) + F_{RAIL} (5.75') = 211 \left(\frac{3.5}{3} \right) + 289 \left(\frac{3.5}{2} \right) + 1200 (5.75)$$

$$MOT = 7652 \# \cdot FT$$

CALCULATE RESISTING MOMENT, MR :

$$MR = (120)(3.5)(7)(\frac{1}{2}) + (250)(7)(\frac{1}{2})$$

$$MR = 16415 \# \cdot FT$$

$$F.S._{OVERTURNING} = \frac{MR}{MOT} = \frac{16415}{7652} = 2.1 > 1.5 \text{ OK } \checkmark$$

DESIGNING RETAINING WALL (A) (3'-0")

C. STABILITY ANALYSIS - BEARING :

CALCULATE ECCENTRICITY :

$$e = B/2 - \frac{MR - M_{OT}}{WEIGHT} = 7/2 - \frac{16415 - 7652}{4690}$$

$$e = 1.6' \therefore \text{RESULTANT LIES OUTSIDE MIDDLE THIRD}$$

$$R = \frac{1}{2} p_{max} (3x_2) ; x_2 = \frac{L}{2} - e = 7/2 - 1.6' = 1.9'$$

$$p_{max} = \frac{2R}{3x_2} = \frac{2(4690)}{3(1.9)} = 1646 \text{ PSF} < 4000 \text{ PSF OK} \checkmark$$