

# MYERS ENGINEERING

## RETAINING WALL CALCULATIONS



Digitally  
signed by  
Mark Myers,  
PE  
Date:  
2021.02.12  
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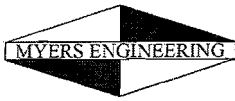
MUST BEAR ORIGINAL BLUE INK SIGNATURE OR  
DIGITAL PDF SIGNATURE FOR PERMIT SUBMITTAL.

**Project: Addendum to Marbella Residence**  
**2641 64<sup>th</sup> Street NW**  
**Gig Harbor, WA**

February 12, 2021

2015 INTERNATIONAL BUILDING CODE  
110 MPH WIND, EXPOSURE C,  $K_{zt} = 1.00$   
RISK CATEGORY II - SOIL SITE CLASS D  
SEISMIC DESIGN CATEGORY D (IBC)

3206 50<sup>th</sup> Street Court NW, Suite 210-B  
Gig Harbor, WA 98335  
Phone: 253-858-3248  
Email: [myengineer@centurytel.net](mailto:myengineer@centurytel.net)



Mark Myers, P.E.  
 Myers Engineering LLC  
 3206 50th St. Ct. NW, Ste 210-B  
 Gig Harbor, WA 98335

Project Name/Number : marbella  
 Title 8ft Stem  
 Dsgnr: Mark Myers, PE  
 Description....

Page : 1  
 Date: 11 FEB 2021

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### Cantilevered Retaining Wall

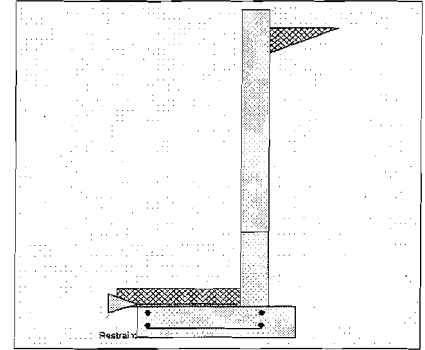
Code: IBC 2018, ACI 318-14, TMS 402-16

#### Criteria

Retained Height = 7.50 ft  
 Wall height above soil = 0.50 ft  
 Slope Behind Wall = 0.00  
 Height of Soil over Toe = 6.00 in  
 Water height over heel = 0.0 ft

#### Soil Data

Allow Soil Bearing = 2,500.0 psf  
 Equivalent Fluid Pressure Method  
 Active Heel Pressure = 35.0 psf/ft  
 =  
 Passive Pressure = 300.0 psf/ft  
 Soil Density, Heel = 125.00 pcf  
 Soil Density, Toe = 125.00 pcf  
 Footing|Soil Friction = 0.400  
 Soil height to ignore for passive pressure = 0.00 in



#### Surcharge Loads

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

#### Lateral Load Applied to Stem

Lateral Load = 0.0 #/ft  
 ...Height to Top = 0.00 ft  
 ...Height to Bottom = 0.00 ft  
 Load Type = Wind (W)  
 (Service Level)  
 Wind on Exposed Stem = 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 = 0.0 ft  
 at Back of Wall  
 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 = 1.65 OK  
 Slab Resists All Sliding !

Total Bearing Load = 2,060 lbs  
 ...resultant ecc. = 10.24 in

Soil Pressure @ Toe = 1,291 psf OK  
 Soil Pressure @ Heel = 0 psf OK  
 Allowable = 2,500 psf  
 Soil Pressure Less Than Allowable  
 ACI Factored @ Toe = 1,808 psf  
 ACI Factored @ Heel = 0 psf  
 Footing Shear @ Toe = 24.4 psi OK  
 Footing Shear @ Heel = 10.3 psi OK  
 Allowable = 75.0 psi

#### Sliding Calcs

Lateral Sliding Force = 1,215.3 lbs

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 1.700  
 Earth, H 1.700  
 Wind, W 1.000  
 Seismic, E 1.000

#### Stem Construction

	2nd	Bottom
Design Height Above Ftc	ft = Stem OK 2.00	Stem OK 0.00
Wall Material Above "Ht"	= Concrete	Concrete
Design Method	= LRFD	LRFD
Thickness	= 8.00	8.00
Rebar Size	= # 4	# 4
Rebar Spacing	= 12.00	10.00
Rebar Placed at	= 6 in	6 in

#### Design Data

fb/FB + fa/Fa = 0.318 0.677

#### Total Force @ Section

Service Level lbs =  
 Strength Level lbs = 899.9 1,673.4

#### Moment....Actual

Service Level ft-# =  
 Strength Level ft-# = 1,649.9 4,183.6

#### Moment....Allowable

ft-# = 5,187.6 6,174.1

#### Shear....Actual

Service Level psi =  
 Strength Level psi = 12.5 23.2

#### Shear....Allowable

psi = 75.0 75.0

#### Anet (Masonry)

in2 =

#### Rebar Depth 'd'

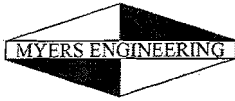
in = 6.00 6.00

#### Masonry Data

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

#### Concrete Data

f'c psi = 2,500.0 2,500.0  
 Fy psi = 60,000.0 60,000.0



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### Cantilevered Retaining Wall

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

#### Concrete Stem Rebar Area Details

2nd Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.0645 in <sup>2</sup> /ft		
(4/3) * As :	0.086 in <sup>2</sup> /ft	Min Stem T&S Reinf Area 1.152 in <sup>2</sup>	
200bd/fy : 200(12)(6)/60000 :	0.24 in <sup>2</sup> /ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in <sup>2</sup> /ft	
0.0018bh : 0.0018(12)(8) :	0.1728 in <sup>2</sup> /ft	Horizontal Reinforcing Options :	
	=====	One layer of :	Two layers of :
Required Area :	0.1728 in <sup>2</sup> /ft	#4@ 12.50 in	#4@ 25.00 in
Provided Area :	0.2 in <sup>2</sup> /ft	#5@ 19.38 in	#5@ 38.75 in
Maximum Area :	0.8128 in <sup>2</sup> /ft	#6@ 27.50 in	#6@ 55.00 in

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.1636 in <sup>2</sup> /ft		
(4/3) * As :	0.2182 in <sup>2</sup> /ft	Min Stem T&S Reinf Area 0.384 in <sup>2</sup>	
200bd/fy : 200(12)(6)/60000 :	0.24 in <sup>2</sup> /ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in <sup>2</sup> /ft	
0.0018bh : 0.0018(12)(8) :	0.1728 in <sup>2</sup> /ft	Horizontal Reinforcing Options :	
	=====	One layer of :	Two layers of :
Required Area :	0.2182 in <sup>2</sup> /ft	#4@ 12.50 in	#4@ 25.00 in
Provided Area :	0.24 in <sup>2</sup> /ft	#5@ 19.38 in	#5@ 38.75 in
Maximum Area :	0.8128 in <sup>2</sup> /ft	#6@ 27.50 in	#6@ 55.00 in

#### Footing Data

Toe Width	=	2.50 ft
Heel Width	=	1.33
Total Footing Width	=	3.83
Footing Thickness	=	10.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	2.92 ft
f'c =	2,500 psi	Fy = 60,000 psi
Footing Concrete Density	=	150.00 pcf
Min. As %	=	0.0018
Cover @ Top	2.00	@ Btm = 3.00 in

#### Footing Design Results

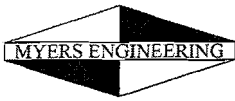
	Toe	Heel
Factored Pressure	= 1,808	0 psf
Mu' : Upward	= 50,091	0 ft-#
Mu' : Downward	= 9,844	330 ft-#
Mu: Design	= 3,354	330 ft-#
Actual 1-Way Shear	= 24.40	10.32 psi
Allow 1-Way Shear	= 75.00	40.00 psi
Toe Reinforcing	= # 4 @ 9.00 in	
Heel Reinforcing	= None Spec'd	
Key Reinforcing	= None Spec'd	
Footing 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: #4@ 11.11 in, #5@ 17.22 in, #6@ 24.44 in, #7@ 33.33 in, #8@ 43.88 in, #9@ 5  
 Heel: phi Mn = phi 5 lambda sqrt(fc) Sm  
 Key: No key defined

Min footing T&S reinf Area	0.83 in <sup>2</sup>
Min footing T&S reinf Area per foot	0.22 in <sup>2</sup> /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

Item	.....OVERTURNING.....			.....RESISTING.....			
	Force lbs	Distance ft	Moment ft-#	Force lbs	Distance ft	Moment ft-#	
HL Act Pres (ab water tbl)	1,215.3	2.78	3,375.8	Soil Over HL (ab. water tbl)	624.7	3.50	2,186.3
HL Act Pres (be water tbl)				Soil Over HL (bel. water tbl)		3.50	2,186.3
Hydrostatic Force				Watre Table			
Buoyant Force =				Sloped Soil Over Heel =			
Surcharge over Heel =				Surcharge Over Heel =			
Surcharge Over Toe =				Adjacent Footing Load =			
Adjacent Footing Load =				Axial Dead Load on Stem =			
Added Lateral Load =				* Axial Live Load on Stem =			
Load @ Stem Above Soil =				Soil Over Toe =	156.3	1.25	195.3
				Surcharge Over Toe =			
				Stem Weight(s) =	800.0	2.83	2,266.7
				Earth @ Stem Transitions =			
<b>Total</b>	<b>= 1,215.3</b>	<b>O.T.M. =</b>	<b>3,375.8</b>	Footing Weight =	479.1	1.92	918.2
				Key Weight =		2.92	
				Vert. Component =			
<b>Resisting/Overturning Ratio</b>		<b>=</b>	<b>1.65</b>	<b>Total =</b>	<b>2,060.1 lbs</b>	<b>R.M. =</b>	<b>5,566.5</b>
Vertical Loads used for Soil Pressure =			2,060.1 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

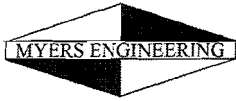
##### Horizontal Deflection at Top of Wall due to settlement of soil

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus 250.0 pci

Horizontal Defl @ Top of Wall (approximate only) 0.075 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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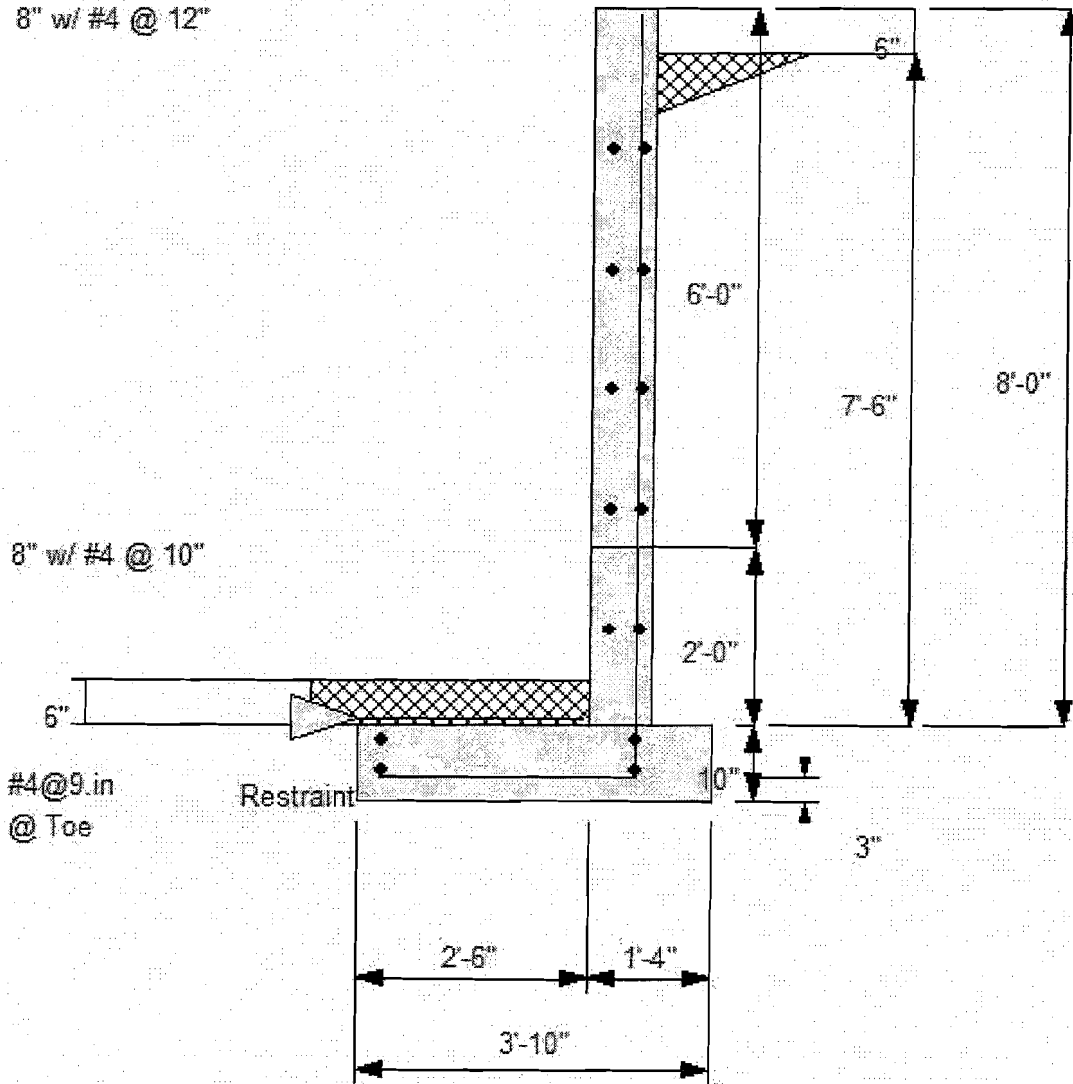
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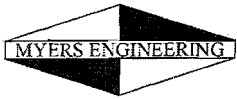
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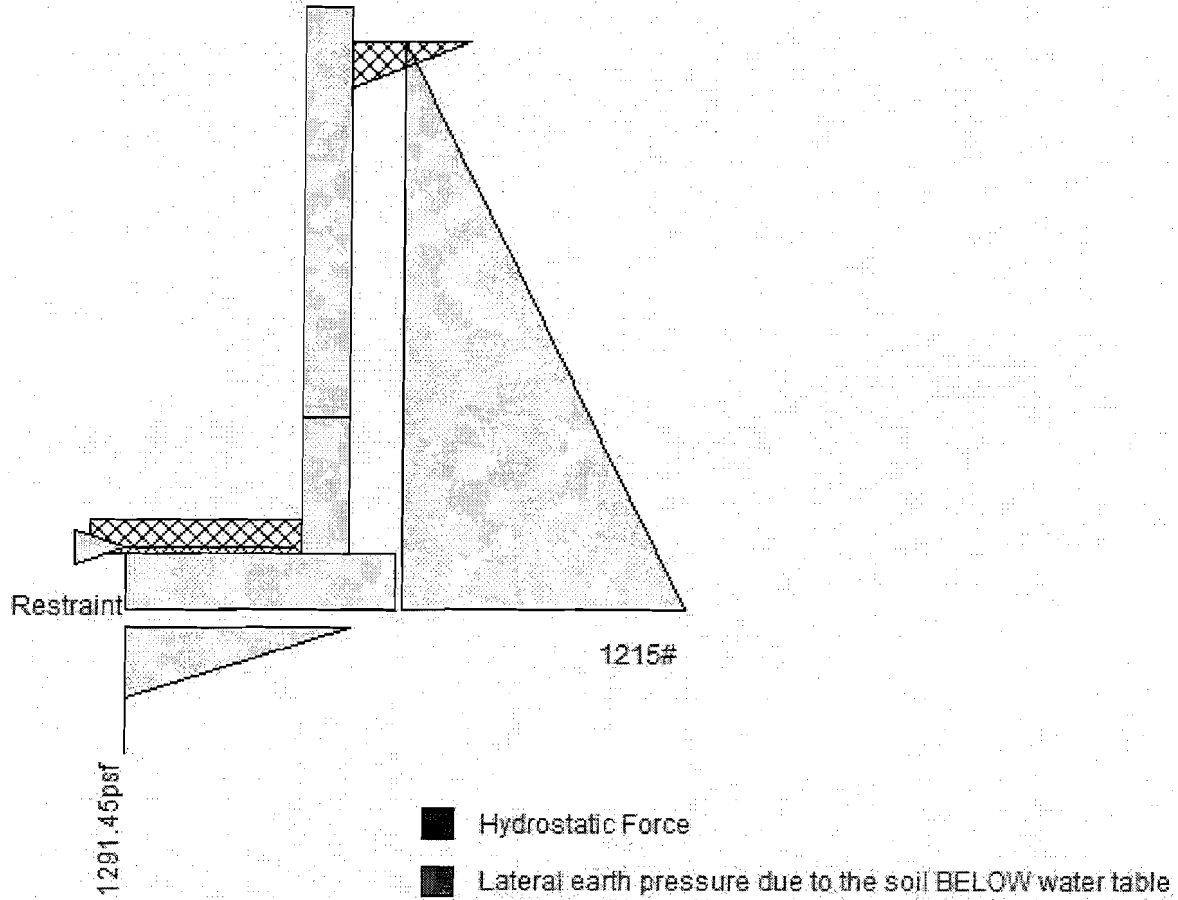
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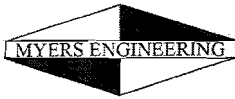
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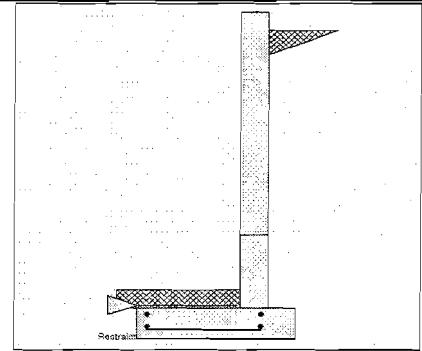
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#### Criteria

Retained Height	=	7.50 ft
Wall height above soil	=	0.50 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water height over heel	=	0.0 ft

#### Soil Data

Allow Soil Bearing	=	3,333.3 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
Passive Pressure	=	300.0 psf/ft
Soil Density, Heel	=	125.00 pcf
Soil Density, Toe	=	125.00 pcf
Footing  Soil Friction	=	0.400
Soil height to ignore for passive pressure	=	0.00 in



#### Surcharge Loads

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

#### Lateral Load Applied to Stem

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

#### Earth Pressure Seismic Load

Method	:	Uniform
Multiplier Used	=	6.000
(Multiplier used on soil density)		

Uniform Seismic Force	=	50.000
Total Seismic Force	=	416.667

#### Design Summary

Wall Stability Ratios		
Overturning	=	1.21 Ratio < 1.5!
Slab Resists All Sliding:		OK w/ seismic
Total Bearing Load	=	2,060 lbs
...resultant ecc.	=	17.32 in
Soil Pressure @ Toe	=	2,900 psf OK
Soil Pressure @ Heel	=	0 psf OK
Allowable Soil Pressure Less Than Allowable	=	3,333 psf
ACI Factored @ Toe	=	4,061 psf
ACI Factored @ Heel	=	0 psf
Footing Shear @ Toe	=	29.9 psi OK
Footing Shear @ Heel	=	10.3 psi OK
Allowable	=	75.0 psi

#### Sliding Calcs

Lateral Sliding Force	=	1,506.9 lbs
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#### Stem Construction

	2nd	Bottom
Design Height Above Ftg	ft = 2.00	Stem OK
Wall Material Above "Ht"	= Concrete	Stem OK
Design Method	= LRFD	Concrete
Thickness	= 8.00	Concrete
Rebar Size	= # 4	Concrete
Rebar Spacing	= 12.00	Concrete
Rebar Placed at	= 6 in	Concrete

#### Design Data

fb/FB + fa/Fa	=	0.463	0.905
---------------	---	-------	-------

#### Total Force @ Section

Service Level	lbs =		
Strength Level	lbs =	1,174.9	2,048.4

#### Moment....Actual

Service Level	ft-# =		
Strength Level	ft-# =	2,406.1	5,589.8

#### Moment....Allowable

ft-# =	5,187.6	6,174.1
--------	---------	---------

#### Shear.....Actual

Service Level	psi =		
Strength Level	psi =	16.3	28.5

#### Shear.....Allowable

psi =	75.0	75.0
-------	------	------

#### Anet (Masonry)

in2 =		
-------	--	--

#### Rebar Depth 'd'

in =	6.00	6.00
------	------	------

#### Masonry Data

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

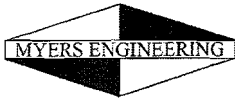
#### Concrete Data

fc	psi =	2,500.0	2,500.0
Fy	psi =	60,000.0	60,000.0

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	1.700
Earth, H	1.700
Wind, W	1.000
Seismic, E	1.000



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#### Concrete Stem Rebar Area Details

2nd Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.0941 in <sup>2</sup> /ft		
(4/3) * As :	0.1255 in <sup>2</sup> /ft	Min Stem T&S Reinf Area 1.152 in <sup>2</sup>	
200bd/fy : 200(12)(6)/60000 :	0.24 in <sup>2</sup> /ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in <sup>2</sup> /ft	
0.0018bh : 0.0018(12)(8) :	0.1728 in <sup>2</sup> /ft	Horizontal Reinforcing Options :	
	=====	One layer of :	Two layers of :
Required Area :	0.1728 in <sup>2</sup> /ft	#4@ 12.50 in	#4@ 25.00 in
Provided Area :	0.2 in <sup>2</sup> /ft	#5@ 19.38 in	#5@ 38.75 in
Maximum Area :	0.8128 in <sup>2</sup> /ft	#6@ 27.50 in	#6@ 55.00 in

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.2186 in <sup>2</sup> /ft		
(4/3) * As :	0.2915 in <sup>2</sup> /ft	Min Stem T&S Reinf Area 0.384 in <sup>2</sup>	
200bd/fy : 200(12)(6)/60000 :	0.24 in <sup>2</sup> /ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in <sup>2</sup> /ft	
0.0018bh : 0.0018(12)(8) :	0.1728 in <sup>2</sup> /ft	Horizontal Reinforcing Options :	
	=====	One layer of :	Two layers of :
Required Area :	0.24 in <sup>2</sup> /ft	#4@ 12.50 in	#4@ 25.00 in
Provided Area :	0.24 in <sup>2</sup> /ft	#5@ 19.38 in	#5@ 38.75 in
Maximum Area :	0.8128 in <sup>2</sup> /ft	#6@ 27.50 in	#6@ 55.00 in

#### Footing Data

Toe Width	=	2.50 ft
Heel Width	=	1.33
Total Footing Width	=	3.83
Footing Thickness	=	10.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	2.92 ft
f <sub>c</sub> =	2,500 psi	F <sub>y</sub> = 60,000 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	=	4,061	0 psf
Mu' : Upward	=	70,135	0 ft-#
Mu' : Downward	=	9,844	330 ft-#
Mu: Design	=	5,024	330 ft-#
Actual 1-Way Shear	=	29.91	10.32 psi
Allow 1-Way Shear	=	75.00	40.00 psi
Toe Reinforcing	=	# 4 @ 9.00 in	
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.

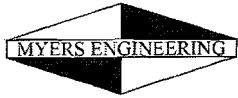
#### Other Acceptable Sizes & Spacings

Toe: #4@ 9.96 in, #5@ 15.44 in, #6@ 21.92 in, #7@ 29.89 in, #8@ 39.36 in, #9@ 49  
 Heel: phi Min = phi 1.5 lambda sqrt(f<sub>c</sub>) S<sub>m</sub>  
 Key: No key defined

#4@10"  
OK

Min footing T&S reinf Area	0.83 in <sup>2</sup>
Min footing T&S reinf Area per foot	0.22 in <sup>2</sup> /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





Mark Myers, P.E.  
 Myers Engineering LLC  
 3206 50th St. Ct. NW, Ste 210-B  
 Gig Harbor, WA 98335

Project Name/Number : marbella  
 Title 8ft Stem w/ Seismic  
 Dsgnr: Mark Myers, PE  
 Description....

Page : 3  
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### Cantilevered Retaining Wall

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

#### 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)	1,215.3	2.78	3,375.8	Soil Over HL (ab. water tbl)	624.7	3.50	2,186.3
HL Act Pres (be water tbl)				Soil Over HL (bel. water tbl)		3.50	2,186.3
Hydrostatic Force				Watre Table			
Buoyant Force =				Sloped Soil Over Heel =			
Surcharge over Heel =				Surcharge Over Heel =			
Surcharge Over Toe =				Adjacent Footing Load =			
Adjacent Footing Load =				Axial Dead Load on Stem =			
Added Lateral Load =				* Axial Live Load on Stem =			
Load @ Stem Above Soil =				Soil Over Toe =	156.3	1.25	195.3
Seismic Earth Load =	291.7	4.17	1,215.3	Surcharge Over Toe =			
=				Stem Weight(s) =	800.0	2.83	2,266.7
<b>Total</b>	<b>= 1,506.9</b>	<b>O.T.M. =</b>	<b>4,591.0</b>	Earth @ Stem Transitions =			
				Footing Weight =	479.1	1.92	918.2
				Key Weight =		2.92	
				Vert. Component =			
				<b>Total =</b>	<b>2,060.1 lbs</b>	<b>R.M. =</b>	<b>5,566.5</b>

Resisting/Overturning Ratio = 1.21  
 Vertical Loads used for Soil Pressure = 2,060.1 lbs

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

If seismic is included, the OTM and sliding ratios may be 1.1 per section 1807.2.3 of IBC.

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

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

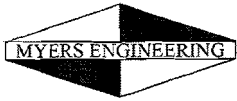
#### Tilt

##### Horizontal Deflection at Top of Wall due to settlement of soil

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus 250.0 pci  
 Horizontal Defl @ Top of Wall (approximate only) 0.168 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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Project Name/Number : marbella  
Title 8ft Stem w/ Seismic  
Dsgnr: Mark Myers, PE  
Description.....

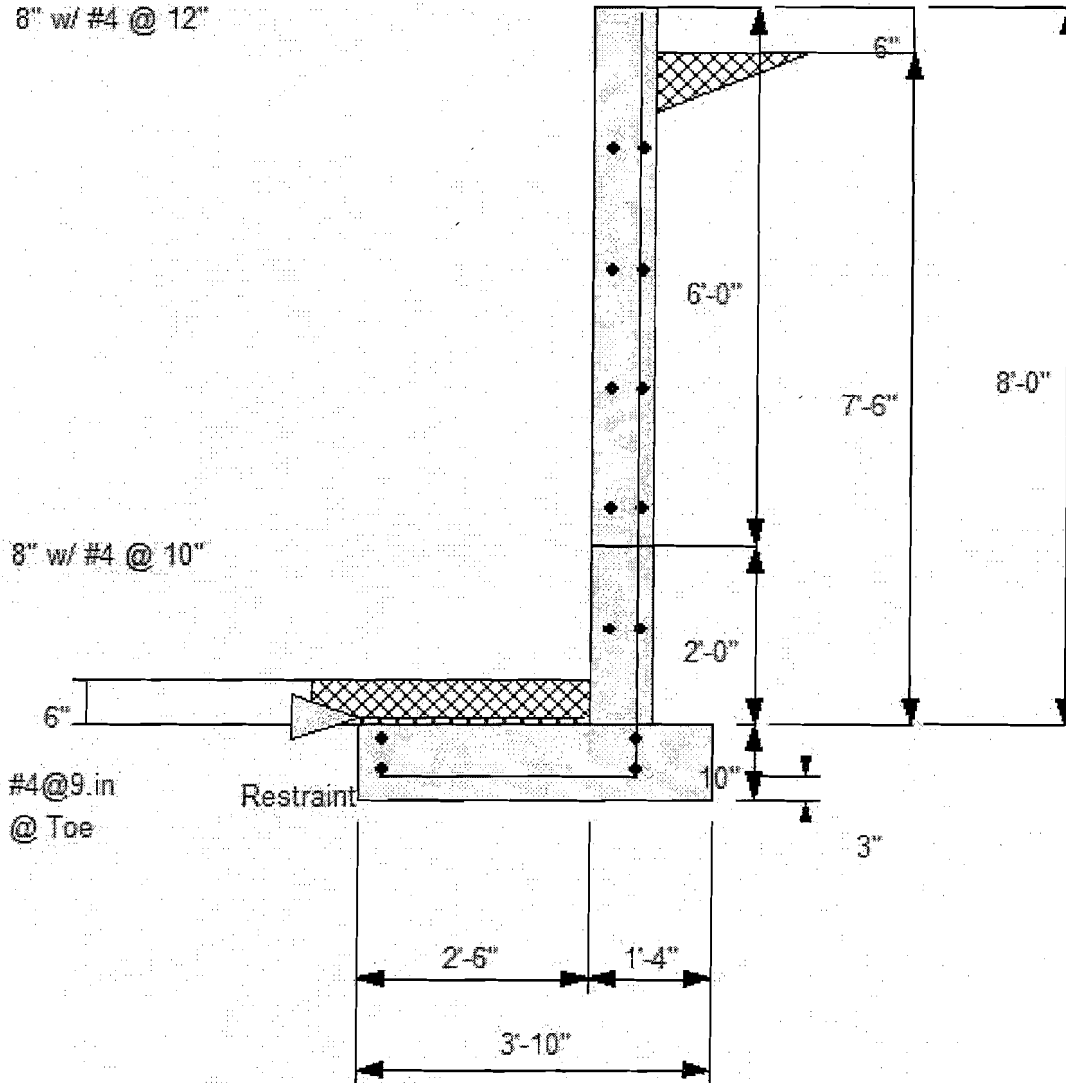
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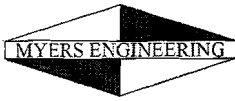
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### Cantilevered Retaining Wall

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





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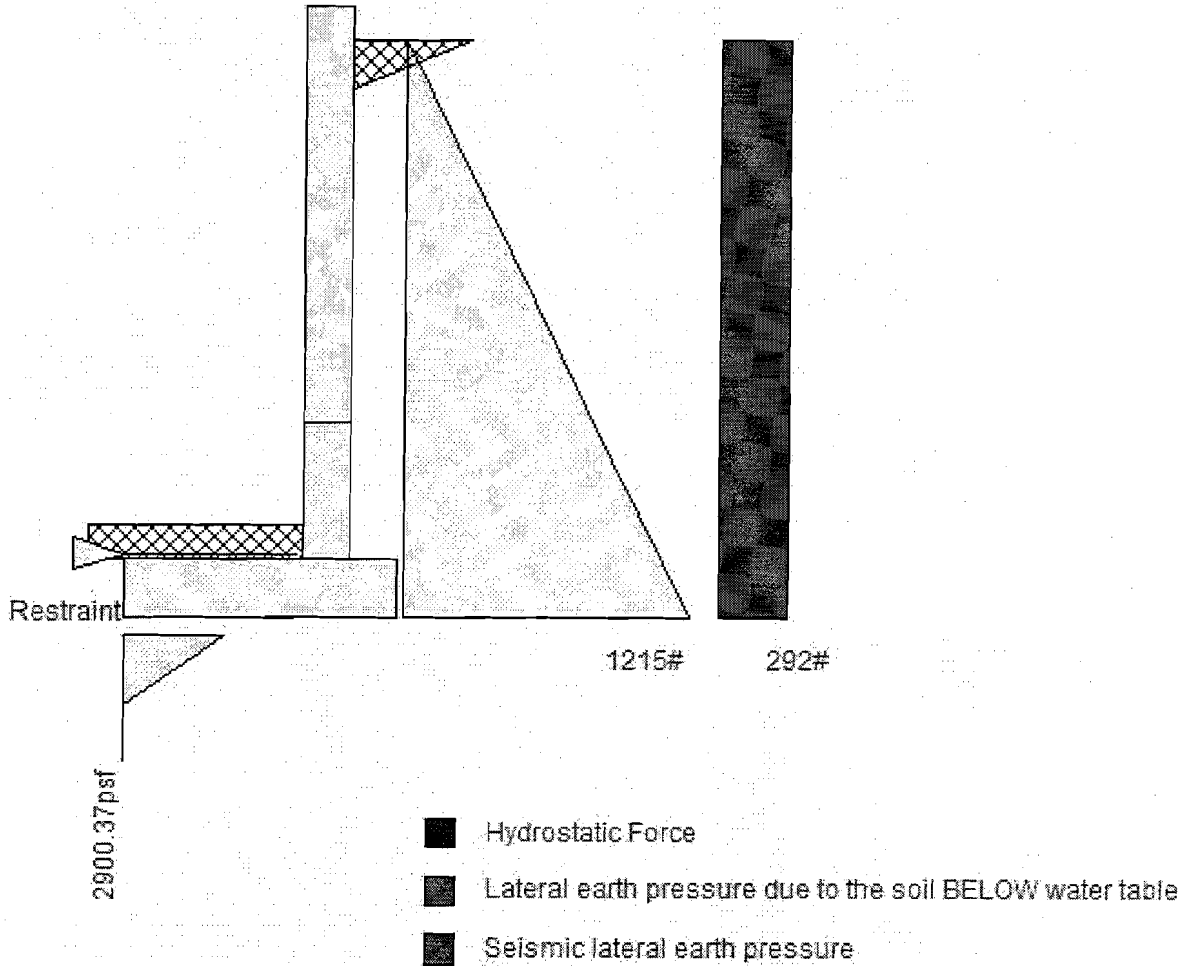
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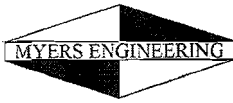
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Code: IBC 2018, ACI 318-14, TMS 402-16





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Project Name/Number : marbella  
 Title 6ft Stem  
 Dsgnr: Mark Myers, PE  
 Description....

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### Cantilevered Retaining Wall

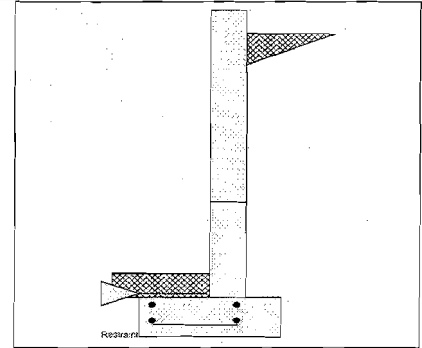
Code: IBC 2018, ACI 318-14, TMS 402-16

#### Criteria

Retained Height	=	5.50 ft
Wall height above soil	=	0.50 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water height over heel	=	0.0 ft

#### Soil Data

Allow Soil Bearing	=	2,500.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
Passive Pressure	=	300.0 psf/ft
Soil Density, Heel	=	125.00 pcf
Soil Density, Toe	=	125.00 pcf
Footing Soil Friction	=	0.400
Soil height to ignore for passive pressure	=	0.00 in



#### Surcharge Loads

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

#### Lateral Load Applied to Stem

Lateral Load	=	0.0 #/ft
...Height to Top	=	0.00 ft
...Height to Bottom	=	0.00 ft
Load Type	=	Wind (W) (Service Level)
Wind on Exposed Stem	=	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 = 1.73 OK  
 Slab Resists All Sliding !

Total Bearing Load	=	1,475 lbs
...resultant ecc.	=	7.16 in

Soil Pressure @ Toe	=	1,335 psf OK
Soil Pressure @ Heel	=	0 psf OK
Allowable	=	2,500 psf
Soil Pressure Less Than Allowable		
ACI Factored @ Toe	=	1,868 psf
ACI Factored @ Heel	=	0 psf
Footing Shear @ Toe	=	12.7 psi OK
Footing Shear @ Heel	=	7.7 psi OK
Allowable	=	75.0 psi

#### Sliding Calcs

Lateral Sliding Force	=	701.9 lbs
-----------------------	---	-----------

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	1.700
Earth, H	1.700
Wind, W	1.000
Seismic, E	1.000

#### Stem Construction

	2nd	Bottom
Design Height Above Ftc	ft = Stem OK 2.00	Stem OK 0.00
Wall Material Above "Ht"	= Concrete	Concrete
Design Method	= LRFD	LRFD
Thickness	= 8.00	8.00
Rebar Size	= # 4	# 4
Rebar Spacing	= 12.00	12.00
Rebar Placed at	= 6 in	6 in

#### Design Data

fb/FB + fa/Fa	=	0.081	0.318
---------------	---	-------	-------

#### Total Force @ Section

Service Level	lbs =		
Strength Level	lbs =	364.4	899.9

#### Moment...Actual

Service Level	ft-# =		
Strength Level	ft-# =	425.2	1,649.9

#### Moment....Allowable

ft-# =	5,187.6	5,187.6
--------	---------	---------

#### Shear.....Actual

Service Level	psi =		
Strength Level	psi =	5.1	12.5

#### Shear.....Allowable

psi =	75.0	75.0
-------	------	------

#### Anet (Masonry)

in2 =		
-------	--	--

#### Rebar Depth 'd'

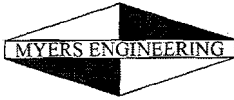
in =	6.00	6.00
------	------	------

#### Masonry Data

f'm	psi =		
Fs	psi =		
Solid Grouting	=		
Modular Ratio 'n'	=		
Wall Weight	psf =	100.0	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	2,500.0
Fy	psi =	60,000.0	60,000.0



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 Gig Harbor, WA 98335

Project Name/Number : marbella

Title 6ft Stem  
 Dsgnr: Mark Myers, PE  
 Description....

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### Cantilevered Retaining Wall

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

#### Concrete Stem Rebar Area Details

2nd Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.0166 in <sup>2</sup> /ft		
(4/3) * As :	0.0222 in <sup>2</sup> /ft	Min Stem T&S Reinf Area 0.768 in <sup>2</sup>	
200bd/fy : 200(12)(6)/60000 :	0.24 in <sup>2</sup> /ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in <sup>2</sup> /ft	
0.0018bh : 0.0018(12)(8) :	0.1728 in <sup>2</sup> /ft	Horizontal Reinforcing Options :	
	=====	One layer of :	Two layers of :
Required Area :	0.1728 in <sup>2</sup> /ft	#4@ 12.50 in	#4@ 25.00 in
Provided Area :	0.2 in <sup>2</sup> /ft	#5@ 19.38 in	#5@ 38.75 in
Maximum Area :	0.8128 in <sup>2</sup> /ft	#6@ 27.50 in	#6@ 55.00 in

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.0645 in <sup>2</sup> /ft		
(4/3) * As :	0.086 in <sup>2</sup> /ft	Min Stem T&S Reinf Area 0.384 in <sup>2</sup>	
200bd/fy : 200(12)(6)/60000 :	0.24 in <sup>2</sup> /ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in <sup>2</sup> /ft	
0.0018bh : 0.0018(12)(8) :	0.1728 in <sup>2</sup> /ft	Horizontal Reinforcing Options :	
	=====	One layer of :	Two layers of :
Required Area :	0.1728 in <sup>2</sup> /ft	#4@ 12.50 in	#4@ 25.00 in
Provided Area :	0.2 in <sup>2</sup> /ft	#5@ 19.38 in	#5@ 38.75 in
Maximum Area :	0.8128 in <sup>2</sup> /ft	#6@ 27.50 in	#6@ 55.00 in

#### Footing Data

Toe Width	=	1.33 ft
Heel Width	=	1.33
Total Footing Width	=	2.67
Footing Thickness	=	10.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	2.92 ft
f'c =	2,500 psi	Fy = 60,000 psi
Footing Concrete Density	=	150.00 pcf
Min. As %	=	0.0018
Cover @ Top	2.00	@ Btm = 3.00 in

#### Footing Design Results

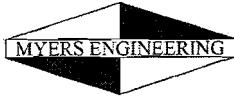
	Toe	Heel
Factored Pressure	= 1,868	0 psf
Mu' : Upward	= 15,914	1 ft-#
Mu' : Downward	= 2,799	253 ft-#
Mu: Design	= 1,093	251 ft-#
Actual 1-Way Shear	= 12.71	7.70 psi
Allow 1-Way Shear	= 75.00	40.00 psi
Toe Reinforcing	= # 4 @ 11.00 in	
Heel Reinforcing	= None Spec'd	
Key Reinforcing	= None Spec'd	
Footing 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: #4@ 11.11 in, #5@ 17.22 in, #6@ 24.44 in, #7@ 33.33 in, #8@ 43.88 in, #9@ 5  
 Heel: phiMn = phi'5'lambda'sqrt(fc)'Sm  
 Key: No key defined

Min footing T&S reinf Area	0.58 in <sup>2</sup>
Min footing T&S reinf Area per foot	0.22 in <sup>2</sup> /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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 Gig Harbor, WA 98335

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Title 6ft Stem  
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 Description....

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### Cantilevered Retaining Wall

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

#### 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)	701.9	2.11	1,481.9	Soil Over HL (ab. water tbl)	458.1	2.33	1,068.7
HL Act Pres (be water tbl)				Soil Over HL (bel. water tbl)		2.33	1,068.7
Hydrostatic Force				Watre Table			
Buoyant Force =				Sloped Soil Over Heel =			
Surcharge over Heel =				Surcharge Over Heel =			
Surcharge Over Toe =				Adjacent Footing Load =			
Adjacent Footing Load =				Axial Dead Load on Stem =			
Added Lateral Load =				* Axial Live Load on Stem =			
Load @ Stem Above Soil =				Soil Over Toe =	83.3	0.67	55.5
				Surcharge Over Toe =			
				Stem Weight(s) =	600.0	1.67	999.8
				Earth @ Stem Transitions =			
				Footing Weight =	333.3	1.33	444.2
				Key Weight =		2.92	
				Vert. Component =			
<b>Total</b>	<b>= 701.9</b>	<b>O.T.M. =</b>	<b>1,481.9</b>	<b>Total =</b>	<b>1,474.7 lbs</b>	<b>R.M.=</b>	<b>2,568.2</b>
<b>Resisting/Overturning Ratio</b>		<b>=</b>	<b>1.73</b>				
Vertical Loads used for Soil Pressure =			1,474.7 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.

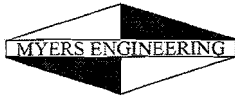
#### Tilt

##### 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) 0.083 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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Project Name/Number : marbella

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Description....

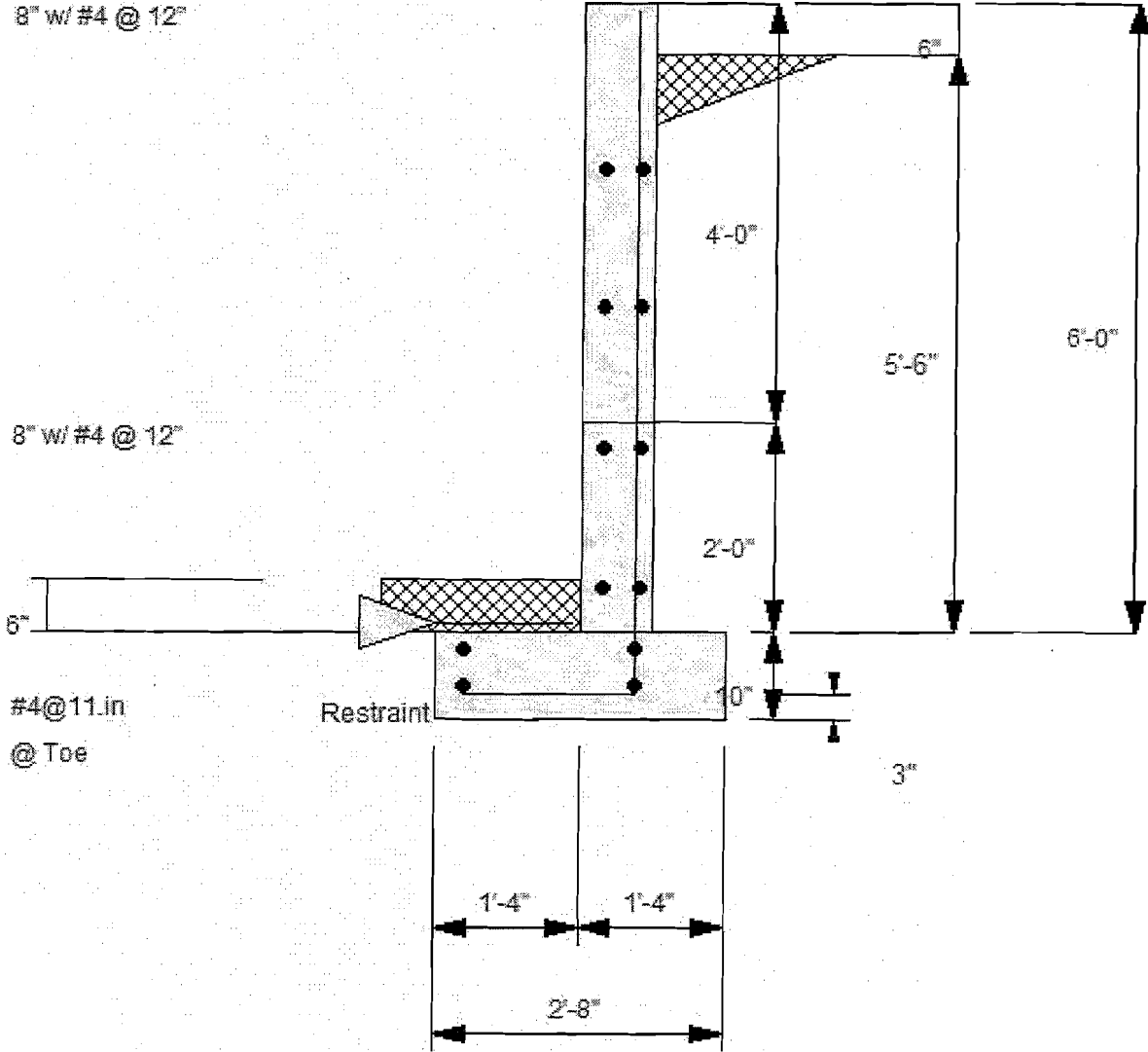
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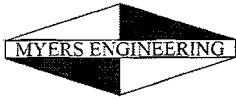
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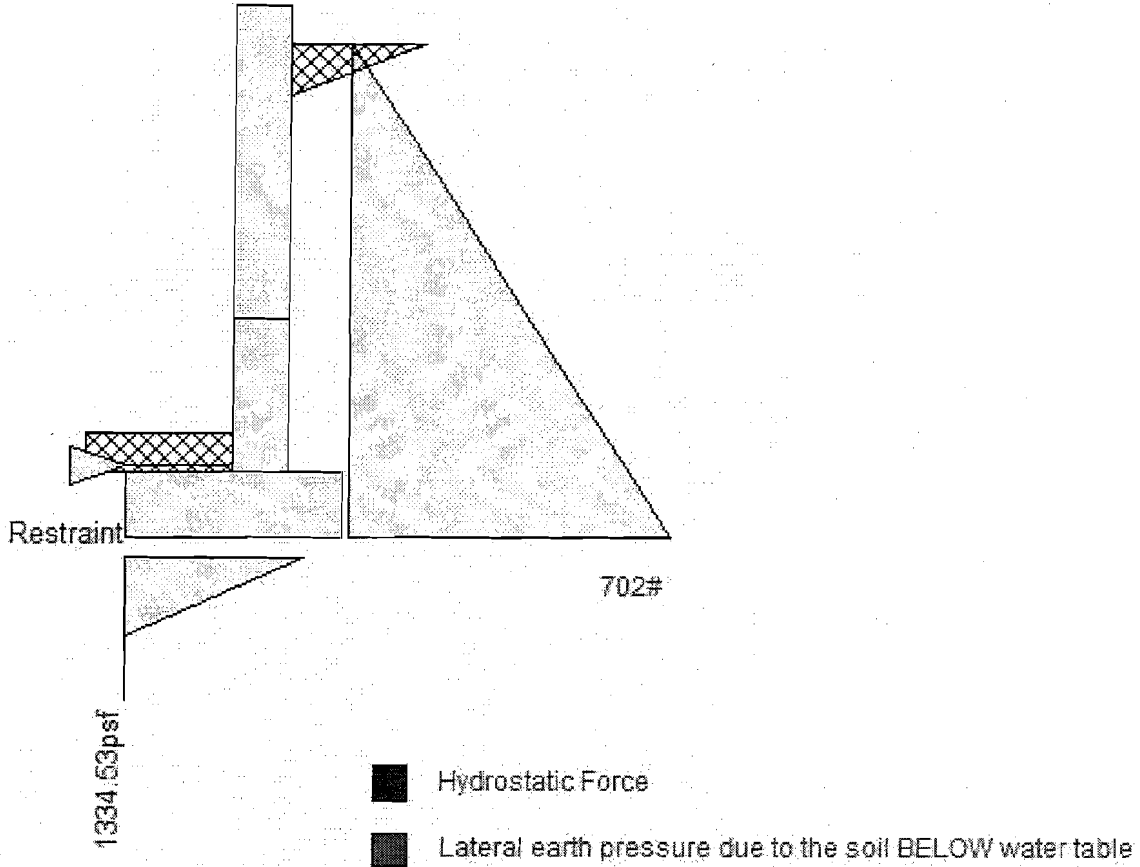
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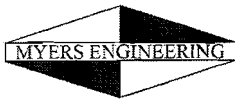
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 Title 6ft Stem w/ Seismic  
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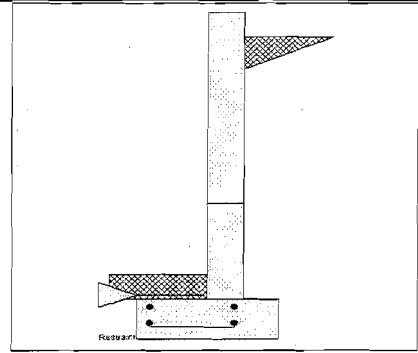
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### Cantilevered Retaining Wall

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

Criteria	
Retained Height	= 5.50 ft
Wall height above soil	= 0.50 ft
Slope Behind Wall	= 0.00
Height of Soil over Toe	= 6.00 in
Water height over heel	= 0.0 ft

Soil Data	
Allow Soil Bearing	= 3,333.3 psf
Equivalent Fluid Pressure Method	
Active Heel Pressure	= 35.0 psf/ft
	=
Passive Pressure	= 300.0 psf/ft
Soil Density, Heel	= 125.00 pcf
Soil Density, Toe	= 125.00 pcf
Footings  Soil Friction	= 0.400
Soil height to ignore for passive pressure	= 0.00 in



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

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

Earth Pressure Seismic Load	
Method	: Uniform
Multiplier Used	= 6.000
(Multiplier used on soil density)	

Uniform Seismic Force	= 38.000
Total Seismic Force	= 240.667

Design Summary	
Wall Stability Ratios	
Overturning	= 1.27 Ratio < 1.5!
Slab Resists All Sliding! <i>OK w/ seismic</i>	
Total Bearing Load	= 1,475 lbs
...resultant ecc.	= 11.50 in
Soil Pressure @ Toe	= 2,622 psf OK
Soil Pressure @ Heel	= 0 psf OK
Allowable	= 3,333 psf
Soil Pressure Less Than Allowable	
ACI Factored @ Toe	= 3,671 psf
ACI Factored @ Heel	= 0 psf
Footing Shear @ Toe	= 21.3 psi OK
Footing Shear @ Heel	= 7.9 psi OK
Allowable	= 75.0 psi
Sliding Calcs	
Lateral Sliding Force	= 870.4 lbs

Stem Construction		2nd	Bottom
Design Height Above Ftg	ft =	Stem OK 2.00	Stem OK 0.00
Wall Material Above "Ht"	=	Concrete	Concrete
Design Method	=	LRFD	LRFD
Thickness	=	8.00	8.00
Rebar Size	=	# 4	# 4
Rebar Spacing	=	12.00	12.00
Rebar Placed at	=	6 in	6 in
Design Data			
fb/FB + fa/Fa	=	0.126	0.428
Total Force @ Section			
Service Level	lbs =		
Strength Level	lbs =	497.4	1,108.9
Moment....Actual			
Service Level	ft-# =		
Strength Level	ft-# =	657.9	2,224.6
Moment.....Allowable	ft-# =	5,187.6	5,187.6
Shear.....Actual			
Service Level	psi =		
Strength Level	psi =	6.9	15.4
Shear.....Allowable	psi =	75.0	75.0
Anet (Masonry)	in2 =		
Rebar Depth 'd'	in =	6.00	6.00

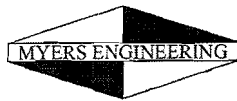
Masonry Data	
fm	psi =
Fs	psi =
Solid Grouting	=
Modular Ratio 'n'	=
Wall Weight	psf = 100.0 100.0
Short Term Factor	=
Equiv. Solid Thick.	=
Masonry Block Type	= Medium Weight
Masonry Design Method	= ASD

Concrete Data	
fc	psi = 2,500.0 2,500.0
Fy	psi = 60,000.0 60,000.0

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	1.700
Earth, H	1.700
Wind, W	1.000
Seismic, E	1.000

16



Mark Myers, P.E.  
 Myers Engineering LLC  
 3206 50th St. Ct. NW, Ste 210-B  
 Gig Harbor, WA 98335

Project Name/Number : marbella  
 Title 6ft Stem w/ Seismic  
 Dsgnr: Mark Myers, PE  
 Description....

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### Cantilevered Retaining Wall

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

#### Concrete Stem Rebar Area Details

2nd Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.0257 in <sup>2</sup> /ft		
(4/3) * As :	0.0343 in <sup>2</sup> /ft	Min Stem T&S Reinf Area 0.768 in <sup>2</sup>	
200bd/fy : 200(12)(6)/60000 :	0.24 in <sup>2</sup> /ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in <sup>2</sup> /ft	
0.0018bh : 0.0018(12)(8) :	0.1728 in <sup>2</sup> /ft	Horizontal Reinforcing Options :	
	=====	One layer of :	Two layers of :
Required Area :	0.1728 in <sup>2</sup> /ft	#4@ 12.50 in	#4@ 25.00 in
Provided Area :	0.2 in <sup>2</sup> /ft	#5@ 19.38 in	#5@ 38.75 in
Maximum Area :	0.8128 in <sup>2</sup> /ft	#6@ 27.50 in	#6@ 55.00 in

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.087 in <sup>2</sup> /ft		
(4/3) * As :	0.116 in <sup>2</sup> /ft	Min Stem T&S Reinf Area 0.384 in <sup>2</sup>	
200bd/fy : 200(12)(6)/60000 :	0.24 in <sup>2</sup> /ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in <sup>2</sup> /ft	
0.0018bh : 0.0018(12)(8) :	0.1728 in <sup>2</sup> /ft	Horizontal Reinforcing Options :	
	=====	One layer of :	Two layers of :
Required Area :	0.1728 in <sup>2</sup> /ft	#4@ 12.50 in	#4@ 25.00 in
Provided Area :	0.2 in <sup>2</sup> /ft	#5@ 19.38 in	#5@ 38.75 in
Maximum Area :	0.8128 in <sup>2</sup> /ft	#6@ 27.50 in	#6@ 55.00 in

#### Footing Data

Toe Width	=	1.33 ft
Heel Width	=	1.33
Total Footing Width	=	2.67
Footing Thickness	=	10.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	2.92 ft
f'c =	2,500 psi	Fy = 60,000 psi
Footing Concrete Density	=	150.00 pcf
Min. As %	=	0.0018
Cover @ Top	2.00	@ Btm = 3.00 in

#### Footing Design Results

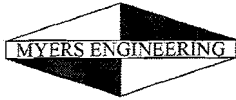
	Toe	Heel
Factored Pressure	= 3,671	0 psf
Mu' : Upward	= 23,736	0 ft-#
Mu' : Downward	= 2,799	253 ft-#
Mu: Design	= 1,745	253 ft-#
Actual 1-Way Shear	= 21.29	7.90 psi
Allow 1-Way Shear	= 75.00	40.00 psi
Toe Reinforcing	= # 4 @ 11.00 in	
Heel Reinforcing	= None Spec'd	
Key Reinforcing	= None Spec'd	
Footing 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: #4@ 11.11 in, #5@ 17.22 in, #6@ 24.44 in, #7@ 33.33 in, #8@ 43.88 in, #9@ 5  
 Heel: phiMn = phi'5'lambda'sqrt(fc)'Sm  
 Key: No key defined

Min footing T&S reinf Area	0.58 in <sup>2</sup>
Min footing T&S reinf Area per foot	0.22 in <sup>2</sup> /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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Project Name/Number : marbella  
 Title 6ft Stem w/ Seismic  
 Dsgnr: Mark Myers, PE  
 Description....

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### Cantilevered Retaining Wall

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

#### 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)	701.9	2.11	1,481.9	Soil Over HL (ab. water tbl)	458.1	2.33	1,068.7
HL Act Pres (be water tbl)				Soil Over HL (bel. water tbl)		2.33	1,068.7
Hydrostatic Force				Watre Table			
Buoyant Force =				Sloped Soil Over Heel =			
Surcharge over Heel =				Surcharge Over Heel =			
Surcharge Over Toe =				Adjacent Footing Load =			
Adjacent Footing Load =				Axial Dead Load on Stem =			
Added Lateral Load =				* Axial Live Load on Stem =			
Load @ Stem Above Soil =				Soil Over Toe =	83.3	0.67	55.5
Seismic Earth Load =	168.5	3.17	533.5	Surcharge Over Toe =			
				Stem Weight(s) =	600.0	1.67	999.8
				Earth @ Stem Transitions =			
<b>Total</b>	<b>870.4</b>	<b>O.T.M. =</b>	<b>2,015.4</b>	Footing Weight =	333.3	1.33	444.2
				Key Weight =		2.92	
				Vert. Component =			
<b>Resisting/Overturning Ratio</b>		<b>=</b>	<b>1.27</b>	<b>Total =</b>	<b>1,474.7 lbs</b>	<b>R.M. =</b>	<b>2,568.2</b>
Vertical Loads used for Soil Pressure =			1,474.7 lbs				

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

If seismic is included, the OTM and sliding ratios may be 1.1 per section 1807.2.3 of IBC.

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

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

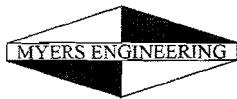
#### Tilt

##### Horizontal Deflection at Top of Wall due to settlement of soil

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus 250.0 pci  
 Horizontal Defl @ Top of Wall (approximate only) 0.164 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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Project Name/Number : marbella

Title 6ft Stem w/ Seismic

Dsgnr: Mark Myers, PE

Description....

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### Cantilevered Retaining Wall

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

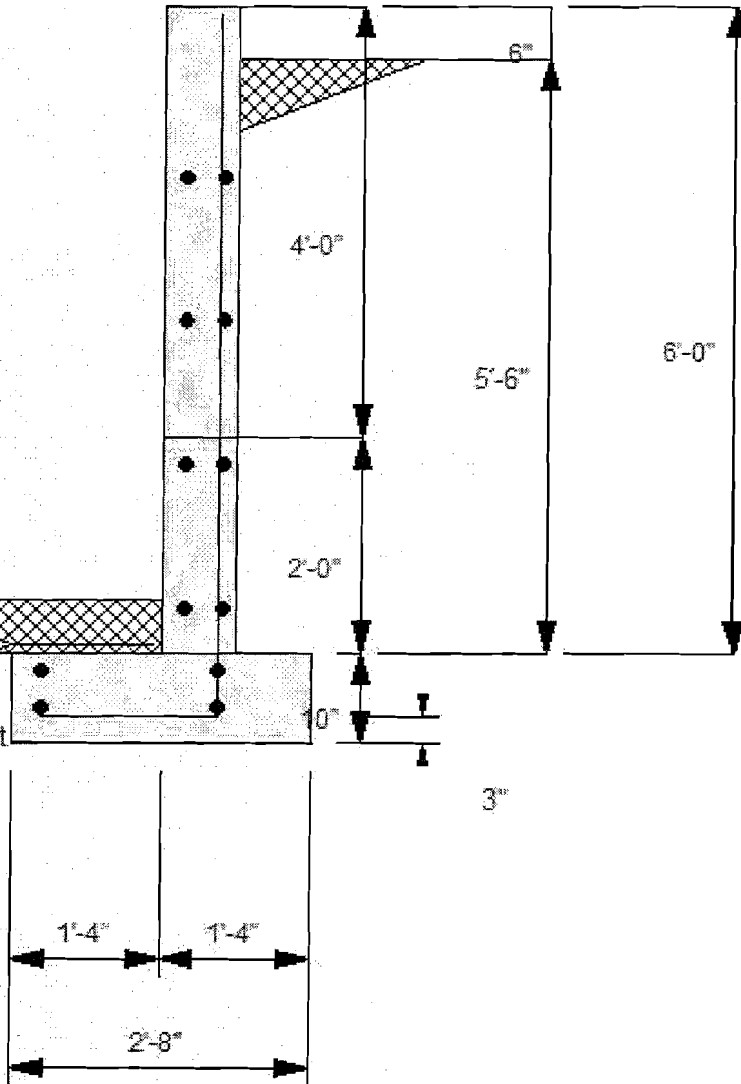
8" w/ #4 @ 12"

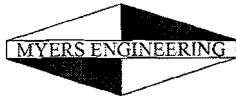
8" w/ #4 @ 12"



#4 @ 11 in  
@ Toe

Restraint





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 Dsgnr: Mark Myers, PE  
 Description....

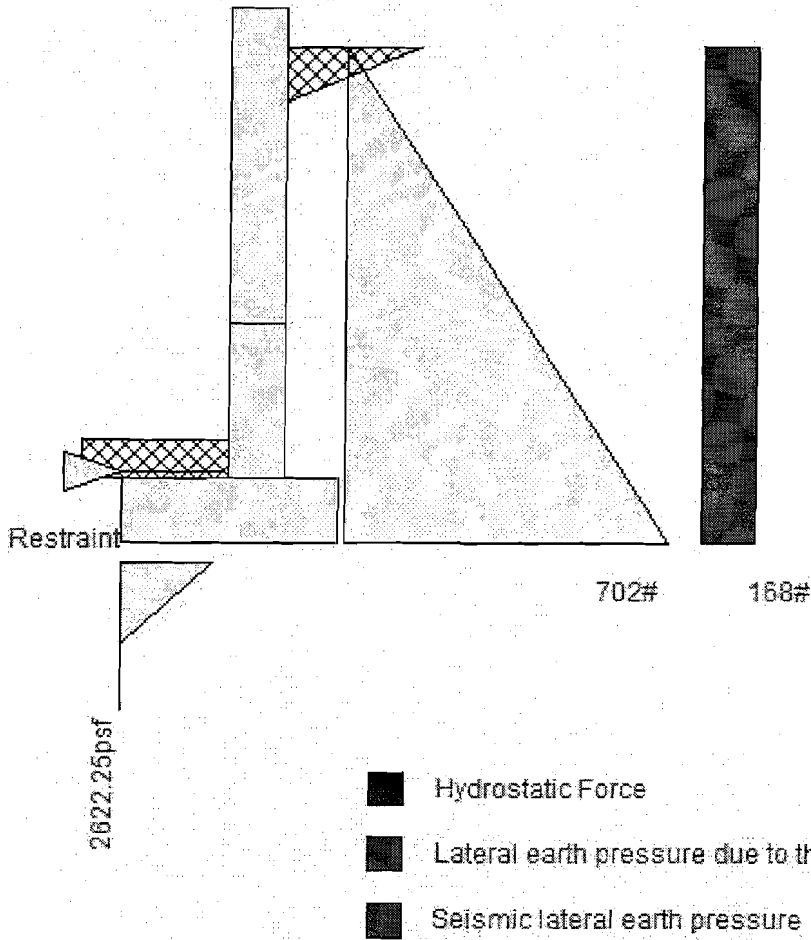
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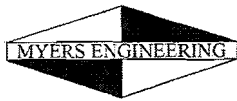
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### Cantilevered Retaining Wall

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Project Name/Number : marbella  
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 Dsgnr: Mark Myers, PE  
 Description....

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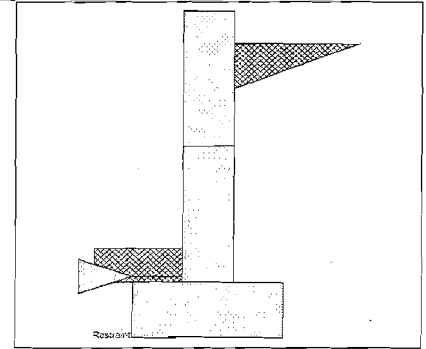
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### Cantilevered Retaining Wall

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	= 6.00 in
Water height over heel	= 0.0 ft

Soil Data	
Allow Soil Bearing	= 2,500.0 psf
Equivalent Fluid Pressure Method	
Active Heel Pressure	= 35.0 psf/ft
Passive Pressure	= 300.0 psf/ft
Soil Density, Heel	= 125.00 pcf
Soil Density, Toe	= 125.00 pcf
Footing Soil Friction	= 0.400
Soil height to ignore for passive pressure	= 0.00 in



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

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

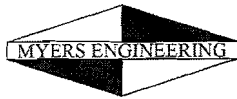
Axial Load Applied to Stem	
Axial Dead Load	= 0.0 lbs
Axial Live Load	= 0.0 lbs
Axial Load Eccentricity	= 0.0 in

Design Summary	
<b>Wall Stability Ratios</b>	
Overturning	= 2.42 OK
Slab Resists All Sliding !	
Total Bearing Load	= 983 lbs
...resultant ecc.	= 3.76 in
Soil Pressure @ Toe	= 953 psf OK
Soil Pressure @ Heel	= 30 psf OK
Allowable Soil Pressure Less Than Allowable	= 2,500 psf
ACI Factored @ Toe	= 1,335 psf
ACI Factored @ Heel	= 42 psf
Footing Shear @ Toe	= 1.3 psi OK
Footing Shear @ Heel	= 3.7 psi OK
Allowable	= 75.0 psi
<b>Sliding Calcs</b>	
Lateral Sliding Force	= 328.6 lbs

Stem Construction		2nd	Bottom
Design Height Above Ftg	ft =	Stem OK 2.00	Stem OK 0.00
Wall Material Above "Ht"	=	Concrete	Concrete
Design Method	=	LRFD	LRFD
Thickness	=	8.00	8.00
Rebar Size	=	# 4	# 4
Rebar Spacing	=	12.00	12.00
Rebar Placed at	=	6 in	6 in
<b>Design Data</b>			
fb/FB + fa/Fa	=	0.006	0.081
<b>Total Force @ Section</b>			
Service Level	lbs =		
Strength Level	lbs =	66.9	364.4
<b>Moment....Actual</b>			
Service Level	ft-# =		
Strength Level	ft-# =	33.5	425.2
Moment....Allowable	ft-# =	5,187.6	5,187.6
<b>Shear.....Actual</b>			
Service Level	psi =		
Strength Level	psi =	0.9	5.1
Shear.....Allowable	psi =	75.0	75.0
Anet (Masonry)	in2 =		
Rebar Depth 'd'	in =	6.00	6.00
<b>Masonry Data</b>			
f'm	psi =		
Fs	psi =		
Solid Grouting	=		
Modular Ratio 'n'	=		
Wall Weight	psf =	100.0	100.0
Short Term Factor	=		
Equiv. Solid Thick.	=		
Masonry Block Type	=	Medium Weight	
Masonry Design Method	=	ASD	
<b>Concrete Data</b>			
f'c	psi =	2,500.0	2,500.0
Fy	psi =	60,000.0	60,000.0

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	1.700
Earth, H	1.700
Wind, W	1.000
Seismic, E	1.000



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 3206 50th St. Ct. NW, Ste 210-B  
 Gig Harbor, WA 98335

Project Name/Number : marbella  
 Title 4ft Stem  
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**Cantilevered Retaining Wall**

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

**Concrete Stem Rebar Area Details**

2nd Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.0013 in2/ft		
(4/3) * As :	0.0017 in2/ft	Min Stem T&S Reinf Area 0.384 in2	
200bd/fy : 200(12)(6)/60000 :	0.24 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in2/ft	
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :	
	=====	One layer of : Two layers of :	
Required Area :	0.1728 in2/ft	#4@ 12.50 in	#4@ 25.00 in
Provided Area :	0.2 in2/ft	#5@ 19.38 in	#5@ 38.75 in
Maximum Area :	0.8128 in2/ft	#6@ 27.50 in	#6@ 55.00 in

Bottom Stem:	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.0166 in2/ft		
(4/3) * As :	0.0222 in2/ft	Min Stem T&S Reinf Area 0.384 in2	
200bd/fy : 200(12)(6)/60000 :	0.24 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in2/ft	
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :	
	=====	One layer of : Two layers of :	
Required Area :	0.1728 in2/ft	#4@ 12.50 in	#4@ 25.00 in
Provided Area :	0.2 in2/ft	#5@ 19.38 in	#5@ 38.75 in
Maximum Area :	0.8128 in2/ft	#6@ 27.50 in	#6@ 55.00 in

**Footing Data**

Toe Width	=	0.67 ft
Heel Width	=	1.33
Total Footing Width	=	2.00
Footing Thickness	=	10.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	2.92 ft
fc =	2,500 psi	Fy = 60,000 psi
Footing Concrete Density	=	150.00 pcf
Min. As %	=	0.0018
Cover @ Top	2.00	@ Btm.= 3.00 in

**Footing Design Results**

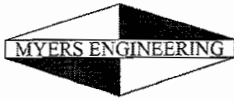
	Toe	Heel
Factored Pressure	= 1,335	42 psf
Mu' : Upward	= 3,179	41 ft-#
Mu' : Downward	= 701	175 ft-#
Mu: Design	= 207	134 ft-#
Actual 1-Way Shear	= 1.32	3.68 psi
Allow 1-Way Shear	= 40.00	40.00 psi
Toe Reinforcing	= None Spec'd	
Heel Reinforcing	= None Spec'd	
Key Reinforcing	= None Spec'd	
Footing Torsion, 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:  $\phi Mn = \phi'5' \lambda \sqrt{fc} S_m$   
 Heel:  $\phi Mn = \phi'5' \lambda \sqrt{fc} S_m$   
 Key: No key defined

Min footing T&S reinf Area	0.43 in2
Min footing T&S reinf Area per foot	0.22 in2 /ft
If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 11.11 in	#4@ 22.22 in
#5@ 17.22 in	#5@ 34.44 in
#6@ 24.44 in	#6@ 48.89 in



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### Cantilevered Retaining Wall

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

#### 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)	328.6	1.44	474.7	Soil Over HL (ab. water tbl)	291.5	1.67	485.9
HL Act Pres (be water tbl)				Soil Over HL (bel. water tbl)		1.67	485.9
Hydrostatic Force				Watre Table			
Buoyant Force =				Sloped Soil Over Heel =			
Surcharge over Heel =				Surcharge Over Heel =			
Surcharge Over Toe =				Adjacent Footing Load =			
Adjacent Footing Load =				Axial Dead Load on Stem =			
Added Lateral Load =				* Axial Live Load on Stem =			
Load @ Stem Above Soil =				Soil Over Toe =	41.7	0.33	13.9
=				Surcharge Over Toe =			
				Stem Weight(s) =	400.0	1.00	400.1
				Earth @ Stem Transitions =			
<b>Total</b>	<b>= 328.6</b>	<b>O.T.M. =</b>	<b>474.7</b>	Footing Weight =	250.0	1.00	250.0
				Key Weight =		2.92	
				Vert. Component =			
<b>Resisting/Overturning Ratio</b>		<b>= 2.42</b>		<b>Total =</b>	<b>983.2 lbs</b>	<b>R.M.=</b>	<b>1,150.0</b>
Vertical Loads used for Soil Pressure =		983.2 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

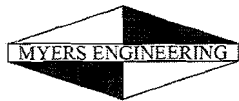
##### Horizontal Deflection at Top of Wall due to settlement of soil

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus 250.0 pci  
 Horizontal Defl @ Top of Wall (approximate only) 0.053 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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Gig Harbor, WA 98335

Project Name/Number : marbella

Title 4ft Stem  
Dsgnr: Mark Myers, PE  
Description....

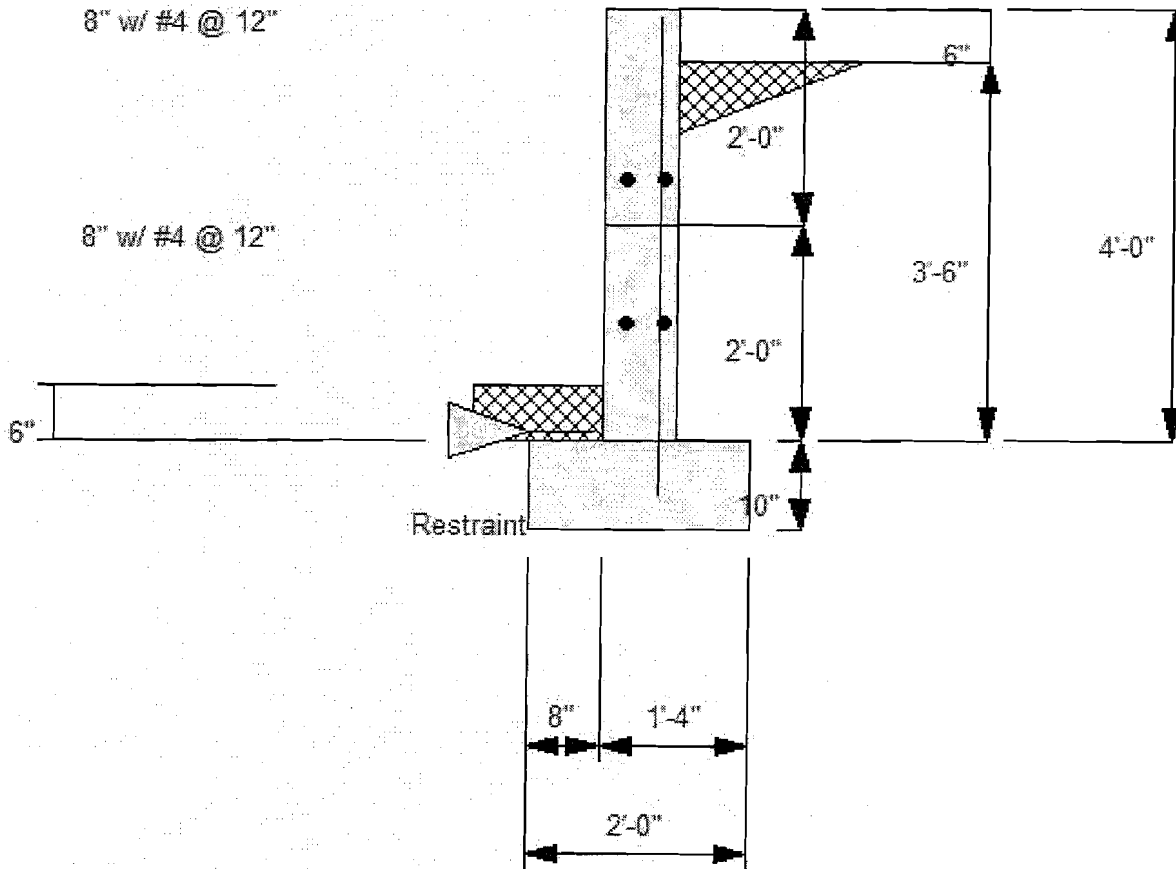
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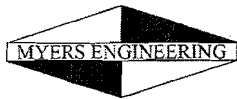
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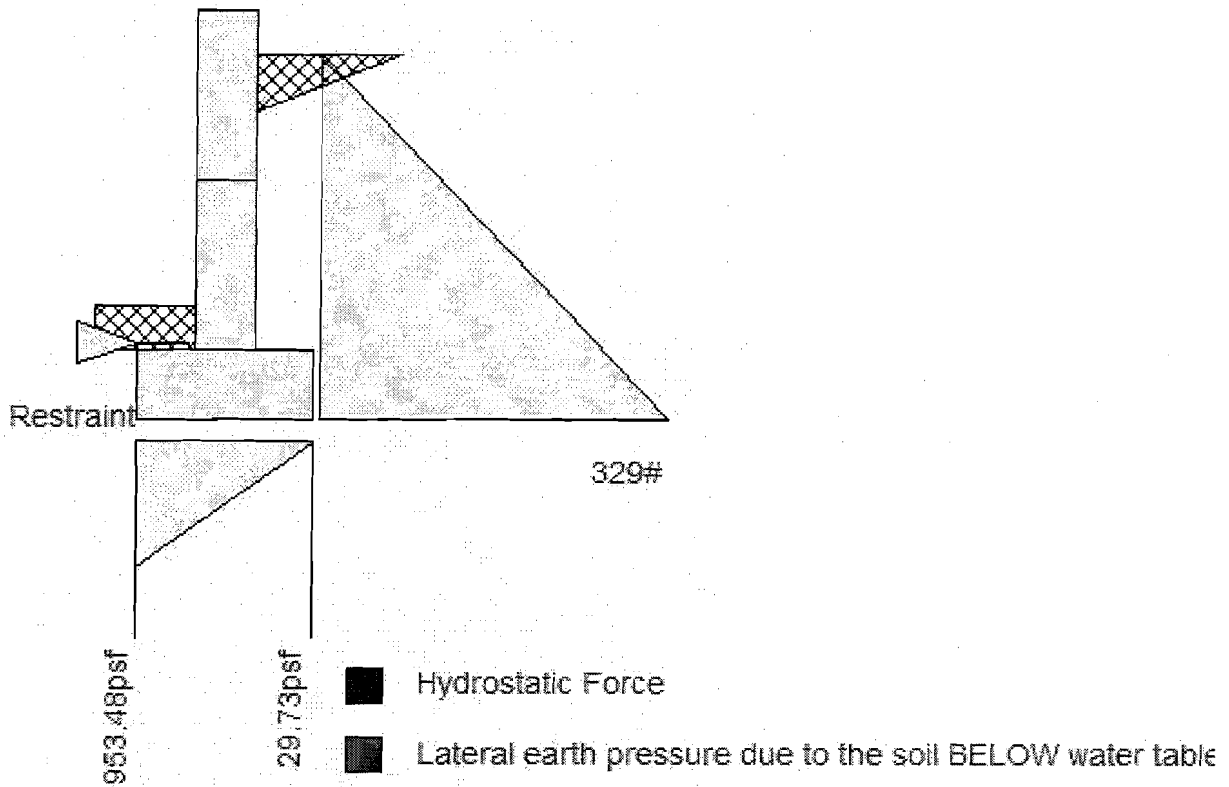
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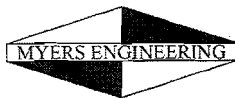
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### Cantilevered Retaining Wall

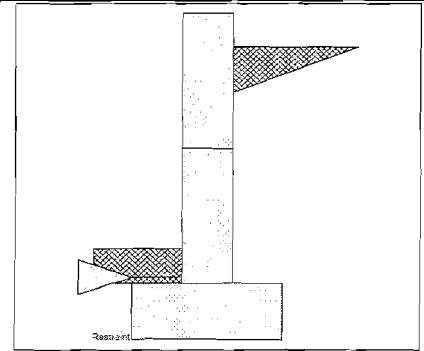
Code: IBC 2018, ACI 318-14, TMS 402-16

#### Criteria

Retained Height = 3.50 ft  
 Wall height above soil = 0.50 ft  
 Slope Behind Wall = 0.00  
 Height of Soil over Toe = 6.00 in  
 Water height over heel = 0.0 ft

#### Soil Data

Allow Soil Bearing = 3,333.3 psf  
 Equivalent Fluid Pressure Method  
 Active Heel Pressure = 35.0 psf/ft  
 =  
 Passive Pressure = 300.0 psf/ft  
 Soil Density, Heel = 125.00 pcf  
 Soil Density, Toe = 125.00 pcf  
 Footing||Soil Friction = 0.400  
 Soil height to ignore for passive pressure = 0.00 in



#### Surcharge Loads

Surcharge Over Heel = 0.0 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

#### Earth Pressure Seismic Load

Method : Uniform  
 Multiplier Used = 6.000  
 (Multiplier used on soil density)

#### 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 = Line Load  
 Base Above/Below Soil at Back of Wall = 0.0 ft  
 Poisson's Ratio = 0.300

#### Design Summary

Wall Stability Ratios  
 Overturning = 1.78 OK  
 Slab Resists All Sliding !

Total Bearing Load = 983 lbs  
 ...resultant ecc. = 5.84 in

Soil Pressure @ Toe = 1,278 psf OK  
 Soil Pressure @ Heel = 0 psf OK  
 Allowable = 3,333 psf  
 Soil Pressure Less Than Allowable  
 ACI Factored @ Toe = 1,789 psf  
 ACI Factored @ Heel = 0 psf  
 Footing Shear @ Toe = 1.9 psi OK  
 Footing Shear @ Heel = 5.2 psi OK  
 Allowable = 75.0 psi

Sliding Calcs  
 Lateral Sliding Force = 407.5 lbs

#### Stem Construction

	2nd	Bottom
Design Height Above Ftg	ft = Stem OK 2.00	Stem OK 0.00
Wall Material Above "Ht"	= Concrete	Concrete
Design Method	= LRFD	LRFD
Thickness	= 8.00	8.00
Rebar Size	= # 4	# 4
Rebar Spacing	= 12.00	12.00
Rebar Placed at	= 6 in	6 in

Design Data  
 fb/FB + fa/Fa = 0.012 0.112

Total Force @ Section  
 Service Level lbs =  
 Strength Level lbs = 105.9 455.4

Moment...Actual  
 Service Level ft-# =  
 Strength Level ft-# = 62.7 584.4  
 Moment.....Allowable ft-# = 5,187.6 5,187.6

Shear.....Actual  
 Service Level psi =  
 Strength Level psi = 1.5 6.3

Shear.....Allowable psi = 75.0 75.0  
 Anet (Masonry) in2 =  
 Rebar Depth 'd' in = 6.00 6.00

#### Masonry Data

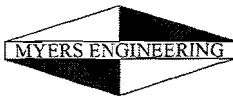
fm psi =  
 Fs psi =  
 Solid Grouting =  
 Modular Ratio 'n' =  
 Wall Weight psf = 100.0 100.0  
 Short Term Factor =  
 Equiv. Solid Thick. =  
 Masonry Block Type = Medium Weight  
 Masonry Design Method = ASD

Concrete Data  
 fc psi = 2,500.0 2,500.0  
 Fy psi = 60,000.0 60,000.0

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 1.700  
 Earth, H 1.700  
 Wind, W 1.000  
 Seismic, E 1.000



Mark Myers, P.E.  
 Myers Engineering LLC  
 3206 50th St. Ct. NW, Ste 210-B  
 Gig Harbor, WA 98335

Project Name/Number : marbella

Title 4ft Stem w/ Seismic  
 Dsgnr: Mark Myers, PE  
 Description....

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#### Concrete Stem Rebar Area Details

2nd Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.0025 in2/ft		
(4/3) * As :	0.0033 in2/ft	Min Stem T&S Reinf Area 0.384 in2	
200bd/fy : 200(12)(6)/60000 :	0.24 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in2/ft	
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :	
	=====	One layer of :	Two layers of :
Required Area :	0.1728 in2/ft	#4@ 12.50 in	#4@ 25.00 in
Provided Area :	0.2 in2/ft	#5@ 19.38 in	#5@ 38.75 in
Maximum Area :	0.8128 in2/ft	#6@ 27.50 in	#6@ 55.00 in

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.0229 in2/ft		
(4/3) * As :	0.0305 in2/ft	Min Stem T&S Reinf Area 0.384 in2	
200bd/fy : 200(12)(6)/60000 :	0.24 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in2/ft	
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :	
	=====	One layer of :	Two layers of :
Required Area :	0.1728 in2/ft	#4@ 12.50 in	#4@ 25.00 in
Provided Area :	0.2 in2/ft	#5@ 19.38 in	#5@ 38.75 in
Maximum Area :	0.8128 in2/ft	#6@ 27.50 in	#6@ 55.00 in

#### Footing Data

Toe Width	=	0.67 ft
Heel Width	=	1.33
Total Footing Width	=	2.00
Footing Thickness	=	10.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	2.92 ft
f <sub>c</sub> =	2,500 psi	F <sub>y</sub> = 60,000 psi
Footing Concrete Density	=	150.00 pcf
Min. As %	=	0.0018
Cover @ Top	2.00	@ Btm.= 3.00 in

#### Footing Design Results

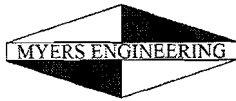
	Toe	Heel
Factored Pressure	= 1,789	0 psf
Mu' : Upward	= 4,085	2 ft-#
Mu' : Downward	= 701	175 ft-#
Mu: Design	= 282	173 ft-#
Actual 1-Way Shear	= 1.87	5.21 psi
Allow 1-Way Shear	= 40.00	40.00 psi
Toe Reinforcing	= None Spec'd	
Heel Reinforcing	= None Spec'd	
Key Reinforcing	= None Spec'd	
Footing Torsion, 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:  $\phi Mn = \phi'5' \lambda \sqrt{fc} Sm$   
 Heel:  $\phi Mn = \phi'5' \lambda \sqrt{fc} Sm$   
 Key: No key defined

Min footing T&S reinf Area	0.43 in2
Min footing T&S reinf Area per foot	0.22 in2 /ft
If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 11.11 in	#4@ 22.22 in
#5@ 17.22 in	#5@ 34.44 in
#6@ 24.44 in	#6@ 48.89 in



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#### 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)	328.6	1.44	474.7	Soil Over HL (ab. water tbl)	291.5	1.67	485.9
HL Act Pres (be water tbl)				Soil Over HL (bel. water tbl)		1.67	485.9
Hydrostatic Force				Watre Table			
Buoyant Force =				Sloped Soil Over Heel =			
Surcharge over Heel =				Surcharge Over Heel =			
Surcharge Over Toe =				Adjacent Footing Load =			
Adjacent Footing Load =				Axial Dead Load on Stem =			
Added Lateral Load =				* Axial Live Load on Stem =			
Load @ Stem Above Soil =				Soil Over Toe =	41.7	0.33	13.9
Seismic Earth Load =	78.9	2.17	170.9	Surcharge Over Toe =			
=				Stem Weight(s) =	400.0	1.00	400.1
<b>Total</b> =	<b>407.5</b>	<b>O.T.M. =</b>	<b>645.5</b>	Earth @ Stem Transitions =			
				Footing Weight =	250.0	1.00	250.0
				Key Weight =		2.92	
				Vert. Component =			
<b>Resisting/Overturning Ratio</b> =			<b>1.78</b>	<b>Total =</b>	<b>983.2 lbs</b>	<b>R.M.=</b>	<b>1,150.0</b>
Vertical Loads used for Soil Pressure =			983.2 lbs	* Axial live load NOT included in total displayed, or used for overturning resistance, but is included for soil pressure calculation.			

If seismic is included, the OTM and sliding ratios may be 1.1 per section 1807.2.3 of IBC.

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

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

#### Tilt

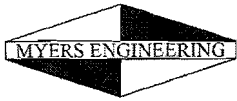
##### Horizontal Deflection at Top of Wall due to settlement of soil

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus 250.0 pci

Horizontal Defl @ Top of Wall (approximate only) 0.071 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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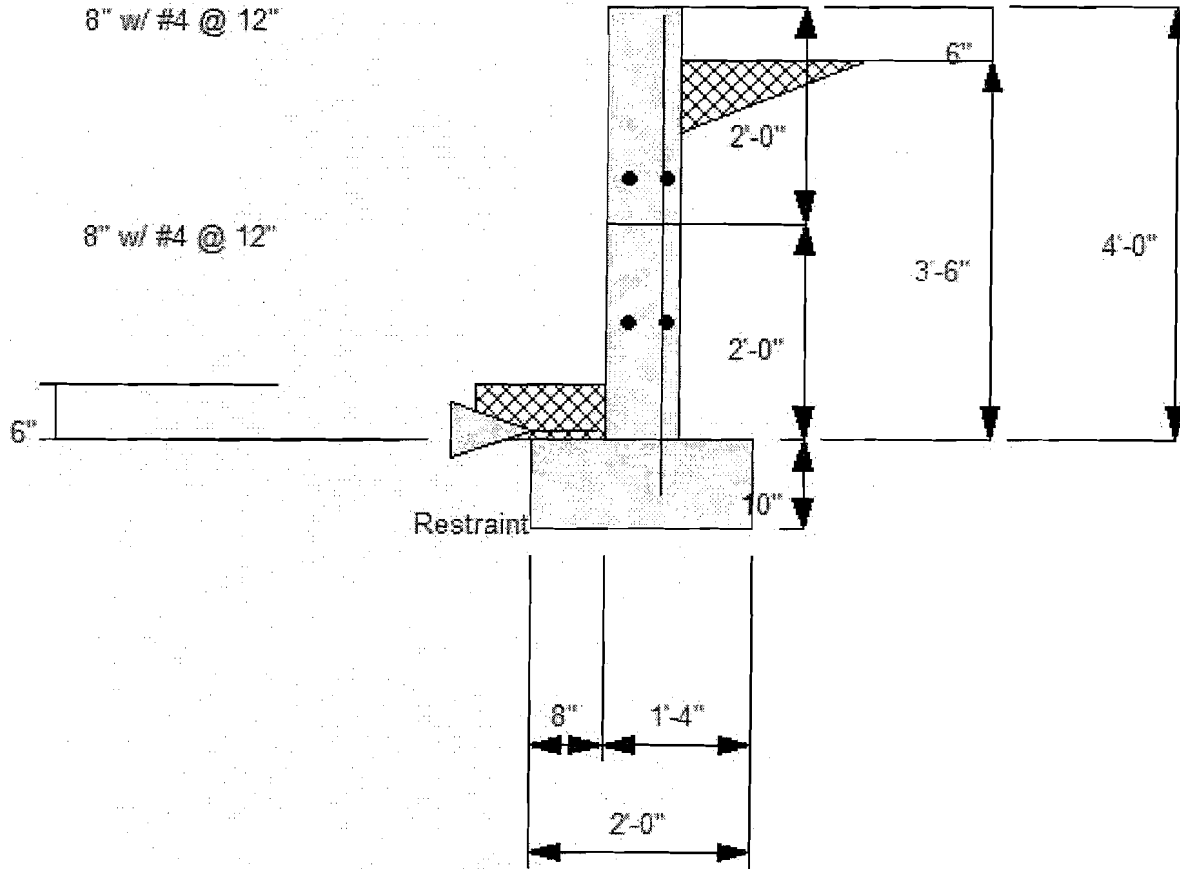
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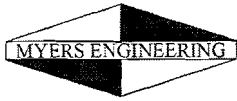
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