BYKONEN
CARTER
QUINN

STRUCTURAL
ENGINEERING

STRUCTURAL CALCULATIONS

Steinborn Residence
8435 SE 47th PL,
Mercer Island, WA 98040

Ectypos Architecture
4212 W Mercer Way,
Mercer Island, WA 98040

August 24, 2023

Supplemental Calculations – Foundation Revisions

2033 Sixth Avenue #995 Seattle, WA 98121 206-264-7784 www.BCQ-SE.com

Project Title:
Engineer:
Project ID:
Project Descr:

Printed: 19 JUL 2023, 12:33PM

Cantilevered Retaining Wall

Project File: Foundations.ec6

DESCRIPTION: SE @ Ext wall (11/S3.1) - flipped CA

Code Reference

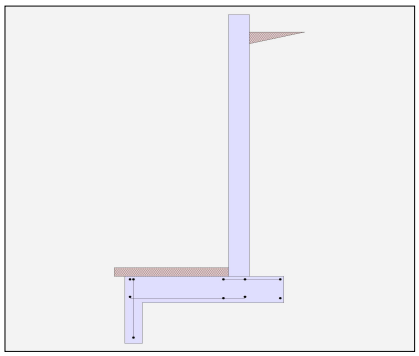
Calculations per IBC 2018 1807.3, CBC 2019, ASCE 7-16

Criteria

Retained Height	=	14.00 ft
Wall height above soil	=	1.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water table above bottom of footing	=	0.0 ft

Soil Data

Allow Soil Bearing	=	4,000.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	40.0 psf/ft
	=	
Passive Pressure	=	300.0 psf/ft
Soil Density, Heel	=	130.00 pcf
Soil Density, Toe	=	130.00 pcf
Footing||Soil Friction	=	0.450
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
Used for Sliding & Overturning		

Axial Load Applied to Stem

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

Lateral Load Applied to Stem

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

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Design Summary

Wall Stability Ratios

Overturning	=	2.35	OK
Sliding	=	1.52	OK
Global Stability	=	1.11	

Total Bearing Load	=	9,926 lbs	
...resultant ecc.	=	6.66 in	
Eccentricity within middle third			
Soil Pressure @ Toe	=	562 psf	OK
Soil Pressure @ Heel	=	1,427 psf	OK
Allowable	=	4,000 psf	
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	787 psf	
ACI Factored @ Heel	=	1,998 psf	
Footing Shear @ Toe	=	15.5 psi	OK
Footing Shear @ Heel	=	25.1 psi	OK
Allowable	=	75.0 psi	

Sliding Calcs

Lateral Sliding Force	=	4,805.0 lbs	
less 100% Passive Force	-	2,816.7 lbs	
less 100% Friction Force	-	4,466.8 lbs	
Added Force Req'd	=	0.0 lbs	OK
....for 1.5 Stability	=	0.0 lbs	OK

Vertical component of active lateral soil pressure IS considered in the calculation of soil bearing pressures.

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	SD	SD
Thickness	=	12.00		
Rebar Size	=	# 7		
Rebar Spacing	=	6.00		
Rebar Placed at	=	Edge		

Design Data

fb/FB + fa/Fa	=	**0.665**
Total Force @ Section		
Service Level	lbs =	
Strength Level	lbs =	6,272.0
Moment....Actual		
Service Level	ft-# =	
Strength Level	ft-# =	29,269.3
Moment.....Allowable	=	43,991.1
Shear.....Actual		
Service Level	psi =	
Strength Level	psi =	54.7
Shear.....Allowable	psi =	75.0
Anet (Masonry)	in2 =	
Wall Weight	psf =	150.0
Rebar Depth 'd'	in =	9.56

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

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DESCRIPTION: SE @ Ext wall (11/S3.1) - flipped CA

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.7036 in2/ft		
(4/3) * As :	0.9382 in2/ft	Min Stem T&S Reinf Area 4.320 in2	
200bd/fy : 200(12)(9.5625)/60000 :	0.3825 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.288 in2/ft	
0.0018bh : 0.0018(12)(12) :	0.2592 in2/ft	Horizontal Reinforcing Options :	
	==========	One layer of :	Two layers of :
Required Area :	0.7036 in2/ft	#4@ 8.33 in	#4@ 16.67 in
Provided Area :	1.2 in2/ft	#5@ 12.92 in	#5@ 25.83 in
Maximum Area :	1.2954 in2/ft	#6@ 18.33 in	#6@ 36.67 in

Footing Data

Toe Width	=	5.00 ft
Heel Width	=	2.67
Total Footing Width	=	7.67
Footing Thickness	=	18.00 in
Key Width	=	10.00 in
Key Depth	=	28.00 in
Key Distance from Toe	=	0.00 ft

f'c = 2,500 psi Fy = 60,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0000
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel	
Factored Pressure	=	787	1,998	psf
Mu' : Upward	=	13,130	3,141	ft-#
Mu' : Downward	=	4,350	9,546	ft-#
Mu: Design	=	8,780 OK	6,405 ft-#	OK
phiMn	=	13,063	39,347	ft-#
Actual 1-Way Shear	=	15.53	25.06	psi
Allow 1-Way Shear	=	75.00	75.00	psi

Toe Reinforcing = # 4 @ 12.00 in
Heel Reinforcing = # 6 @ 9.02 in
Key Reinforcing = # 5 @ 10.00 in
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@ 13.08 in, #5@ 20.27 in, #6@ 28.78 in, #7@ 39.24 in, #8@ 51.67 in, #9@ 65.41 in, #10@ 83.07 in

Heel: #4@ 19.19 in, #5@ 29.75 in, #6@ 42.23 in, #7@ 57.59 in, #8@ 75.83 in, #9@ 95.99 in, #10@ 121.91 in

Key: #4@ 8.49 in, #5@ 13.16 in, #6@ 18 in, #7@ 18

Min footing T&S reinf Area 2.98 in2
Min footing T&S reinf Area per foot 0.39 in2 /ft

If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 6.17 in	#4@ 12.35 in
#5@ 9.57 in	#5@ 19.14 in
#6@ 13.58 in	#6@ 27.16 in

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LIC# : KW-06015393, Build:20.23.05.25 BYKONEN CARTER QUINN (c) ENERCALC INC 1983-2023

DESCRIPTION: SE @ Ext wall (11/S3.1) - flipped CA

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)		4,805.0	5.17	24,825.8	Soil Over HL (ab. water tbl)	3,033.9	6.83	20,732.4
HL Act Pres (be water tbl)					Soil Over HL (bel. water tbl)		6.83	20,732.4
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	=				* Axial Live Load on Stem	=		
Load @ Stem Above Soil	=				Soil Over Toe	=	325.0	2.50	812.5
	=				Surcharge Over Toe	=		
					Stem Weight(s)	=	2,250.0	5.50	12,375.0
					Earth @ Stem Transitions	=		
					Footing Weight	=	1,725.1	3.83	6,613.1
					Key Weight	=	291.7	0.42	121.5
					Vert. Component	=	2,300.6	7.67	17,639.0
Total	=	4,805.0	**O.T.M.** =	24,825.8	**Total =**		9,926.3 lbs	**R.M.=**	58,293.6

Resisting/Overturning Ratio = **2.35**

Vertical Loads used for Soil Pressure = 9,926.3 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 considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS 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)	0.000	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.

DESCRIPTION: SE @ Ext wall (11/S3.1) - flipped CA

Rebar Lap & Embedment Lengths Information

Stem Design Segment: Bottom
Stem Design Height: 0.00 ft above top of footing

Lap Splice length for #7 bar specified in this stem design segment (25.4.2.3a) =	40.95 in
Development length for #7 bar specified in this stem design segment =	31.50 in
Hooked embedment length into footing for #7 bar specified in this stem design segment =	8.62 in
As Provided =	1.2000 in2/ft
As Required =	0.7036 in2/ft

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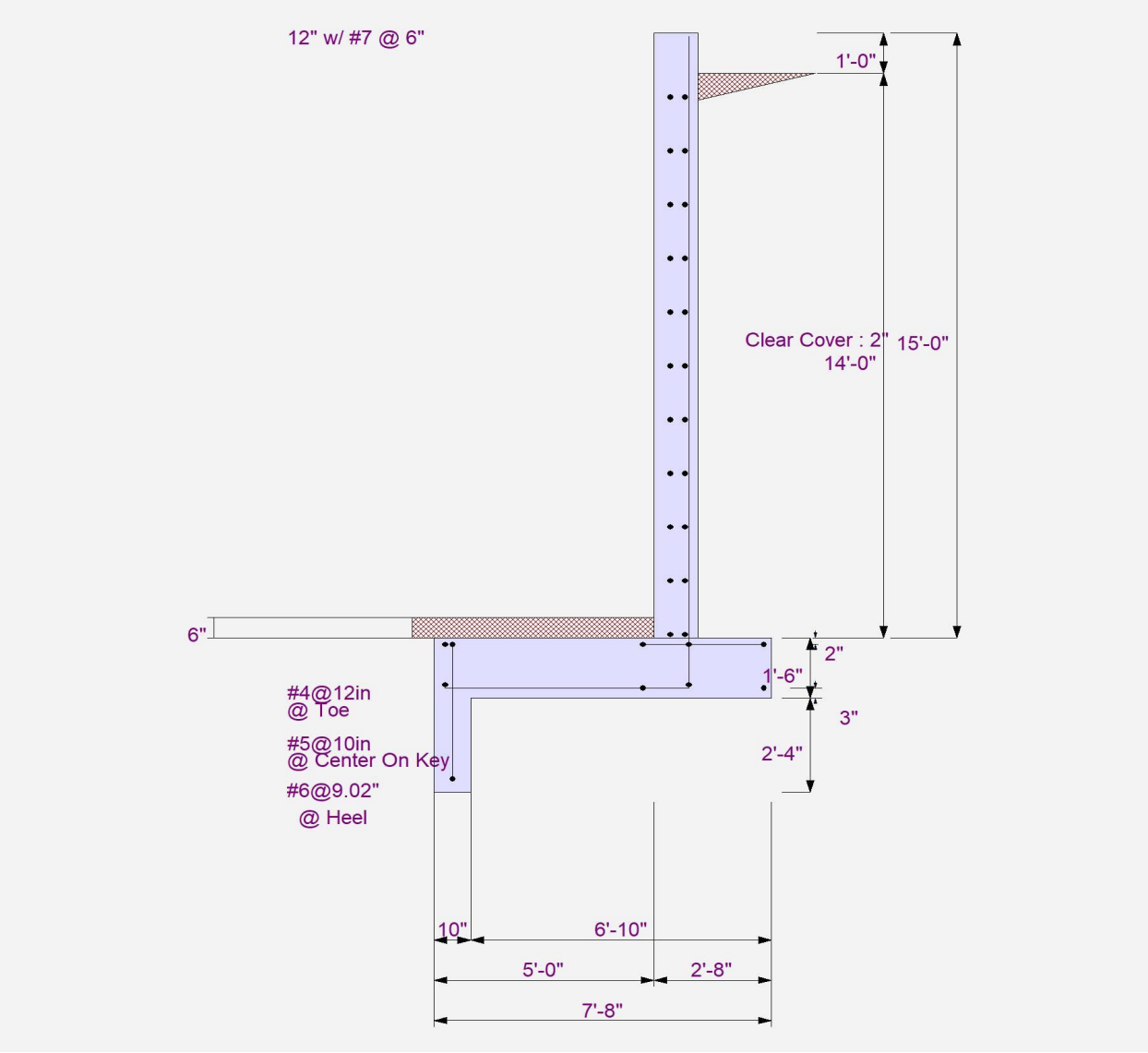

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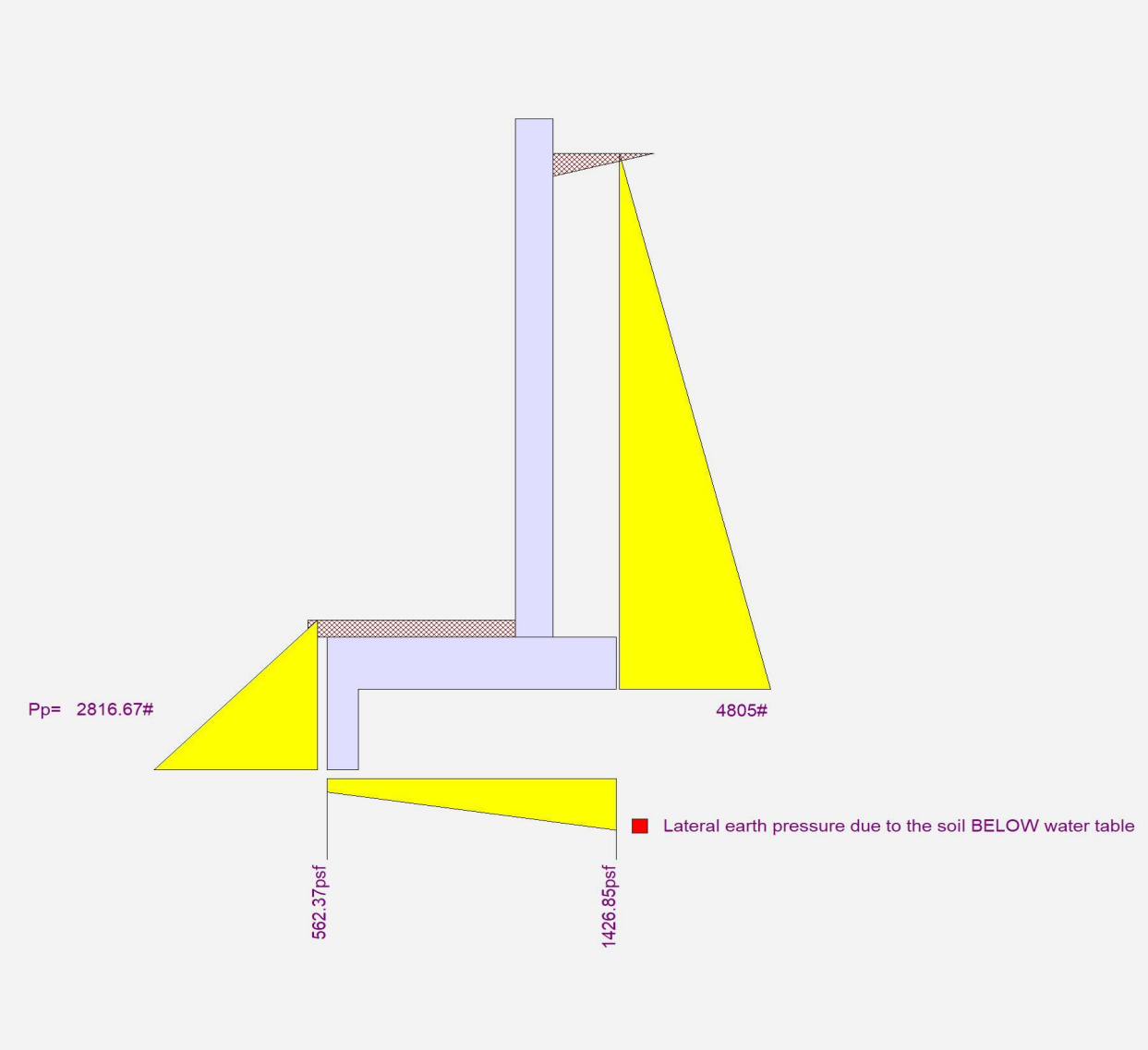

1. Shear wall demands have been increased where seismic controls design and h/L is greater than 2:1 per SDPWS Table 4.3.4. Where wind controls design, shearwall demands have been decreased 40% per IBC 2306.3.

WALL LINE A

UPPER		**WIND TRIB =**	11%		**ΣL =**	14.25						
		0.6W (k) =	1.30									
		SEISMIC TRIB =	11%									
		0.7E (k) =	0.82								*Wall weight*	
Segment Count	HT (ft)	LENGTH (ft)	h/L	2/(h/L)[1]	0.6W (plf)	0.7E (plf)	SW	SW Cap (plf)	Tension (k)	0.6-0.14Sds	[0.6-0.14Sds]D (k)	Net T (k)
1	9.4	14.3	0.66	1.00	65	57	SW 1	240	0.6	0.47	0.6	0.3
Concrete												

WALL LINE B

ROOF		**WIND TRIB =**	50%	**OPEN FRONT**	**ΣL =**	27.00						
		0.6W (k) =	1.45	1.75								
		SEISMIC TRIB =	50%									
		0.7E (k) =	2.77	2.16							*Wall weight*	
Segment Count	HT (ft)	LENGTH (ft)	h/L	2/(h/L)[1]	0.6W (plf)	0.7E (plf)	SW	SW Cap (plf)	Tension (k)	0.6-0.14Sds	[0.6-0.14Sds]D (k)	Net T (k)
1	10.2	15.0	0.68	1.00	46	103	SW 1	240	1.0	0.47	0.7	0.7
1	10.2	12.0	0.85	1.00	46	103	SW 1	240	1.0	0.47	0.6	0.8
UPPER		**WIND TRIB =**	33%		**ΣL =**	18.00						
		0.6W (k) =	5.65									
		SEISMIC TRIB =	33%									
		0.7E (k) =	5.22								*Wall weight*	
Segment Count	HT (ft)	LENGTH (ft)	h/L	2/(h/L)[1]	0.6W (plf)	0.7E (plf)	SW	SW Cap (plf)	Tension (k)	0.6-0.14Sds	[0.6-0.14Sds]D (k)	Net T (k)
1	9.4	5.5	1.70	1.00	224	290	SW 2	355	2.7	0.47	0.2	2.6
1	9.4	12.5	0.75	1.00	224	290	SW 2	355	2.7	0.47	0.5	2.4
Concrete												

WALL LINE C

MAIN		**WIND TRIB =**	21%									
		0.6W (k) =	2.92									
		SEISMIC TRIB =	23%									
		0.7E (k) =	0.97								*Wall weight*	
Segment Count	HT (ft)	LENGTH (ft)	h/L	2/(h/L)[1]	0.6W (plf)	0.7E (plf)	SW	SW Cap (plf)	Tension (k)	0.6-0.14Sds	[0.6-0.14Sds]D (k)	Net T (k)
1	9.4	15.0	0.63	1.00	87	40	SW 1	240	0.8	0.47	0.7	0.5
1	9.4	9.0	1.04	1.00	87	40	SW 1	240	0.8	0.47	0.4	0.6
Concrete												

WALL LINE D

ROOF		**WIND TRIB =**	50%	**OPEN FRONT**	**ΣL =**	14.00						
		0.6W (k) =	1.45	1.75								
		SEISMIC TRIB =	50%									
		0.7E (k) =	2.77	2.16							*Wall weight*	
Segment Count	HT (ft)	LENGTH (ft)	h/L	2/(h/L)[1]	0.6W (plf)	0.7E (plf)	SW	SW Cap (plf)	Tension (k)	0.6-0.14Sds	[0.6-0.14Sds]D (k)	Net T (k)
1	10.2	4.0	2.55	0.78	89	252	SW 2	355	2.0	0.47	0.2	1.9
1	10.2	10.0	1.02	1.00	89	198	SW 2	355	2.0	0.47	0.5	1.8
UPPER		**WIND TRIB =**	39%		**ΣL =**	18.50						
		0.6W (k) =	6.06									
		SEISMIC TRIB =	39%									
		0.7E (k) =	5.66								*Wall weight*	
Segment Count	HT (ft)	LENGTH (ft)	h/L	2/(h/L)[1]	0.6W (plf)	0.7E (plf)	SW	SW Cap (plf)	Tension (k)	0.6-0.14Sds	[0.6-0.14Sds]D (k)	Net T (k)
1	9.4	5.5	1.70	1.00	234	306	SW 4	595	2.9	0.47	0.2	2.7
1	9.4	4.0	2.34	0.85	234	359	SW 4	595	2.9	0.47	0.2	2.8
1	9.4	9.0	1.04	1.00	234	306	SW 4	595	2.9	0.47	0.4	2.7
MAIN		**WIND TRIB =**	23%		**ΣL =**	28.80						
		0.6W (k) =	9.25									
		SEISMIC TRIB =	26%									
		0.7E (k) =	6.76								*Wall weight*	
Segment Count	HT (ft)	LENGTH (ft)	h/L	2/(h/L)[1]	0.6W (plf)	0.7E (plf)	SW	SW Cap (plf)	Tension (k)	0.6-0.14Sds	[0.6-0.14Sds]D (k)	Net T (k)
1	9.4	12.0	0.78	1.00	229	235	SW 4	595	2.2	0.47	0.5	1.9
1	9.4	2.8	3.35	0.60	229	393	SW 4	595	2.2	0.47	0.1	2.1
1	9.4	5.0	1.88	1.00	229	235	SW 4	595	2.2	0.47	0.2	2.1
1	9.4	9.0	1.04	1.00	229	235	SW 4	595	2.2	0.47	0.4	2.0
Concrete												

WALL LINE E

UPPER		**WIND TRIB =**	17%		**ΣL =**	20.00						
		0.6W (k) =	2.01									
		SEISMIC TRIB =	17%									
		0.7E (k) =	1.26								*Wall weight*	
Segment Count	HT (ft)	LENGTH (ft)	h/L	2/(h/L)[1]	0.6W (plf)	0.7E (plf)	SW	SW Cap (plf)	Tension (k)	0.6-0.14Sds	[0.6-0.14Sds]D (k)	Net T (k)
1	9.4	20.0	0.47	1.00	72	63	SW 1	240	0.7	0.47	0.9	0.2
MAIN		**WIND TRIB =**	43%		**ΣL =**	12.00						
		0.6W (k) =	7.98									
		SEISMIC TRIB =	35%									
		0.7E (k) =	2.73								*Wall weight*	
Segment Count	HT (ft)	LENGTH (ft)	h/L	2/(h/L)[1]	0.6W (plf)	0.7E (plf)	SW	SW Cap (plf)	Tension (k)	0.6-0.14Sds	[0.6-0.14Sds]D (k)	Net T (k)
1	9.4	12.0	0.78	1.00	475	228	SW 4	595	4.5	0.47	0.5	4.2
Concrete												

1. Shear wall demands have been increased where seismic controls design and h/L is greater than 2:1 per SDPWS Table 4.3.4. Where wind controls design, shearwall demands have been decreased 40% per IBC 2306.3.

WALL LINE 2

ROOF		**WIND TRIB =**	22%		**ΣL =**	11.30						
		0.6W (k) =	0.99									
		SEISMIC TRIB =	22%									
		0.7E (k) =	1.22								*Wall weight*	
Segment Count	HT (ft)	LENGTH (ft)	h/L	2/(h/L)[1]	0.6W (plf)	0.7E (plf)	SW	SW Cap (plf)	Tension (k)	0.6-0.14Sds	[0.6-0.14Sds]D (k)	Net T (k)
1	10.2	11.3	0.90	1.00	63	108	SW 1	240	1.1	0.47	0.5	0.8
Concrete												

WALL LINE 3

ROOF		**WIND TRIB =**	78%		**ΣL =**	11.80						
		0.6W (k) =	3.51									
		SEISMIC TRIB =	78%									
		0.7E (k) =	4.32								*Wall weight*	
Segment Count	HT (ft)	LENGTH (ft)	h/L	2/(h/L)[1]	0.6W (plf)	0.7E (plf)	SW	SW Cap (plf)	Tension (k)	0.6-0.14Sds	[0.6-0.14Sds]D (k)	Net T (k)
1	10.2	7.0	1.46	1.00	212	366	SW 3	455	3.7	0.47	0.3	3.6
1	10.2	4.8	2.13	0.94	212	389	SW 3	455	3.7	0.47	0.2	3.6
UPPER		**WIND TRIB =**	50%		**ΣL =**	36.50						
		0.6W (k) =	7.71									
		SEISMIC TRIB =	50%									
		0.7E (k) =	8.03								*Wall weight*	
Segment Count	HT (ft)	LENGTH (ft)	h/L	2/(h/L)[1]	0.6W (plf)	0.7E (plf)	SW	SW Cap (plf)	Tension (k)	0.6-0.14Sds	[0.6-0.14Sds]D (k)	Net T (k)
1	9.4	24.5	0.38	1.00	151	220	SW 1	240	2.1	0.47	1.1	1.5
1	9.4	12.0	0.78	1.00	151	220	SW 1	240	2.1	0.47	0.5	1.8
MAIN		**WIND TRIB =**	50%		**ΣL =**	33.50						
		0.6W (k) =	10.21									
		SEISMIC TRIB =	50%									
		0.7E (k) =	10.13								*Wall weight*	
Segment Count	HT (ft)	LENGTH (ft)	h/L	2/(h/L)[1]	0.6W (plf)	0.7E (plf)	SW	SW Cap (plf)	Tension (k)	0.6-0.14Sds	[0.6-0.14Sds]D (k)	Net T (k)
1	8.5	24.5	0.35	1.00	218	302	SW 2	355	2.6	0.47	1.0	2.1
1	8.5	9.0	0.95	1.00	218	302	SW 2	355	2.6	0.47	0.4	2.4
Concrete												

WALL LINE 4

UPPER		**WIND TRIB =**	50%		**ΣL =**	12.70						
		0.6W (k) =	4.20									
		SEISMIC TRIB =	50%									
		0.7E (k) =	3.71								*Wall weight*	
Segment Count	HT (ft)	LENGTH (ft)	h/L	2/(h/L)[1]	0.6W (plf)	0.7E (plf)	SW	SW Cap (plf)	Tension (k)	0.6-0.14Sds	[0.6-0.14Sds]D (k)	Net T (k)
1	9.4	6.0	1.56	1.00	236	292	SW 3	455	2.7	0.47	0.3	2.6
1	9.4	3.8	2.47	0.81	236	360	SW 3	455	2.7	0.47	0.2	2.7
1	9.4	2.9	3.23	0.62	236	472	SW 3	455	2.7	0.47	0.1	2.7
MAIN		**WIND TRIB =**	50%		**ΣL =**	21.00						
		0.6W (k) =	6.71									
		SEISMIC TRIB =	47%									
		0.7E (k) =	5.69								*Wall weight*	
Segment Count	HT (ft)	LENGTH (ft)	h/L	2/(h/L)[1]	0.6W (plf)	0.7E (plf)	SW	SW Cap (plf)	Tension (k)	0.6-0.14Sds	[0.6-0.14Sds]D (k)	Net T (k)
1	8.5	21.0	0.41	1.00	228	271	SW 3	455	2.3	0.47	0.8	1.9
Concrete												

WALL LINE 5

MAIN		**WIND TRIB =**	18%		**ΣL =**	3.80						
		0.6W (k) =	0.90									
		SEISMIC TRIB =	6%									
		0.7E (k) =	0.25								*Wall weight*	
Segment Count	HT (ft)	LENGTH (ft)	h/L	2/(h/L)[1]	0.6W (plf)	0.7E (plf)	SW	SW Cap (plf)	Tension (k)	0.6-0.14Sds	[0.6-0.14Sds]D (k)	Net T (k)
1	8.5	3.8	2.25	0.89	170	75	SW 1	240	1.4	0.47	0.2	1.4
Concrete												