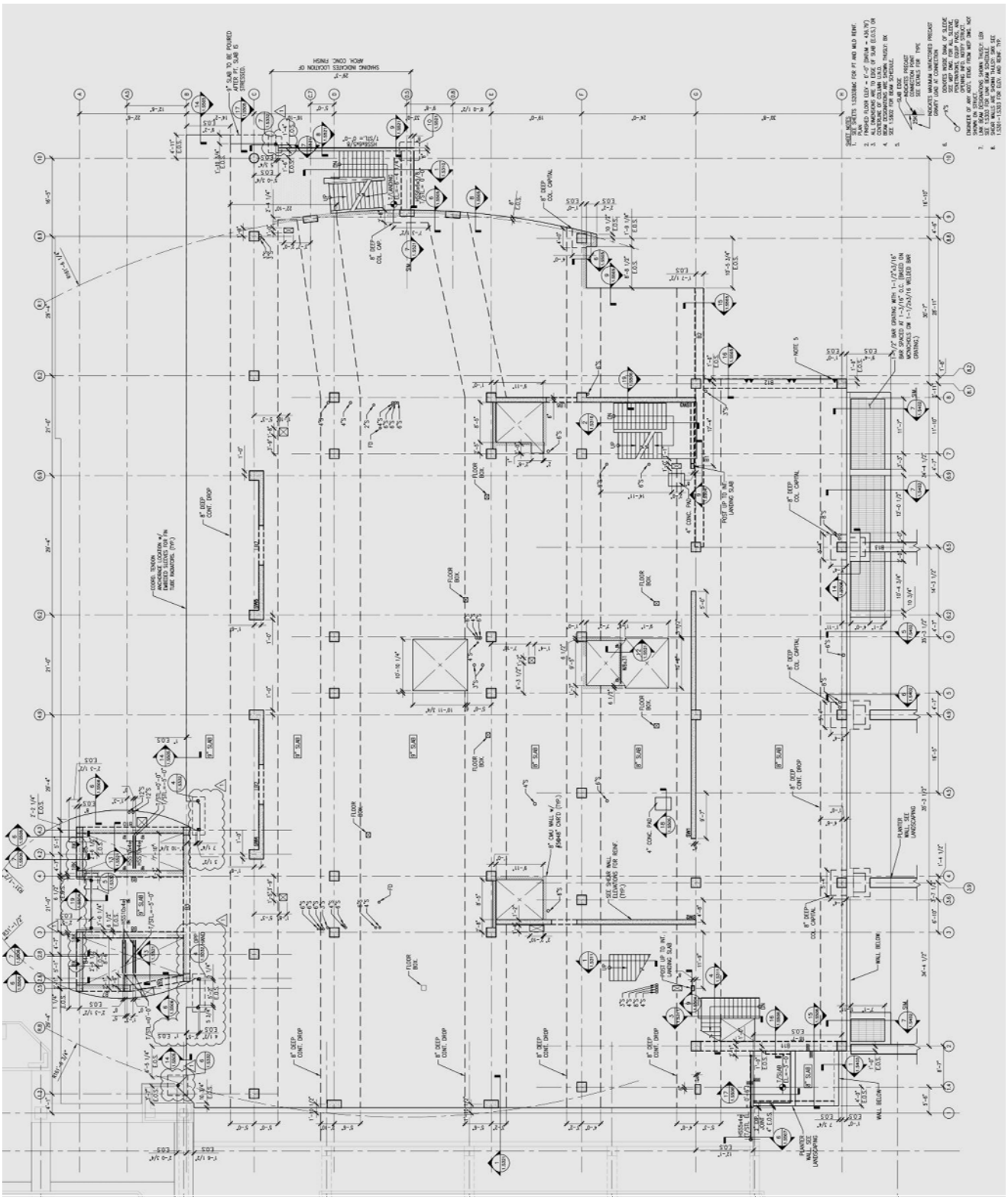
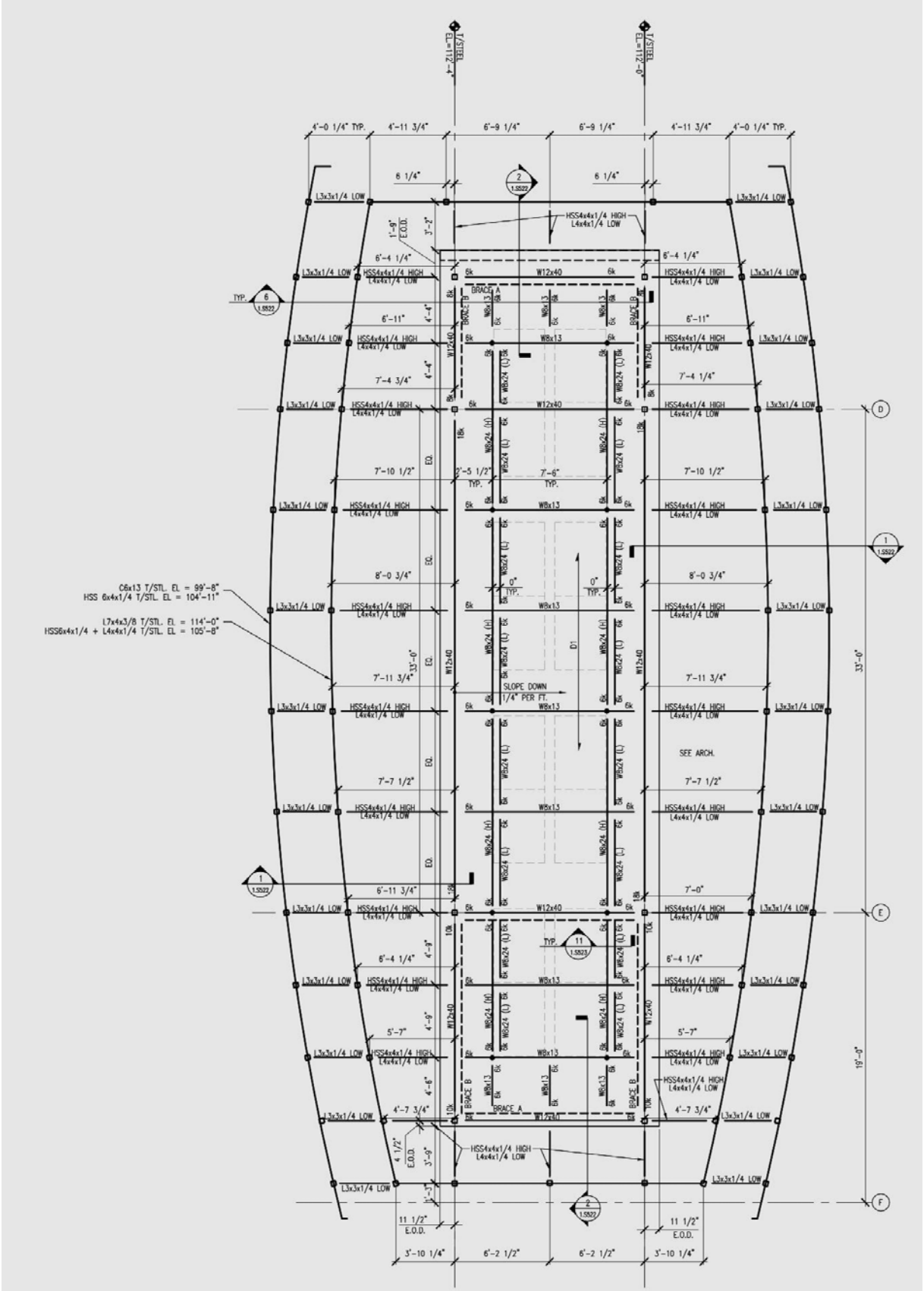
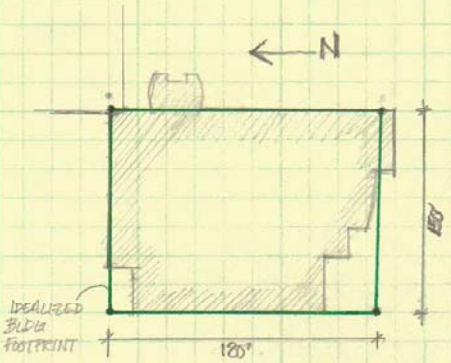
Appendix A – Typical Plans




C6x13 T/STL. EL = 99'-8"
HSS 6x4x1/4 T/STL. EL = 104'-11"
L7x4x3/8 T/STL. EL = 114'-0"
HSS6x4x1/4 + L4x4x1/4 T/STL. EL = 105'-8"
SLOPE DOWN 1/4" PER FT.
SEE ARCH.
BRACE A
BRACE B
W12x40
W8x13
W8x24 (H)
W8x24 (L)
HSS4x4x1/4 HIGH L4x4x1/4 LOW
L3x3x1/4 LOW
33'-0"
19'-9"

Appendix B – Wind Calculations

JAKE WIEST WIND



*WHILE THE HIGHEST PT. ON THE BLDG IS 114', THE MAJORITY OF THE ROOF IS @ 100', WHICH WILL BE USED FOR SIMPLIFICATION

V = 90 MPH FIG. 6-1
I = 1.15 TAB 6-1
EXPOSURE B
K_z = .99 TAB 6-3
K_{zt} = 1.0
K_d = .85 TAB 6-4 MWFRS

VELOCITY PRESSURE

$q = .00256 K_z K_{zt} K_d V^2 I$

$= .00256(.99)(1.0)(.85)(90^2)(1.15)$

$= 20.1$ psf FOR $h = 100$ ft

(REST ON EXCEL)

Ta (FROM SEISMIC) = .698

$f = 1/T = 1/.698 = 1.4 > 1$ Hz

RIGID STRUCTURE

G = 0.85

$GC_{pi} = \pm 0.18$: FULLY ENCLOSED

DESIGN WIND PRESSURE

$P = qGC_p - q_i(GC_{pi})$

C_p

WINDWARD - $C_p = .8$

SIDEWALL $C_p = -.7$

LEE NORMAL 180' 100/180 = .83 = -0.5

NORMAL 150' 100/150 = 1.2 = -0.46

WINDWARD P @ 100'

$P = 20.1(.85)(.8) - 20.1(\pm .18)$

$= 13.7 \pm 3.6$ psf

(REST ON EXCEL)

ROOF C_p: 100/150 = .67 →
100/180 = .56 →

0 to h/2 = -1.04
-.948

>h/2 = -.882
-.896

Appendix C – Seismic Calculation (As Designed)

JAKE WIEST | SEISMIC

- OCCUPANCY CATEGORY III – IMPORTANCE FACTOR = 1.25
- SITE CLASS - D

$S_S = .156$
$S_1 = .051$
(VALUES FROM USGS SEISMIC HAZARD CURVES & UNIFORM HAZARD RESPONSE SPECTRA)
EST. VALUES FROM MAPS .16 & .05 RESPECTIVELY)

$F_a = 1.6$ (TABLE 11.4-1)
$F_v = 2.4$ (TAB. 11.4-2)

$S_{MS} = F_a S_S = .156(1.6) = .2496$

$S_{M1} = F_v S_1 = .051(2.4) = .1224$

$S_{DS} = \frac{2}{3} S_{MS} = \frac{2}{3}(.2496) = .1664$ $S_{DC} = A$

$S_{D1} = \frac{2}{3} S_{M1} = \frac{2}{3}(.1224) = .0816$ $S_{DC} = B \leftarrow$ CONTROLS

T. 12.8-2 ∴ $C_t = .02$
$x = .75$

$T_a = C_t h_n^x = .02(114)^{.75} = .6988$ $T_L = 8s$ $T = C_u T_a = 1.7(.6988) = 1.19$

$C_S = \frac{S_{DS}}{(R/I)} = \frac{.166}{(4/1.25)} = .052s$ < $C_S = \frac{S_{D1}}{T(R/I)} = \frac{.0816}{1.19(4/1.25)} = .0214$

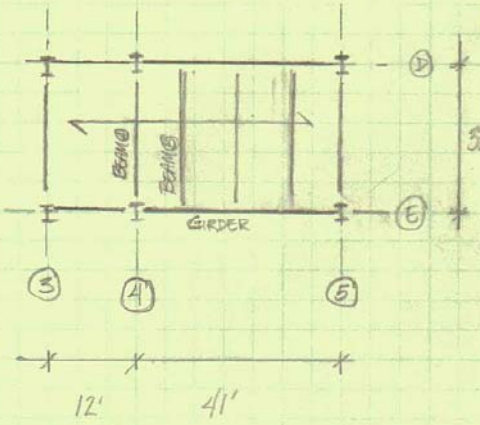
$C_S = .0214$

$V = WC_S = 28000k \times .0214 = 600k$

Appendix D – Steel Framing Hand Calculations

JAKE WIEST — COMPOSITE SLAB + MTL DECK ON COMPOSITE BMS + GIRDERS

USING BAY FROM PT DESIGN



LIVE LOAD = 100 psf
DEAD LOAD = 15 psf MEP → SUPERIMPOSED LOAD = 115 psf

AS UNSHORED CONSTR. IS MORE ECONOMICAL, WOULD LIKE TO PICK A DECK THAT CAN BE PLACED 12' UNSHORED SO NO INFILL BEAMS NEED ADDED IN THE SMALLER BAYS.

2VLI 18 W/3" LW TOPPING CHOSEN
MAX UNSHORED: 12'9" > 12' ✓ (2 SPAN COND.)
CARRIES 122 psf @ 12'-8" SPAN > 115 ✓

GIVEN SLAB CONSTRAINTS MEAN 3 INFILL BEAMS IN LARGE BAY @ 10.25' SPACING

TOTAL SLAB DEPTH = 5"
TOTAL SLAB WT. = 59 psf

BEAM DESIGN

LL = 100 psf

$LL_{RED} = .25 + \frac{15}{\sqrt{33 \times 20.5}} = .83 = 83$ psf

↳ > 400 ✓

DL = 39 + 15 + 10 = 64 psf
↑ CONN'T

BEAM (A)

$W_U = [1.2(64) + 1.6(83)] \frac{10.25+12}{2}$

$= 2.83$ k/f

$M_U = \frac{2.83(83)^2}{8} = 317$ k-ft

BEAM (B)

$W_U = [1.2(64) + 1.6(83)] 10.25$

$= 2.15$ k/f

$M_U = 293$ k-ft

$b_{eff} = \frac{SPAN}{8} = \frac{33 \times 12}{8} = 99" \leq 2 \times \frac{1}{2} SPACING = \left(\frac{10.25+12}{2}\right) \times 12 = 133.5"$

USE 99" FOR BOTH

AS DEFLECTION WILL LIKELY CONTROL, DESIGN 1 BM. FOR LARGER TRIB.

ASSUME $a \approx 1'' \therefore Y_2 = 5 - .5 = 4.5''$

W14×88 : $\phi M_n = 425$ $\Sigma Q_n = 386$ $386/17.2 = 22.4 \rightarrow 46$ STUDS/BM

W16×86 : $\phi M_n = 389$ $\Sigma Q_n = 229$ $229/17.2 = 13.3 \rightarrow 28$ STUDS/BM

W18×35 : $\phi M_n = 347$ $\Sigma Q_n = 194$ $194/17.2 = 11.3 \rightarrow 24$ STUDS/BM

W16×31 : $\phi M_n = 340$ $\Sigma Q_n = 213$ $213/17.2 = 12.4 \rightarrow 26$ STUDS/BM TRY

Check a: $a = \frac{213}{.85(4)(4)(.85)} = .74'' \checkmark$

(f'_c, λ FOR LW)

UNSHORED

$w_U = [1.2(39) + 1.6(20)]\left(\frac{10.25+12}{2}\right) + 1.2(31) = .914$ k/lf

([1.2] NO REP OR BM, [1.6] CONSTR LL, [1.2] BM)

$M_U = \frac{.914(38)^2}{8} = 124 < 203$ k-ft $\checkmark$

WET CONC. DEFL.

$w = 39\left(\frac{10.25+12}{2}\right) + 31 = .465$ k/lf

$\Delta = \frac{5(.465)(33)^4(1728)}{384(29000)(575)} = 1.14''$

$\Delta_{max} = \frac{33(12)}{240} = 1.65 \therefore$ ok

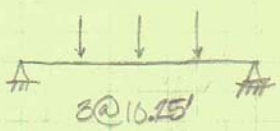
LL DEFL.

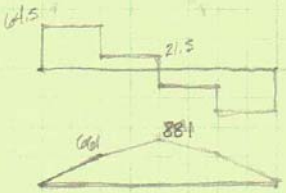
$w = 39\left(\frac{10.25+12}{2}\right) = .923$

$\Delta = \frac{5(.923)(33)^4(1728)}{384(29000)(825)} = 1.02$

$\Delta_{max} = \frac{33(12)}{360} = 1.1 \therefore$ ok

GIRDER DESIGN





19'-8" SPAN ON OTHER SIDE OF GIRDER

$P_D = 15.2k \leftarrow [(84 \times 10.25) + 91]26'$

$P_L = 15.8k \leftarrow LL_{RED} = .25 + \frac{15}{141(\times(38+19)} = .5748$

$67.5psf \times 10.25' \times 26' = 15.3k$

$P_U = 48k$

$M_U = 881\ k\text{-}ft$

$b_{eff} = \frac{41 \times 12}{8} \times 2 = 128" \leq \left(\frac{19+83}{2}\right)12 = 812" \therefore 128"$ CONTROLS

$Y2 = 4.5"$ (assume 1")

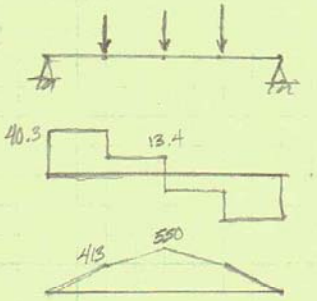
TRY W21×68:

$\phi M_n = 881 k\text{-}ft \quad \Sigma Q_n = 342 \quad 342/17.2 = 19.9 \rightarrow 40$ STUDS/BM

$a = \frac{342}{.85(123)(4)(.85)} = .96 \therefore ok$

UNSHORED

$P_U = 1.2(15.3) + 1.6\left(\frac{20 \times 10.25 \times 26'}{1000}\right) = 26.9$



+

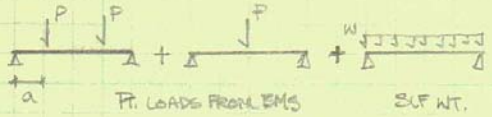
MOMENT FROM SLF WT.

W21×68: $\phi M_n = 600 k\text{-}ft > 564.3 \therefore ok$

$\frac{.088(41)^2}{8} = 14.3 + 550 = 564.3\ ft\text{-}k$

WET CONC. DEFL.

ASSUMPTION: SUPER POSITION OF DEFL IS EQUAL TO REAL



$P = [(39 \times 10.25) + 35]26' = 11.3\,k$

$$\frac{Pa}{24EI}(3L^2 - 4a^2) + \frac{PL^3}{48EI} + \frac{5wL^4}{384EI}$$

$$1728 < \left[\frac{11.3(10.25)}{24(29000)(148)}(3(41)^2 - 4(10.25)^2) + \frac{11.3(41)^3}{48(29000)(148)} + \frac{5(.068)(41)^4}{384(29000)(148)}\right]$$

$\Delta = 1.65''$

$\Delta_{MAX} = \frac{12 \times 41}{240} = 2.05''$ ✓

LL DEFL.

SAME ASSUMPTION:

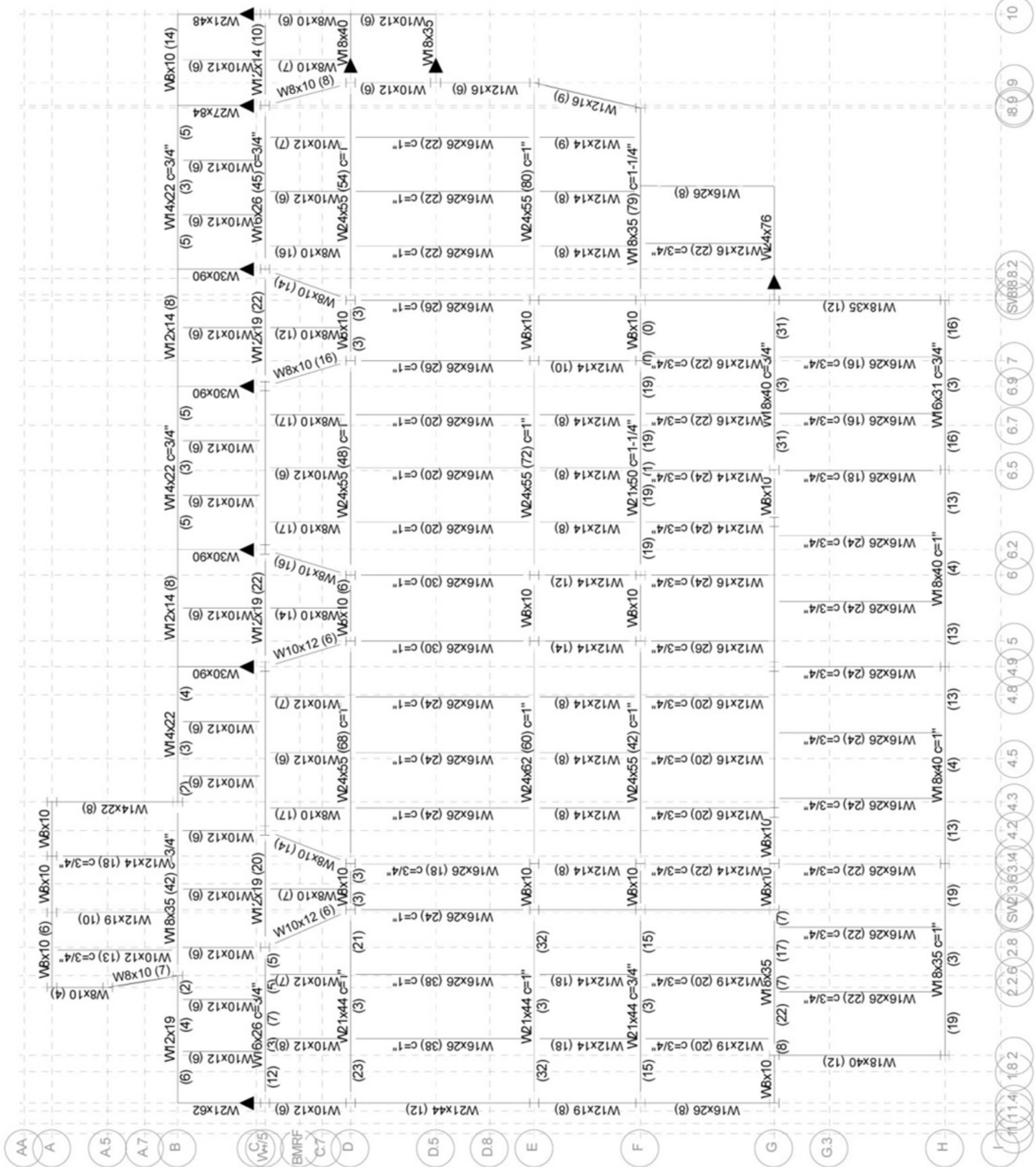
$P = [(57.5) \times 10.25]26' = 15.3\,k$

$$\frac{1728}{29000(2680)}\left[\frac{15.3(10.25)}{24}(3(41)^2 - 4(10.25)^2) + \frac{15.3(41)^3}{48}\right]$$

$\Delta = 1.18''$

$\Delta_{MAX} = \frac{12 \times 41}{360} = 1.37''$ ✓

Appendix E – RAM Designs



Appendix F – MD Preliminary Sizing

Braced Frame 2 - 50%							Size Selection							
Story Ht	Bay Length	Brace Length	Shear	Axial Force	Inc By Tor	Trial Size, A = P/F	Size	A	r	KL/r	Fe	Fcr	P	Optimized
19	24	30.61	33.05	42.15	50.58	1.01	HSS6x6x3/8	7.58	2.28	161.11	11.03	9.67	65.97	HSS8x8x3/8
17	24	29.41	103.6	126.96	152.35	3.05	HSS8x8x3/8	10.4	3.1	113.85	22.08	19.37	181.27	HSS8x8x3/8
17	24	29.41	142.85	175.06	210.07	4.20	HSS9x9x3/8	11.8	3.51	100.55	28.31	23.30	247.47	HSS9x9x5/8
17	24	29.41	186.4	228.42	274.11	5.48	HSS10x10x3/8	13.2	3.92	90.03	35.31	26.67	316.79	HSS9x9x5/8
15.5	24	28.57	230.8	274.75	329.70	6.59	HSS9x9x5/8	18.7	3.4	100.84	28.15	23.21	390.66	HSS10x10x5/8
14	24	27.78	268.32	310.64	372.76	7.46	HSS9x9x5/8	18.7	3.4	98.06	29.76	24.09	405.42	HSS10x10x5/8
15	19	24.21	301.68	384.36	461.24	9.22	HSS9x9x5/8	18.7	3.4	85.44	39.21	28.15	473.79	HSS10x10x5/8
10	19	21.47	301.68	340.91	409.10	8.18	HSS9x9x5/8	18.7	3.4	75.78	49.84	31.26	526.11	HSS10x10x5/8

Braced Frame 3 - 50%							Size Selection							
Story Ht	Bay Length	Brace Length	Shear	Axial Force	Inc By Tor	Trial Size, A = P/F	Size	A	r	KL/r	Fe	Fcr	P	Optimized
19	24	30.61	33.05	42.15	50.58	1.01	HSS6x6x3/8	7.58	2.28	161.11	11.03	9.67	65.97	HSS8x8x3/8
17	24	29.41	103.6	126.96	152.35	3.05	HSS8x8x3/8	10.4	3.1	113.85	22.08	19.37	181.27	HSS8x8x3/8
17	24	29.41	142.85	175.06	210.07	4.20	HSS9x9x3/8	11.8	3.51	100.55	28.31	23.30	247.47	HSS9x9x3/8
17	24	29.41	186.4	228.42	274.11	5.48	HSS10x10x3/8	13.2	3.92	90.03	35.31	26.67	316.79	HSS9x9x3/8
15.5	24	28.57	230.8	274.75	329.70	6.59	HSS9x9x5/8	18.7	3.4	100.84	28.15	23.21	390.66	HSS9x9x5/8
14	24	27.78	268.32	310.64	372.76	7.46	HSS9x9x5/8	18.7	3.4	98.06	29.76	24.09	405.42	HSS9x9x5/8
15	24	28.30	301.68	355.76	426.91	8.54	HSS10x10x5/8	21	3.8	89.37	35.83	26.88	508.00	HSS10x10x5/8
10	24	26.00	301.68	326.82	392.18	7.84	HSS9x9x5/8	18.7	3.4	91.76	33.99	26.11	439.38	HSS10x10x5/8

Braced Frame 4 - 25% Chevron (Assuming only half is in compr)							Size Selection							
Story Ht	Bay Length	Brace Length	Shear	Axial Force	Inc By Tor	Trial Size, A = P/F	Size	A	r	KL/r	Fe	Fcr	P	Optimized
19	29.33	24.00	8.2625	13.52	16.23	0.32	HSS4x4x5/16	4.1	1.49	193.299	7.66	6.72	24.79	
17	29.33	22.45	25.90	39.65	47.58	0.95	HSS5x5x3/8	6.18	1.87	144.0727	13.79	12.09	67.26	HSS5x5x3/8
17	29.33	22.45	35.71	54.67	65.61	1.31	HSS5x5x3/8	6.18	1.87	144.0727	13.79	12.09	67.26	HSS6x6x3/8
17	29.33	22.45	43.6375	66.81	80.17	1.60	HSS6x6x3/8	7.58	2.28	118.1649	20.50	17.98	122.64	HSS6x6x3/8
15.5	29.33	21.34	49.5875	72.15	86.58	1.73	HSS6x6x3/8	7.58	2.28	112.3055	22.69	19.69	134.34	HSS6x6x3/8
14	29.33	20.27	57.58	79.61	95.53	1.91	HSS6x6x3/8	7.58	2.28	106.7088	25.14	21.38	145.89	HSS6x6x3/8
15	29.33	20.98	64.8	92.69	111.23	2.22	HSS6x6x3/8	7.58	2.28	110.4087	23.48	20.26	138.21	HSS6x6x3/8
10	29.33	17.75	64.8	78.43	94.12	1.88	HSS6x6x3/8	7.58	2.28	93.42101	32.80	25.57	174.46	HSS6x6x3/8

Braced Frame 5 - 25% Chevron (Assuming only half is in compr)							Size Selection							
Story Ht	Bay Length	Brace Length	Shear	Axial Force	Inc By Tor	Trial Size, A = P/F	Size	A	r	KL/r	Fe	Fcr	P	Optimized
19	29.33	24.00	8.2625	13.52	16.23	0.32	HSS4x4x5/16	4.1	1.49	193.30	7.66	6.72	24.79	
17	29.33	22.45	25.9	39.65	47.58	0.95	HSS5x5x3/8	6.18	1.87	144.07	13.79	12.09	67.26	HSS5x5x3/8
17	29.33	22.45	35.713	54.67	65.61	1.31	HSS5x5x3/8	6.18	1.87	144.07	13.79	12.09	67.26	HSS6x6x3/8
17	29.33	22.45	43.638	66.81	80.17	1.60	HSS6x6x3/8	7.58	2.28	118.16	20.50	17.98	122.64	HSS6x6x3/8
15.5	29.33	21.34	49.588	72.15	86.58	1.73	HSS6x6x3/8	7.58	2.28	112.31	22.69	19.69	134.34	HSS6x6x3/8
14	29.33	20.27	57.58	79.61	95.53	1.91	HSS6x6x3/8	7.58	2.28	106.71	25.14	21.38	145.89	HSS6x6x3/8
15	29.33	20.98	64.8	92.69	111.23	2.22	HSS6x6x3/8	7.58	2.28	110.41	23.48	20.26	138.21	HSS6x6x3/8
10	20	22.36	129.6	144.90	173.88	3.48	HSS8x8x3/8	10.4	3.1	86.56	38.20	27.79	260.11	HSS8x8x3/8

Note: Bottom Floor Not Chevron

Braced Frame 1 - 50%							Size Selection							
	Bay Length	Brace Length	Shear	Axial Force	Inc By Tor	Trial Size, A = P/F	Size	A	r	KL/r	Fe	Fcr	P	Optimized
19	26	32.20	33.05	40.93	49.12	0.98	HSS6x6x3/8	7.58	2.28	169.4868	9.96	8.74	59.61	HSS8x8x3/8
17	26	31.06	103.6	123.78	148.54	2.97	HSS8x8x1/2	13.5	3.04	122.6228	19.04	16.69	202.83	HSS8x8x3/8
17	26	31.06	142.85	170.68	204.81	4.10	HSS8x8x1/2	13.5	3.04	122.6228	19.04	16.69	202.83	HSS9x9x1/2
17	26	31.06	174.55	208.55	250.26	5.01	HSS9x9x1/2	15.3	3.45	108.0503	24.52	20.97	288.82	HSS9x9x1/2
15.5	26	30.27	198.35	230.92	277.11	5.54	HSS9x9x5/8	18.7	3.4	106.834	25.08	21.35	359.26	HSS9x9x5/8
14	26	29.53	230.32	261.59	313.90	6.28	HSS9x9x5/8	18.7	3.4	104.2223	26.35	22.15	372.83	HSS9x9x5/8
15	26	30.02	259.2	299.24	359.09	7.18	HSS10x10x5/8	21	3.8	94.78946	31.85	25.13	475.04	HSS10x10x5/8
10	26	27.86	259.2	277.71	333.25	6.67	HSS10x10x5/8	21	3.8	87.96877	36.99	27.33	516.59	HSS10x10x5/8

Note: One Frame, Top Brace takes entire shear

Braced Frame 1: One Frame
Column Betw Lines 6 and 6.5

Floor	Ht	Length	Trib Area	Infl Area	DL(psf)	LL Reduction	LL	P	P From Vb	Total P	Size	A	r	KL/r	Fe	Fcr	P	Optimized
											Size Selection							
Roof	19	26	482	1931	80	0.59	59.14	78.63	869.3169231	947.95	W14x132	38.8	3.76	60.6383	77.84	35.92	1254.33	W14x82
Pent	17	26	482	1931	110	0.49	150.00	214.56	869.3169231	1083.87	W14x132	38.8	3.76	54.25532	97.23	37.74	1317.76	W14x82
5th	17	26	482	1931	80	0.45	44.71	282.38	869.3169231	1151.69	W14x132	38.8	3.76	54.25532	97.23	37.74	1317.76	W14x120
4th	17	26	482	1931	80	0.42	42.07	348.92	869.3169231	1218.24	W14x132	38.8	3.76	54.25532	97.23	37.74	1317.76	W14x120
3rd	15.5	26	482	1931	80	0.40	40.27	414.60	869.3169231	1283.92	W14x132	38.8	3.76	49.46809	116.96	39.02	1362.52	W14x120
2nd	14	26	482	1931	80	0.40	40.00	480.16	869.3169231	1349.47	W14x145	42.7	3.98	42.21106	160.64	40.80	1568.11	W14x176
1st	15	26	482	1931	80	0.40	40.00	545.71	869.3169231	1415.03	W14x145	42.7	3.98	45.22613	139.93	40.09	1540.54	W14x176
Terrace	10	26	482	1931	80	0.40	40.00	611.26	869.3169231	1480.58	W14x159	46.7	4	30	318.02	43.30	1819.80	W14x176

Braced Frame 1: One Frame
Column 4.9

Floor	Ht	Length	Trib Area	Infl Area	DL(psf)	LL Reduction	LL	P	P From Vb	Total P	Size	A	r	KL/r	Fe	Fcr	P	Optimized
											Size Selection							
Roof	19	26	711	2844	80	0.53	53.13	111.72	869.3169231	981.03	W14x132	38.8	3.76	60.6383	77.84	35.92	1254.33	W14x82
Pent	17	26	711	2844	110	0.45	150.00	312.22	869.3169231	1181.54	W14x132	38.8	3.76	54.25532	97.23	37.74	1317.76	W14x82
5th	17	26	711	2844	80	0.41	41.24	409.80	869.3169231	1279.11	W14x145	42.7	3.98	51.25628	108.94	38.55	1481.41	W14x120
4th	17	26	711	2844	80	0.40	40.00	506.49	869.3169231	1375.81	W14x145	42.7	3.98	51.25628	108.94	38.55	1481.41	W14x120
3rd	15.5	26	711	2844	80	0.40	40.00	603.19	869.3169231	1472.51	W14x159	46.7	4	46.5	132.37	39.77	1671.66	W14x120
2nd	14	26	711	2844	80	0.40	40.00	699.88	869.3169231	1569.20	W14x159	46.7	4	42	162.26	40.85	1717.05	W14x176
1st	15	26	711	2844	80	0.40	40.00	796.58	869.3169231	1665.90	W14x176	51.8	4.02	44.77612	142.76	40.20	1873.95	W14x176
Terrace	10	26	711	2844	80	0.40	40.00	893.28	869.3169231	1762.59	W14x176	51.8	4.02	29.85075	321.21	43.32	2019.75	W14x176

Braced Frame 4 and 5
Column 4.2/4.9 and 6.2/6.9

Floor	Ht	Length	Trib Area	Infl Area	DL(psf)	LL Reduction	LL	P	P From Vb	Total P	Size	A	r	KL/r	Fe	Fcr	P	Optimized
											Size Selection							
Roof	19	29.33	390	1560	80	0.63	62.98	65.12	385.3092397	450.43	W14x82	24	2.48	91.93548	33.86	26.05	562.72	W14x53
Pent	17	29.33	390	1560	110	0.52	150.00	175.10	385.3092397	560.41	W14x90	26.5	3.7	55.13514	94.15	37.49	894.21	W14x53
5th	17	29.33	390	1560	80	0.47	46.93	230.84	385.3092397	616.15	W14x90	26.5	3.7	55.13514	94.15	37.49	894.21	W14x68
4th	17	29.33	390	1560	80	0.44	43.99	285.44	385.3092397	670.75	W14x90	26.5	3.7	55.13514	94.15	37.49	894.21	W14x68
3rd	15.5	29.33	390	1560	80	0.42	41.98	339.25	385.3092397	724.56	W14x90	26.5	3.7	50.27027	113.26	38.81	925.59	W14x68
2nd	14	29.33	390	1560	80	0.41	40.50	392.49	385.3092397	777.80	W14x90	26.5	3.7	45.40541	138.83	40.04	955.03	W14x99
1st	15	29.33	390	1560	80	0.40	40.00	445.53	385.3092397	830.84	W14x99	29.1	3.71	48.51752	121.59	39.26	1028.31	W14x99
Terrace	10	29.33	390	1560	80	0.40	40.00	498.57	385.3092397	883.88	W14x99	29.1	3.71	32.34501	273.58	42.87	1122.87	W14x99

Braced Frame 2 and 3
Column G/F

Floor	Ht	Length	Trib Area	Infl Area	DL(psf)	LL Reduction	LL	P	P From Vb	Total P	Size	A	r	KL/r	Fe	Fcr	P	Optimized
											Size Selection							
Roof	19	24	503	2014	80	0.58	58.42	81.70	1096.104	1177.80	W14x145	42.7	3.98	57.28643	87.22	36.89	1417.60	W14x82
Pent	17	24	503	2014	110	0.49	150.00	223.55	1096.104	1319.65	W14x145	42.7	3.98	51.25628	108.94	38.55	1481.41	W14x82
5th	17	24	503	2014	80	0.44	44.30	294.12	1096.104	1390.22	W14x145	42.7	3.98	51.25628	108.94	38.55	1481.41	W14x120
4th	17	24	503	2014	80	0.42	41.71	363.38	1096.104	1459.49	W14x159	46.7	4	51	110.04	38.62	1623.05	W14x120
3rd	15.5	24	503	2014	80	0.40	40.00	431.79	1096.104	1527.90	W14x159	46.7	4	46.5	132.37	39.77	1671.66	W14x120
2nd	14	24	503	2014	80	0.40	40.00	500.20	1096.104	1596.30	W14x159	46.7	4	42	162.26	40.85	1717.05	W14x176
1st	15	24	503	2014	80	0.40	40.00	568.61	1096.104	1664.71	W14x176	51.8	4.02	44.77612	142.76	40.20	1873.95	W14x176
Terrace	10	24	503	2014	80	0.40	40.00	637.02	1096.104	1733.12	W14x176	51.8	4.02	29.85075	321.21	43.32	2019.75	W14x176

Appendix G – MD Story Drifts

QCX - Direct X

Story	Height	δxe	δye	Amplified by Cd/I δx	Amplified by Cd/I δy	Δx	Δy	Δa = .015sx
Roof	19.00	2.86	-	7.44	-	1.74	-	3.42
Penthouse	17.00	2.19	-	5.69	-	1.20	-	3.06
Level 5	17.00	1.73	-	4.50	-	1.17	-	3.06
Level 4	17.00	1.28	-	3.33	-	1.14	-	3.06
Level 3	15.50	0.84	-	2.18	-	0.88	-	2.79
Level 2	14.00	0.50	-	1.30	-	0.73	-	2.52
Level 1	15.00	0.22	-	0.57	-	0.57	-	2.70

QCXE - X + Ecc

Story	Height	δxe	δye	Amplified by Cd/I δx	Amplified by Cd/I δy	Δx	Δy	Δa = .015sx
Roof	19.00	2.93	-	7.62	-	1.77	-	3.42
Penthouse	17.00	2.25	-	5.85	-	1.25	-	3.06
Level 5	17.00	1.77	-	4.60	-	1.20	-	3.06
Level 4	17.00	1.31	-	3.41	-	1.14	-	3.06
Level 3	15.50	0.87	-	2.26	-	0.94	-	2.79
Level 2	14.00	0.51	-	1.33	-	0.70	-	2.52
Level 1	15.00	0.24	-	0.62	-	0.62	-	2.70

QCXE- X - Ecc

Story	Height	δxe	δye	Amplified by Cd/I δx	Amplified by Cd/I δy	Δx	Δy	Δa = .015sx
Roof	19.00	2.79	-	7.25	-	1.61	-	3.42
Penthouse	17.00	2.17	-	5.64	-	1.25	-	3.06
Level 5	17.00	1.69	-	4.39	-	1.14	-	3.06
Level 4	17.00	1.25	-	3.25	-	1.04	-	3.06
Level 3	15.50	0.85	-	2.21	-	0.88	-	2.79
Level 2	14.00	0.51	-	1.33	-	0.75	-	2.52
Level 1	15.00	0.22	-	0.57	-	0.57	-	2.70

QCY Direct Y

Story	Height	δxe	δye	Amplified by Cd/I δx	Amplified by Cd/I δy	Δx	Δy	Δa = .015sx
Roof	19.00	-	3.55	-	9.23	-	1.56	3.42
Penthouse	17.00	-	2.95	-	7.67	-	1.85	3.06
Level 5	17.00	-	2.24	-	5.82	-	1.64	3.06
Level 4	17.00	-	1.61	-	4.19	-	1.59	3.06
Level 3	15.50	-	1.00	-	2.60	-	1.20	2.79
Level 2	14.00	-	0.54	-	1.40	-	0.88	2.52
Level 1	15.00	-	0.20	-	0.52	-	0.52	2.70

QCYE Y + Ecc

Story	Height	δxe	δye	Amplified by Cd/I δx	Amplified by Cd/I δy	Δx	Δy	Δa = .015sx
Roof	19.00	-	3.55	-	9.23	-	1.53	3.42
Penthouse	17.00	-	2.96	-	7.70	-	1.82	3.06
Level 5	17.00	-	2.26	-	5.88	-	1.66	3.06
Level 4	17.00	-	1.62	-	4.21	-	1.59	3.06
Level 3	15.50	-	1.01	-	2.63	-	1.25	2.79
Level 2	14.00	-	0.53	-	1.38	-	0.78	2.52
Level 1	15.00	-	0.23	-	0.60	-	0.60	2.70

QCYE- Y -

Story	Height	δxe	δye	Amplified by Cd/I δx	Amplified by Cd/I δy	Δx	Δy	Δa = .015sx
Roof	19.00	-	3.56	-	9.26	-	1.61	3.42
Penthouse	17.00	-	2.94	-	7.64	-	1.92	3.06
Level 5	17.00	-	2.20	-	5.72	-	1.59	3.06
Level 4	17.00	-	1.59	-	4.13	-	1.61	3.06
Level 3	15.50	-	0.97	-	2.52	-	1.20	2.79
Level 2	14.00	-	0.51	-	1.33	-	0.78	2.52
Level 1	15.00	-	0.21	-	0.55	-	0.55	2.70

QX100'30E

Story	Height	δxe	δye	Amplified by Cd/I δx	Amplified by Cd/I δy	Δx	Δy	Δa = .015sx
Roof	19.00	2.95	1.09	7.67	2.83	1.79	0.34	3.42
Penthouse	17.00	2.26	0.96	5.88	2.50	1.33	0.65	3.06
Level 5	17.00	1.75	0.71	4.55	1.85	1.12	0.49	3.06
Level 4	17.00	1.32	0.52	3.43	1.35	1.17	0.52	3.06
Level 3	15.50	0.87	0.32	2.26	0.83	0.96	0.36	2.79
Level 2	14.00	0.50	0.18	1.30	0.47	0.62	0.26	2.52
Level 1	15.00	0.26	0.08	0.68	0.21	0.68	0.21	2.70

QX30'100

Story	Height	δxe	δye	Amplified by Cd/I δx	Amplified by Cd/I δy	Δx	Δy	Δa = .015sx
Roof	19.00	0.99	3.56	2.57	9.26	0.65	1.51	3.42
Penthouse	17.00	0.74	2.98	1.92	7.75	0.39	1.92	3.06
Level 5	17.00	0.59	2.24	1.53	5.82	0.39	1.61	3.06
Level 4	17.00	0.44	1.62	1.14	4.21	0.42	1.61	3.06
Level 3	15.50	0.28	1.00	0.73	2.60	0.29	1.20	2.79
Level 2	14.00	0.17	0.54	0.44	1.40	0.23	0.86	2.52
Level 1	15.00	0.08	0.21	0.21	0.55	0.21	0.55	2.70

QX100'30E-

Story	Height	δxe	δye	Amplified by Cd/I δx	Amplified by Cd/I δy	Δx	Δy	Δa = .015sx
Roof	19.00	2.80	1.08	7.28	2.81	1.59	0.44	3.42
Penthouse	17.00	2.19	0.91	5.69	2.37	1.27	0.60	3.06
Level 5	17.00	1.70	0.68	4.42	1.77	1.14	0.42	3.06
Level 4	17.00	1.26	0.52	3.28	1.35	1.09	0.57	3.06
Level 3	15.50	0.84	0.30	2.18	0.78	0.94	0.39	2.79
Level 2	14.00	0.48	0.15	1.25	0.39	0.65	0.23	2.52
Level 1	15.00	0.23	0.06	0.60	0.16	0.60	0.16	2.70

QX30'100-

Story	Height	δxe	δye	Amplified by Cd/I δx	Amplified by Cd/I δy	Δx	Δy	Δa = .015sx
Roof	19.00	0.87	3.56	2.26	9.26	0.52	1.66	3.42
Penthouse	17.00	0.67	2.92	1.74	7.59	0.39	1.82	3.06
Level 5	17.00	0.52	2.22	1.35	5.77	0.36	1.64	3.06
Level 4	17.00	0.38	1.59	0.99	4.13	0.34	1.53	3.06
Level 3	15.50	0.25	1.00	0.65	2.60	0.26	1.25	2.79
Level 2	14.00	0.15	0.52	0.39	1.35	0.18	0.81	2.52
Level 1	15.00	0.08	0.21	0.21	0.55	0.21	0.55	2.70

Appendix H – Foundation Spreadsheets

Col Line

1.4			2			2.5			2.6			2.8			3			SW2		
G	**Load**	**Db**	**H**	**Load**	**Db**	**A.5**	**Load**	**Db**	**B**	**Load**	**Db**	**SW4/5 - C**	**Load**	**Db**	**A**	**Load**	**Db**	**D**	**Load**	**Db**
W10x33	74	2.5	W10x49	267	2.5	W10x33	45	2.5	W10x60	354	2.5	W10x60	350	2.5	W10x33	136	2.5	W12x72	502	3
			W10x45						W10x49			W10x49						W12x65		
			W10x33						W10x45			W10x39						W12x53		
F			**G**	**Load**	**Db**	**A**	**Load**	**Db**												
W10x60	352	2.5	W10x68	377	2.5	W10x33	63	2.5												
W10x49			W10x54																	
W10x45			W10x49																	
E																				
W10x77	438	2.5																		
W10x60																				
W10x49																				
D	408	2.5																		
W10x68																				
W10x54																				
W10x49																				
SW4/5 - C	308	2.5																		
W12x72																				
W12x65																				
W12x58																				

3.9			4			4.3			4.9			5			6			6.5		
H	**Load**	**Db**	**A**	**Load**	**Db**	**B**	**Load**	**Db**	**H**	**Load**	**Db**	**F**	**Load**	**Db**	**F**	**Load**	**Db**	**H**	**Load**	**Db**
W14x82	513	2.5	W10x33	117	2.5	W10x60	365	2.5	W10x88	521	3	W12x79	535	3	W12x79	521	3	W10x77	484	2.5
W14x68						W10x49			W10x68			W12x65			W12x65			W10x60		
W14x61						W10x45			W10x49			W12x58			W12x53			W10x49		
G	**Load**	**Db**				**A**	**Load**	**Db**				**E**	**Load**	**Db**	**E**	**Load**	**Db**	**G**	**Load**	**Db**
W10x49	276	2.5				W10x33	65	2.5				W12x96	650	3	W12x96	630	3	W12x79	537	3
W10x45												W12x79			W12x79			W12x65		
W10x33												W12x65			W12x65			W12x53		
F	**Load**	**Db**										**D**	**Load**	**Db**	**D**	**Load**	**Db**			
W12x79	500	3										W12x87	602	3	W12x87	587	3			
W12x65												W12x72			W12x72					
W12x53												W12x65			W12x65					
E	**Load**	**Db**																		
W12x87	607	3																		
W12x72																				
W12x65																				
D	**Load**	**Db**																		
W12x87	563	3																		
W12x72																				
W12x58																				

7			SW3			8.2			8.8			8.9			9			10		
F	**Load**	**Db**	**H**	**Load**	**Db**	**SW4/5 - C**	**Load**	**Db**	**F**	**Load**	**Db**	**SW4/5 - C**	**Load**	**Db**	**E**	**Load**	**Db**	**SW4/5 - C**	**Load**	**Db**
W12x72	501	3	W10x49	238	2.5	W14x120	521	3	W10x49	247	2.5	W14x109	501	3	W12x72	447	2.5	W14x53	191	2.5
W12x65			W10x45			W14x99			W10x45			W14x90			W12x65			W14x48		
W12x53			W10x39			W14x90			W10x39						W12x53					
E	**Load**	**Db**	**D**	**Load**	**Db**										**D.5**	**Load**	**Db**			
W12x96	620	3	W12x87	580	3										W10 x60	178	2.5			
W12x72			W12x79												W10x54					
W12x65			W12x65												W10x49					
D	**Load**	**Db**													**D**	**Load**	**Db**			
W12x87	576	3													W14x99	570	3			
W12x72															W14x90					
W12x65																				

Bearing	80000 psf
Friction	800 psf

Db	L	Bearing	Skin	Total
2.5	35	392.70	188.50	581.19
3	35	565.49	226.19	791.68
3.5	35	769.69	263.89	1033.58
4	35	1005.31	301.59	1306.90
4.5	35	1272.34	339.29	1611.64
5	35	1570.80	376.99	1947.79
5.5	35	1900.66	414.69	2315.35
6	35	2261.94	452.39	2714.33
6.5	35	2654.64	490.09	3144.73
7	35	3078.76	527.79	3606.55

Appendix I – SCBF Design

INVERTED V-CHEVRON-BEAM DESIGN BRACE = HSS8×8×½ ASTM 500 GRADE B

MAX DEPTH = 36"

ASSUMED FORCE IN TENSION: $P_t = R_y F_y A_g = 1.4(13.5)(46) = 869\,k$

" IN COMPRESSION: $P_c = .3P_n = .3(13.5)(28.2) = 114\,k$

UNBALANCED FORCE ON BM: $Q_b = P_{by} - P_{cy}$

$P_{by} = 869\left(\frac{17}{22.5}\right) = 657\,k$

$P_{cy} = 114\left(\frac{17}{22.5}\right) = 86\,k$

$Q_b = 657 - 86 = 571\,k$

AXIAL FORCE IN BM:

$P_{bx} = 869\left(\frac{14.7}{22.5}\right) = 568\,k$

$P_{cx} = 114\left(\frac{14.7}{22.5}\right) = 75\,k$

$P_u = \frac{568+75}{2} = 322\,k$

MOMENT IN BM: (POINT LOADS APPROXIMATED AS DISTRIB. FOR SIMPLICITY)

ASSUME BM SLF WT = 350 PLF

DL = 80 PSF

LL = 150 PSF ← PENTHOUSE = WORST CASE

TRIB AREA = 15'

$M_D = (80\times15 + 350)(29.33)^2/8 = 167\,k\text{-}ft$

$M_L = (150\times15)(29.33)^2/8 = 242\,k\text{-}ft$

$M_Q = 571\,(29.33)/4 = 4189\,k\text{-}ft$

$M_u = 1.2M_D + .5M_L + 1.0M_Q = 4544\,k$

TRY 38×354

$\lambda_f = b_f/2t_f = 3.85$ $\lambda_p = .38\sqrt{29000/50} = 9.15$: FLANGE COMPACT

$\lambda_w = h/t_w = 25.7$ $\lambda_p = 3.76\sqrt{29000/50} = 90.6$; WEB COMPACT

$L_b = \frac{29.53}{2} - \frac{d}{2} = 14.7 - 14.2/2\times12 = 14.1'$

TABLE 3-2

$L_p = 13.2$ $\phi M_p = 5830$

$L_r = 49.8$ $\phi M_r = 3260$

$\phi M_n = 5278$ K-ft

COMPRESSIVE STR.

$\frac{KL_x}{r_x} = \frac{29.53(12)}{14.5} = 24.3$ $\phi F_{CR} = 38.2$ TABLE 4-22

$\frac{KL_y}{r_y} = \frac{14.7(12)}{3.74} = 47.2$ $\phi P_{nc} = 3973$ k

SECOND ORDER EFFECTS

$P_{e1} = \pi^2 EI/(KL)^2 = 50832$ $P_r = 322$

$M_{rx} = 1.01(4544) = 4589$

$C_M = 1$

$B_1 = \frac{1}{1 - 322/50832} = 1.01$

COMBO LOADING

$P_r/P_c = 322/3973 = .081 < .2$: $\frac{P_r}{2P_c} + \left[\frac{M_{rx}}{M_{cx}} + \frac{M_{ry}}{M_{cy}}\right] < 1.0$

$= \frac{.081}{2} + \frac{4589}{5278} = .91 < 1$ ✓

SHEAR: $V_u = 57\text{V}/2 + 1.2\left[(.08\times15 + 318)(29.53)/2\right] + .5\left[(.15\times15)(29.53)/2\right]$

$= 329$ k

TABLE 3-2: $\phi V_n = 1240$ k ✓

LATERAL BRACE REQ:

$P_{br} = .02 M_{rx} C_d/h_o = .02(4589)(12)/33.5 = 33$ k ← MIN. BRACE STR. @ MIDSPAN

BRACE TO BEAM CONNECTION

BRACE = HSS 8x8x½
BM = W33x354
PL = A36 STL

$T_u = 869$

BRACE TO GUSSET WELD: $D \le \frac{F_{UBE}\,t}{3.09\ k/in} = \frac{58(.5)}{3.09} = 9.4$ SIXTEENTHS

TRY (4) ½" WELDS $l_w = \frac{P_u}{4(1.392)D} = \frac{869}{4(1.392)(8)} = 19.5"$

USE (4) 20" LONG, ½" FILLET WELDS

GUSSET PL THICKNESS

$t_{MIN} = \frac{P_u}{2\phi(.6F_y)L} = \frac{869}{2(.75)(.6\cdot 58)(20)} = .83$ TRY 1"

SHEAR LAG

$\phi R_t F_u A_e \ge R_y F_y A_g$

$.75(58)(1.3)A_e \ge 869$

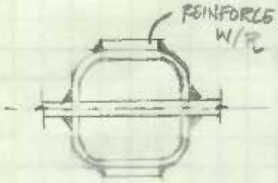
$A_e \ge 15.4$

$A_e = A_n U$

$A_n = A_g - 2(1+\frac{1}{8})t = 13.5 - 2(1.125)(.5) = 12.4$

$l > H, U = .85$

$A_e = 10.54 < 15.4$: $A_{e_{CP}} = \frac{15.4}{.85} - 10.54 = 7.58$



TRY 5/8 t PL, WORKABLE FLAT = 5.75 in, SAY 5.25 in WIDE

	$\bar{x}$	A	$A\bar{x}$
HALF HSS	3	6.75	20.25
PL	4.5125	3.28	14.15

$\bar{X} = 3.43 - \frac{1}{2}^{PL\,t} = 2.93$

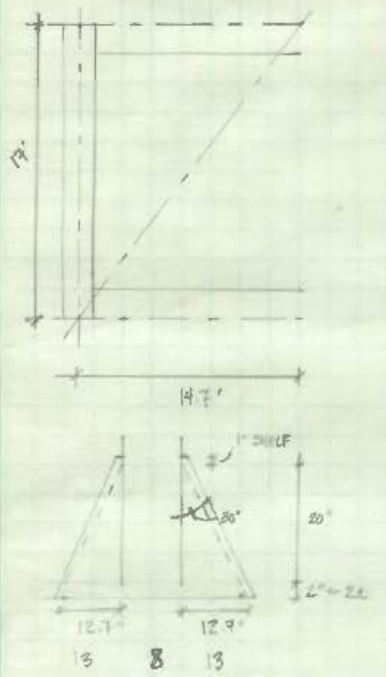
$U = 1 - \frac{\bar{X}}{20} = .85$ (l_{WELD})

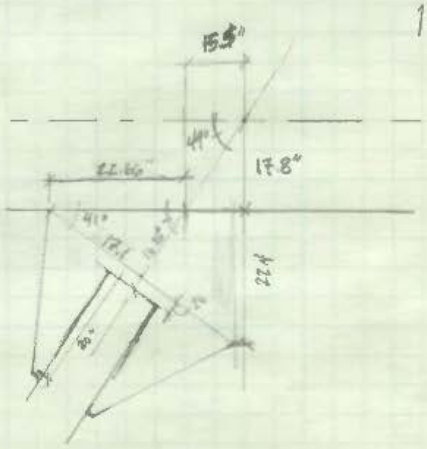
$\phi_t P_n = .75(1.3(12.4) + 1.2(6.56))(.85)(58)$
$= 887\ k$ ✓

WELD FOR COVER PL

MAX WELD = $t - \frac{1}{16} = \frac{9}{16}$: USE ½"

$l_w \ge \frac{\phi R_t F_u A_B}{2(1.392)D} = 7.69$ USE 8" LONG, ½" FILLET WELDS





I = 76.3

$\frac{KL}{r} = \frac{17.7 \times 12}{3.04} = 69.9 \leq 118$ $F_e = 68$

$F_{cr} = 34.7$

$P_{cr} = 1.1(1.4)(13.5)(34.7) = 721\,k$

$V = (869 + 721)\left(\frac{14.7}{22.5}\right) = 1039\,k$

$T = (869 - 721)\left(\frac{14.7}{22.5}\right) = 96.7\,k$

$M = V(d_w/2) = 1039(35.6/2) = 18494\,k\text{-in}$

WELD @ GUSSET/BM INTERFACE

$S_w = l^2/6 = 76.3^2/6 = 970\ in^3/in$

$f_v = 1039/76.3 = 13.6\ k/in$

$f_a = 96.7/76.3 = 1.27\ k/in$

$f_b = \frac{18494}{970} = 19.01\ k/in$

$f_{pz} = \sqrt{f_v^2 + (f_a + f_b)^2}$

$= 24.4$

$f_{avg} = \frac{1}{2}\left(\sqrt{f_v^2 + (f_a - f_b)^2} + \sqrt{f_v^2 + (f_a + f_b)^2}\right)$

$= 23.5$

$\frac{24.4}{23.5} = 1.04 < 1.25$

$f_r = 1.25\, f_{avg} = 29.4$

$D \geq \frac{29.4}{2(1.392)} = 10.6$ SIXTEENTHS

FULL LENGTH 5/4" WELD

GUSSET COMPR. YIELDING

$r = t/\sqrt{12} = .289$ in

$\frac{KL}{r} = \frac{1.2(17)}{.289} = 70.6$

$\phi F_{CR} = 24.8$ TABLE 4-22

$L_w = 21_w \tan 30 + D = 31$

$\phi R_n = 770\text{k} > 721\text{k}$ ✓

GUSSET TENSION YIELD

$= .9(36)(31)(1)$
$= 1004$ ✓

CHECK BM WEB LOCAL YIELD

$f_c = f_b + f_a = 1.27 + 19.01 = 20.3$ k/in

$f_t = 17.7$ k/in

$L_t = \left(\frac{f_t}{f_t + f_c}\right) l_g = \frac{17.7}{17.7+20.3}(76.8) = 35.5$ in

$R_u = \frac{1}{2} L_t f_t = 314$ k

$\phi R_n = 1.0[(5k+N)F_{yw}t_w] = (5\times 2.88 + 35.5)(50)(1.16) = 2894 > 314$ ✓

BM WEB CRIPPLING

$R_u = \frac{1}{2}(L_g - L_t) f_c = 414$ k $\qquad L_c = \left(\frac{f_c}{f_c+f_t}\right) l_g = 40.8$

$$R_n = .8 t_w^2 \left[1 + 3\left(\frac{N}{d}\right)\left(\frac{t_w}{t_f}\right)^{1.5}\right]\sqrt{\frac{EF_y t_f}{t_w}}$$

$$= .8(1.16)^2\left[1 + 3\left(\frac{40.8}{35.6}\right)\left(\frac{1.16}{2.09}\right)^{1.5}\right]\sqrt{\frac{29000(50)(2.09)}{1.16}} \times .75$$

$\phi R_n = 8160\text{k} > 414$ ✓

FREE EDGE BUCKLING GUSSET

$L_{f\,MAX} = .79 t \sqrt{E/F_y} = 21.2$ ADD 3/8" x 8½" W/ ¼" FILLET @ 4 YIELD LINES

Appendix J – MRSA

Mode	Period	UX	UY	Cmi	(Cmi*Ux)^2	(Cmi*Uy)^2	Sa	/(R/I)
1	1.725041	0.5152	70.4698	0.072462	1.394E-07	2.608E-03	0.347818	0.072462046
2	1.60468	31.7643	1.2925	0.077897	6.122E-04	1.014E-06	0.373906	0.077897151
3	1.183462	41.2288	0.0039	0.105622	1.896E-03	1.697E-11	0.506987	0.105622318
4	0.471367	0.001	19.9877	0.208333	4.340E-12	1.734E-03	1	0.208333333
5	0.414642	14.7315	0.0005	0.208333	9.419E-04	1.085E-12	1	0.208333333
6	0.401094	0.0144	0.6507	0.208333	9.000E-10	1.838E-06	1	0.208333333
7	0.271695	5.7715	0.2072	0.208333	1.446E-04	1.863E-07	1	0.208333333
SUM		94.0267	92.6123		3.595E-03	4.345E-03		

Cmx	0.0600
Cmy	0.0659

				x=North	y=South			
W	15447.65							
MRSA		ELF			% Deduction	%Allowable	MRSA Vfir	With ρ = 1.3
Vbx	926.2405	Vbx	1622.518		0.570866118	0.85	1379.14	1792.882
Vby	1018.202	Vby	1622.518		0.627544472	0.85	1379.14	1792.882

Appendix K – CA Layout 1 Preliminary Sizes

Braced Frame 2 - 50%							Size Selection							
Story Ht	Bay Length	Brace Length	Shear	Axial Force	Inc By Tor	Trial Size, A = P/F	Size	A	r	KL/r	Fe	Fcr	P	Optimized
19	24	30.61	134.1795	171.14	205.36	4.11	HSS8x8x1/2	13.5	3.04	120.83	19.60	17.19	208.89	W14x176
17	24	29.41	420.875	515.76	618.92	12.38	HSS12x12x5/8	25.7	4.62	76.39	49.05	32.63	754.81	W14x176
17	24	29.41	560.82	687.26	824.71	16.49	W14x132	38.8	3.76	93.86	32.49	26.25	916.79	W14x176
17	24	29.41	709.085	868.95	1042.74	20.85	W14x145	42.7	3.98	88.68	36.40	28.14	1081.29	W14x176
15.5	24	28.57	805.805	959.25	1151.10	23.02	W14x159	46.7	4	85.71	38.96	29.22	1228.15	W14x193
14	24	27.78	873.34	1011.07	1213.28	24.27	W14x159	46.7	4	83.35	41.19	30.08	1264.44	W14x193
15	19	24.21	899.405	1145.91	1375.09	27.50	W14x159	46.7	4	72.62	54.27	34.00	1429.08	W14x211
10	19	21.47	899.405	1016.37	1219.64	24.39	W14x145	42.7	3.98	64.74	68.30	36.80	1414.37	W14x132

Braced Frame 3 - 50%							Size Selection							
Story Ht	Bay Length	Brace Length	Shear	Axial Force	Inc By Tor	Trial Size, A = P/F	Size	A	r	KL/r	Fe	Fcr	P	Optimized
19	24	30.61	134.18	171.14	205.36	4.11	HSS8x8x1/2	13.5	3.04	120.83	19.60	17.19	208.89	W14x176
17	24	29.41	420.88	515.76	618.92	12.38	HSS12x12x5/8	25.7	4.62	76.39	49.05	32.63	754.81	W14x176
17	24	29.41	560.82	687.26	824.71	16.49	W14x132	38.8	3.76	93.86	32.49	26.25	916.79	W14x176
17	24	29.41	709.09	868.95	1042.74	20.85	W14x145	42.7	3.98	88.68	36.40	28.14	1081.29	W14x176
15.5	24	28.57	805.81	959.25	1151.10	23.02	W14x159	46.7	4	85.71	38.96	29.22	1228.15	W14x193
14	24	27.78	873.34	1011.07	1213.28	24.27	W14x159	46.7	4	83.35	41.19	30.08	1264.44	W14x193
15	24	28.30	899.41	1060.62	1272.75	25.45	W14x159	46.7	4	84.91	39.70	29.52	1240.54	W14x193
10	24	26.00	899.41	974.36	1169.23	23.38	W14x145	42.7	3.98	78.39	46.58	31.90	1226.03	W14x159

Braced Frame 4 - 25% Chevron (Assuming only half is in compr)							Size Selection							
Story Ht	Bay Length	Brace Length	Shear	Axial Force	Inc By Tor	Trial Size, A = P/F	Size	A	r	KL/r	Fe	Fcr	P	Optimized
19	29.33	24.00	33.544875	54.90	65.88	1.32	HSS6x6x3/8	7.58	2.28	126.3226	17.94	15.73	107.31	
17	29.33	22.45	105.22	161.08	193.30	3.87	HSS8x8x1/2	13.5	3.04	88.62367	36.44	28.16	342.09	HSS8x8x1/2
17	29.33	22.45	140.21	214.65	257.58	5.15	HSS8x8x1/2	13.5	3.04	88.62367	36.44	28.16	342.09	HSS8x8x1/2
17	29.33	22.45	177.27125	271.39	325.67	6.51	HSS8x8x1/2	13.5	3.04	88.62367	36.44	28.16	342.09	HSS8x8x1/2
15.5	29.33	21.34	201.45125	293.12	351.74	7.03	HSS8x8x1/2	13.5	3.04	84.22913	40.34	29.76	361.63	HSS8x8x1/2
14	29.33	20.27	218.335	301.85	362.22	7.24	HSS8x8x1/2	13.5	3.04	80.03159	44.69	31.30	380.33	HSS8x8x1/2
15	29.33	20.98	224.85125	321.64	385.97	7.72	HSS9x9x5/8	18.7	3.4	74.0388	52.21	33.49	563.62	HSS9x9x5/8
10	29.33	17.75	224.85125	272.15	326.58	6.53	HSS8x8x1/2	13.5	3.04	70.06576	58.30	34.92	424.28	HSS9x9x5/8

Note: No Top Bracing Currently Planned for Frames 4 and 5

Braced Frame 5 - 25% Chevron (Assuming only half is in compr)							Size Selection							
Story Ht	Bay Length	Brace Length	Shear	Axial Force	Inc By Tor	Trial Size, A = P/F	Size	A	r	KL/r	Fe	Fcr	P	Optimized
19	29.33	24.00	33.545	54.90	65.88	1.32	HSS6x6x3/8	7.58	2.28	126.32	17.94	15.73	107.31	
17	29.33	22.45	105.22	161.08	193.30	3.87	HSS8x8x1/2	13.5	3.04	88.62	36.44	28.16	342.09	HSS8x8x1/2
17	29.33	22.45	140.21	214.65	257.58	5.15	HSS8x8x1/2	13.5	3.04	88.62	36.44	28.16	342.09	HSS8x8x1/2
17	29.33	22.45	177.27	271.39	325.67	6.51	HSS8x8x1/2	13.5	3.04	88.62	36.44	28.16	342.09	HSS8x8x1/2
15.5	29.33	21.34	201.45	293.12	351.74	7.03	HSS8x8x1/2	13.5	3.04	84.23	40.34	29.76	361.63	HSS8x8x1/2
14	29.33	20.27	218.34	301.85	362.22	7.24	HSS8x8x1/2	13.5	3.04	80.03	44.69	31.30	380.33	HSS8x8x1/2
15	29.33	20.98	224.85	321.64	385.97	7.72	HSS9x9x5/8	18.7	3.4	74.04	52.21	33.49	563.62	HSS9x9x5/8
10	20	22.36	449.7	502.78	603.34	12.07	HSS10x10x5/8	21	3.8	70.61	57.40	34.72	656.30	HSS10x10x5/8

Note: Bottom Floor Not Chevron

Braced Frame 1 - 50%							Size Selection							
	Bay Length	Brace Length	Shear	Axial Force	Inc By Tor	Trial Size, A = P/F	Size	A	r	KL/r	Fe	Fcr	P	Optimized
19	26	32.20	134.1795	166.19	199.43	3.99	HSS8x8x1/2	13.5	3.04	127.1151	17.71	15.53	188.75	W14x193
17	26	31.06	420.875	502.86	603.43	12.07	HSS12x12x5/8	25.7	4.62	80.68688	43.96	31.06	718.48	W14x193
17	26	31.06	560.82	670.06	804.07	16.08	W14x132	38.8	3.76	99.14186	29.12	24.37	850.99	W14x193
17	26	31.06	709.085	847.21	1016.65	20.33	W14x145	42.7	3.98	93.66166	32.63	26.33	1011.75	W14x193
15.5	26	30.27	805.805	938.13	1125.76	22.52	W14x145	42.7	3.98	91.26519	34.36	27.19	1045.07	W14x193
14	26	29.53	873.34	991.90	1190.28	23.81	W14x176	51.8	4.02	88.1482	36.84	28.33	1320.71	W14x193
15	26	30.02	899.405	1038.35	1246.02	24.92	W14x176	51.8	4.02	89.60198	35.65	27.80	1295.99	W14x193
10	26	27.86	899.405	963.64	1156.36	23.13	W14x159	46.7	4	83.57033	40.98	30.01	1261.12	W14x193

Note: One Frame, Top Brace takes entire shear

Braced Frame 1: One Frame

Column Betw Lines 6 and 6.5

Floor	Ht	Length	Trib Area	Infl Area	DL(psf)	LL Reduction	LL	P	P From Vb	Total P
Roof	19	26	482	1931	80	0.59	59.14	72.09	3014.736375	3086.83
Pent	17	26	482	1931	110	0.49	150.00	171.87	3014.736375	3186.60
5th	17	26	482	1931	80	0.45	44.71	228.91	3014.736375	3243.65
4th	17	26	482	1931	80	0.42	42.07	285.32	3014.736375	3300.06
3rd	15.5	26	482	1931	80	0.40	40.27	341.30	3014.736375	3356.03
2nd	14	26	482	1931	80	0.40	40.00	397.21	3014.736375	3411.95
1st	15	26	482	1931	80	0.40	40.00	453.12	3014.736375	3467.86
Terrace	10	26	482	1931	80	0.40	40.00	509.03	3014.736375	3523.77

Size Selection

Size	A	r	KL/r	Fe	Fcr	P	Optimized
W14x311	91.4	4.2	54.28571	97.12	40.31	3315.74	W14x159
W14x311	91.4	4.2	48.57143	121.32	42.08	3461.34	W14x159
W14x311	91.4	4.2	48.57143	121.32	42.08	3461.34	W14x257
W14x311	91.4	4.2	48.57143	121.32	42.08	3461.34	W14x257
W14x311	91.4	4.2	44.28571	145.94	43.32	3563.54	W14x257
W14x311	91.4	4.2	40	178.89	44.48	3658.91	W14x455
W14x311	91.4	4.2	42.85714	155.83	43.72	3596.12	W14x455
W14x311	91.4	4.2	28.57143	350.62	47.10	3874.69	W14x455

Braced Frame 1: One Frame

Column 4.9

Floor	Ht	Length	Trib Area	Infl Area	DL(psf)	LL Reduction	LL	P	P From Vb	Total P
Roof	19	26	711	2844	80	0.53	53.13	104.21	3014.736375	3118.94
Pent	17	26	711	2844	110	0.45	150.00	251.38	3014.736375	3266.12
5th	17	26	711	2844	80	0.41	41.24	334.30	3014.736375	3349.04
4th	17	26	711	2844	80	0.40	40.00	416.78	3014.736375	3431.51
3rd	15.5	26	711	2844	80	0.40	40.00	499.25	3014.736375	3513.99
2nd	14	26	711	2844	80	0.40	40.00	581.73	3014.736375	3596.46
1st	15	26	711	2844	80	0.40	40.00	664.20	3014.736375	3678.94
Terrace	10	26	711	2844	80	0.40	40.00	746.68	3014.736375	3761.42

Size Selection

Size	A	r	KL/r	Fe	Fcr	P	Optimized
W14x311	91.4	4.2	54.28571	97.12	40.31	3315.74	W14x159
W14x311	91.4	4.2	48.57143	121.32	42.08	3461.34	W14x159
W14x311	91.4	4.2	48.57143	121.32	42.08	3461.34	W14x257
W14x311	91.4	4.2	48.57143	121.32	42.08	3461.34	W14x257
W14x311	91.4	4.2	44.28571	145.94	43.32	3563.54	W14x257
W14x311	91.4	4.2	40	178.89	44.48	3658.91	W14x455
W14x342	101	4.24	42.45283	158.81	43.83	3983.86	W14x455
W14x311	91.4	4.2	28.57143	350.62	47.10	3874.69	W14x455

Braced Frame 4 and 5

Column 4.2/4.9 and 6.2/6.9

Floor	Ht	Length	Trib Area	Infl Area	DL(psf)	LL Reduction	LL	P	P From Vb	Total P
Roof	19	29.33	390	1560	80	0.63	62.98	59.08	1336.228192	1395.31
Pent	17	29.33	390	1560	110	0.52	150.00	139.81	1336.228192	1476.04
5th	17	29.33	390	1560	80	0.47	46.93	186.40	1336.228192	1522.63
4th	17	29.33	390	1560	80	0.44	43.99	232.42	1336.228192	1568.65
3rd	15.5	29.33	390	1560	80	0.42	41.98	278.05	1336.228192	1614.27
2nd	14	29.33	390	1560	80	0.41	40.50	323.38	1336.228192	1659.61
1st	15	29.33	390	1560	80	0.40	40.00	368.62	1336.228192	1704.85
Terrace	10	29.33	390	1560	80	0.40	40.00	413.86	1336.228192	1750.09

Size Selection

Size	A	r	KL/r	Fe	Fcr	P	Optimized
W14x145	42.7	3.98	57.28643	87.22	39.33	1511.58	W14x109
W14x145	42.7	3.98	51.25628	108.94	41.26	1585.68	W14x109
W14x145	42.7	3.98	51.25628	108.94	41.26	1585.68	W14x132
W14x145	42.7	3.98	51.25628	108.94	41.26	1585.68	W14x132
W14x145	42.7	3.98	46.73367	131.05	42.62	1637.90	W14x132
W14x145	42.7	3.98	42.21106	160.64	43.89	1686.79	W14x193
W14x159	46.7	4	45	141.34	43.12	1812.29	W14x193
W14x159	46.7	4	30	318.02	46.82	1967.66	W14x193

Braced Frame 2 and 3

Column G/F

Floor	Ht	Length	Trib Area	Infl Area	DL(psf)	LL Reduction	LL	P	P From Vb	Total P
Roof	19	24	503	2014	80	0.58	58.42	75.05	3265.964406	3341.02
Pent	17	24	503	2014	110	0.49	150.00	179.17	3265.964406	3445.14
5th	17	24	503	2014	80	0.44	44.30	238.60	3265.964406	3504.57
4th	17	24	503	2014	80	0.42	41.71	297.38	3265.964406	3563.35
3rd	15.5	24	503	2014	80	0.40	40.00	355.73	3265.964406	3621.69
2nd	14	24	503	2014	80	0.40	40.00	414.08	3265.964406	3680.04
1st	15	24	503	2014	80	0.40	40.00	472.43	3265.964406	3738.39
Terrace	10	24	503	2014	80	0.40	40.00	530.77	3265.964406	3796.74

Size Selection

Size	A	r	KL/r	Fe	Fcr	P	Optimized BF 3
W14x342	101	4.24	53.77358	98.98	40.47	3678.86	W14x145
W14x342	101	4.24	48.11321	123.64	42.21	3837.30	W14x145
W14x342	101	4.24	48.11321	123.64	42.21	3837.30	W14x233
W14x342	101	4.24	48.11321	123.64	42.21	3837.30	W14x233
W14x342	101	4.24	43.86792	148.73	43.44	3948.44	W14x233
W14x342	101	4.24	39.62264	182.31	44.58	4052.11	W14x342
W14x342	101	4.24	42.45283	158.81	43.83	3983.86	W14x342
W14x342	101	4.24	28.30189	357.33	47.16	4286.46	W14x342

Appendix L – CA Layout 1 Story Drifts

QX100Y30E

Story	Height	δxe	δye	Amplified by Cd/I δx	Amplified by Cd/I δy	Δx	Δy	Δa = .015sx
Roof	19.00	3.16	1.19	12.64	4.76	2.76	0.52	3.42
Penthouse	17.00	2.47	1.06	9.88	4.24	1.96	0.84	3.06
Level 5	17.00	1.98	0.85	7.92	3.40	1.92	0.80	3.06
Level 4	17.00	1.50	0.65	6.00	2.60	1.96	0.88	3.06
Level 3	15.50	1.01	0.43	4.04	1.72	1.72	0.72	2.79
Level 2	14.00	0.58	0.25	2.32	1.00	1.20	0.60	2.52
Level 1	15.00	0.28	0.10	1.12	0.40	1.12	0.40	2.70

QX100Y30E-

Story	Height	δxe	δye	Amplified by Cd/I δx	Amplified by Cd/I δy	Δx	Δy	Δa = .015sx
Roof	19.00	4.02	1.97	16.08	7.88	2.44	0.36	3.42
Penthouse	17.00	3.41	1.88	13.64	7.52	2.84	1.68	3.06
Level 5	17.00	2.70	1.46	10.80	5.84	2.76	1.48	3.06
Level 4	17.00	2.01	1.09	8.04	4.36	2.72	1.52	3.06
Level 3	15.50	1.33	0.71	5.32	2.84	2.44	1.24	2.79
Level 2	14.00	0.72	0.40	2.88	1.60	1.76	0.88	2.52
Level 1	15.00	0.28	0.18	1.12	0.72	1.12	0.72	2.70

QX30Y100

Story	Height	δxe	δye	Amplified by Cd/I δx	Amplified by Cd/I δy	Δx	Δy	Δa = .015sx
Roof	19.00	1.04	4.02	4.16	16.08	0.84	2.44	3.42
Penthouse	17.00	0.83	3.41	3.32	13.64	0.64	2.84	3.06
Level 5	17.00	0.67	2.70	2.68	10.80	0.60	2.76	3.06
Level 4	17.00	0.52	2.01	2.08	8.04	0.72	2.72	3.06
Level 3	15.50	0.34	1.33	1.36	5.32	0.48	2.44	2.79
Level 2	14.00	0.22	0.72	0.88	2.88	0.40	1.76	2.52
Level 1	15.00	0.12	0.28	0.48	1.12	0.48	1.12	2.70

QX30Y100-

Story	Height	δxe	δye	Amplified by Cd/I δx	Amplified by Cd/I δy	Δx	Δy	Δa = .015sx
Roof	19.00	0.88	4.16	3.52	16.64	0.76	2.72	3.42
Penthouse	17.00	0.69	3.48	2.76	13.92	0.40	2.96	3.06
Level 5	17.00	0.59	2.74	2.36	10.96	0.56	2.76	3.06
Level 4	17.00	0.45	2.05	1.80	8.20	0.40	2.64	3.06
Level 3	15.50	0.35	1.39	1.40	5.56	0.40	2.32	2.79
Level 2	14.00	0.25	0.81	1.00	3.24	0.40	1.80	2.52
Level 1	15.00	0.15	0.36	0.60	1.44	0.60	1.44	2.70

QCY

Story	Height	δxe	δye	Amplified by Cd/I δx	Amplified by Cd/I δy	Δx	Δy	Δa = .015sx
Roof	19.00	-	4.48	-	17.92	-	3.32	3.42
Penthouse	17.00	-	3.65	-	14.60	-	3.00	3.06
Level 5	17.00	-	2.90	-	11.60	-	3.04	3.06
Level 4	17.00	-	2.14	-	8.56	-	3.32	3.06
Level 3	15.50	-	1.31	-	5.24	-	2.44	2.79
Level 2	14.00	-	0.70	-	2.80	-	1.76	2.52
Level 1	15.00	-	0.26	-	1.04	-	1.04	2.70

QCYE

Story	Height	δxe	δye	Amplified by Cd/I δx	Amplified by Cd/I δy	Δx	Δy	Δa = .015sx
Roof	19.00	-	4.45	-	17.80	-	3.08	3.42
Penthouse	17.00	-	3.68	-	14.72	-	2.92	3.06
Level 5	17.00	-	2.95	-	11.80	-	2.96	3.06
Level 4	17.00	-	2.21	-	8.84	-	2.24	3.06
Level 3	15.50	-	1.65	-	6.60	-	2.76	2.79
Level 2	14.00	-	0.96	-	3.84	-	2.60	2.52
Level 1	15.00	-	0.31	-	1.24	-	1.24	2.70

QCYE-

Story	Height	δxe	δye	Amplified by Cd/I δx	Amplified by Cd/I δy	Δx	Δy	Δa = .015sx
Roof	19.00	-	4.55	-	18.20	-	3.36	3.42
Penthouse	17.00	-	3.71	-	14.84	-	2.76	3.06
Level 5	17.00	-	3.02	-	12.08	-	2.92	3.06
Level 4	17.00	-	2.29	-	9.16	-	2.92	3.06
Level 3	15.50	-	1.56	-	6.24	-	2.80	2.79
Level 2	14.00	-	0.86	-	3.44	-	2.36	2.52
Level 1	15.00	-	0.27	-	1.08	-	1.08	2.70

QCX

Story	Height	δxe	δye	Amplified by Cd/I δx	Amplified by Cd/I δy	Δx	Δy	Δa = .015sx
Roof	19.00	3.68	-	14.72	-	3.04	-	3.42
Penthouse	17.00	2.92	-	11.68	-	2.56	-	3.06
Level 5	17.00	2.28	-	9.12	-	2.32	-	3.06
Level 4	17.00	1.70	-	6.80	-	2.36	-	3.06
Level 3	15.50	1.11	-	4.44	-	1.84	-	2.79
Level 2	14.00	0.65	-	2.60	-	1.36	-	2.52
Level 1	15.00	0.31	-	1.24	-	1.24	-	2.70

QCXE

Story	Height	δxe	δye	Amplified by Cd/I δx	Amplified by Cd/I δy	Δx	Δy	Δa = .015sx
Roof	19.00	3.75	-	15.00	-	3.16	-	3.42
Penthouse	17.00	2.96	-	11.84	-	2.48	-	3.06
Level 5	17.00	2.34	-	9.36	-	2.40	-	3.06
Level 4	17.00	1.74	-	6.96	-	2.36	-	3.06
Level 3	15.50	1.15	-	4.60	-	1.96	-	2.79
Level 2	14.00	0.66	-	2.64	-	1.40	-	2.52
Level 1	15.00	0.31	-	1.24	-	1.24	-	2.70

QCXE-

Story	Height	δxe	δye	Amplified by Cd/I δx	Amplified by Cd/I δy	Δx	Δy	Δa = .015sx
Roof	19.00	3.11	-	12.44	-	2.72	-	3.42
Penthouse	17.00	2.43	-	9.72	-	2.08	-	3.06
Level 5	17.00	1.91	-	7.64	-	1.96	-	3.06
Level 4	17.00	1.42	-	5.68	-	1.96	-	3.06
Level 3	15.50	0.93	-	3.72	-	1.48	-	2.79
Level 2	14.00	0.56	-	2.24	-	1.20	-	2.52
Level 1	15.00	0.26	-	1.04	-	1.04	-	2.70

Appendix M – CA Layout 2 Preliminary Sizing

Braced Frame 2 - 25%							Size Selection							
Story Ht	Bay Length	Brace Length	Shear	Axial Force	Inc By Tor	Trial Size, A = P/F	Size	A	r	KL/r	Fe	Fcr	P	Optimized
19	24	30.61	103.22	131.64	157.97	3.16	HSS12x12x5/8	25.7	4.62	79.51	45.28	31.49	728.47	HSS9x9x5/8
17	24	29.41	161.88	198.37	238.04	4.76	HSS12x12x5/8	25.7	4.62	76.39	49.05	32.63	754.81	HSS9x9x5/8
17	24	29.41	215.70	264.33	317.20	6.34	HSS12x12x5/8	25.7	4.62	76.39	49.05	32.63	754.81	HSS9x9x5/8
17	24	29.41	272.73	334.21	401.05	8.02	HSS12x12x5/8	25.7	4.62	76.39	49.05	32.63	754.81	HSS9x9x5/8
15.5	24	28.57	309.93	368.94	442.73	8.85	HSS12x12x5/8	25.7	4.62	74.21	51.98	33.43	773.18	HSS12x12x5/8
14	24	27.78	335.90	388.87	466.65	9.33	HSS12x12x5/8	25.7	4.62	72.17	54.95	34.17	790.24	HSS12x12x5/8
15	19	24.21	345.93	440.73	528.88	10.58	HSS12x12x5/8	25.7	4.62	62.88	72.40	37.45	866.18	HSS12x12x5/8
10	19	21.47	345.93	390.91	469.09	9.38	HSS12x12x5/8	25.7	4.62	55.77	92.03	39.83	921.27	HSS12x12x5/8

Braced Frame 7 - 25%							Size Selection							
Story Ht	Bay Length	Brace Length	Shear	Axial Force	Inc By Tor	Trial Size, A = P/F	Size	A	r	KL/r	Fe	Fcr	P	Optimized
19														
17	33	37.12	161.88	182.09	218.51	4.37	HSS12x12x5/8	25.7	4.62	96.42	30.79	25.34	586.05	HSS10x10x5/8
17	33	37.12	215.70	242.64	291.17	5.82	HSS12x12x5/8	25.7	4.62	96.42	30.79	25.34	586.05	HSS10x10x5/8
17	33	37.12	272.73	306.79	368.14	7.36	HSS12x12x5/8	25.7	4.62	96.42	30.79	25.34	586.05	HSS12x12x5/8
15.5	33	36.46	309.93	342.41	410.89	8.22	HSS12x12x5/8	25.7	4.62	94.70	31.92	25.95	600.31	HSS12x12x5/8
14	33	35.85	335.90	364.88	437.85	8.76	HSS12x12x5/8	25.7	4.62	93.11	33.02	26.53	613.56	HSS12x12x5/8
15	33	36.25	345.93	379.98	455.98	9.12	HSS12x12x5/8	25.7	4.62	94.15	32.29	26.15	604.85	HSS12x12x5/8
10	33	34.48	345.93	361.46	433.75	8.68	HSS12x12x5/8	25.7	4.62	89.56	35.68	27.81	643.32	HSS12x12x5/8

Frames 7 and 8 Discontinued at upper level

Braced Frame 3 - 25%							Size Selection							
Story Ht	Bay Length	Brace Length	Shear	Axial Force	Inc By Tor	Trial Size, A = P/F	Size	A	r	KL/r	Fe	Fcr	P	Optimized
19	24	30.61	103.22	131.64	157.97	3.16	HSS12x12x5/8	25.7	4.62	79.51	45.28	31.49	728.47	HSS12x12x5/8
17	24	29.41	161.88	198.37	238.04	4.76	HSS12x12x5/8	25.7	4.62	76.39	49.05	32.63	754.81	HSS12x12x5/8
17	24	29.41	215.7	264.33	317.20	6.34	HSS12x12x5/8	25.7	4.62	76.39	49.05	32.63	754.81	HSS12x12x5/8
17	24	29.41	272.73	334.21	401.05	8.02	HSS12x12x5/8	25.7	4.62	76.39	49.05	32.63	754.81	HSS12x12x5/8
15.5	24	28.57	309.93	368.94	442.73	8.85	HSS12x12x5/8	25.7	4.62	74.21	51.98	33.43	773.18	HSS12x12x5/8
14	24	27.78	335.9	388.87	466.65	9.33	HSS12x12x5/8	25.7	4.62	72.17	54.95	34.17	790.24	HSS12x12x5/8
15	24	28.30	345.93	407.93	489.52	9.79	HSS12x12x5/8	25.7	4.62	73.51	52.96	33.68	779.02	HSS12x12x5/8
10	24	26.00	345.93	374.75	449.70	8.99	HSS12x12x5/8	25.7	4.62	67.53	62.76	35.82	828.56	HSS12x12x5/8

Braced Frame 8 - 25%							Size Selection							
Story Ht	Bay Length	Brace Length	Shear	Axial Force	Inc By Tor	Trial Size, A = P/F	Size	A	r	KL/r	Fe	Fcr	P	Optimized
19														
17	21	27.02	161.88	208.27	249.92	5.00	HSS10x10x5/8	21	3.8	85.32	39.32	29.36	554.97	HSS12x12x5/8
17	21	27.02	215.7	277.52	333.02	6.66	HSS10x10x5/8	21	3.8	85.32	39.32	29.36	554.97	HSS12x12x5/8
17	21	27.02	272.73	350.89	421.06	8.42	HSS10x10x5/8	21	3.8	85.32	39.32	29.36	554.97	HSS12x12x5/8
15.5	21	26.10	309.93	385.20	462.24	9.24	HSS10x10x5/8	21	3.8	82.42	42.13	30.43	575.05	HSS12x12x5/8
14	21	25.24	335.9	403.70	484.44	9.69	HSS10x10x5/8	21	3.8	79.70	45.06	31.42	593.90	HSS12x12x5/8
15	21	25.81	345.93	425.11	510.13	10.20	HSS10x10x5/8	21	3.8	81.50	43.10	30.77	581.48	HSS12x12x5/8
10	21	23.26	345.93	383.14	459.77	9.20	HSS10x10x5/8	21	3.8	73.45	53.05	33.70	636.97	HSS12x12x5/8

Braced Frame 4 - 25% Chevron (Assuming only half is in compr)							Size Selection							
Story Ht	Bay Length	Brace Length	Shear	Axial Force	Inc By Tor	Trial Size, A = P/F	Size	A	r	KL/r	Fe	Fcr	P	Optimized
19	29.33	24.00	25.80	42.23	50.68	1.01	HSS5x5x3/8	6.18	1.87	154.019	12.07	10.58	58.85	
17	29.33	22.45	80.94	123.91	148.69	2.97	HSS8x8x1/2	13.5	3.04	85.61842	39.04	29.25	355.44	HSS8x8x1/2
17	29.33	22.45	107.85	165.11	198.14	3.96	HSS8x8x1/2	13.5	3.04	88.62367	36.44	28.16	342.09	HSS8x8x1/2
17	29.33	22.45	136.36	208.76	250.52	5.01	HSS8x8x1/2	13.5	3.04	88.62367	36.44	28.16	342.09	HSS8x8x1/2
15.5	29.33	21.34	154.96	225.48	270.57	5.41	HSS8x8x1/2	13.5	3.04	84.22913	40.34	29.76	361.63	HSS8x8x1/2
14	29.33	20.27	167.95	232.19	278.63	5.57	HSS8x8x1/2	13.5	3.04	80.03159	44.69	31.30	380.33	HSS8x8x1/2
15	29.33	20.98	172.96	247.42	296.90	5.94	HSS8x8x1/2	13.5	3.04	82.80655	41.74	30.29	367.97	HSS8x8x1/2
10	29.33	17.75	172.96	209.35	251.22	5.02	HSS8x8x1/2	13.5	3.04	70.06576	58.30	34.92	424.28	HSS8x8x1/2

Note: No Top Bracing Currently Planned for Frames 4 and 5

Braced Frame 1 - 25%							Size Selection							
	Bay Length	Brace Length	Shear	Axial Force	Inc By Tor	Trial Size, A = P/F	Size	A	r	KL/r	Fe	Fcr	P	Optimized
19	26	32.20	206.43	255.68	306.81	6.14	HSS10x10x5/8	21	3.8	101.6921	27.68	23.47	443.66	HSS10x10x5/8
17	26	31.06	161.88	193.41	232.09	4.64	HSS10x10x5/8	21	3.8	98.09826	29.74	24.74	467.57	HSS10x10x5/8
17	26	31.06	215.70	257.72	309.26	6.19	HSS10x10x5/8	21	3.8	98.09826	29.74	24.74	467.57	HSS10x10x5/8
17	26	31.06	272.73	325.85	391.02	7.82	HSS10x10x5/8	21	3.8	98.09826	29.74	24.74	467.57	HSS10x10x5/8
15.5	26	30.27	309.93	360.82	432.98	8.66	HSS10x10x5/8	21	3.8	95.58828	31.32	25.63	484.49	HSS10x10x5/8
14	26	29.53	335.90	381.50	457.80	9.16	HSS10x10x5/8	21	3.8	93.25151	32.91	26.48	500.38	HSS10x10x5/8
15	26	30.02	345.93	399.37	479.24	9.58	HSS10x10x5/8	21	3.8	94.78946	31.85	25.92	489.91	HSS10x10x5/8
10	26	27.86	345.93	370.63	444.75	8.90	HSS10x10x5/8	21	3.8	87.96877	36.99	28.39	536.66	HSS10x10x5/8

Note: Two Rows of Braced Frames Except at Top Level

Braced Frame 5 - 25% Chevron (Assuming only half is in compr)							Size Selection							
Story Ht	Bay Length	Brace Length	Shear	Axial Force	Inc By Tor	Trial Size, A = P/F	Size	A	r	KL/r	Fe	Fcr	P	Optimized
19	29.33	24.00	25.804	42.23	50.68	1.01	HSS5x5x3/8	6.18	1.87	154.02	12.07	10.58	58.85	
17	29.33	22.45	80.938	123.91	148.69	2.97	HSS8x8x1/2	13.5	3.04	88.62	36.44	28.16	342.09	HSS8x8x1/2
17	29.33	22.45	107.85	165.11	198.14	3.96	HSS8x8x1/2	13.5	3.04	88.62	36.44	28.16	342.09	HSS8x8x1/2
17	29.33	22.45	136.36	208.76	250.52	5.01	HSS8x8x1/2	13.5	3.04	88.62	36.44	28.16	342.09	HSS8x8x1/2
15.5	29.33	21.34	154.96	225.48	270.57	5.41	HSS8x8x1/2	13.5	3.04	84.23	40.34	29.76	361.63	HSS8x8x1/2
14	29.33	20.27	167.95	232.19	278.63	5.57	HSS8x8x1/2	13.5	3.04	80.03	44.69	31.30	380.33	HSS8x8x1/2
15	29.33	20.98	172.96	247.42	296.90	5.94	HSS8x8x1/2	13.5	3.04	82.81	41.74	30.29	367.97	HSS8x8x1/2
10	20	22.36	345.93	386.76	464.11	9.28	HSS9x9x5/8	18.7	3.4	78.92	45.95	31.71	533.67	HSS9x9x5/8

Note: Bottom Floor Not Chevron

Braced Frame 6 - 25%							Size Selection							
	Bay Length	Brace Length	Shear	Axial Force	Inc By Tor	Trial Size, A = P/F	Size	A	r	KL/r	Fe	Fcr	P	Optimized
19														
17	24.33	29.68	161.88	197.48	236.97	4.74	HSS10x10x5/8	21	3.8	93.72879	32.58	26.30	497.13	HSS10x10x5/8
17	24.33	29.68	215.7	263.14	315.77	6.32	HSS10x10x5/8	21	3.8	93.72879	32.58	26.30	497.13	HSS10x10x5/8
17	24.33	29.68	272.73	332.70	399.24	7.98	HSS10x10x5/8	21	3.8	93.72879	32.58	26.30	497.13	HSS10x10x5/8
15.5	24.33	28.85	309.93	367.48	440.97	8.82	HSS10x10x5/8	21	3.8	91.0985	34.49	27.25	515.11	HSS10x10x5/8
14	24.33	28.07	335.9	387.54	465.05	9.30	HSS10x10x5/8	21	3.8	88.64346	36.43	28.15	532.01	HSS10x10x5/8
15	24.33	28.58	345.93	406.38	487.66	9.75	HSS10x10x5/8	21	3.8	90.25995	35.13	27.56	520.87	HSS10x10x5/8
10	26	27.86	345.93	370.63	444.75	8.90	HSS10x10x5/8	21	3.8	87.96877	36.99	28.39	536.66	HSS10x10x5/8

Braced Frame 1:Two Frames											Size Selection							
Column Betw Lines 6 and 6.5 AND Between 4.2 and 4.3																		
Floor	Ht	Length	Trib Area	Infl Area	DL(psf)	LL Reduction	LL	P	P From Vb	Total P	Size	A	r	KL/r	Fe	Fcr	P	Optimized
Roof	19	52	482	1931	80	0.59	59.14	72.09	579.7569952	651.85	W14x90	26.5	3.7	61.62162	75.38	37.88	903.40	W14x90
Pent	17	52	482	1931	110	0.49	150.00	171.87	579.7569952	751.62	W14x90	26.5	3.7	55.13514	94.15	40.04	954.84	W14x90
5th	17	52	482	1931	80	0.45	44.71	228.91	579.7569952	808.67	W14x90	26.5	3.7	55.13514	94.15	40.04	954.84	W14x109
4th	17	52	482	1931	80	0.42	42.07	285.32	579.7569952	865.08	W14x99	29.1	3.71	54.98652	94.66	40.08	1049.77	W14x109
3rd	15.5	52	482	1931	80	0.40	40.27	341.30	579.7569952	921.06	W14x99	29.1	3.71	50.13477	113.87	41.61	1089.66	W14x109
2nd	14	52	482	1931	80	0.40	40.00	397.21	579.7569952	976.97	W14x99	29.1	3.71	45.28302	139.58	43.04	1127.17	W14x159
1st	15	52	482	1931	80	0.40	40.00	453.12	579.7569952	1032.88	W14x99	29.1	3.71	48.51752	121.59	42.09	1102.45	W14x159
Terrace	10	52	482	1931	80	0.40	40.00	509.03	579.7569952	1088.79	W14x99	29.1	3.71	32.34501	273.58	46.32	1213.06	W14x159

Braced Frame 1:Two Frames											Size Selection							
Column Betw Lines 6 and 6.5 AND Between 4.2 and 4.3																		
Floor	Ht	Length	Trib Area	Infl Area	DL(psf)	LL Reduction	LL	P	P From Vb	Total P	Size	A	r	KL/r	Fe	Fcr	P	Optimized
Roof	19	52	482	1931	80	0.59	59.14	72.09	579.7569952	651.85	W14x90	26.5	3.7	61.62162	75.38	37.88	903.40	W14x90
Pent	17	52	482	1931	110	0.49	150.00	171.87	579.7569952	751.62	W14x90	26.5	3.7	55.13514	94.15	40.04	954.84	W14x90
5th	17	52	482	1931	80	0.45	44.71	228.91	579.7569952	808.67	W14x90	26.5	3.7	55.13514	94.15	40.04	954.84	W14x109
4th	17	52	482	1931	80	0.42	42.07	285.32	579.7569952	865.08	W14x90	26.5	3.7	55.13514	94.15	40.04	954.84	W14x109
3rd	15.5	52	482	1931	80	0.40	40.27	341.30	579.7569952	921.06	W14x90	26.5	3.7	50.27027	113.26	41.56	991.31	W14x109
2nd	14	52	482	1931	80	0.40	40.00	397.21	579.7569952	976.97	W14x90	26.5	3.7	45.40541	138.83	43.00	1025.63	W14x159
1st	15	52	482	1931	80	0.40	40.00	453.12	579.7569952	1032.88	W14x99	29.1	3.71	48.51752	121.59	42.09	1102.45	W14x159
Terrace	10	52	482	1931	80	0.40	40.00	509.03	579.7569952	1088.79	W14x90	26.5	3.7	32.43243	272.11	46.30	1104.22	W14x159

Braced Frame 4 and 5											Size Selection							
Column 4.2/4.9 and 6.2/6.9																		
Floor	Ht	Length	Trib Area	Infl Area	DL(psf)	LL Reduction	LL	P	P From Vb	Total P	Size	A	r	KL/r	Fe	Fcr	P	Optimized
Roof	19	29.33	390	1560	80	0.63	62.98	59.08	1027.86784	1086.95	W14x120	35.3	3.74	60.96257	77.01	38.10	1210.53	W14x74
Pent	17	29.33	390	1560	110	0.52	150.00	139.81	1027.86784	1167.68	W14x120	35.3	3.74	54.54545	96.20	40.22	1277.94	W14x74
5th	17	29.33	390	1560	80	0.47	46.93	186.40	1027.86784	1214.27	W14x120	35.3	3.74	54.54545	96.20	40.22	1277.94	W14x99
4th	17	29.33	390	1560	80	0.44	43.99	232.42	1027.86784	1260.29	W14x120	35.3	3.74	54.54545	96.20	40.22	1277.94	W14x99
3rd	15.5	29.33	390	1560	80	0.42	41.98	278.05	1027.86784	1305.91	W14x120	35.3	3.74	49.73262	115.72	41.73	1325.71	W14x99
2nd	14	29.33	390	1560	80	0.41	40.50	323.38	1027.86784	1351.25	W14x120	35.3	3.74	44.91979	141.85	43.14	1370.61	W14x159
1st	15	29.33	390	1560	80	0.40	40.00	368.62	1027.86784	1396.49	W14x132	38.8	3.76	47.87234	124.89	42.29	1476.63	W14x159
Terrace	10	29.33	390	1560	80	0.40	40.00	413.86	1027.86784	1441.73	W14x132	38.8	3.76	31.91489	281.00	46.41	1620.69	W14x159

Braced Frame 2 and 3											Size Selection							
Column G/F																		
Floor	Ht	Length	Trib Area	Infl Area	DL(psf)	LL Reduction	LL	P	P From Vb	Total P	Size	A	r	KL/r	Fe	Fcr	P	Optimized
Roof	19	24	503	2014	80	0.58	58.42	75.05	1256.140156	1331.19	W14x132	38.8	3.76	60.6383	77.84	38.21	1334.39	W14x120
Pent	17	24	503	2014	110	0.49	150.00	179.17	1256.140156	1435.31	W14x132	38.8	3.76	54.25532	97.23	40.32	1407.90	W14x120
5th	17	24	503	2014	80	0.44	44.30	238.60	1256.140156	1494.74	W14x145	42.7	3.98	51.25628	108.94	41.26	1585.68	W14x176
4th	17	24	503	2014	80	0.42	41.71	297.38	1256.140156	1553.52	W14x145	42.7	3.98	51.25628	108.94	41.26	1585.68	W14x176
3rd	15.5	24	503	2014	80	0.40	40.00	355.73	1256.140156	1611.87	W14x145	42.7	3.98	46.73367	131.05	42.62	1637.90	W14x176
2nd	14	24	503	2014	80	0.40	40.00	414.08	1256.140156	1670.22	W14x145	42.7	3.98	42.21106	160.64	43.89	1686.79	W14x211
1st	15	24	503	2014	80	0.40	40.00	472.43	1256.140156	1728.57	W14x159	46.7	4	45	141.34	43.12	1812.29	W14x211
Terrace	10	24	503	2014	80	0.40	40.00	530.77	1256.140156	1786.91	W14x145	42.7	3.98	30.15075	314.85	46.78	1797.93	W14x211

Braced Frame 7
Column D/E

Floor	Ht	Length	Trib Area	Infl Area	DL(psf)	LL Reduction	LL	P	P From Vb	Total P
Roof	19	33	455	1820	80	0.60	60.16	68.29	913.5564773	981.84
Pent	17	33	455	1820	110	0.50	150.00	162.47	913.5564773	1076.03
5th	17	33	455	1820	80	0.45	45.30	216.46	913.5564773	1130.01
4th	17	33	455	1820	80	0.43	42.58	269.82	913.5564773	1183.38
3rd	15.5	33	455	1820	80	0.41	40.72	322.77	913.5564773	1236.33
2nd	14	33	455	1820	80	0.40	40.00	375.55	913.5564773	1289.11
1st	15	33	455	1820	80	0.40	40.00	428.33	913.5564773	1341.89
Terrace	10	33	455	1820	80	0.40	40.00	481.11	913.5564773	1394.67

Size Selection

Size	A	r	KL/r	Fe	Fcr	P	Optimized
W14x99	29.1	3.71	61.45553	75.78	37.94	993.52	W14x109
W14x99	29.1	3.71	54.98652	94.66	40.08	1049.77	W14x109
W14x109	32	3.73	54.69169	95.69	40.18	1157.12	W14x145
W14x109	32	3.73	54.69169	95.69	40.18	1157.12	W14x145
W14x109	32	3.73	49.86595	115.10	41.69	1200.61	W14x145
W14x120	35.3	3.74	44.91979	141.85	43.14	1370.61	W14x193
W14x120	35.3	3.74	48.12834	123.56	42.21	1341.01	W14x193
W14x120	35.3	3.74	32.08556	278.02	46.37	1473.32	W14x193

Braced Frame 8
Column D.5/C

Floor	Ht	Length	Trib Area	Infl Area	DL(psf)	LL Reduction	LL	P	P From Vb	Total P
Roof	19	21	663	2652	80	0.54	54.13	97.50	1435.58875	1533.09
Pent	17	21	663	2652	110	0.46	150.00	234.74	1435.58875	1670.33
5th	17	21	663	2652	80	0.42	41.82	312.25	1435.58875	1747.84
4th	17	21	663	2652	80	0.40	40.00	389.16	1435.58875	1824.75
3rd	15.5	21	663	2652	80	0.40	40.00	466.07	1435.58875	1901.66
2nd	14	21	663	2652	80	0.40	40.00	542.98	1435.58875	1978.57
1st	15	21	663	2652	80	0.40	40.00	619.89	1435.58875	2055.48
Terrace	10	21	663	2652	80	0.40	40.00	696.79	1435.58875	2132.38

Size Selection

Size	A	r	KL/r	Fe	Fcr	P	Optimized
W14x145	42.7	3.98	57.28643	87.22	39.33	1511.58	W14x109
W14x159	46.7	4	51	110.04	41.34	1737.54	W14x109
W14x159	46.7	4	51	110.04	41.34	1737.54	W14x109
W14x159	46.7	4	51	110.04	41.34	1737.54	W14x145
W14x176	51.8	4.02	46.26866	133.70	42.76	1993.25	W14x145
W14x176	51.8	4.02	41.79104	163.88	44.01	2051.56	W14x211
W14x176	51.8	4.02	44.77612	142.76	43.18	2013.16	W14x211
W14x176	51.8	4.02	29.85075	321.21	46.85	2183.97	W14x211

Appendix N – Brace Removal Tables

X

	dmax	dmin	davg	dmax/dav	Δ1	Δ2	Δavg	Δmax/Δavg	
Brace 4/5									
Roof	4.24	3.30	3.77	1.12	0.91	0.60	0.76	1.2	PHOUSE
Penthouse	3.33	2.70	3.02	1.10	0.75	0.51	0.63	1.2	
Level 5	2.58	2.19	2.39	1.08	0.65	0.52	0.59	1.1	
Level 4	1.93	1.67	1.80	1.07	0.63	0.50	0.57	1.1	
Level 3	1.30	1.17	1.24	1.05	0.54	0.47	0.51	1.1	
Level 2	0.76	0.70	0.73	1.04	0.41	0.35	0.38	1.1	
Level 1	0.35	0.35	0.35	1.00	0.35	0.35	0.35	1.0	
Roof	4.27	3.31	3.79	1.13	0.98	0.60	0.79	1.2	5th
Penthouse	3.29	2.71	3.00	1.10	0.62	0.48	0.55	1.1	
Level 5	2.67	2.23	2.45	1.09	0.73	0.56	0.65	1.1	
Level 4	1.94	1.67	1.81	1.07	0.64	0.50	0.57	1.1	
Level 3	1.30	1.17	1.24	1.05	0.54	0.47	0.51	1.1	
Level 2	0.76	0.70	0.73	1.04	0.41	0.35	0.38	1.1	
Level 1	0.35	0.35	0.35	1.00	0.35	0.35	0.35	1.0	
Roof	4.27	3.31	3.79	1.13	0.97	0.60	0.79	1.2	4th
Penthouse	3.30	2.71	3.01	1.10	0.62	0.48	0.55	1.1	
Level 5	2.68	2.23	2.46	1.09	0.65	0.52	0.59	1.1	
Level 4	2.03	1.71	1.87	1.09	0.72	0.54	0.63	1.1	
Level 3	1.31	1.17	1.24	1.06	0.55	0.47	0.51	1.1	
Level 2	0.76	0.70	0.73	1.04	0.41	0.35	0.38	1.1	
Level 1	0.35	0.35	0.35	1.00	0.35	0.35	0.35	1.0	
Roof	4.29	3.33	3.81	1.13	0.97	0.60	0.79	1.2	3rd
Penthouse	3.32	2.73	3.03	1.10	0.62	0.48	0.55	1.1	
Level 5	2.70	2.25	2.48	1.09	0.65	0.53	0.59	1.1	
Level 4	2.05	1.72	1.89	1.09	0.64	0.51	0.58	1.1	
Level 3	1.41	1.21	1.31	1.08	0.64	0.51	0.58	1.1	
Level 2	0.77	0.70	0.74	1.05	0.42	0.35	0.39	1.1	
Level 1	0.35	0.35	0.35	1.00	0.35	0.35	0.35	1.0	
Roof	4.27	3.31	3.79	1.13	0.96	0.59	0.78	1.2	2nd
Penthouse	3.31	2.72	3.02	1.10	0.61	0.48	0.55	1.1	
Level 5	2.70	2.24	2.47	1.09	0.66	0.53	0.60	1.1	
Level 4	2.04	1.71	1.88	1.09	0.63	0.50	0.57	1.1	
Level 3	1.41	1.21	1.31	1.08	0.55	0.46	0.51	1.1	
Level 2	0.86	0.75	0.81	1.07	0.50	0.40	0.45	1.1	
Level 1	0.36	0.35	0.36	1.01	0.36	0.35	0.36	1.0	
Roof	4.29	3.35	3.82	1.12	0.96	0.60	0.78	1.2	1st
Penthouse	3.33	2.75	3.04	1.10	0.63	0.49	0.56	1.1	
Level 5	2.70	2.26	2.48	1.09	0.64	0.53	0.59	1.1	
Level 4	2.06	1.73	1.90	1.09	0.64	0.51	0.58	1.1	
Level 3	1.42	1.22	1.32	1.08	0.54	0.47	0.51	1.1	
Level 2	0.88	0.75	0.82	1.08	0.42	0.35	0.39	1.1	
Level 1	0.46	0.40	0.43	1.07	0.46	0.40	0.43	1.1	

X

	dmax	dmin	davg	dmax/dav	Δ1	Δ2	Δavg	Δmax/Δavg	
Brace 1									
Roof	4.14	3.32	3.73	1.11	0.88	0.54	0.71	1.2	PHOUSE
Penthous	3.26	2.78	3.02	1.08	0.67	0.57	0.62	1.1	
Level 5	2.59	2.21	2.40	1.08	0.65	0.53	0.59	1.1	
Level 4	1.94	1.68	1.81	1.07	0.63	0.51	0.57	1.1	
Level 3	1.31	1.17	1.24	1.06	0.55	0.47	0.51	1.1	
Level 2	0.76	0.70	0.73	1.04	0.41	0.35	0.38	1.1	
Level 1	0.35	0.35	0.35	1.00	0.35	0.35	0.35	1.0	
Roof	4.16	3.37	3.77	1.10	0.87	0.52	0.70	1.3	5th
Penthous	3.29	2.85	3.07	1.07	0.66	0.52	0.59	1.1	
Level 5	2.63	2.33	2.48	1.06	0.69	0.64	0.67	1.0	
Level 4	1.94	1.69	1.82	1.07	0.63	0.52	0.58	1.1	
Level 3	1.31	1.17	1.24	1.06	0.55	0.47	0.51	1.1	
Level 2	0.76	0.70	0.73	1.04	0.41	0.35	0.38	1.1	
Level 1	0.35	0.35	0.35	1.00	0.35	0.35	0.35	1.0	
Roof	4.20	3.41	3.81	1.10	0.90	0.55	0.73	1.2	4th
Penthous	3.30	2.86	3.08	1.07	0.63	0.52	0.58	1.1	
Level 5	2.67	2.34	2.51	1.07	0.66	0.51	0.59	1.1	
Level 4	2.01	1.83	1.92	1.05	0.70	0.65	0.68	1.0	
Level 3	1.31	1.18	1.25	1.05	0.55	0.48	0.52	1.1	
Level 2	0.76	0.70	0.73	1.04	0.41	0.35	0.38	1.1	
Level 1	0.35	0.35	0.35	1.00	0.35	0.35	0.35	1.0	
Roof	4.20	3.38	3.79	1.11	0.93	0.57	0.75	1.2	3rd
Penthous	3.27	2.81	3.04	1.08	0.62	0.48	0.55	1.1	
Level 5	2.65	2.33	2.49	1.06	0.65	0.53	0.59	1.1	
Level 4	2.00	1.80	1.90	1.05	0.63	0.51	0.57	1.1	
Level 3	1.37	1.29	1.33	1.03	0.60	0.58	0.59	1.0	
Level 2	0.77	0.71	0.74	1.04	0.42	0.36	0.39	1.1	
Level 1	0.35	0.35	0.35	1.00	0.35	0.35	0.35	1.0	
Roof	4.21	3.41	3.81	1.10	0.93	0.58	0.76	1.2	2nd
Penthous	3.28	2.83	3.06	1.07	0.63	0.49	0.56	1.1	
Level 5	2.65	2.34	2.50	1.06	0.65	0.53	0.59	1.1	
Level 4	2.00	1.81	1.91	1.05	0.63	0.51	0.57	1.1	
Level 3	1.37	1.30	1.34	1.03	0.55	0.47	0.51	1.1	
Level 2	0.82	0.83	0.83	0.99	0.46	0.48	0.47	1.0	
Level 1	0.36	0.35	0.36	1.01	0.36	0.35	0.36	1.0	
Roof	4.19	3.35	3.77	1.11	0.94	0.58	0.76	1.2	1st
Penthous	3.25	2.77	3.01	1.08	0.62	0.48	0.55	1.1	
Level 5	2.63	2.29	2.46	1.07	0.65	0.53	0.59	1.1	
Level 4	1.98	1.76	1.87	1.06	0.63	0.50	0.57	1.1	
Level 3	1.35	1.26	1.31	1.03	0.54	0.46	0.50	1.1	
Level 2	0.81	0.80	0.81	1.01	0.41	0.36	0.39	1.1	
Level 1	0.40	0.44	0.42	0.95	0.40	0.44	0.42	1.0	

X

	dmax	dmin	davg	dmax/dav	Δ1	Δ2	Δavg	Δmax/Δavg	
Brace 6									
Roof	4.31	3.54	3.93	1.10	1.01	0.68	0.85	1.2	PHOUSE
Penthous	3.30	2.86	3.08	1.07	0.70	0.64	0.67	1.0	
Level 5	2.60	2.22	2.41	1.08	0.66	0.54	0.60	1.1	
Level 4	1.94	1.68	1.81	1.07	0.63	0.51	0.57	1.1	
Level 3	1.31	1.17	1.24	1.06	0.55	0.47	0.51	1.1	
Level 2	0.76	0.70	0.73	1.04	0.41	0.35	0.38	1.1	
Level 1	0.35	0.35	0.35	1.00	0.35	0.35	0.35	1.0	
Roof	4.26	3.46	3.86	1.10	0.97	0.63	0.80	1.2	5th
Penthous	3.29	2.83	3.06	1.08	0.63	0.48	0.56	1.1	
Level 5	2.66	2.35	2.51	1.06	0.72	0.66	0.69	1.0	
Level 4	1.94	1.69	1.82	1.07	0.63	0.52	0.58	1.1	
Level 3	1.31	1.17	1.24	1.06	0.55	0.47	0.51	1.1	
Level 2	0.76	0.70	0.73	1.04	0.41	0.35	0.38	1.1	
Level 1	0.35	0.35	0.35	1.00	0.35	0.35	0.35	1.0	
Roof	4.28	3.51	3.90	1.10	0.97	0.63	0.80	1.2	4th
Penthous	3.31	2.88	3.10	1.07	0.63	0.49	0.56	1.1	
Level 5	2.68	2.39	2.54	1.06	0.66	0.55	0.61	1.1	
Level 4	2.02	1.84	1.93	1.05	0.71	0.66	0.69	1.0	
Level 3	1.31	1.18	1.25	1.05	0.55	0.48	0.52	1.1	
Level 2	0.76	0.70	0.73	1.04	0.41	0.35	0.38	1.1	
Level 1	0.35	0.35	0.35	1.00	0.35	0.35	0.35	1.0	
Roof	4.23	3.42	3.83	1.11	0.96	0.60	0.78	1.2	3rd
Penthous	3.27	2.82	3.05	1.07	0.62	0.49	0.56	1.1	
Level 5	2.65	2.33	2.49	1.06	0.65	0.52	0.59	1.1	
Level 4	2.00	1.81	1.91	1.05	0.63	0.51	0.57	1.1	
Level 3	1.37	1.30	1.34	1.03	0.60	0.59	0.60	1.0	
Level 2	0.77	0.71	0.74	1.04	0.42	0.36	0.39	1.1	
Level 1	0.35	0.35	0.35	1.00	0.35	0.35	0.35	1.0	
Roof	4.24	3.44	3.84	1.10	0.96	0.60	0.78	1.2	2nd
Penthous	3.28	2.84	3.06	1.07	0.62	0.49	0.56	1.1	
Level 5	2.66	2.35	2.51	1.06	0.66	0.53	0.60	1.1	
Level 4	2.00	1.82	1.91	1.05	0.63	0.51	0.57	1.1	
Level 3	1.37	1.31	1.34	1.02	0.55	0.48	0.52	1.1	
Level 2	0.82	0.83	0.83	0.99	0.46	0.48	0.47	1.0	
Level 1	0.36	0.35	0.36	1.01	0.36	0.35	0.36	1.0	
Roof	4.20	3.36	3.78	1.11	0.95	0.59	0.77	1.2	1st
Penthous	3.25	2.77	3.01	1.08	0.62	0.48	0.55	1.1	
Level 5	2.63	2.29	2.46	1.07	0.65	0.52	0.59	1.1	
Level 4	1.98	1.77	1.88	1.06	0.63	0.51	0.57	1.1	
Level 3	1.35	1.26	1.31	1.03	0.54	0.46	0.50	1.1	
Level 2	0.81	0.80	0.81	1.01	0.41	0.36	0.39	1.1	
Level 1	0.40	0.44	0.42	0.95	0.40	0.44	0.42	1.0	

Y

	dmax	dmin	davg	dmax/dav	Δ1	Δ2	Δavg	Δmax/Δavg	
Brace 7									
Roof	4.90	3.67	4.29	1.14	0.89	0.70	0.80	1.1	PHOUSE
Penthouse	4.01	2.97	3.49	1.15	0.81	0.76	0.79	1.0	
Level 5	3.20	2.21	2.71	1.18	0.84	0.56	0.70	1.2	
Level 4	2.36	1.65	2.01	1.18	0.81	0.54	0.68	1.2	
Level 3	1.55	1.11	1.33	1.17	0.66	0.47	0.57	1.2	
Level 2	0.89	0.64	0.77	1.16	0.51	0.37	0.44	1.2	
Level 1	0.38	0.27	0.33	1.17	0.38	0.27	0.33	1.2	
Roof	4.90	3.68	4.29	1.14	0.89	0.67	0.78	1.1	5th
Penthouse	4.01	3.01	3.51	1.14	0.82	0.54	0.68	1.2	
Level 5	3.19	2.47	2.83	1.13	0.83	0.81	0.82	1.0	
Level 4	2.36	1.66	2.01	1.17	0.81	0.55	0.68	1.2	
Level 3	1.55	1.11	1.33	1.17	0.66	0.46	0.56	1.2	
Level 2	0.89	0.65	0.77	1.16	0.51	0.39	0.45	1.1	
Level 1	0.38	0.26	0.32	1.19	0.38	0.26	0.32	1.2	
Roof	4.91	3.66	4.29	1.15	0.89	0.65	0.77	1.2	4th
Penthouse	4.02	3.01	3.52	1.14	0.83	0.52	0.68	1.2	
Level 5	3.19	2.49	2.84	1.12	0.84	0.55	0.70	1.2	
Level 4	2.35	1.94	2.15	1.10	0.79	0.82	0.81	1.0	
Level 3	1.56	1.12	1.34	1.16	0.67	0.48	0.58	1.2	
Level 2	0.89	0.64	0.77	1.16	0.51	0.38	0.45	1.1	
Level 1	0.38	0.26	0.32	1.19	0.38	0.26	0.32	1.2	
Roof	4.90	3.61	4.26	1.15	0.89	0.63	0.76	1.2	3rd
Penthouse	4.01	2.98	3.50	1.15	0.82	0.52	0.67	1.2	
Level 5	3.19	2.46	2.83	1.13	0.84	0.54	0.69	1.2	
Level 4	2.35	1.92	2.14	1.10	0.80	0.56	0.68	1.2	
Level 3	1.55	1.36	1.46	1.07	0.66	0.71	0.69	1.0	
Level 2	0.89	0.65	0.77	1.16	0.51	0.39	0.45	1.1	
Level 1	0.38	0.26	0.32	1.19	0.38	0.26	0.32	1.2	
Roof	4.91	3.53	4.22	1.16	0.89	0.60	0.75	1.2	2nd
Penthouse	4.02	2.93	3.48	1.16	0.83	0.52	0.68	1.2	
Level 5	3.19	2.41	2.80	1.14	0.83	0.54	0.69	1.2	
Level 4	2.36	1.87	2.12	1.12	0.81	0.54	0.68	1.2	
Level 3	1.55	1.33	1.44	1.08	0.67	0.47	0.57	1.2	
Level 2	0.88	0.86	0.87	1.01	0.50	0.59	0.55	1.1	
Level 1	0.38	0.27	0.33	1.17	0.38	0.27	0.33	1.2	
Roof	4.88	3.39	4.14	1.18	0.88	0.58	0.73	1.2	1st
Penthouse	4.00	2.81	3.41	1.17	0.82	0.51	0.67	1.2	
Level 5	3.18	2.30	2.74	1.16	0.83	0.52	0.68	1.2	
Level 4	2.35	1.78	2.07	1.14	0.80	0.53	0.67	1.2	
Level 3	1.55	1.25	1.40	1.11	0.67	0.45	0.56	1.2	
Level 2	0.88	0.80	0.84	1.05	0.50	0.37	0.44	1.1	
Level 1	0.38	0.43	0.41	0.94	0.38	0.43	0.41	1.1	

Y

	dmax	dmin	davg	dmax/dav	Δ1	Δ2	Δavg	Δmax/Δavg	
Brace 2									
Roof	4.95	3.28	4.12	1.20	0.92	0.54	0.73	1.3	PHOUSE
Penthouse	4.03	2.74	3.39	1.19	0.83	0.58	0.71	1.2	
Level 5	3.20	2.16	2.68	1.19	0.84	0.53	0.69	1.2	
Level 4	2.36	1.63	2.00	1.18	0.81	0.53	0.67	1.2	
Level 3	1.55	1.10	1.33	1.17	0.66	0.45	0.56	1.2	
Level 2	0.89	0.65	0.77	1.16	0.51	0.38	0.45	1.1	
Level 1	0.38	0.27	0.33	1.17	0.38	0.27	0.33	1.2	
Roof	4.96	3.30	4.13	1.20	0.92	0.52	0.72	1.3	5th
Penthouse	4.04	2.78	3.41	1.18	0.82	0.51	0.67	1.2	
Level 5	3.22	2.27	2.75	1.17	0.86	0.64	0.75	1.1	
Level 4	2.36	1.63	2.00	1.18	0.81	0.53	0.67	1.2	
Level 3	1.55	1.10	1.33	1.17	0.66	0.45	0.56	1.2	
Level 2	0.89	0.65	0.77	1.16	0.51	0.38	0.45	1.1	
Level 1	0.38	0.27	0.33	1.17	0.38	0.27	0.33	1.2	
Roof	4.96	3.34	4.15	1.20	0.91	0.54	0.73	1.3	4th
Penthouse	4.05	2.80	3.43	1.18	0.82	0.50	0.66	1.2	
Level 5	3.23	2.30	2.77	1.17	0.84	0.54	0.69	1.2	
Level 4	2.39	1.76	2.08	1.15	0.83	0.65	0.74	1.1	
Level 3	1.56	1.11	1.34	1.17	0.67	0.46	0.57	1.2	
Level 2	0.89	0.65	0.77	1.16	0.50	0.37	0.44	1.1	
Level 1	0.39	0.28	0.34	1.16	0.39	0.28	0.34	1.2	
Roof	4.96	3.38	4.17	1.19	0.91	0.56	0.74	1.2	3rd
Penthouse	4.05	2.82	3.44	1.18	0.82	0.51	0.67	1.2	
Level 5	3.23	2.31	2.77	1.17	0.83	0.53	0.68	1.2	
Level 4	2.40	1.78	2.09	1.15	0.81	0.53	0.67	1.2	
Level 3	1.59	1.25	1.42	1.12	0.69	0.60	0.65	1.1	
Level 2	0.90	0.65	0.78	1.16	0.51	0.37	0.44	1.2	
Level 1	0.39	0.28	0.34	1.16	0.39	0.28	0.34	1.2	
Roof	4.95	3.41	4.18	1.18	0.89	0.57	0.73	1.2	2nd
Penthouse	4.06	2.84	3.45	1.18	0.83	0.51	0.67	1.2	
Level 5	3.23	2.33	2.78	1.16	0.83	0.53	0.68	1.2	
Level 4	2.40	1.80	2.10	1.14	0.81	0.53	0.67	1.2	
Level 3	1.59	1.27	1.43	1.11	0.66	0.46	0.56	1.2	
Level 2	0.93	0.81	0.87	1.07	0.54	0.52	0.53	1.0	
Level 1	0.39	0.29	0.34	1.15	0.39	0.29	0.34	1.1	
Roof	5.02	3.70	4.36	1.15	0.90	0.63	0.77	1.2	1st
Penthouse	4.12	3.07	3.60	1.15	0.83	0.55	0.69	1.2	
Level 5	3.29	2.52	2.91	1.13	0.85	0.56	0.71	1.2	
Level 4	2.44	1.96	2.20	1.11	0.82	0.57	0.70	1.2	
Level 3	1.62	1.39	1.51	1.08	0.67	0.49	0.58	1.2	
Level 2	0.95	0.90	0.93	1.03	0.52	0.41	0.47	1.1	
Level 1	0.43	0.49	0.46	0.93	0.43	0.49	0.46	1.1	

Y

	dmax	dmin	davg	dmax/dav	Δ1	Δ2	Δavg	Δmax/Δavg	
Brace 3									
Roof	4.93	3.34	4.14	1.19	0.81	0.63	0.72	1.1	PHOUSE
Penthouse	4.12	2.71	3.42	1.21	0.93	0.54	0.74	1.3	
Level 5	3.19	2.17	2.68	1.19	0.83	0.53	0.68	1.2	
Level 4	2.36	1.64	2.00	1.18	0.81	0.54	0.68	1.2	
Level 3	1.55	1.10	1.33	1.17	0.66	0.46	0.56	1.2	
Level 2	0.89	0.64	0.77	1.16	0.51	0.37	0.44	1.2	
Level 1	0.38	0.27	0.33	1.17	0.38	0.27	0.33	1.2	
Roof	4.97	3.34	4.16	1.20	0.81	0.63	0.72	1.1	5th
Penthouse	4.16	2.71	3.44	1.21	0.83	0.51	0.67	1.2	
Level 5	3.33	2.20	2.77	1.20	0.97	0.56	0.77	1.3	
Level 4	2.36	1.64	2.00	1.18	0.81	0.54	0.68	1.2	
Level 3	1.55	1.10	1.33	1.17	0.66	0.46	0.56	1.2	
Level 2	0.89	0.64	0.77	1.16	0.51	0.37	0.44	1.2	
Level 1	0.38	0.27	0.33	1.17	0.38	0.27	0.33	1.2	
Roof	5.01	3.34	4.18	1.20	0.83	0.62	0.73	1.1	4th
Penthouse	4.18	2.72	3.45	1.21	0.82	0.51	0.67	1.2	
Level 5	3.36	2.21	2.79	1.21	0.85	0.54	0.70	1.2	
Level 4	2.51	1.67	2.09	1.20	0.95	0.57	0.76	1.3	
Level 3	1.56	1.10	1.33	1.17	0.67	0.46	0.57	1.2	
Level 2	0.89	0.64	0.77	1.16	0.51	0.37	0.44	1.2	
Level 1	0.38	0.27	0.33	1.17	0.38	0.27	0.33	1.2	
Roof	5.02	3.32	4.17	1.20	0.85	0.60	0.73	1.2	3rd
Penthouse	4.17	2.72	3.45	1.21	0.83	0.52	0.68	1.2	
Level 5	3.34	2.20	2.77	1.21	0.83	0.53	0.68	1.2	
Level 4	2.51	1.67	2.09	1.20	0.81	0.54	0.68	1.2	
Level 3	1.70	1.13	1.42	1.20	0.81	0.49	0.65	1.2	
Level 2	0.89	0.64	0.77	1.16	0.51	0.37	0.44	1.2	
Level 1	0.38	0.27	0.33	1.17	0.38	0.27	0.33	1.2	
Roof	5.01	3.32	4.17	1.20	0.87	0.60	0.74	1.2	2nd
Penthouse	4.14	2.72	3.43	1.21	0.81	0.52	0.67	1.2	
Level 5	3.33	2.20	2.77	1.20	0.84	0.53	0.69	1.2	
Level 4	2.49	1.67	2.08	1.20	0.80	0.54	0.67	1.2	
Level 3	1.69	1.13	1.41	1.20	0.67	0.46	0.57	1.2	
Level 2	1.02	0.67	0.85	1.21	0.63	0.40	0.52	1.2	
Level 1	0.39	0.27	0.33	1.18	0.39	0.27	0.33	1.2	
Roof	4.98	3.29	4.14	1.20	0.88	0.60	0.74	1.2	1st
Penthouse	4.10	2.69	3.40	1.21	0.81	0.50	0.66	1.2	
Level 5	3.29	2.19	2.74	1.20	0.83	-0.46	0.19	4.5	
Level 4	2.46	2.65	2.56	0.96	0.80	1.53	1.17	0.7	
Level 3	1.66	1.12	1.39	1.19	0.66	0.45	0.56	1.2	
Level 2	1.00	0.67	0.84	1.20	0.51	0.38	0.45	1.1	
Level 1	0.49	0.29	0.39	1.26	0.49	0.29	0.39	1.3	

Y

	dmax	dmin	davg	dmax/dav	Δ1	Δ2	Δavg	Δmax/Δavg	
Brace 8									
Roof	5.13	3.28	4.21	1.22	0.95	0.59	0.77	1.2	PHOUSE
Penthouse	4.18	2.69	3.44	1.22	1.00	0.51	0.76	1.3	
Level 5	3.18	2.18	2.68	1.19	0.83	0.54	0.69	1.2	
Level 4	2.35	1.64	2.00	1.18	0.80	0.53	0.67	1.2	
Level 3	1.55	1.11	1.33	1.17	0.66	0.46	0.56	1.2	
Level 2	0.89	0.65	0.77	1.16	0.51	0.38	0.45	1.1	
Level 1	0.38	0.27	0.33	1.17	0.38	0.27	0.33	1.2	
Roof	5.15	3.28	4.22	1.22	0.94	0.59	0.77	1.2	5th
Penthouse	4.21	2.69	3.45	1.22	0.82	0.52	0.67	1.2	
Level 5	3.39	2.17	2.78	1.22	1.04	0.53	0.79	1.3	
Level 4	2.35	1.64	2.00	1.18	0.80	0.53	0.67	1.2	
Level 3	1.55	1.11	1.33	1.17	0.66	0.46	0.56	1.2	
Level 2	0.89	0.65	0.77	1.16	0.51	0.38	0.45	1.1	
Level 1	0.38	0.27	0.33	1.17	0.38	0.27	0.33	1.2	
Roof	5.17	3.28	4.23	1.22	0.92	0.59	0.76	1.2	4th
Penthouse	4.25	2.69	3.47	1.22	0.82	0.52	0.67	1.2	
Level 5	3.43	2.17	2.80	1.23	0.83	0.54	0.69	1.2	
Level 4	2.60	1.63	2.12	1.23	1.04	0.52	0.78	1.3	
Level 3	1.56	1.11	1.34	1.17	0.67	0.46	0.57	1.2	
Level 2	0.89	0.65	0.77	1.16	0.51	0.38	0.45	1.1	
Level 1	0.38	0.27	0.33	1.17	0.38	0.27	0.33	1.2	
Roof	5.18	3.27	4.23	1.23	0.91	0.59	0.75	1.2	3rd
Penthouse	4.27	2.68	3.48	1.23	0.83	0.51	0.67	1.2	
Level 5	3.44	2.17	2.81	1.23	0.83	0.54	0.69	1.2	
Level 4	2.61	1.63	2.12	1.23	0.81	0.54	0.68	1.2	
Level 3	1.80	1.09	1.45	1.25	0.91	0.44	0.68	1.3	
Level 2	0.89	0.65	0.77	1.16	0.51	0.38	0.45	1.1	
Level 1	0.38	0.27	0.33	1.17	0.38	0.27	0.33	1.2	
Roof	5.17	3.28	4.23	1.22	0.90	0.59	0.75	1.2	2nd
Penthouse	4.27	2.69	3.48	1.23	0.82	0.52	0.67	1.2	
Level 5	3.45	2.17	2.81	1.23	0.84	0.54	0.69	1.2	
Level 4	2.61	1.63	2.12	1.23	0.80	0.53	0.67	1.2	
Level 3	1.81	1.10	1.46	1.24	0.67	0.47	0.57	1.2	
Level 2	1.14	0.63	0.89	1.29	0.75	0.36	0.56	1.4	
Level 1	0.39	0.27	0.33	1.18	0.39	0.27	0.33	1.2	
Roof	5.18	3.25	4.22	1.23	0.90	0.59	0.75	1.2	1st
Penthouse	4.28	2.66	3.47	1.23	0.83	0.51	0.67	1.2	
Level 5	3.45	2.15	2.80	1.23	0.84	0.53	0.69	1.2	
Level 4	2.61	1.62	2.12	1.23	0.80	0.53	0.67	1.2	
Level 3	1.81	1.09	1.45	1.25	0.67	0.46	0.57	1.2	
Level 2	1.14	0.63	0.89	1.29	0.52	0.37	0.45	1.2	
Level 1	0.62	0.26	0.44	1.41	0.62	0.26	0.44	1.4	

Appendix O – CA Layout 2, Story Drifts and Torsional Irregularity

Torsional Irregularity X Direction

Story	δmax	δmin	δavg	δmax/δavg	Δ1	Δ2	Δavg	Δmax/Δavg	Ax
Roof	4.01	3.24	3.625	1.11	1.01	0.62	0.82	1.2	0.85
Penthouse	3	2.62	2.81	1.07	0.60	0.49	0.55	1.1	0.79
Level 5	2.4	2.13	2.265	1.06	0.62	0.53	0.58	1.1	0.78
Level 4	1.78	1.6	1.69	1.05	0.59	0.49	0.54	1.1	0.77
Level 3	1.19	1.11	1.15	1.03	0.49	0.45	0.47	1.0	0.74
Level 2	0.7	0.66	0.68	1.03	0.37	0.33	0.35	1.1	0.74
Level 1	0.33	0.33	0.33	1.00	0.33	0.33	0.33	1.0	0.69

Torsional Irregularity Y Direction

Story	δmax	δmin	δavg	δmax/δavg	Δ1	Δ2	Δavg	Δmax/Δavg	Ax
Roof	4.95	3.43	4.19	1.18	0.93	0.64	0.79	1.2	0.97
Penthouse	4.02	2.79	3.405	1.18	0.86	0.55	0.71	1.2	0.97
Level 5	3.16	2.24	2.7	1.17	0.86	0.58	0.72	1.2	0.95
Level 4	2.3	1.66	1.98	1.16	0.80	0.56	0.68	1.2	0.94
Level 3	1.5	1.1	1.3	1.15	0.65	0.46	0.56	1.2	0.92
Level 2	0.85	0.64	0.745	1.14	0.48	0.37	0.43	1.1	0.90
Level 1	0.37	0.27	0.32	1.16	0.37	0.27	0.32	1.2	0.93

QCX

Story	Height	δxe	δye	δx Amplified by Cd/I	δy Amplified by Cd/I	Δx	Δy	Δa = .015sx
Roof	19.00	3.68	-	14.72	-	3.24	-	3.42
Penthouse	17.00	2.87	-	11.48	-	2.28	-	3.06
Level 5	17.00	2.30	-	9.20	-	2.28	-	3.06
Level 4	17.00	1.73	-	6.92	-	2.16	-	3.06
Level 3	15.50	1.19	-	4.76	-	2.00	-	2.79
Level 2	14.00	0.69	-	2.76	-	1.36	-	2.52
Level 1	15.00	0.35	-	1.40	-	1.40	-	2.70

QCY

Story	Height	δxe	δye	δx Amplified by Cd/I	δy Amplified by Cd/I	Δx	Δy	Δa = .015sx
Roof	19.00	-	4.12	-	16.48	-	2.80	3.42
Penthouse	17.00	-	3.42	-	13.68	-	2.92	3.06
Level 5	17.00	-	2.69	-	10.76	-	2.84	3.06
Level 4	17.00	-	1.98	-	7.92	-	2.72	3.06
Level 3	15.50	-	1.30	-	5.20	-	2.24	2.79
Level 2	14.00	-	0.74	-	2.96	-	1.60	2.52
Level 1	15.00	-	0.34	-	1.36	-	1.36	2.70

QCXE

Story	Height	δxe	δye	δx Amplified by Cd/I	δy Amplified by Cd/I	Δx	Δy	Δa = .015sx
Roof	19.00	3.67	-	14.68	-	3.32	-	3.42
Penthouse	17.00	2.84	-	11.36	-	2.16	-	3.06
Level 5	17.00	2.30	-	9.20	-	2.28	-	3.06
Level 4	17.00	1.73	-	6.92	-	2.16	-	3.06
Level 3	15.50	1.19	-	4.76	-	1.92	-	2.79
Level 2	14.00	0.71	-	2.84	-	1.48	-	2.52
Level 1	15.00	0.34	-	1.36	-	1.36	-	2.70

QCYE

Story	Height	δxe	δye	δx Amplified by Cd/I	δy Amplified by Cd/I	Δx	Δy	Δa = .015sx
Roof	19.00	-	4.14	-	16.56	-	2.84	3.42
Penthouse	17.00	-	3.43	-	13.72	-	2.88	3.06
Level 5	17.00	-	2.71	-	10.84	-	2.88	3.06
Level 4	17.00	-	1.99	-	7.96	-	2.60	3.06
Level 3	15.50	-	1.34	-	5.36	-	2.40	2.79
Level 2	14.00	-	0.74	-	2.96	-	1.56	2.52
Level 1	15.00	-	0.35	-	1.40	-	1.40	2.70

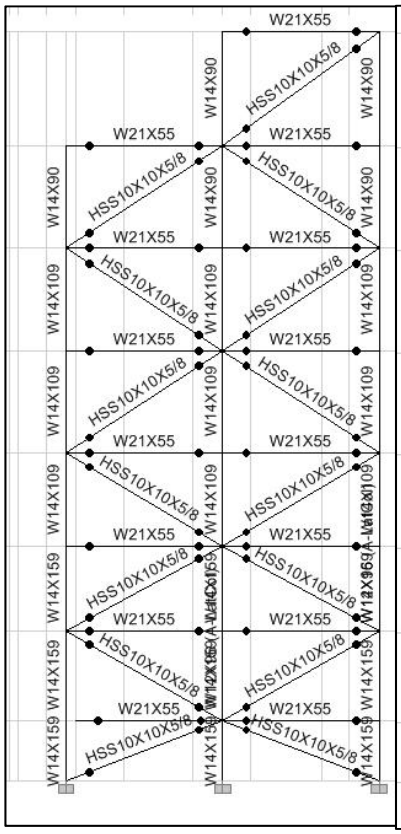
QX100Y30E

Story	Height	δxe	δye	δx Amplified by Cd/I	δy Amplified by Cd/I	Δx	Δy	Δa = .015sx
Roof	19.00	3.67	1.28	14.68	5.12	3.24	0.96	3.42
Penthouse	17.00	2.86	1.04	11.44	4.16	2.20	0.88	3.06
Level 5	17.00	2.31	0.82	9.24	3.28	2.24	0.88	3.06
Level 4	17.00	1.75	0.60	7.00	2.40	2.27	0.84	3.06
Level 3	15.50	1.18	0.39	4.73	1.56	1.97	0.64	2.79
Level 2	14.00	0.69	0.23	2.76	0.92	1.40	0.52	2.52
Level 1	15.00	0.34	0.10	1.36	0.40	1.36	0.40	2.70

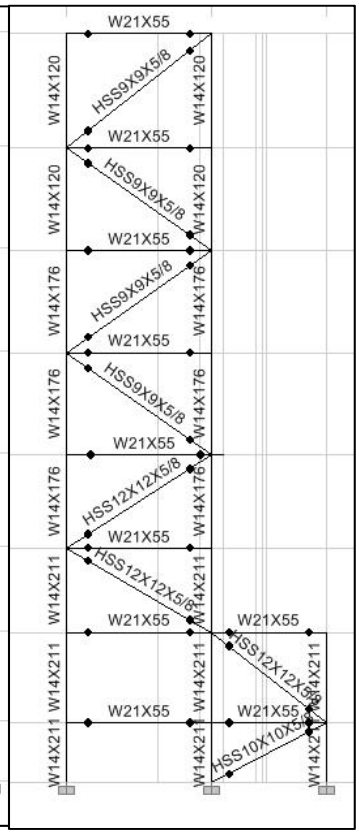
QX30Y100

Story	Height	δxe	δye	δx Amplified by Cd/I	δy Amplified by Cd/I	Δx	Δy	Δa = .015sx
Roof	19.00	1.14	4.12	4.56	16.48	1.04	2.80	3.42
Penthouse	17.00	0.88	3.42	3.52	13.68	0.68	2.84	3.06
Level 5	17.00	0.71	2.71	2.84	10.84	0.68	2.92	3.06
Level 4	17.00	0.54	1.98	2.16	7.92	0.76	2.76	3.06
Level 3	15.50	0.35	1.29	1.40	5.16	0.52	2.16	2.79
Level 2	14.00	0.22	0.75	0.88	3.00	0.40	1.64	2.52
Level 1	15.00	0.12	0.34	0.48	1.36	0.48	1.36	2.70

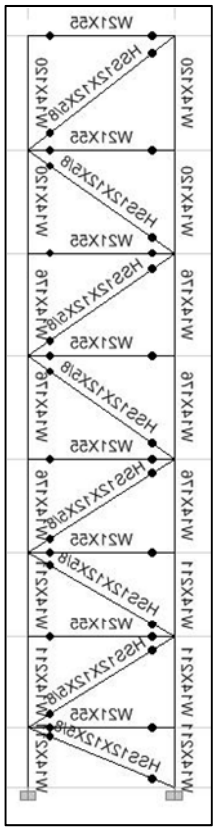
Appendix P – CA Layout 2 Brace Configuration



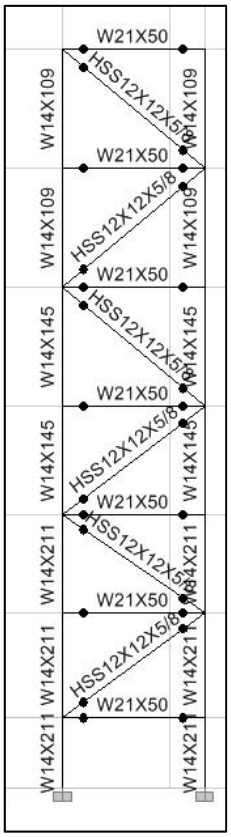
BF 1/6



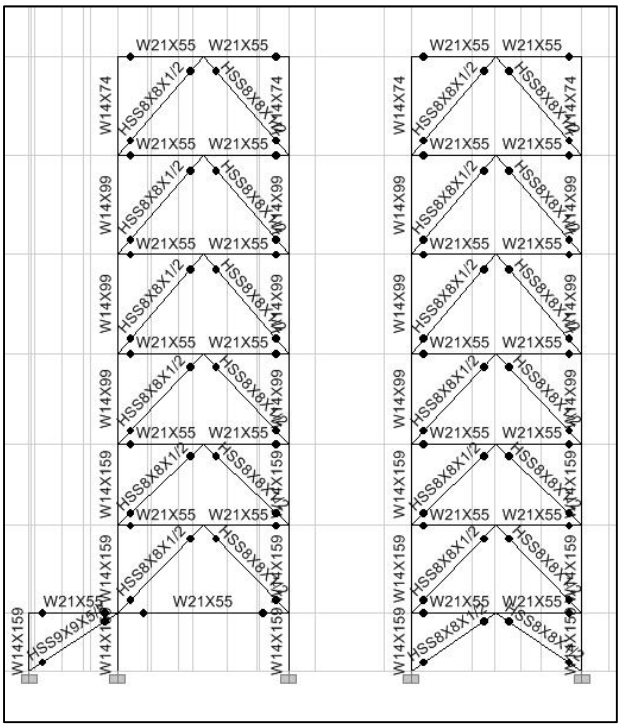
BF 2



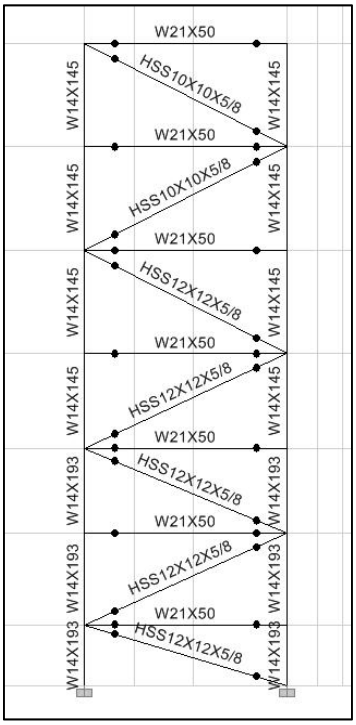
BF 3



BF 8



BF 4/5



BF 7

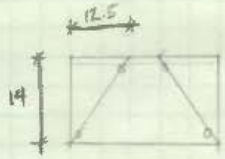
Appendix Q – Eccentric Braced Frame Design

LINK BM SHEAR

PHOUSE 98 k
3rd 121 k
4th 134 k
3rd 156 k
2nd 144 k
1st 168 k

HSS 9 x 9 x 5/8 → ϕP_n = 560 k, F_{cr} = 38.3
BRACE L = 21.1
STORY HT = 17
BAY LENGTH = 29.33

EBF DESIGN - 1ST FLR (WORST CASE SHEAR)
TRY W18x86 — LENGTH = 4.33'



LINK BM

$V_D = \frac{.08 \times 4.33}{2}$ $V_U = 158.4$ k

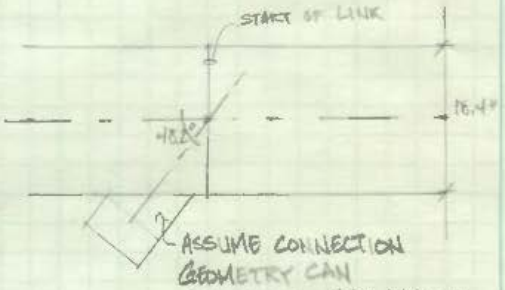
$V_L = \frac{.1 \times 4.33}{2}$

V_Q = 158 k ETABS

$M_D = \frac{.08 \times 4.33^2}{12}$ M_U = 348.8 k

$M_L = \frac{.1 \times 4.33^2}{12}$

M_Q = 348 k-ft



ASSUME CONNECTION GEOMETRY CAN ACCOMODATE HSS WHOSE CTR LINE CROSSES INSIDE LINK BUT CONNECTION REMAINS OUTSIDE

SLENDERNESS CHECK

λ_f = 7.2

$\lambda_{ps} = .3\sqrt{\frac{E}{F_y}}$ = 7.22 ✓

λ_w = 53.4

$C_a \leq 0.125$ (NO AXIAL)

$\lambda_{ps} = 3.14\sqrt{\frac{E}{F_y}}(1 - 1.54(C_a))$ = 75.6 ✓

SHEAR STR.

$.15R_y = .15F_yA_g$ = 190 k

$P_u < .15R_y$

$V_p = .6F_{ya}A_w = .6(d_b - 2t_f)t_wF_y$ = 243 k

$\frac{2M_p}{e} = \frac{2F_yZ}{e} = \frac{2(50)(186)}{52}$ = 358 k

$\phi V_n = .9(243) = 219 > 158.4$ ✓

LINK ROTATION ANGLE

$\frac{V_p e}{M_p} = \frac{243(52)}{30 \times 186} = 1.36 < 1.6$ LINK DOMINATED BY SHEAR YIELDING

ROTATION LIMIT = .08

$\gamma_p = \frac{L}{e}\theta_p \quad : \quad \theta_p = \frac{\Delta_p}{h}$ $\quad \theta_p = \frac{1.36}{(14 \times 12)} = .0093$

$\gamma_p = \frac{29.38(12)}{52}(.0093) = .063$ ✓

LATERAL BRACING REQ.

$R_u = .06 R_y F_y Z / h_o = .06(1.1)(50)(186)/(17.6) = 34.9\ k$

STIFFENER REQUIREMENTS

$w_{min} = b_f - \frac{2t_w}{2} = \frac{11.1 - 2(.48)}{2} = 5.07$ in

$t_{min} = .75 t_w \geq 3/8$

$= .36 \geq 3/8$ ← use 3/8

FULL DEPTH, 3/8 in × 5 1/8 in STIFFENERS ON EITHER SIDE OF LINK ELEMENT

INTERMEDIATE STIFFENERS
FOR LINK ROTATION = .08 RADIAN

$30 t_w - d/5 = 30(.48) - 18.4/5 = 10.72$ in

LINK ROTATION ≤ .02

$52 t_w - d/5 = 21.28$ in

INTERPOLATING → 13.71 in = MAX SPACING

$t_{min} = t_w \geq 3/8 \rightarrow .48$ in $\quad w_{min} = b_f/2 - t_w = 5.07$ in

FULL DEPTH, ½ in × 5⅛ in INTERMEDIATE WEB STIFFENERS
@ 13" o.c. (< 137 ✓)

STIFFENER TO WEB

$$D = \frac{F_y A_{st}}{2(1.392)[d - 2t_f - 2(2\frac{3}{8})]}$$

← WEB CLIP TO COMPLY W/ AWS D1.8

$$= \frac{36(.5 \times 5.125)}{2(1.392)[18.4 - 2(.77) - 2(2\frac{3}{8})]} = 2.73 \text{ SIXTEENTHS} \rightarrow \frac{3}{16}\text{'s}$$

COMPLY'S W/ TABLE J2.4

USE DOUBLE SIDED 3/16 in FILLET WELDS TO CONNECT STIFFENERS TO WEB

STIFFENER TO FLANGE

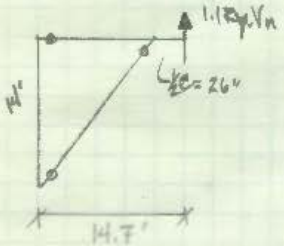
$$D = \frac{F_y A_{st}}{4(2)(1.392)(5\frac{1}{8} - .75)}$$

← ASSUMED CLIP

$= 1.89$ SIXTEENTHS → 3/16's ✓ PER J2.4

USE DOUBLE SIDED 3/16 in FILLET WELD TO CONNECT STIFFENERS TO FLANGE

BEAM OUTSIDE LINK



$1.1R_yV_n = 1.1 \times 1.1 \times 243 = 294$

$P_E = \frac{1.1R_yV_nL}{2h} = 808\ k$

$M = \frac{294(52)}{2} = 7,644\ k\text{-}in$

$V_E = 28.7\ k$ FROM E-TABS

$P_u = 308$
$M_u = 637$
$V_u = 28.7$

$\lambda_w = h/t_w = 33.4$
$\lambda_p = 90.6$ ✓

$L_b = L - \frac{c}{2} - 2\left(\frac{d_c/2}{2}\right) = 29.33 - \frac{52/12}{2} - 2\left(\frac{14.2}{24}\right)$

$= 11.9'$

SECOND ORDER

$P_{e1} = 21479\ k$

$B_1 = \frac{1}{1 - \frac{312}{21479}} = 1.01$

$M_{rx} = 643.37$

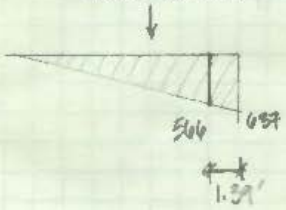
$P = 1.09 \times 10^{-3}$ $b_x = 1.55 \times 10^{-3}$

$\frac{P_r}{P_c} = \frac{pP_r}{R_y} = .305$

$b_x\frac{M_{rx}}{R_y} = .782$

$> = 1.09 > 1.0$
NO GOOD

MOMENT ON BM → FIND POINT BM DOESN'T NEED BRACING



$1 = .305 + \frac{1.55 \times 10^{-3} M_{rx}}{1.1}$

$M_{rx} = 506\ ft\text{-}k$

USE COVER PL

FIND REQUIRED MOMENT CAPACITY TO MAKE 687 k-ft WORK

$1.0 \geq P_r/P_c + 8/9\, M_r/M_c$ $\quad KL_y = 57$, $F_{cr} = 36$ k

$= \frac{308}{1.1 \times 25.3 \times 36} + 8/9 \left(\frac{687}{M_c}\right)$

$M_c = 817 = FZ \quad Z_{REQ} = 196 \quad 18 \times 36 \rightarrow 18$

$Z_{PL} \Rightarrow 196 - 36 = b(t)(d+t)$

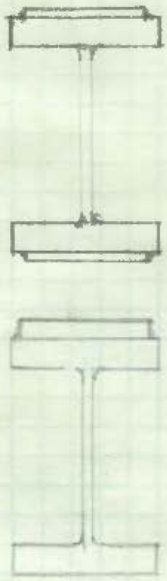
$10 = 10(t)(18.4+t)$

$= 18.4t + t^2 - 10$

$t_{min} = .06$"

PROVIDE 1/8" PL FROM LINK ZONE TO $1.3d' + d \rightarrow 3'$

USE 1/8" FILLET WELDS



NOTE, BOTTOM PL WOULD LIKELY INTERFERE W/ CONNECTION, TRY JUST TOP PL.

TRY 10 x 1/4 A36 PL

$10 \times .25 \times \frac{36}{50} + 25.2 = 27.2 = PNA \rightarrow 13.5\,in^2$

$18.5 - 1.8 - 8.55 = 3.15\,in^2 \quad 3.15/.48 = 6.56$ in WEB

(8.55: FLANGE; 1.8: UNCOATED AREA OF PL)

SUM OF MOMENTS ABOUT PNA

$.48(6.56)\frac{6.56}{2} + 10.3(.46)\left(\frac{10.3}{2}\right) + 8.55(10.3 + .77/2)$

$+ 8.55(6.56 + .77/2) + 1.8(6.56 + .77 + .25/2)$

$Z = 200\,in^3 > Z_{REQ} = 196$

Appendix R – Detailed Cost Breakdown

Gravity Beam							
	#	Length	Weight/LF	Total Wt	Bare Cost($/L.F)	Plus Labor and Equip	Total Cost
W8x10	146	1620	10	16309	14.6	21.6	34988.1
W10x33	7	154	33	5088	47.9	54.9	8455.6
W10x12	191	2991	12	36024	17.5	24.5	73171.8
W10x15	1	12.7	15	190	21.7	28.7	364.4
W10x22	6	106.3	22	2346	32.0	39.0	4145.8
W12x14	142	2514.6	14	35596	20.5	27.5	69216.4
W8x15	1	15.3	15	232	22.0	29.0	443.5
W12x40	1	22.5	40	896	57.7	64.7	1456.7
W12x16	66	1401.3	16	22459	23.2	30.2	42374.7
W10x17	2	42	17	713	24.6	31.6	1327.9
W8x18	10	156.1	18	2794	26.0	33.0	5144.0
W12x53	6	184	53	9767	77.0	84.0	15450.2
W12x65	1	30.67	65	1993	94.2	101.2	3104.5
W12x19	45	982.2	19	18617	27.5	34.5	33870.1
W8x21	16	255.3	21	5352	30.4	37.4	9547.5
W14x22	58	1103.7	22	24374	32.0	39.0	43068.2
W8x24	7	139.7	24	3364	34.9	41.9	5855.7
W12x26	9	171	26	4451	37.7	44.7	7651.0
W14x30	1	19.53	30	588	43.7	50.7	989.3
W14x48	1	24	48	1152	69.6	76.6	1838.4
W14x53	6	184	53	9767	77.0	84.0	15450.2
W14x61	6	198	61	12060	88.3	95.3	18873.0
W14x38	6	144	38	5488	55.3	62.3	8965.6
W16x26	157	4727.3	26	123539	37.9	44.9	212222.7
W16x31	53	1225.3	31	38065	45.0	52.0	63771.4
W16x45	1	12.33	45	558	65.6	72.6	895.4
W16x67	2	46.33	67	3106	97.2	104.2	4828.0
W18x35	25	669.8	35	23477	50.8	57.8	38730.3
W10x39	7	174.7	39	6835	56.7	63.7	11133.7
W8x40	1	33	40	1314	57.7	64.7	2136.3
W16x40	2	65	40	2608	58.2	65.2	4236.6
W18x40	24	590.8	40	23720	58.2	65.2	38529.6
W18x76	1	33	76	2504	110.0	117.0	3861.8
W21x44	86	2721.9	44	120407	64.1	71.1	193643.5
W12x45	2	54.7	45	2437	64.6	71.6	3916.6
W21x48	12	292.3	48	14024	69.6	76.6	22380.9
W21x62	12	300.3	62	18697	90.3	97.3	29212.8
W24x55	22	628.1	55	34625	79.9	86.9	54603.0
W24x62	10	337	62	20873	89.8	96.8	32624.9
W24x68	29	982	68	67165	99.2	106.2	104263.3
W24x76	18	557.7	76	42510	110.5	117.5	65543.4
W24x104	36	1405.5	104	146348	151.0	158.0	222043.1
W24x117	12	473.3	117	55397	169.7	176.7	83638.8
W24x103	1	34.5	103	3557	149.5	156.5	5399.2
W24x131	2	65.1	131	8532	190.0	197.0	12827.1
W24x146	1	34.7	146	5072	211.9	218.9	7597.3
W24x192	8	313.1	192	59987	277.8	284.8	89172.9
W27x84	3	81.2	84	6853	122.4	129.4	10505.3
W30x90	32	540.6	90	48562	130.3	137.3	74199.1
W30x99	1	20.5	99	2030	143.6	150.6	3087.0
W30x116	1	15.67	116	1823	168.7	175.7	2753.0
W33x118	4	62.7	118	7399	171.1	178.1	11167.5

Gravity Columns							
	#	Length	Weight/ft	Total Weight	Bare Cost($/L.F)	Plus Labor/Equip	Total Cost
W10x33	7	783	33	25839	47.85	54.85	42947.55
W10x39	2	72	39	2808	56.55	63.55	4575.6
W10x45	7	257	45	11565	65.25	72.25	18568.25
W10x49	13	531	49	26019	71.05	78.05	41444.55
W10x54	5	248	54	13392	78.3	85.3	21154.4
W10x60	7	294	60	17640	87	94	27636
W10x68	2	88.5	68	6018	98.6	105.6	9345.6
W10x77	2	78	77	6006	111.65	118.65	9254.7
W10x88	1	39	88	3432	127.6	134.6	5249.4
W12x53	6	216	53	11448	76.85	83.85	18111.6
W12x58	2	72	58	4176	84.1	91.1	6559.2
W12x65	12	526.5	65	34222.5	94.25	101.25	53308.125
W12x72	10	453	72	32616	104.4	111.4	50464.2
W12x79	7	265	79	20935	114.55	121.55	32210.75
W12x87	6	234	87	20358	126.15	133.15	31157.1
W12x96	2	78	96	7488	139.2	146.2	11403.6
W14x48	1	36	48	1728	69.6	76.6	2757.6
W14x53	1	88.5	53	4690.5	76.85	83.85	5394.075
W14x61	1	36	61	2196	88.45	95.45	2525.4
W14x68	1	49.5	68	3366	98.6	105.6	3870.9
W14x82	1	36	82	2952	118.9	125.9	3394.8
W14x90	4	157.5	90	14175	130.5	137.5	16301.25
W14x99	2	121.5	99	12028.5	143.55	150.55	13832.775
W14x109	1	36	109	3924	158.05	165.05	4512.6
W14x120	1	36	120	4320	174	181	4968
Misc.							
	#	Cost					
Shear Studs	8446	122467					
	Wt (kips)						
Lanterns	203	294350					
Total Tonnage of Steel		804	10% Inc.	Totals:	884		
Cost w Labor/Equip		$2,672,441			$3,233,654		

Lateral System						
Rockville, MD						
Braces						
	#	Length	Weight/ft	Total Weight	Bare Cost($/L.F)	Cost
HSS5x5x3/8	4	89.8	22.4	2011.52	38	3395
HSS6x6x3/8	22	465.5	27.5	12801.25	45	20971
HSS8x8x3/8	7	206.2	37.7	7773.74	60	12276
HSS9x9x3/8	2	58.8	42.8	2516.64	67	3926
HSS9x9x1/2	2	62.1	55.7	3458.97	85	5284
HSS9x9x5/8	6	174.7	67.8	11844.66	102	17868
HSS10x10x5/8	8	214.3	76.3	16351.09	114	24504
Beams						
	#	Length	Weight/ft	Total Weight	Bare Cost($/L.F)	Cost
W16x21	16	304	21	6384	36	10889
W18x40	16	384	40	15360	63	24115
W24x68	16	469.3	68	31912.4	103	48131
W24x94	16	416	94	39104	139	58024
Columns						
	#	Length	Weight/ft	Total Weight	Bare Cost($/L.F)	Cost
W14x53	4	144	53	7632	81	11701
W14x68	4	198	68	13464	103	20307
W14x82	6	216	82	17712	122	26447
W14x99	4	156	99	15444	147	22866
W14x120	6	297	120	35640	176	52391
W14x176	6	234	176	41184	256	59885
Total Tonnage	140	0% Increase		Totals:	154	
Cost	$422,982				$511,808	
San Francisco, Existing Setup						
Braces						
	#	Length	Weight/ft	Total Weight	Bare Cost($/L.F)	Cost
HSS8x8x1/2	20	436.4	48.85	21318	75	32890
HSS9x9x5/8	6	119.5	67.82	8104	102	12225
HSS10x10x5/8	1	22.4	76.33	1710	114	2562
W14x132	1	21	132	2772	193	4062
W14x159	1	21	159	3339	232	4867
W14x176	8	240	176	42240	256	61421
W14x193	13	390	193	75270	280	109223
W14x211	1	24.2	211	5106.2	306	7396
Beams						
	#	Length	Weight/ft	Total Weight	Bare Cost($/L.F)	Cost
W16x21	16	304	21	6384	36	10889
W18x40	16	384	40	15360	63	24115
W33x354	16	469.3	354	166132.2	509	238724
W24x94	16	58.8	94	5527.2	139	8201
Columns						
	#	Length	Weight/ft	Total Weight	Bare Cost($/L.F)	Cost
W14x109	4	144	109	15696	161	23152
W14x132	4	198	132	26136	193	38301
W14x145	4	144	145	20880	212	30514
W14x159	2	72	159	11448	232	16688
W14x193	4	156	193	30108	280	43689
W14x211	2	99	211	20889	306	30256
W14x233	2	99	233	23067	337	33349
W14x257	2	99	257	25443	371	36723
W14x342	4	156	342	53352	492	76696
W14x455	2	78	455	35490	652	50864
Total Tonnage	308	0% Increase		Totals:	339	
Cost	$896,810				$1,085,140	

San Francisco, Additional Frames						
Braces						
	#	Length	Weight/ft	Total Weight	Bare Cost($/L.F)	Cost
HSS8x8x1/2	26	624	48.85	30482	75	47029
HSS9x9x5/8	5	142	67.82	9630	102	14527
HSS10x10x5/8	17	510	76.33	38928	114	58338
HSS12x12x5/8	28	870	93.34	81206	139	120532
Beams						
	#	Length	Weight/ft	Total Weight	Bare Cost($/L.F)	Cost
W16x21	24	304	21	6384	36	10889
W18x40	24	384	40	15360	63	24115
W33x354	16	469.3	354	166132.2	509	238724
W24x94	16	58.8	94	5527.2	139	8201
Columns						
	#	Length	Weight/ft	Total Weight	Bare Cost($/L.F)	Cost
W14x74	4	144	74	10656	111	15996
W14x90	3	108	90	9720	134	14450
W14x99	4	198	99	19602	147	29023
W14x109	7	293	109	31937	161	47109
W14x120	4	144	120	17280	176	25402
W14x145	4	82	145	11890	212	17376
W14x159	7	273	159	43407	232	63276
W14x176	4	198	176	34848	256	50672
W14x193	2	78	193	15054	280	21845
W14x211	6	234	233	54522	337	78825
Total Tonnage	301	0% Increase		Totals:	331	
Cost	$886,329				$1,072,458	
San Francisco, Additional Frames, EBF						
Braces						
	#	Length	Weight/ft	Total Weight	Bare Cost($/L.F)	Cost
HSS9x9x5/8	33	820	67.82	55612	102	83890
HSS10x10x5/8	7	210	76.33	16029	114	24022
HSS12x12x5/8	32	960	93.34	89606	139	133001
Beams						
	#	Length	Weight/ft	Total Weight	Bare Cost($/L.F)	Cost
W16x21	24	304	21	6384	36	10889
W18x40	24	384	40	15360	63	24115
W18x86	16	469.3	86	40359.8	128	60127
W24x94	16	58.8	94	5527.2	139	8201
Columns						
	#	Length	Weight/ft	Total Weight	Bare Cost($/L.F)	Cost
W14x74	4	144	74	10656	111	15996
W14x90	3	108	90	9720	134	14450
W14x99	4	198	99	19602	147	29023
W14x109	7	293	109	31937	161	47109
W14x120	4	144	120	17280	176	25402
W14x145	4	82	145	11890	212	17376
W14x159	7	273	159	43407	232	63276
W14x176	4	198	176	34848	256	50672
W14x193	4	156	193	30108	280	43689
W14x211	4	156	233	36348	337	52550
Total Tonnage	237	0% Increase		Totals:	261	
Cost	$703,787				$851,583	

Concrete

		Sq Ft.	CY	f'c (psi)	Cost	Total
NW SOG	5"	30000	463	4500	$133.00	$61,574.07
LW Slab	3"	16560	153	3000	$167.00	$25,606.67
	6"	180000	3333	3000	$167.00	$556,666.67
	6.25"	27600	532	3000	$167.00	$88,912.04
Pumping			4019		$28.00	$112,534.07
Steel Trowel		210000	$ 0.72			$151,200.00
		LF				
Saw Cuts		8000	$ 0.75			$6,000.00
Vapor Barrier		30000	$ 0.32			$9,600.00

		Ht	Length	CY	f'c (psi)	Cost	Total Cost
Basement Wall	12"	12	420	187	4500	$133.00	$24,826.67
Wall Footings	24"	1	420	31	4500	$133.00	$4,137.78
Pumping				187		$29.00	$5,413.33

		Sq Ft.	Cost		
Formwork	Walls	8400	$ 1.89		$15,876.00
	Slab/Footings	1000	$ 1.89		$1,890.00

		Sq Ft.	Cost	Included in Structural Steel	
Metal Deck	2VLI	216000	$2.70		$583,200.00
	3VLI	27600	$3.20		$88,320.00
	Roof Deck	15600	$3.10		$48,360.00

Reinforcing

		Sq Ft.	Cost		Total
Welded Wire	6x6W2.1xW2.1	207600	$0.75		$155,700.00
	Ton	Cost	Waste		
Uncoated Reinforcing Stl	10.08	$1,012.00	10%		$11,221.06
	Sq Ft	Cost			
Chairs	180600	$ 0.35			$63,210.00

Total $1,553,242.02

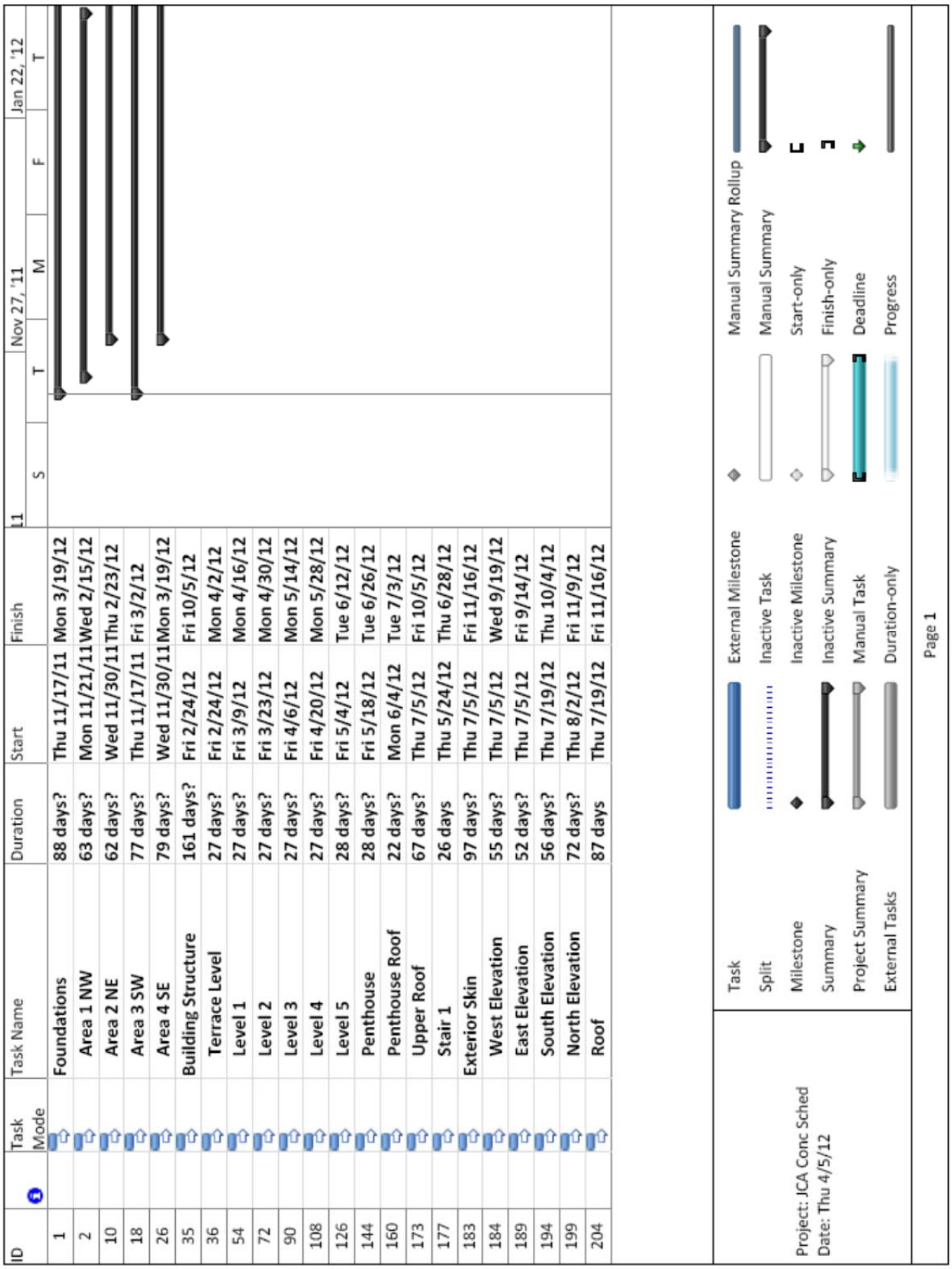
Foundations

	Diameter	#	CY	f'c	Cost	Total
Pier	2.5	47	299	4000	$ 135.00	$40,374.34
	3	15	137	4000	$ 135.00	$18,555.02
	5	11	280	4000	$ 135.00	$37,797.25
Pumping			716		$ 28.00	$20,061.82
	4.5	11	227	4000	$ 135.00	
	Tons	Cost	Waste			
Reinforcing	26.7	$ 1,508.00	10%			$44,289.96

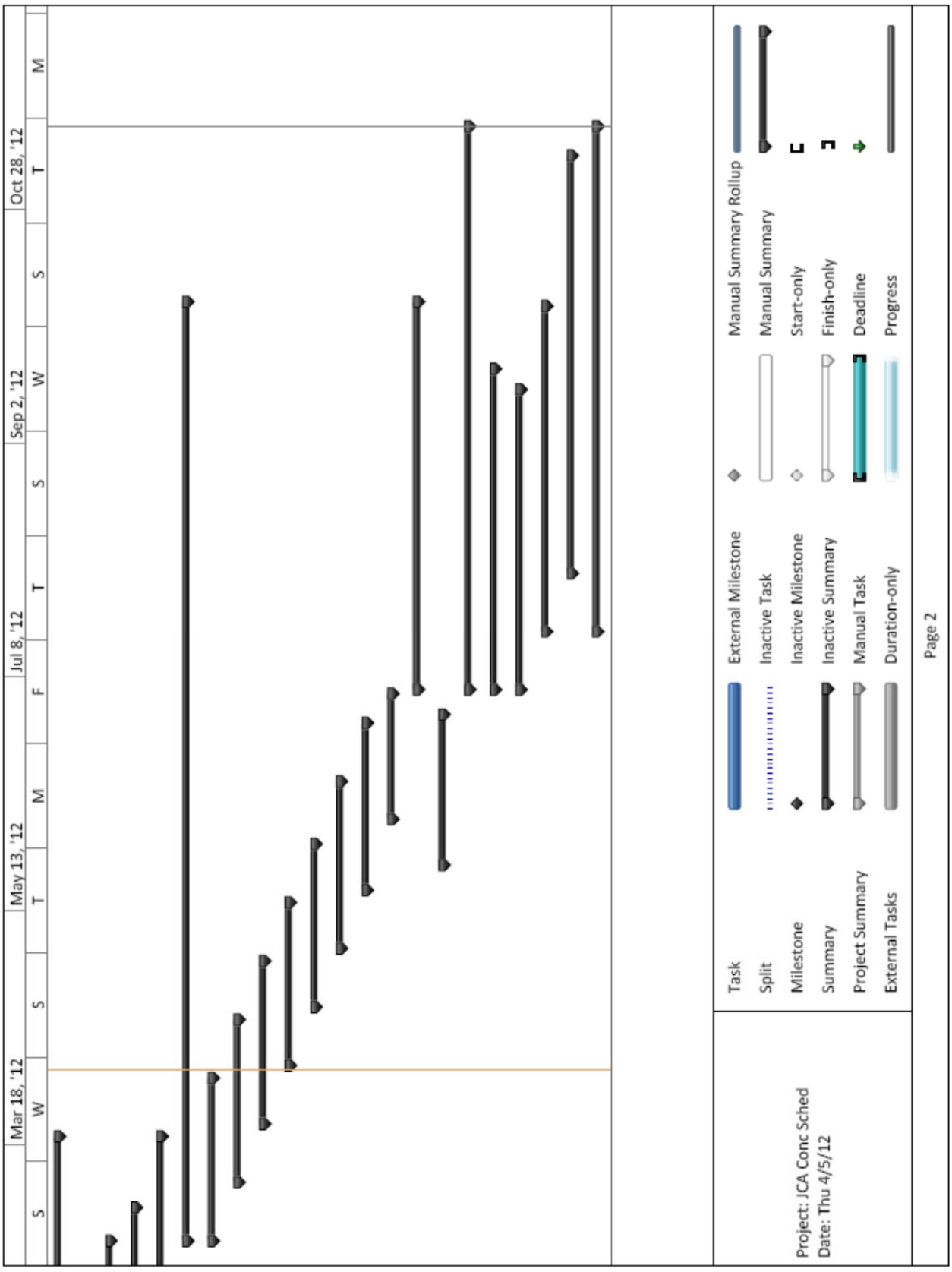
Auguring	Diameter	#	L.F.	Cost	Total
	36	62	2,170	$ 38.00	$82,460.00
	60	11	385	$ 104.50	$40,232.50

Total $340,525.06

Appendix S – Original Schedule



ID	Task Mode	Task Name	Duration	Start	Finish
1		Foundations	88 days?	Thu 11/17/11	Mon 3/19/12
2		Area 1 NW	63 days?	Mon 11/21/11	Wed 2/15/12
10		Area 2 NE	62 days?	Wed 11/30/11	Thu 2/23/12
18		Area 3 SW	77 days?	Thu 11/17/11	Fri 3/2/12
26		Area 4 SE	79 days?	Wed 11/30/11	Mon 3/19/12
35		Building Structure	161 days?	Fri 2/24/12	Fri 10/5/12
36		Terrace Level	27 days?	Fri 2/24/12	Mon 4/2/12
54		Level 1	27 days?	Fri 3/9/12	Mon 4/16/12
72		Level 2	27 days?	Fri 3/23/12	Mon 4/30/12
90		Level 3	27 days?	Fri 4/6/12	Mon 5/14/12
108		Level 4	27 days?	Fri 4/20/12	Mon 5/28/12
126		Level 5	28 days?	Fri 5/4/12	Tue 6/12/12
144		Penthouse	28 days?	Fri 5/18/12	Tue 6/26/12
160		Penthouse Roof	22 days?	Mon 6/4/12	Tue 7/3/12
173		Upper Roof	67 days?	Thu 7/5/12	Fri 10/5/12
177		Stair 1	26 days	Thu 5/24/12	Thu 6/28/12
183		Exterior Skin	97 days?	Thu 7/5/12	Fri 11/16/12
184		West Elevation	55 days?	Thu 7/5/12	Wed 9/19/12
189		East Elevation	52 days?	Thu 7/5/12	Fri 9/14/12
194		South Elevation	56 days?	Thu 7/19/12	Thu 10/4/12
199		North Elevation	72 days?	Thu 8/2/12	Fri 11/9/12
204		Roof	87 days	Thu 7/19/12	Fri 11/16/12

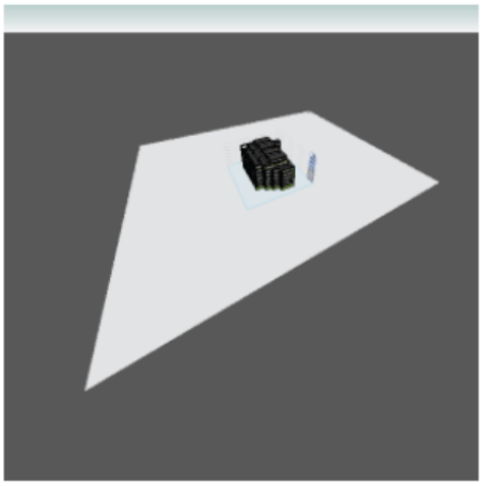

Mar 18, '12
May 13, '12
Jul 8, '12
Sep 2, '12
Oct 28, '12
S W S T M F T S W S T M
Project: JCA Conc Sched
Date: Thu 4/5/12
Task
Split
Milestone
Summary
Project Summary
External Tasks
External Milestone
Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
Deadline
Progress
Page 2

Appendix T – Vasari Energy Model

JCA

Analyzed at 4/1/2012 8:01:44 PM

Mass



Building Performance Factors

Location:	E Jefferson St & Maryland Ave, Rockville, MD 20850, USA
Weather Station:	48099
Outdoor Temperature:	Max: 93°F/Min: 4°F
Floor Area:	172,816 sf
Exterior Wall Area:	85,885 sf
Average Lighting Power:	1.01 W / ft²
People:	767 people
Exterior Window Ratio:	0.50
Electrical Cost:	$0.13 / kWh
Fuel Cost:	$0.97 / Therm

Energy Use Intensity

Electricity EUI:	18 kWh / sf / yr
Fuel EUI:	25 kBtu / sf / yr
Total EUI:	88 kBtu / sf / yr

Life Cycle Energy Use/Cost

Life Cycle Electricity Use:	95,510,580 kWh
Life Cycle Fuel Use:	1,315,437 Therms
Life Cycle Energy Cost:	$6,110,403

*30-year life and 6.1% discount rate for costs

Renewable Energy Potential

Roof Mounted PV System (Low efficiency):	167,071 kWh / yr
Roof Mounted PV System (Medium efficiency):	334,142 kWh / yr
Roof Mounted PV System (High efficiency):	501,214 kWh / yr
Single 15' Wind Turbine Potential:	825 kWh / yr

*PV efficiencies are assumed to be 5%, 10% and 15% for low, medium and high efficiency systems

Appendix U – Sunpower T5 Roof Tiles

SUNPOWER

T5 SOLAR ROOF TILE

EXCEPTIONAL EFFICIENCY & PERFORMANCE

Electrical Data

Measured at Standard Test Conditions (STC): Irradiance 1000W/m², AM 1.5, and cell temperature 25° C

Peak Power *	P_{max}	320 W (+5/-3%)	327 W (+5/-3%)
Rated Voltage	V_{mpp}	54.7 V	54.7 V
Rated Current	I_{mpp}	5.86 A	5.98 A
Open Circuit Voltage	V_{oc}	64.8 V	64.9 V
Short Circuit Current	I_{sc}	6.24 A	6.46 A
Maximum System Voltage	UL	600 V	
Temperature Coefficients	Power Voltage (V_{oc}) Current (I_{sc})	-0.38% / K -176.6 mV / K 3.5 mA / K	
NOCT		45° C +/-2° C	
Series Fuse Rating		20 A	

Mechanical Data

Solar Laminate	SunPower™ 320 Solar Laminate, or SunPower 327 Solar Laminate
Solar Cells	96 SunPower all-back contact monocrystalline
Front Glass	SunPower 320 Solar Laminate: High transmission tempered glass with anti-reflective (AR) coating SunPower 327 Solar Laminate: High transmission tempered glass with anti-reflective (AR) coating
Junction Box	IP-65 rated with 3 bypass diodes, 32 x 155 x 128 (mm)
Output Cables	1000 mm length cables / MultiContact (MC4) connectors
Frame	Polymer material with fiber reinforcement, PPE+PS
Tile Weight	47 lbs (21.3 kg)
Roof Coverage	85% N–S

Tested Operating Conditions

Temperature	-40° F to +185° F (-40° C to +85° C)
Max load	50 psf 245kg/m² (2400 Pa) front and back – e.g. wind
Impact Resistance	Hail 1 in (25 mm) at 52mph (23 m/s)

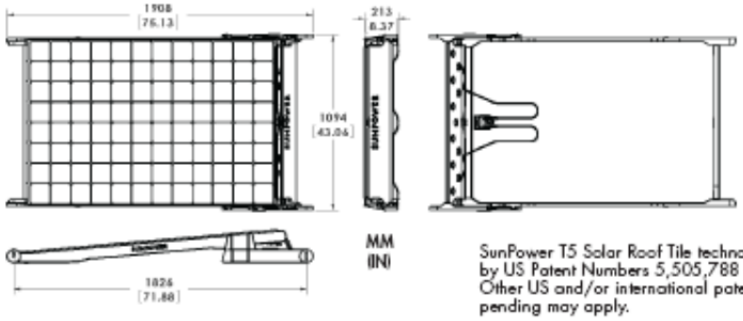
*Other laminates may be available upon request

Warranties and Certifications

Warranty	25-year limited power warranty 10-year limited product warranty
Certifications	CSA listed (Tested to UL 1703), Class C Fire Rating

Built in the USA. Complies with the "Buy American" clause of The American Recovery and Reinvestment Act of 2009.

Dimensions



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(IN)

SunPower T5 Solar Roof Tile technology is protected by US Patent Numbers 5,505,788 and RE 38,988. Other US and/or international patents issued or pending may apply.

CAUTION: READ SAFETY AND INSTALLATION INSTRUCTIONS BEFORE USING THE PRODUCT.

Visit sunpowercorp.com for details

sunpowercorp.com

Appendix V – System Advisor Model Cash Flow

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Energy (kWh)	0	55,522	55,244	54,968	54,693	54,420	54,148	53,877	53,608	53,340	53,073	52,808	52,544	52,281	52,019	51,759
Energy Value ($)	0	9,751.68	9,945.49	10,143.16	10,344.76	10,550.36	10,760.05	10,973.90	11,192.01	11,414.45	11,641.31	11,872.68	12,108.65	12,349.31	12,594.75	12,845.07
Operating Expenses																
Fixed O&M Annual	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fixed O&M	0	1,059.08	1,085.56	1,112.70	1,140.51	1,169.03	1,198.25	1,228.21	1,258.91	1,290.39	1,322.65	1,355.71	1,389.61	1,424.35	1,459.95	1,496.45
Variable O&M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Insurance	0	1,121.90	1,149.95	1,178.70	1,208.17	1,238.37	1,269.33	1,301.06	1,333.59	1,366.93	1,401.10	1,436.13	1,472.03	1,508.83	1,546.55	1,585.22
Property Assessed Value	0	224,380.48	224,380.48	224,380.48	224,380.48	224,380.48	224,380.48	224,380.48	224,380.48	224,380.48	224,380.48	224,380.48	224,380.48	224,380.48	224,380.48	224,380.48
Property Taxes	0	4,487.61	4,487.61	4,487.61	4,487.61	4,487.61	4,487.61	4,487.61	4,487.61	4,487.61	4,487.61	4,487.61	4,487.61	4,487.61	4,487.61	4,487.61
Net Salvage Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Operating Costs	0	6,668.59	6,723.12	6,779	6,836.29	6,895.01	6,955.19	7,016.88	7,080.11	7,144.93	7,211.36	7,279.45	7,349.25	7,420.79	7,494.12	7,569.28
Deductible Expenses	0	-6,668.59	-6,723.12	-6,779	-6,836.29	-6,895.01	-6,955.19	-7,016.88	-7,080.11	-7,144.93	-7,211.36	-7,279.45	-7,349.25	-7,420.79	-7,494.12	-7,569.28
Financing																
Debt Balance	0	-224,380.48	-218,280.80	-211,815.13	-204,961.53	-197,696.71	-189,995.99	-181,833.24	-173,180.72	-164,009.05	-154,287.08	-143,981.80	-133,058.19	-121,479.17	-109,205.41	-96,195.22
Debt Interest Payment	0	13,462.83	13,096.85	12,708.91	12,297.69	11,861.80	11,399.76	10,909.99	10,390.84	9,840.54	9,257.23	8,638.91	7,983.49	7,288.75	6,552.32	5,771.71
Debt Repayment	0	6,099.68	6,465.66	6,853.60	7,264.82	7,700.71	8,162.75	8,652.52	9,171.67	9,721.97	10,305.29	10,923.60	11,579.02	12,273.76	13,010.19	13,790.80
Debt Total Payment	0	19,562.51	19,562.51	19,562.51	19,562.51	19,562.51	19,562.51	19,562.51	19,562.51	19,562.51	19,562.51	19,562.51	19,562.51	19,562.51	19,562.51	19,562.51
Federal IBI	0															
State IBI	0															
Utility IBI	0															
Other IBI	0															
Total IBI	0															
Federal CBI	0															
State CBI	0															
Utility CBI	0															
Other CBI	0															
Total CBI	0															
Federal PBI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
State PBI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Utility PBI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other PBI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total PBI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Federal PTC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
State PTC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Federal ITC		67,314.14														
State ITC		0														
Tax Effect on Equity (State)																
State Depreciation Schedule (%)	0	20	32	19.2	11.52	11.52	5.76	0	0	0	0	0	0	0	0	0
State Depreciation	0	38,144.68	61,031.49	36,618.89	21,971.34	21,971.34	10,985.67	0	0	0	0	0	0	0	0	0
State Income Taxes	0	-4,079.33	-5,659.60	-3,927.48	-2,877.37	-2,850.97	-2,053.84	-1,254.88	-1,222.97	-1,188.98	-1,152.80	-1,114.29	-1,073.29	-1,029.67	-983.25	-933.87
State Tax Savings	0	4,079.33	5,659.60	3,927.48	2,877.37	2,850.97	2,053.84	1,254.88	1,222.97	1,188.98	1,152.80	1,114.29	1,073.29	1,029.67	983.25	933.87
Tax Effect on Equity (Federal)																
Federal Depreciation Schedule (%)	0	20	32	19.2	11.52	11.52	5.76	0	0	0	0	0	0	0	0	0
Federal Depreciation	0	38,144.68	61,031.49	36,618.89	21,971.34	21,971.34	10,985.67	0	0	0	0	0	0	0	0	0
Federal Income Taxes	0	-15,175.10	-21,053.72	-14,610.21	-10,703.82	-10,605.61	-7,640.30	-4,668.16	-4,549.44	-4,423.02	-4,288.42	-4,145.14	-3,992.65	-3,830.36	-3,657.69	-3,473.99
Federal Tax Savings	0	82,489.24	21,053.72	14,610.21	10,703.82	10,605.61	7,640.30	4,668.16	4,549.44	4,423.02	4,288.42	4,145.14	3,992.65	3,830.36	3,657.69	3,473.99
After Tax Cost	0	60,337.46	427.69	-7,803.83	-12,817.61	-13,000.94	-16,823.56	-20,656.35	-20,870.22	-21,095.44	-21,332.65	-21,582.54	-21,845.82	-22,123.27	-22,415.69	-22,723.93
After Tax Cashflow	0	66,867.19	7,087.19	-1,011.97	-5,890.76	-5,936.42	-9,618.64	-13,308.23	-13,376.05	-13,452.32	-13,537.63	-13,632.59	-13,737.87	-13,854.17	-13,982.24	-14,122.87
Payback	-224,380.48	81,981.58	22,322.51	14,351.52	9,608.60	9,706.95	6,177.40	2,649.62	2,753.33	2,858.87	2,966.30	3,075.63	3,186.90	3,300.14	3,415.39	3,532.67
Cumulative payback	-224,380.48	-142,398.90	-120,076.39	-105,724.87	-96,116.27	-86,409.32	-80,231.92	-77,582.30	-74,828.98	-71,970.10	-69,003.81	-65,928.18	-62,741.28	-59,441.14	-56,025.76	-52,493.09

16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
51,501	51,243	50,987	50,732	50,478	50,226	49,975	49,725	49,476	49,229	48,983	48,738	48,494	48,252	48,010
13,100.37	13,360.74	13,626.29	13,897.11	14,173.31	14,455.01	14,742.30	15,035.30	15,334.13	15,638.90	15,949.72	16,266.72	16,590.02	16,919.75	17,256.03
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1,533.86	1,572.21	1,611.52	1,651.80	1,693.10	1,735.43	1,778.81	1,823.28	1,868.86	1,915.59	1,963.48	2,012.56	2,062.88	2,114.45	2,167.31
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1,624.85	1,665.47	1,707.11	1,749.78	1,793.53	1,838.37	1,884.33	1,931.44	1,979.72	2,029.21	2,079.94	2,131.94	2,185.24	2,239.87	2,295.87
224,380.48	224,380.48	224,380.48	224,380.48	224,380.48	224,380.48	224,380.48	224,380.48	224,380.48	224,380.48	224,380.48	224,380.48	224,380.48	224,380.48	224,380.48
4,487.61	4,487.61	4,487.61	4,487.61	4,487.61	4,487.61	4,487.61	4,487.61	4,487.61	4,487.61	4,487.61	4,487.61	4,487.61	4,487.61	4,487.61
0	0	0	0	0	0	0	0	0	0	0	0	0	0	44,876.10
7,646.32	7,725.29	7,806.23	7,889.20	7,974.24	8,061.40	8,150.75	8,242.33	8,336.19	8,432.41	8,531.03	8,632.12	8,735.73	8,841.93	-35,925.31
-7,646.32	-7,725.29	-7,806.23	-7,889.20	-7,974.24	-8,061.40	-8,150.75	-8,242.33	-8,336.19	-8,432.41	-8,531.03	-8,632.12	-8,735.73	-8,841.93	35,925.31
-82,404.42	-67,786.17	-52,290.83	-35,865.77	-18,455.20	0	0	0	0	0	0	0	0	0	0
4,944.27	4,067.17	3,137.45	2,151.95	1,107.31	0	0	0	0	0	0	0	0	0	0
14,618.25	15,495.34	16,425.06	17,410.57	18,455.20	0	0	0	0	0	0	0	0	0	0
19,562.51	19,562.51	19,562.51	19,562.51	19,562.51	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-881.34	-825.47	-766.06	-702.88	-635.71	-564.3	-570.55	-576.96	-583.53	-590.27	-597.17	-604.25	-611.5	-618.94	2,514.77
881.34	825.47	766.06	702.88	635.71	564.3	570.55	576.96	583.53	590.27	597.17	604.25	611.5	618.94	-2,514.77
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-3,278.59	-3,070.76	-2,849.73	-2,614.71	-2,364.84	-2,099.19	-2,122.45	-2,146.30	-2,170.75	-2,195.80	-2,221.48	-2,247.80	-2,274.78	-2,302.44	9,354.95
3,278.59	3,070.76	2,849.73	2,614.71	2,364.84	2,099.19	2,122.45	2,146.30	2,170.75	2,195.80	2,221.48	2,247.80	2,274.78	2,302.44	-9,354.95
-23,048.91	-23,391.57	-23,752.95	-24,134.12	-24,536.21	-5,397.92	-5,457.74	-5,519.06	-5,581.92	-5,646.34	-5,712.38	-5,780.06	-5,849.44	-5,920.56	24,055.59
-14,276.90	-14,445.22	-14,628.79	-14,828.61	-15,045.76	4,281.16	4,413.70	4,548.58	4,685.82	4,825.46	4,967.55	5,112.13	5,259.23	5,408.91	35,610.22
3,652.03	3,773.50	3,897.11	4,022.90	4,150.90	4,281.16	4,413.70	4,548.58	4,685.82	4,825.46	4,967.55	5,112.13	5,259.23	5,408.91	35,610.22
-48,841.06	-45,067.56	-41,170.45	-37,147.56	-32,996.66	-28,715.50	-24,301.80	-19,753.22	-15,067.40	-10,241.94	-5,274.38	-162.25	5,096.98	10,505.89	46,116.11