

This Wall in File: f:\server backup\retain pro 10\rp 2021\21-140.RPX

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Cantilevered Retaining Wall

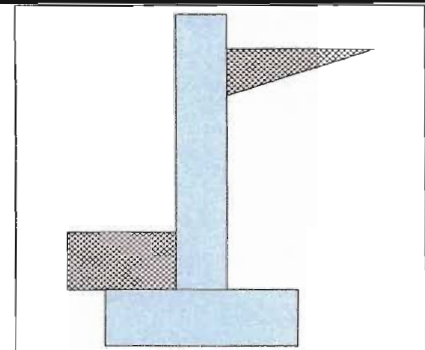
Code: IBC 2018, ACI 318-14, TMS 402-16

Criteria

Retained Height	=	3.50 ft
Wall height above soil	=	0.50 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	10.00 in
Water height over heel	=	0.0 ft

Soil Data

Allow Soil Bearing	=	2,000.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
Passive Pressure	=	250.0 psf/ft
Soil Density, Heel	=	120.00 pcf
Soil Density, Toe	=	0.00 pcf
Footing Soil Friction	=	0.300
Soil height to ignore for passive pressure	=	0.00 in



Surcharge Loads

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

Lateral Load Applied to Stem

Lateral Load	=	21.0 #/ft
...Height to Top	=	3.50 ft
...Height to Bottom	=	0.00 ft
Load Type	=	Seismic (E) (Strength 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		Line Load
Base Above/Below Soil at Back of Wall	=	0.0 ft
Poisson's Ratio	=	0.300

Axial Load Applied to Stem

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

Design Summary

Wall Stability Ratios

Overturning	=	2.76 OK
Sliding	=	1.78 OK
Total Bearing Load	=	1,098 lbs
...resultant ecc.	=	3.31 in
Soil Pressure @ Toe	=	729 psf OK
Soil Pressure @ Heel	=	148 psf OK
Allowable	=	2,000 psf
Soil Pressure Less Than Allowable		
ACI Factored @ Toe	=	1,021 psf
ACI Factored @ Heel	=	208 psf
Footing Shear @ Toe	=	2.4 psi OK
Footing Shear @ Heel	=	3.9 psi OK
Allowable	=	75.0 psi
Sliding Calcs		
Lateral Sliding Force	=	380.1 lbs
less 100% Passive Force	=	- 347.2 lbs
less 100% Friction Force	=	- 329.3 lbs
Added Force Req'd	=	0.0 lbs OK
...for 1.5 Stability	=	0.0 lbs OK

Stem Construction

Design Height Above Ftg	ft =	0.00
Wall Material Above "Ht"	=	Concrete
Design Method	=	LRFD
Thickness	=	8.00
Rebar Size	=	# 4
Rebar Spacing	=	12.00
Rebar Placed at	=	6.5 in
Design Data		
fb/FB + fa/Fa	=	0.138
Total Force @ Section		
Service Level	lbs =	
Strength Level	lbs =	416.5
Moment...Actual		
Service Level	ft-# =	
Strength Level	ft-# =	528.8
Moment....Allowable	=	3,805.6
Shear....Actual		
Service Level	psi =	
Strength Level	psi =	5.3
Shear....Allowable	psi =	75.0
Anet (Masonry)	in2 =	
Rebar Depth 'd'	in =	6.50

Masonry Data

fm	psi =	
Fs	psi =	
Solid Grouting	=	
Modular Ratio 'n'	=	
Wall Weight	psf =	100.0
Short Term Factor	=	
Equiv. Solid Thick.	=	
Masonry Block Type	=	Medium Weight
Masonry Design Method	=	ASD

Concrete Data

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

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

Load Factors

Building Code	IBC 2018, ACI
Dead Load	1.400
Live Load	1.600
Earth, H	1.600
Wind, W	1.000
Seismic, E	1.000

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Cantilevered Retaining Wall

Code: IBC 2018, ACI 318-14, TMS 402-16

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.0285 in ² /ft		
(4/3) * As :	0.038 in ² /ft	Min Stem T&S Reinf Area 0.768 in ²	
200bd/fy : 200(12)(6.5)/40000 :	0.39 in ² /ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in ² /ft	
0.0018bh : 0.0018(12)(8) :	0.1728 in ² /ft	Horizontal Reinforcing Options :	
	=====	One layer of :	Two layers of :
Required Area :	0.1728 in ² /ft	#4@ 12.50 in	#4@ 25.00 in
Provided Area :	0.2 in ² /ft	#5@ 19.38 in	#5@ 38.75 in
Maximum Area :	1.3208 in ² /ft	#6@ 27.50 in	#6@ 55.00 in

Footing Data

Toe Width	=	0.92 ft
Heel Width	=	1.58
Total Footing Width	=	2.50
Footing Thickness	=	10.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.83 ft
f _c =	2,500 psi	F _y = 40,000 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	=	1,021	208 psf
Mu' : Upward	=	4,651	129 ft-#
Mu' : Downward	=	1,589	321 ft-#
Mu: Design	=	255	191 ft-#
Actual 1-Way Shear	=	2.44	3.88 psi
Allow 1-Way Shear	=	40.00	40.00 psi
Toe Reinforcing	=	None Spec'd	
Heel Reinforcing	=	None Spec'd	
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: $\phi Mn = \phi'5' \lambda \sqrt{f_c} S_m$
 Heel: $\phi Mn = \phi'5' \lambda \sqrt{f_c} S_m$
 Key: No key defined

Min footing T&S reinf Area	0.54	in ²
Min footing T&S reinf Area per foot	0.22	in ² /ft
If one layer of horizontal bars:	If two layers of horizontal bars:	
#4@ 11.11 in	#4@ 22.22 in	
#5@ 17.22 in	#5@ 34.44 in	
#6@ 24.44 in	#6@ 48.89 in	

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Cantilevered Retaining Wall

Code: IBC 2018, ACI 318-14, TMS 402-16

Summary of Overturning & Resisting Forces & Moments

ItemOVERTURNING.....			RESISTING.....			
	Force lbs	Distance ft	Moment ft-#		Force lbs	Distance ft	Moment ft-#	
HL Act Pres (ab water tbl)	328.6	1.44	474.7	Soil Over HL (ab. water tbl)	385.0	2.04	786.2	
HL Act Pres (be water tbl)				Soil Over HL (bel. water tbl)		2.04	786.2	
Hydrostatic Force				Water Table				
Buoyant Force =				Sloped Soil Over Heel =				
Surcharge over Heel =				Surcharge Over Heel =				
Surcharge Over Toe =				Adjacent Footing Load =				
Adjacent Footing Load =				Axial Dead Load on Stem =				
Added Lateral Load =	51.5	2.58	132.9	* Axial Live Load on Stem =				
Load @ Stem Above Soil =				Soil Over Toe =		0.46		
				Surcharge Over Toe =				
				Stem Weight(s) =	400.0	1.25	500.1	
				Earth @ Stem Transitions =				
Total	=	380.1	O.T.M. =	607.6	Footing Weight =	312.5	1.25	390.7
					Key Weight =		0.83	
					Vert. Component =			
Resisting/Overturning Ratio			=	2.76	Total =	1,097.5 lbs	R.M. =	1,677.0
Vertical Loads used for Soil Pressure =		1,097.5	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) 0.032 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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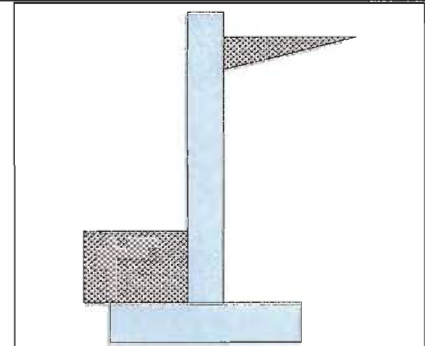
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Criteria

Retained Height	=	5.50 ft
Wall height above soil	=	0.50 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	18.00 in
Water height over heel	=	0.0 ft

Soil Data

Allow Soil Bearing	=	2,000.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
Passive Pressure	=	250.0 psf/ft
Soil Density, Heel	=	120.00 pcf
Soil Density, Toe	=	0.00 pcf
Footing Soil Friction	=	0.300
Soil height to ignore for passive pressure	=	0.00 in



Surcharge Loads

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

Lateral Load Applied to Stem

Lateral Load	=	33.0 #/ft
...Height to Top	=	5.50 ft
...Height to Bottom	=	0.00 ft
Load Type	=	Seismic (E) (Strength 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	=	Line Load
Base Above/Below Soil at Back of Wall	=	0.0 ft
Poisson's Ratio	=	0.300

Axial Load Applied to Stem

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

Design Summary

Wall Stability Ratios

Overturning	=	2.29 OK
Sliding	=	1.53 OK
Total Bearing Load	=	1,973 lbs
...resultant ecc.	=	5.86 in
Soil Pressure @ Toe	=	1,035 psf OK
Soil Pressure @ Heel	=	92 psf OK
Allowable	=	2,000 psf
Soil Pressure Less Than Allowable		
ACI Factored @ Toe	=	1,449 psf
ACI Factored @ Heel	=	129 psf
Footing Shear @ Toe	=	7.5 psi OK
Footing Shear @ Heel	=	10.4 psi OK
Allowable	=	75.0 psi
Sliding Calcs		
Lateral Sliding Force	=	829.0 lbs
less 100% Passive Force	= -	680.6 lbs
less 100% Friction Force	= -	591.8 lbs
Added Force Req'd	=	0.0 lbs OK
....for 1.5 Stability	=	0.0 lbs OK

Stem Construction

Design Height Above Ftg	ft =	Stem OK 0.00
Wall Material Above "Ht"	=	Concrete
Design Method	=	LRFD
Thickness	=	8.00
Rebar Size	=	# 4
Rebar Spacing	=	12.00
Rebar Placed at	=	6.5 in

Design Data

fb/FB + fa/Fa	=	0.539
Total Force @ Section		
Service Level	lbs =	
Strength Level	lbs =	1,028.5
Moment....Actual		
Service Level	ft-# =	
Strength Level	ft-# =	2,052.0
Moment....Allowable	=	3,805.6

Shear....Actual

Service Level	psi =	
Strength Level	psi =	13.2
Shear....Allowable	psi =	75.0
Anet (Masonry)	in2 =	
Rebar Depth 'd'	in =	6.50

Masonry Data

f _m	psi =	
F _s	psi =	
Solid Grouting	=	
Modular Ratio 'n'	=	
Wall Weight	psf =	100.0
Short Term Factor	=	
Equiv. Solid Thick.	=	
Masonry Block Type	=	Medium Weight
Masonry Design Method	=	ASD

Concrete Data

f _c	psi =	2,500.0
F _y	psi =	40,000.0

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

Load Factors

Building Code	IBC 2018,ACI
Dead Load	1.400
Live Load	1.600
Earth, H	1.600
Wind, W	1.000
Seismic, E	1.000

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Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.1107 in ² /ft		
(4/3) * As :	0.1475 in ² /ft	Min Stem T&S Reinf Area 1.152 in ²	
200bd/fy : 200(12)(6.5)/40000 :	0.39 in ² /ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in ² /ft	
0.0018bh : 0.0018(12)(8) :	0.1728 in ² /ft	Horizontal Reinforcing Options :	
	=====	One layer of :	Two layers of :
Required Area :	0.1728 in ² /ft	#4@ 12.50 in	#4@ 25.00 in
Provided Area :	0.2 in ² /ft	#5@ 19.38 in	#5@ 38.75 in
Maximum Area :	1.3208 in ² /ft	#6@ 27.50 in	#6@ 55.00 in

Footing Data

Toe Width	=	1.42 ft
Heel Width	=	2.08
Total Footing Width	=	3.50
Footing Thickness	=	10.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft
f _c =	2,500 psi	F _y = 40,000 psi
Footing Concrete Density	=	150.00 pcf
Min. As %	=	0.0018
Cover @ Top	2.00	@ Btm = 3.00 in

Footing Design Results

		<u>Toe</u>	<u>Heel</u>
Factored Pressure	=	1,449	129 psf
Mu' : Upward	=	15,312	308 ft-#
Mu' : Downward	=	5,144	1,103 ft-#
Mu: Design	=	847	795 ft-#
Actual 1-Way Shear	=	7.49	10.37 psi
Allow 1-Way Shear	=	40.00	40.00 psi
Toe Reinforcing	=	None Spec'd	
Heel Reinforcing	=	None Spec'd	
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: $\phi M_n = \phi'5' \lambda \sqrt{f_c} S_m$
 Heel: $\phi M_n = \phi'5' \lambda \sqrt{f_c} S_m$
 Key: No key defined

Min footing T&S reinf Area	0.76	in ²
Min footing T&S reinf Area per foot	0.22	in ² /ft
If one layer of horizontal bars:		If two layers of horizontal bars:
#4@ 11.11 in		#4@ 22.22 in
#5@ 17.22 in		#5@ 34.44 in
#6@ 24.44 in		#6@ 48.89 in

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Summary of Overturning & Resisting Forces & Moments

ItemOVERTURNING.....		RESISTING.....			
	Force lbs	Distance ft	Moment ft-#	Force lbs	Distance ft	Moment ft-#	
HL Act Pres (ab water tbl)	701.9	2.11	1,481.9	Soil Over HL (ab. water tbl)	935.0	2.79	2,610.5
HL Act Pres (be water tbl)				Soil Over HL (bel. water tbl)		2.79	2,610.5
Hydrostatic Force				Watre Table			
Buoyant Force =				Sloped Soil Over Heel =			
Surcharge over Heel =				Surcharge Over Heel =			
Surcharge Over Toe =				Adjacent Footing Load =			
Adjacent Footing Load =				Axial Dead Load on Stem =			
Added Lateral Load =	127.1	3.58	455.3	* Axial Live Load on Stem =			
Load @ Stem Above Soil =				Soil Over Toe =		0.71	
				Surcharge Over Toe =			
				Stem Weight(s) =	600.0	1.75	1,050.2
				Earth @ Stem Transitions =			
				Footing Weight =	437.5	1.75	765.8
				Key Weight =			
				Vert. Component =			
Total	= 829.0	O.T.M. =	1,937.1	Total =	1,972.5 lbs	R.M. =	4,426.5
Resisting/Overturning Ratio		=	2.29				
Vertical Loads used for Soil Pressure =		1,972.5 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) 0.049 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.