ANNÉE STRUCTURAL ENGINEERING, LLC

Structural Calculations

(Revisions to Permit)

Project:

Lanctot Residence

4603 89th Avenue SE
Mercer Island, WA 98040

For:

Sturman Architects
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Bellevue, WA 98004

By:

Année Structural Engineering, LLC
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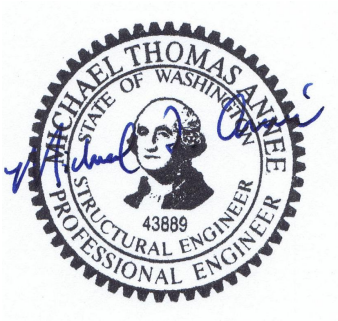
Date:

July 31, 2023



TO MAIN FLOOR WALLS:

LINE ③,④: V_{34} = 30% (10,120#) + 34% (2,368#)

+ 1,825# + 1,810# = 7,471#

V_{34} = 7,471#/20.85' = 359#/ft. → SW4

LINE ⑥: V_6 = 44% (10,120#) + 66% (2,368#)

+ 3,659# = 9,978#

V_6 = 9,978#/17.4' = 573#/ft. → SW2

LINE ⑨,⑩: $V_{9\text{-}10}$ = 26% (10,120#) + 2,905# = 5,536#

$V_{9\text{-}10}$ = 5,536#/11.4' = 486#/ft. → SW3

LINE Ⓑ,Ⓒ: V_{BC} = 32% (9,715#) + 3,202# = 6,311#

V_{BC} = 6,311#/14.9' = 424#/ft. → SW3

LINE Ⓕ,Ⓖ: V_{FG} = 50% (9,715#) + 4,484# = 9,342#

V_{FG} = 9,342#/32.0' = 292#/ft. → SW4

LINE Ⓗ: V_H = 19% (9,715#) + 2,168# = 3,916#

V_H = 3,916#/17.8' = 220#/ft. → SW6

DIAPHRAGM FORCES; DRAG/COLLECTOR LOADS:

AT ROOF DIAPHRAGM:

LINE ⑤ AT GRID Ⓖ: D_{5G} = 67% (2,368#) =

= 1,587# ↔ DSC2

LINE Ⓑ: $D_B = \frac{23.5'}{29.0'}(3,659\#) = 3,071\#$ → (6) A35

LINE Ⓙ: D_J = 208#/ft. $\left(\frac{13.25^2}{2}\right)$/23.5' = 1,474# → DSC2

LINE Ⓒ: $D_C = \frac{22.7'}{48.5'}(32\% \times 8,238\# \times 1.25) = 1,565\#$ → DSC2

LINE Ⓕ: $D_F = \frac{33.5'}{51.75'}(45\% \times 8,238\# \times 1.25) = 3,033\#$ → DSC5

LINE Ⓖ: D_G = 199#/ft. $\left(\frac{15.3^2}{2}\right)$/28.9' = 805# ↔ DSC2

AT UPPER FLR. DIAPHRAGM:

LINE ③,④: $D_{34} = \frac{17'}{50'}(30\% \times 10,267\# \times 1.25 + 34\%\,(2,368\#) + 1,830\#)$

@ Ⓖ ~7.0' (348#/ft.) ≈ 217# → NO HARDWARE REQ'D

@ Ⓓ = 2,438# → DSC2 ; @ Ⓔ = 606#

LINE ⑤: $D_5 = \frac{33'}{50'}(2,368\#) = 1,563\#$

$L_{d_5} = 1,563\#/[2(180 \times 0.98)] = 4.67'$

∴ CS16 × 1'-4" + 54" = 6'-8"

LINE ⑥: $D_6 = \frac{24.1'}{45.5'}\left(44\% \times 10{,}367^{\#} \times 1.25 + 66\%\,(2{,}368^{\#})\right)$

$= 3{,}451^{\#} \rightarrow$ CMSTC16 x 21-0" x 9'-4" = 11'-4"

$L_{d_6} = 3{,}451^{\#} / [(180 \times 93 + 240 \times 0.93)] = 8.84'$

LINE Ⓑ: $D_B = \frac{30.75'}{48.25'}\left(32\% \times 10{,}367^{\#} \times 1.75\right) + 3{,}202^{\#}$

$- 35'\,(49^{\#}/\text{ft.}) = 4{,}118^{\#} \rightarrow$ DSC5 or (8) A35's

LINE Ⓕ: $D_F = \frac{24.5'}{91.75'}\left(50\% \times 10{,}367^{\#} \times 1.25\right) + 4{,}484^{\#}$

$- 24.5'\,(34^{\#}/\text{ft.}) = 3{,}488^{\#} \rightarrow$ DSC5

LINE Ⓖ: $D_G = \frac{47.25'}{54.75'}\left(57\% \times 10{,}367^{\#} \times 1.25'\right)$

$- 7.5'\,(34^{\#}/\text{ft.}) = 3{,}022^{\#} \rightarrow$ CMSTC16

$L_{d_6} = 3{,}022^{\#} / [2(140 \times 93)] = 11.6'$

∴ CMSTC16 x 9'-6"

OVERTURNING: FROM UPPER FLR. WALLS:

LINE Ⓕ: $T_F = 39^{\#}/\text{ft.}\,(9.0') - \frac{8'}{2}(0.6 \times 90) = 3{,}204^{\#}$

SIM. @ ⑤ AND ⑨⑩ 2,690# → MSTC52 or MSTC48B3

LINE Ⓗ: $T_H = 17^{\#}/\text{ft.}\,(9.0') - \frac{15.75'}{2}(0.6 \times 90) = 1{,}114^{\#}$

SIM. @ Ⓒ AND ① 1,427# 1,720# → CS16

LINE ⑥: $T_6 = 28^{\#}/\text{ft.}\,(9.0') - \frac{13'}{2}(0.6 \times 90) = 2{,}178^{\#}$

→ MSTC40

FROM MAIN FLOOR WALLS:

LINE ③,④: $T_{34} = 35^{\#}/\text{ft.}\,(12.0') - \frac{13.5'}{2}(0.6 \times 120)$

$= 3{,}810^{\#} \rightarrow$ HDU4/5

$= 5{,}488^{\#}$ @ Ⓑ → HDU5

LINE ⑥: $T_6 = 57^{\#}(11.05') - \frac{20.5'}{2}(0.6 \times 22.1) = 4{,}971^{\#}$

→ HDU5 + 4½DP

LINE ⑩: $T_{10} = 48^{\#}(11.05') - \frac{43'}{2}(0.6 \times 98) + 2{,}680^{\#}$

$= 7{,}909^{\#} \rightarrow$ HDU8

LINE Ⓑ,Ⓒ: $T_{BC} = 42^{\#}(11.05') - \frac{63'}{2}(0.6 \times 98) = 4{,}506^{\#}$

→ HDU5

LINE Ⓕ,Ⓖ: $T_{FG} = 29^{\#}(12.0') - \frac{7.5'}{2}(0.6 \times 120) = 3{,}234^{\#}$ @ ③,④

$= 29^{\#}(11.05') + \frac{11.8'}{24.5'}(3{,}234^{\#}) - \frac{24.5'}{2}(0.6 \times 24.1)$

$= 3{,}013^{\#} \rightarrow$ HDU4/5

LINE Ⓗ: $T_H = 17^{\#}(11.05') + 1{,}114^{\#} - \frac{11.5'}{2}(0.6 \times 108)$

$= 2{,}631^{\#} \rightarrow$ HDU2

LATERAL ANALYSIS – SEISMIC WEIGHT:

AT ROOF; $W_R = 504\,ft^2\,(17\#/ft^2) + 10\#/ft^2\,(\frac{12'}{2} \times 46')$

$= 11{,}328\#$

DESIGN BASE SHEAR, $V = 1{,}163\#$ (ASD)

WIND ANALYSIS PER ASCE 7 §27.5:

TRANSVERSE DIR; NORTH-TO-SOUTH:

AT ROOF; $W_{R_T} = 153\,ft^2\,(13.4\#/ft^2) + 61\,ft^2\,(7.5-(5.7))$

$= 3{,}620\#$

LONGITUDINAL DIR; EAST-TO-WEST:

AT ROOF; $W_{R_L} = 199\,ft^2\,(18.4\#/ft^2) = 3{,}662\#$

∴ WIND CONTROLS IN BOTH DIRECTIONS

LATERAL LOAD DISTRIBUTION; TO MAIN PLR. WALLS:

LINES ①,②; $V_1 = V_2 = 50\%\,(3{,}620\#) = 1{,}810\#$

$V_1 = 1{,}810\#/7.8' = 232\#/ft. \rightarrow$ SW6

~~$V_2 = 1{,}810\#/15.5' = 117\#/ft. \rightarrow$ SW6~~

LINES Ⓐ,Ⓓ; $V_A = V_D = 50\%\,(3{,}662\#) = 1{,}831\#$

$V_A = 1{,}831\#/19.95' = 92\#/ft. \rightarrow$ SW6

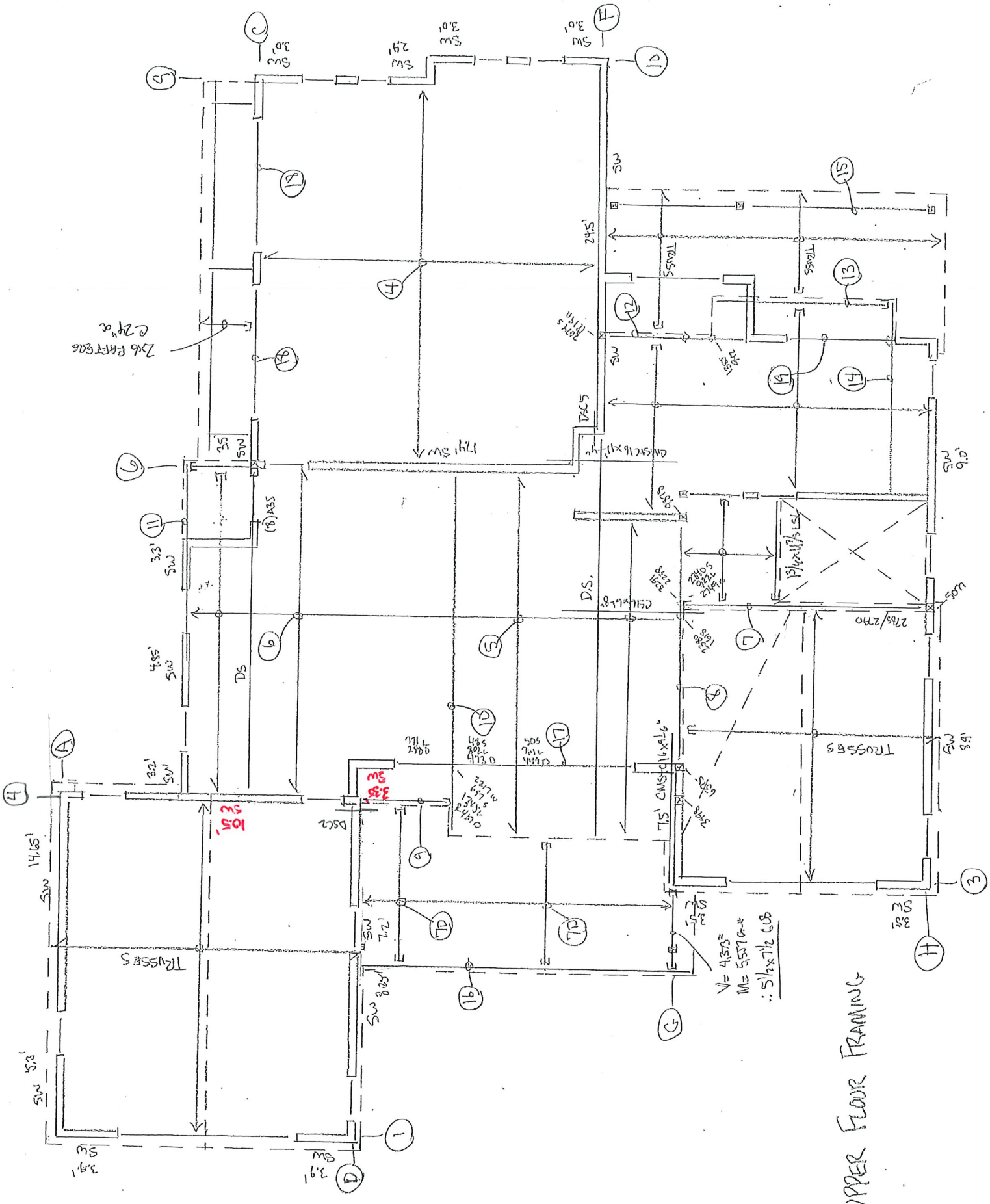
$V_D = 1{,}831\#/15.25' = 120\#/ft. \rightarrow$ SW6

OVERTURNING; FROM MAIN PLR. WALLS:

LINE ①; $T_1 = 232\#(12.6') - \frac{16.1'}{2}(0.6 \times 120)$

$= 2{,}204\# \rightarrow$ HDU2

SIM. @ ~~②~~, Ⓐ, Ⓓ


UPPER FLOOR FRAMING

Project Title:
Engineer:
Project ID:
Project Descr:

Cantilevered Retaining Wall

Project File: King swim spa retaining wall.ec6

DESCRIPTION: 4'-2" Swim Spa retaining wall

Code Reference

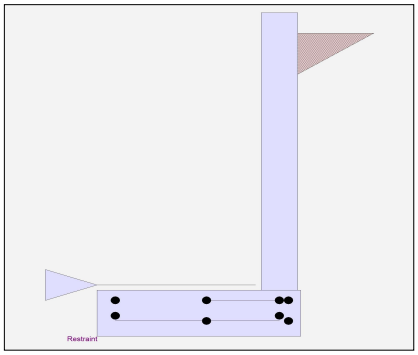
Calculations per IBC 2018 1807.3, CBC 2019, ASCE 7-16

Criteria

Retained Height	=	4.17 ft
Wall height above soil	=	0.33 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	0.00 in
Water table above bottom of footing	=	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	=	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	=	50.0 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	=	Seismic (E) (Service Level)
Wind on Exposed Stem (Service Level)	=	0.0 psf

Adjacent Footing Load

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

Project Title:
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Cantilevered Retaining Wall

Project File: King swim spa retaining wall.ec6

DESCRIPTION: 4'-2" Swim Spa retaining wall

Design Summary

Wall Stability Ratios

Overturning	=	1.55	OK
Slab Resists All Sliding !			
Global Stability	=	1.38	
Total Bearing Load	=	675 lbs	
...resultant ecc.	=	8.30 in	
Eccentricity outside middle third			
Soil Pressure @ Toe	=	639 psf	OK
Soil Pressure @ Heel	=	0 psf	OK
Allowable	=	2,500 psf	
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	894 psf	
ACI Factored @ Heel	=	0 psf	
Footing Shear @ Toe	=	10.3 psi	OK
Footing Shear @ Heel	=	0.4 psi	OK
Allowable	=	75.0 psi	

Sliding Calcs

Lateral Sliding Force	=	495.4 lbs

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

		Bottom
		Stem OK
Design Height Above Ftg	ft =	0.00
Wall Material Above "Ht"	=	Concrete
Design Method	=	SD
Thickness	=	6.00
Rebar Size	=	# 4
Rebar Spacing	=	12.00
Rebar Placed at	=	Center
Design Data		
fb/FB + fa/Fa	=	**0.353**
Total Force @ Section		
Service Level	lbs =	
Strength Level	lbs =	584.2
Moment....Actual		
Service Level	ft-# =	
Strength Level	ft-# =	879.6
Moment.....Allowable	=	2,487.6
Shear.....Actual		
Service Level	psi =	
Strength Level	psi =	16.2
Shear.....Allowable	psi =	75.0
Anet (Masonry)	in2 =	
Wall Weight	psf =	75.0
Rebar Depth 'd'	in =	3.00

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 =	2,500.0
Fy	psi =	60,000.0

Project Title:
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Cantilevered Retaining Wall

Project File: King swim spa retaining wall.ec6

DESCRIPTION: 4'-2" Swim Spa retaining wall

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.0729 in2/ft		
(4/3) * As :	0.0972 in2/ft	Min Stem T&S Reinf Area 0.648 in2	
200bd/fy : 200(12)(3)/60000 :	0.12 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.144 in2/ft	
0.0018bh : 0.0018(12)(6) :	0.1296 in2/ft	Horizontal Reinforcing Options :	
	==========	One layer of :	Two layers of :
Required Area :	0.1296 in2/ft	#4@ 16.67 in	#4@ 33.33 in
Provided Area :	0.2 in2/ft	#5@ 25.83 in	#5@ 51.67 in
Maximum Area :	0.4064 in2/ft	#6@ 36.67 in	#6@ 73.33 in

Footing Data

Toe Width	=	2.25 ft
Heel Width	=	0.54
Total Footing Width	=	2.79
Footing Thickness	=	9.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	1.00 ft

f'c = 2,500 psi Fy = 60,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel	
Factored Pressure	=	894	0	psf
Mu' : Upward	=	1,460	0	ft-#
Mu' : Downward	=	342	1	ft-#
Mu: Design	=	1,119 OK	1	ft-# OK
phiMn	=	4,963	OK - Flush	
Actual 1-Way Shear	=	10.32	0.44	psi
Allow 1-Way Shear	=	75.00	75.00	psi

Toe Reinforcing = # 4 @ 12.00 in
Heel Reinforcing = Flush heel condition. No reinforcing required.
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@ 12.34 in, #5@ 19.13 in, #6@ 27.16 in, #7@ 37.03 in, #8@ 48.76 in, #9@ 61.72 in, #10@ 78.39 in

Heel: Flush heel condition. No reinforcing required.

Key: No key defined

Min footing T&S reinf Area 0.54 in2
Min footing T&S reinf Area per foot 0.19 in2 /ft

If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 12.35 in	#4@ 24.69 in
#5@ 19.14 in	#5@ 38.27 in
#6@ 27.16 in	#6@ 54.32 in

Project Title:
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Cantilevered Retaining Wall

Project File: King swim spa retaining wall.ec6

DESCRIPTION: 4'-2" Swim Spa retaining wall

Summary of Overturning & Resisting Forces & Moments

Item		.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#		.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)		423.6	1.64	694.7	Soil Over HL (ab. water tbl)	20.9	2.77	57.8
HL Act Pres (be water tbl)					Soil Over HL (bel. water tbl)		2.77	57.8
Hydrostatic Force					Water Table			
Buoyant Force	=				Sloped Soil Over Hee	=		
Surcharge over Heel	=	71.8	2.46	176.5	Surcharge Over Heel	= 2.1	2.77	5.8
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	=		
	=				Surcharge Over Toe	=		
					Stem Weight(s)	= 337.7	2.50	844.3
					Earth @ Stem Transitions	=		
					Footing Weight	= 314.1	1.40	438.4
					Key Weight	=	1.00	
					Vert. Component	=		
Total	=	495.4	**O.T.M.** =	871.2	**Total =**	674.7 lbs	**R.M.=**	1,346.3

Resisting/Overturning Ratio = **1.55**

Vertical Loads used for Soil Pressure = 674.7 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	200.0	pci
Horizontal Defl @ Top of Wall (approximate only)	0.036	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.

Cantilevered Retaining Wall

DESCRIPTION: 4'-2" Swim Spa 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 #4 bar specified in this stem design segment (25.4.2.3a) =	18.72 in
Development length for #4 bar specified in this stem design segment =	14.40 in
Hooked embedment length into footing for #4 bar specified in this stem design segment =	6.00 in
As Provided =	0.2000 in2/ft
As Required =	0.1296 in2/ft

Project Title:
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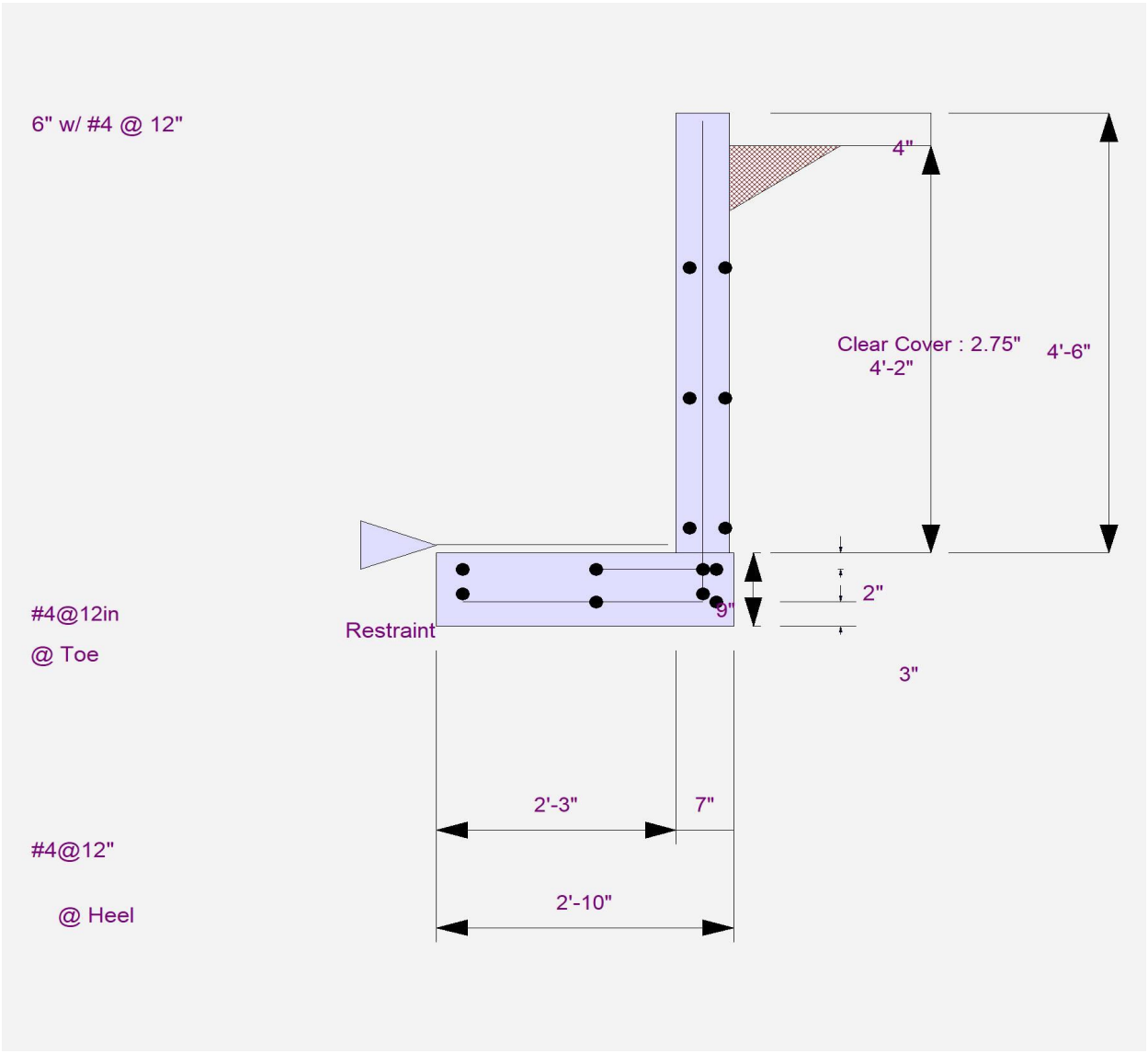
Cantilevered Retaining Wall

Project File: King swim spa retaining wall.ec6

DESCRIPTION: 4'-2" Swim Spa retaining wall



Project Title:
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Cantilevered Retaining Wall

Project File: King swim spa retaining wall.ec6

DESCRIPTION: 4'-2" Swim Spa retaining wall