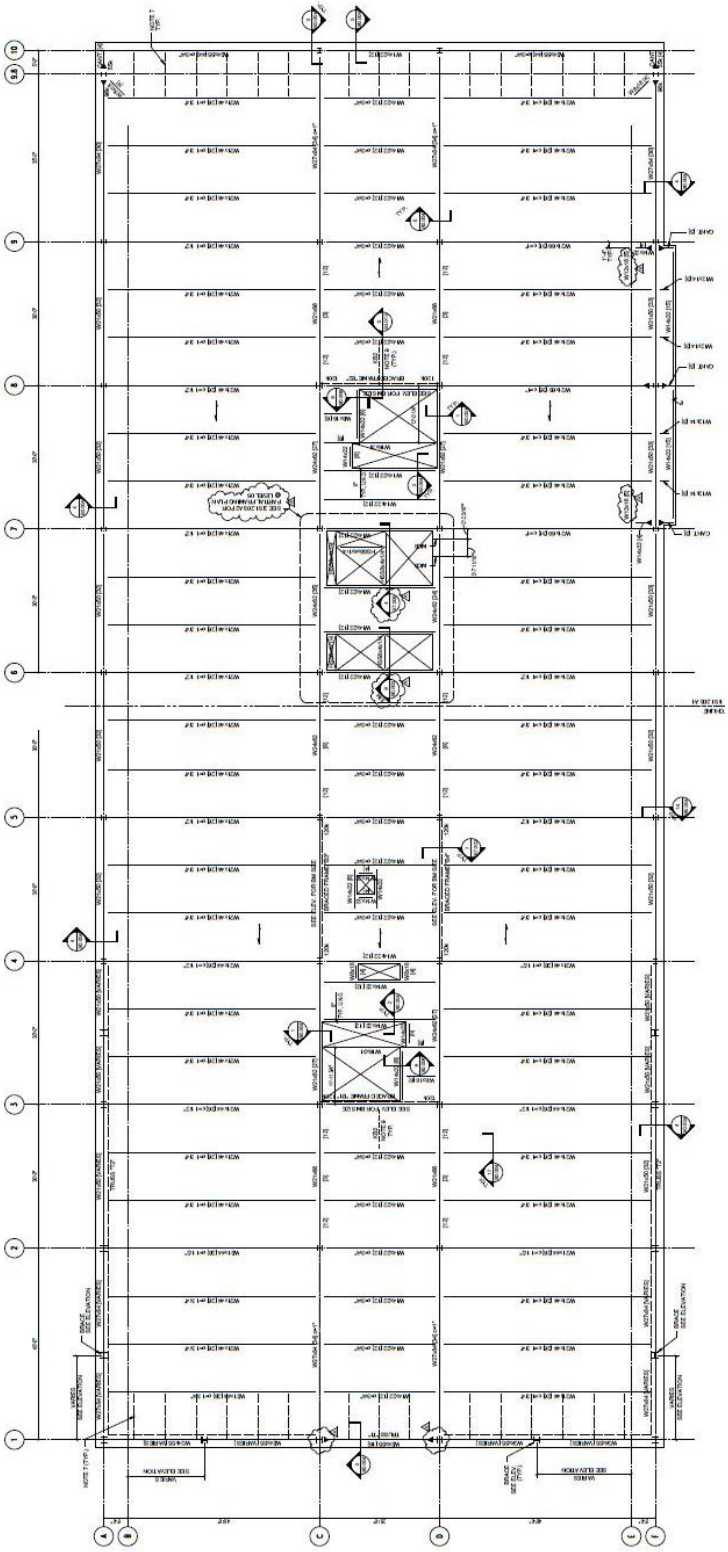
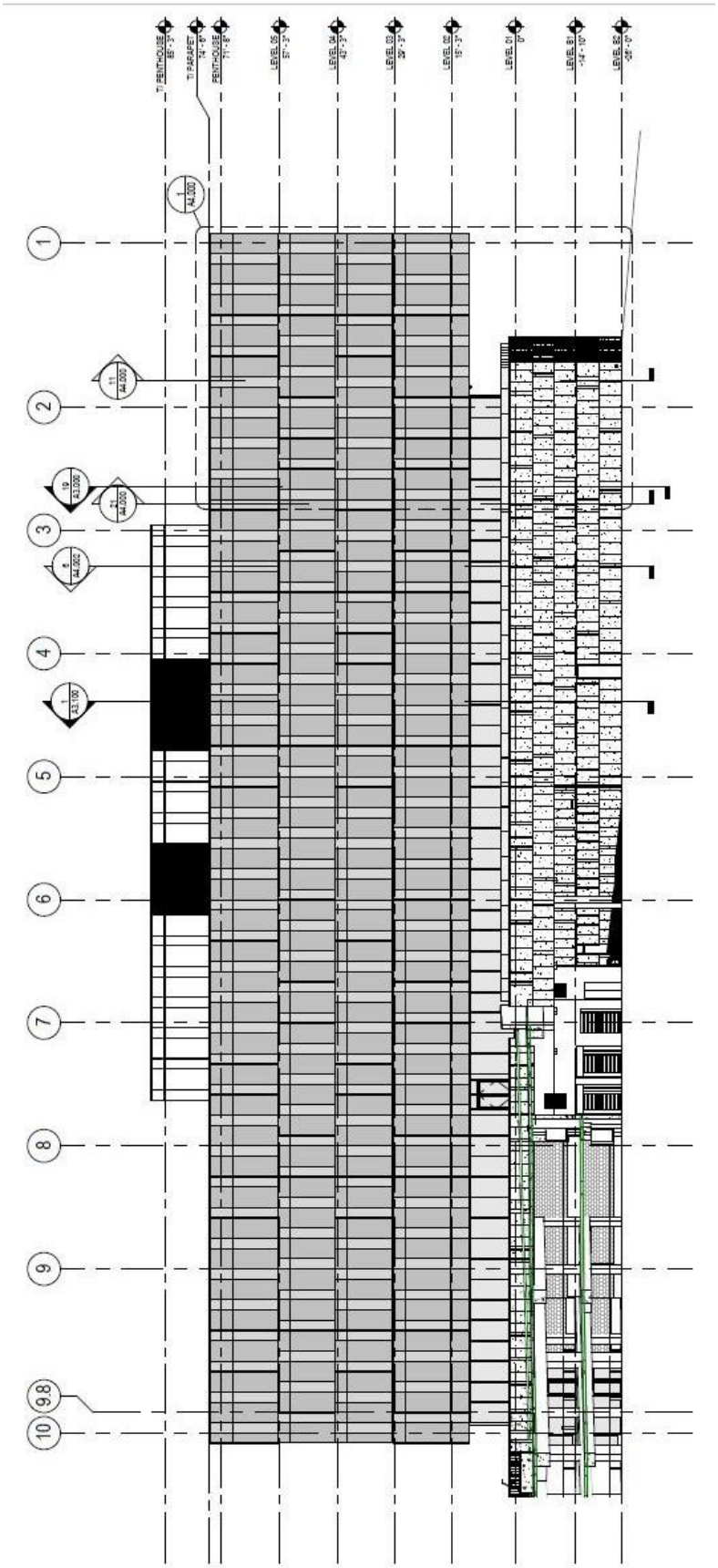
Appendices

Appendix A: Additional Plans





Appendix B: As Built Wind Calculations

Begins next page.

WIND LOADING

ASCE 7-05 ANALYTICAL PROCEDURE

- DETERMINE BASIC WIND SPEED, V
  V = 90 mph [FIG. 6-1]
- WIND DIRECTIONALITY FACTOR, K_d
  FOR BUILDINGS, $K_d = 0.85$ [TABLE 6-4]
- IMPORTANCE FACTOR, I
  OCCUPANCY CATEGORY III [TABLE 1-1]
  I = 1.15 [TABLE 6-1]
- EXPOSURE CATEGORY
  - HILLY TERRAIN WITH SURROUNDING DEVELOPMENTS AND SOME TREES ∴ EXPOSURE B [§ 6.5.6]
- TOPOGRAPHIC FACTOR, K_{zt}
  - BUILDING BUILT INTO LOW HILL NOT ON TOP ∴ $K_{zt} = 1.0$
- GUST FACTOR
  - ESTIMATE NATURAL FREQUENCY

$$n_1 = 75/H \quad [\text{EQN. CG-18}]$$

H < 300 ft, < 4 Less OR

$$n_1 = 75/111.25 = 0.674 < 1 \therefore \text{FLEXIBLE}$$

  - DETERMINE G_f IN NW-SE DIRECTION

$$g_Q = g_v = 3.4$$

$$g_R = \sqrt{2\ln(3600 \cdot 0.674)} + \frac{0.577}{\sqrt{2\ln(3600 \cdot 0.674)}} = 4.09$$

  - DETERMINE RESPONSE FACTOR, R

$$\bar{b} = 0.45$$

$$\bar{\alpha} = 1/4.0 = 0.25 \quad [\text{TABLE 6-2}]$$

$$\bar{z} = \max\begin{cases} 0.6h = 0.6(104) = 62.4 \\ z_{min} = 30' \end{cases}$$

JUSTIFICATION NEXT PAGE $\longrightarrow h = \frac{97.65' + 111.25'}{2} = 104'$

$\therefore \bar{z} = 62.4'$

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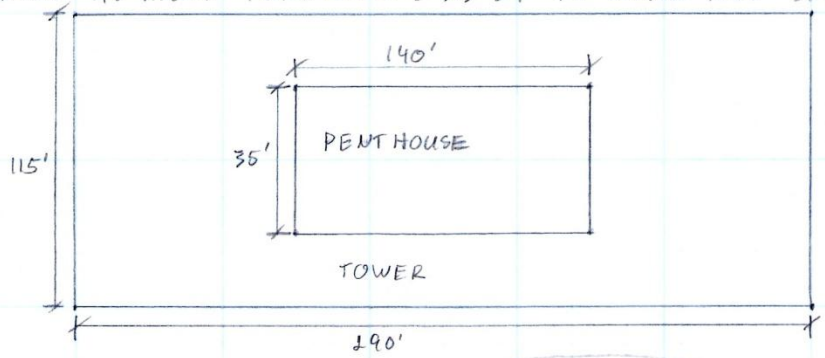
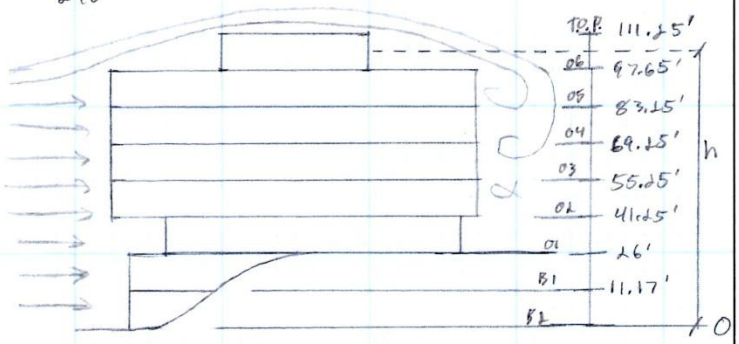
MEAN ROOF HEIGHT JUSTIFICATION

- BECAUSE PENTHOUSE IS SET BACK, IT WILL NOT SEE FULL WIND/ CAUSE AS MUCH TURBULANCE AS IF IT WERE NOT SET BACK.

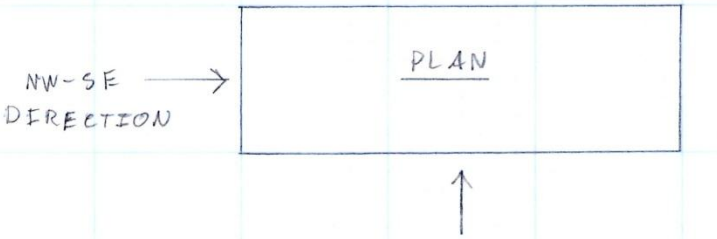


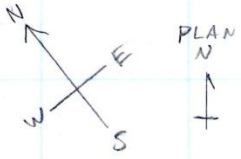
- AREA RATIO;
  $\frac{(140)(35)}{(115)(190)} = 0.15 < 0.5$
- LENGTH RATIO;
  $140/190 = 0.48 < 0.5$
- WIDTH RATIO;
  $35/115 = 0.30 < 0.5$



∴ USE MEAN ROOF HEIGHT TO THE MIDHEIGHT OF THE PENTHOUSE.

BUILDING AND WIND DIRECTIONS W.R.T. TRUE NORTH





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$\bar{V}_z = \bar{b}\left(\frac{\bar{z}}{33}\right)^{\alpha} V\left(\frac{88}{60}\right) = 0.45\left(\frac{62.4}{33}\right)^{0.25}(90)\left(\frac{88}{60}\right) = 69.7$

$l = 320'$

$\bar{\varepsilon} = 1/3.0 = 0.33$ [TABLE 6-2]

$L_z = l\left(\frac{\bar{z}}{33}\right)^{\bar{\varepsilon}} = 320\left(\frac{62.4}{33}\right)^{0.33} = 395$

$N_1 = \frac{n_1 L_z}{\bar{V}} = \frac{0.674(395)}{69.7} = 3.82$

$R_n = \frac{7.47 N_1}{(1+10.3N_1)^{5/3}} = \frac{7.47(3.82)}{(1+10.3\cdot 3.82)^{5/3}} = 0.060$

DAMPING RATIO, β FROM COMMENTARY §C6.5.8

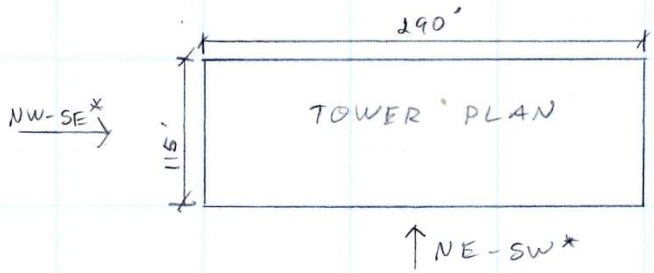
ASSUME $\beta = 0.015$

- FOR R_h

$\eta = \frac{4.6 n_1 h}{\bar{V}_z} = \frac{4.6(0.674)(104)}{69.7} = 4.626$

$R_h = \frac{1}{\eta} - \frac{1}{2\eta^2}(1-e^{-2\eta})$

$= \frac{1}{4.626} - \frac{1}{2\cdot 4.626^2}(1-e^{-2\cdot 4.626}) = R_h = 0.192$



* TRUE NORTH RELATED WIND DIRECTIONS (SEE PREVIOUS PAGE)

	NW-SE	NE-SW
B	115'	290'
L	290'	115'

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- FOR R_B

$$n = \frac{4.6\, h_1\, B}{V_z} = \frac{4.6(0.672)(115')}{62.7} = 5.670$$

$$R_B = \frac{1}{5.67} - \frac{1}{2 \cdot 5.67^2}\left(1 - e^{-2 \cdot 5.67}\right) = 0.161$$

- FOR R_L

$$n = \frac{15.4\, n_1\, L}{V_z} = \frac{15.4\,(0.674)(290')}{62.7} = 48.0$$

$$R_L = \frac{1}{48.0} - \frac{1}{2 \cdot 48.0^2}\left(1 - e^{-2 \cdot 48.0}\right) = 0.021$$

$$R = \sqrt{\tfrac{1}{\beta} R_n R_h R_B (0.53 + 0.47 R_L)}$$

$$= \sqrt{(1/0.015)(0.060)(0.192)(0.161)(0.53 + 0.47 \cdot 0.021)}$$

$$R = 0.258$$

- FIND INTENSITY OF TURBULENCE, I_z

$c = 0.30$ [TABLE 6-2]

$$I_z = c\left(\frac{33}{z}\right)^{1/6} = 0.30\left(\frac{33}{62.4}\right)^{1/6} = 0.270$$

- BACKGROUND RESPONSE, Q

$$Q = \sqrt{\frac{1}{1 + 0.63\left(\frac{B+h}{L_z}\right)^{0.63}}} = \sqrt{\frac{1}{1 + 0.63\left(\frac{115+104}{395}\right)^{0.63}}}$$

$$Q = 0.835$$

$$G_f = 0.925\left(\frac{1 + 1.7 I_z \sqrt{g_Q^2 Q^2 + g_R^2 R^2}}{1 + 1.7 g_v I_z}\right)$$

$$= 0.925\left(\frac{1 + 1.7(0.270)\sqrt{3.4^2 \cdot 0.835^2 + 4.09^2 \cdot 0.258^2}}{1 + 1.7(3.4)(0.270)}\right)$$

$$G_{f\ NW\text{-}SE} = 0.863$$

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- DETERMINE G_f IN NE-SW DIRECTION

$g_Q = g_v = 3.4$ $\quad \bar{V}_z = 69.7$ $\quad R_n = 0.060$

$g_r = 4.09$ $\quad L_z = 345$ $\quad \beta = 0.015$

$\bar{z} = 62.4'$ $\quad N_1 = 3.82$ $\quad I_z = 0.270$

$R_h = 0.192$ $\quad h = 104'$

- FOR R_B

$$n = \frac{4.6(0.674)(190)}{69.7} = 12.9$$

$$R_B = \frac{1}{12.9} - \frac{1}{2 \cdot 12.9^2}\left(1 - e^{-2 \cdot 12.9}\right) = 0.745$$

- FOR R_L

$$n = \frac{15.4(0.674)(115')}{69.7} = 17.1$$

$$R_L = \frac{1}{17.1} - \frac{1}{2 \cdot 17.1^2}\left(1 - e^{-2 \cdot 17.1}\right) = 0.0568$$

- R

$$R = \sqrt{\left(\tfrac{1}{0.015}\right)(0.060)(0.192)(0.745)(0.53 + 0.47 \cdot 0.0568)} = 0.564$$

- Q

$$Q = \sqrt{\frac{1}{1 + 0.63\left(\frac{190 + 104}{345}\right)^{0.63}}} = 0.738$$

- G_f

$$= 0.925\left(\frac{1 + 1.7(0.270)\sqrt{3.4^2(0.738^2) + (4.09^2)(0.564^2)}}{1 + 1.7(3.4)(0.270)}\right)$$

$$G_{f\,NE-SW} = 1.00$$

- ENCLOSURE CLASSIFICATION [§6.5.9]
  - NO OPENINGS ∴ ENCLOSED

- INTERNAL PRESSURE COEFFICIENT, GC_{pi}

$GC_{pi} = \pm 0.18$ [FIG. 6-5]

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• EXTERNAL PRESSURE COEFFICIENTS, C_p

- WALLS NW-SE DIRECTION [FIG. 6-6]

WINDWARD WALL: $C_p = 0.8$ (USE W/ q_z)

SIDE WALL: $C_p = -0.7$ (USE W/ q_h)

LEEWARD WALL:

$L/B = 290/115 = 2.52$

INTERPOLATE:

L/B	C_p
2	-0.3
2.52	-0.274
4	-0.2

$\frac{(-0.2 - -0.3)}{4-2}(2.52-2) + -0.3 =$

$C_p = -0.274$ (USE W/ q_h)

- WALLS NE-SW DIRECTION

WINDWARD WALL: $C_p = 0.8$ (USE W/ q_z)

SIDEWALL: $C_p = -0.7$ (USE W/ q_h)

LEEWARD WALL:

$L/B = 115/290 = 0.397$ ∴ $C_p = -0.5$ (USE W/ q_h)

- ROOF NW-SE DIRECTION

$h/L = 104/290 = 0.36 \geq 0.5$

HORIZ DIST FROM WINDWARD EDGE	C_p
0 TO 52'	-0.9, -0.18
52' TO 104'	-0.9, -0.18
104' TO 208'	-0.5, -0.18
> 208	-0.3, -0.18

- ROOF NE-SW DIRECTION

$h/L = 104/115' = 0.904$

• 0 TO 52':

0.5	-0.9
0.904	-1.01
1.0	$-1.3(0.6) = -1.04$

$\frac{-1.04 - -0.9}{1 - 0.5}(0.904 - 0.5) + -0.9$

REDUCE? ⇒ $(39.25')(190') \sim 11000$ ∴ REDUCE BY 0.8

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TITLE: WIND LOAD C_p CALCULATIONS

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- 52' TO 104'

0.5	-0.9	$\frac{-0.7-(-0.9)}{1-0.5}(0.904-0.5)+(-0.9)$
0.904	-0.738	
1.0	-0.7	

- 104' TO 208'

0.5	-0.5	$\frac{-0.7-(-0.5)}{1-0.5}(0.904-0.5)+(-0.5)$
0.904	-0.661	
1.0	-0.7	

- > 208'

0.5	-0.3	$\frac{-0.7-(-0.3)}{1-0.5}(0.904-0.5)+(-0.3)$
0.904	-0.623	
1.0	-0.7	

* SEE FOLLOWING EXCEL SHEETS FOR PRESSURE CALCULATIONS

- DESIGN WIND PRESSURES
  - FOR FLEXIBLE BUILDINGS

$$p = q\,G_f\,C_p - q_i(GC_{pi}) \quad [\text{EQN. } 6\text{-}19]$$

  - FOR PARAPETS

$$p_p = q_p\,GC_{pn} \quad [\text{EQN. } 6\text{-}20]$$

$GC_{pn} = +1.5$ WINDWARD PARAPET
$GC_{pn} = -1.0$ LEEWARD PARAPET

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TITLE: WIND LOAD C_p CALCULATIONS

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$K_z=2.01(z/z_g)^{2/\alpha}$

$q_z=0.00256K_zK_{zt}K_dV^2I$

Kd=	0.85	
Kzt=	1	
V=	90	mph
I=	1.15	
z_g=	1200	ft

Determine K_z and q_z						
Floor	z	z_g (ft)	α	K_z	q_z	OR:
B1	11.17	1200	7	0.528	10.7	
1	26	1200	7	0.673	13.6	
2	41.25	1200	7	0.767	15.6	
3	55.25	1200	7	0.834	16.9	
4	69.25	1200	7	0.890	18.0	
5	83.25	1200	7	0.938	19.0	
6	97.65	1200	7	0.982	19.9	
Tower Parapet	100.65	1200	7	0.990	20.1	q_p
Mean Roof Height	104	1200	7	0.999	20.3	q_h
T.O. Penthouse	111.25	1200	7	1.019	20.7	
Penthouse Parapet	114.25	1200	7	1.027	20.8	q_p

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MWFRS ANALYSIS: NE-SW Walls								
Floor	z	q	Windward (PSF)	Leeward (PSF)	Tribuary Height(ft.)	Tributary Area(SF)	Story Shear(k)	Story M_{OT}(ft.-k)
B1	11.17	10.7	8.57	-10.1	18.585	5390	100.76	189.2
1	26	13.6	10.91	-10.1	15.04	3685	77.50	1432.3
2	41.25	15.6	12.44	-10.1	14.625	4241	95.73	3248.8
3	55.25	16.9	13.53	-10.1	14	4060	96.04	4633.8
4	69.25	18.0	14.43	-10.1	14	4060	99.70	6206.2
5	83.25	19.0	15.21	-10.1	14.2	4118	104.33	7944.8
6	97.65	19.9	15.92	-10.1	7.2	2088	54.38	5114.5
Tower Parapet	100.65	20.1	30.10	-20.3	3	870	43.81	4344.0
Mean Roof Height	104	20.3	16.21	-10.1	6.975	977	25.71	2584.7
T.O. Penthouse	111.25	20.7	16.52	-10.1	3.625	508	13.52	1480.1
Penthouse Parapet	114.25	20.8	31.21	-20.3	3	420	21.62	2437.3
						Base Shear and M_{OT}=	**733**	**39615**

$p=qG_fC_p-q_i(GC_{pi})$

G_f=	1.0	
C_p=	0.8	Windward
	-0.5	Leeward
GC_{pn}=	1.5	Windward
	-1.0	Leeward
q_h=	20.7	ft.

MWFRS ANALYSIS: NE-SW ROOF				
Dist. H	0' to 52'	52' to 104'	104' to 208'	>208'
C_p	-1.01	-0.738	-0.662	-0.623
Pressure (PSF)	**-20.9**	**-15.2**	**-13.7**	**-12.9**

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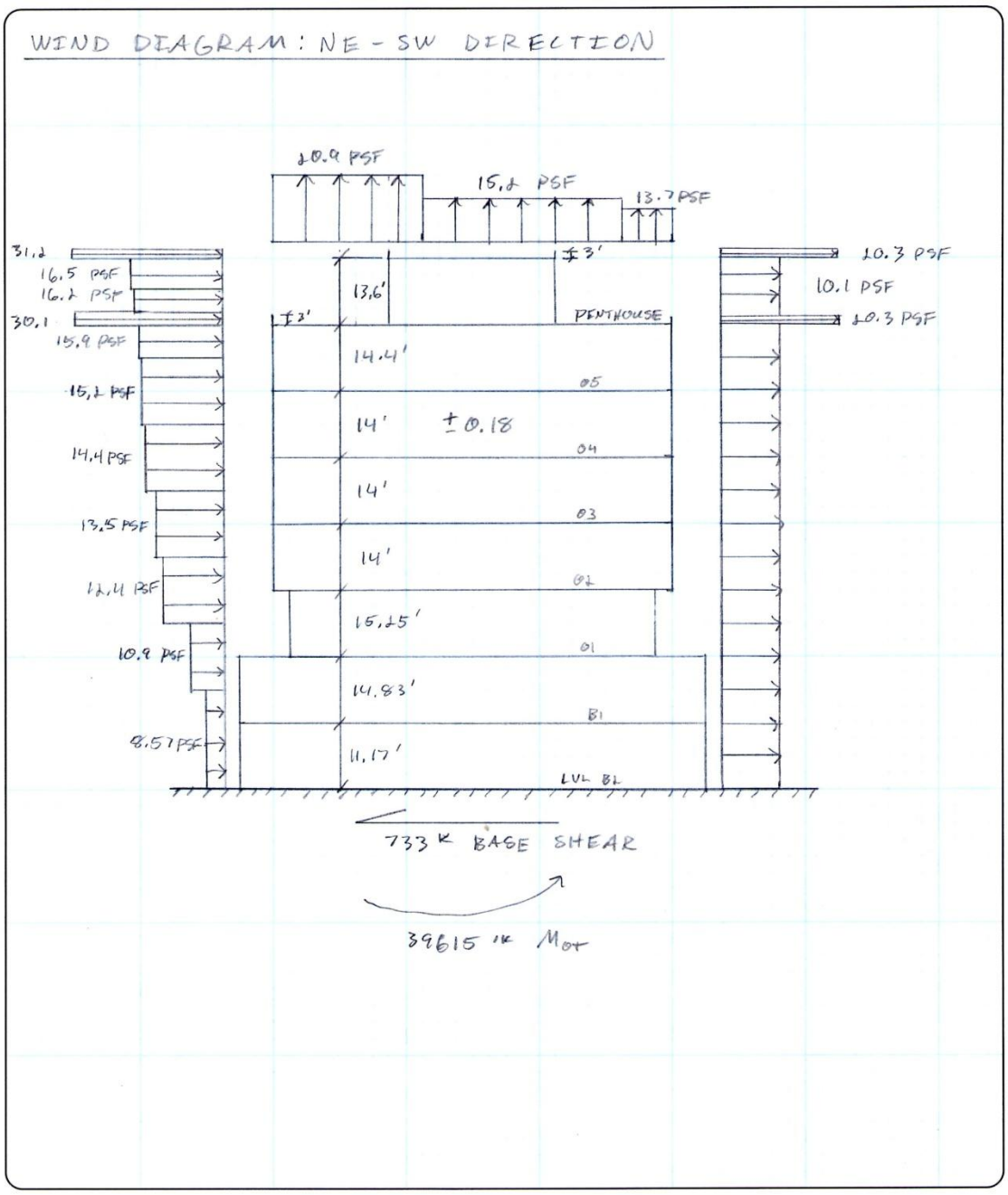

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MWFRS ANALYSIS: NW-SE Walls								
Floor	z	q	Windward (PSF)	Leeward (PSF)	Tribuary Height(ft.)	Tributary Area(SF)	Story Shear(k)	Story M_{OT}(ft.-k)
B1	11.17	10.7	7.39	-4.79	18.585	2323	28.30	53.1
1	26	13.6	9.41	-4.79	15.04	1579	22.43	414.4
2	41.25	15.6	10.74	-4.79	14.625	1682	26.12	886.3
3	55.25	16.9	11.67	-4.79	14	1610	26.51	1278.9
4	69.25	18.0	12.45	-4.79	14	1610	27.76	1727.9
5	83.25	19.0	13.12	-4.79	14.2	1633	29.25	2227.6
6	97.65	19.9	13.74	-4.79	7.2	828	15.34	1442.7
Tower Parapet	100.65	20.1	30.10	-20.26	3	345	17.37	1722.6
Mean Roof Height	104	20.3	13.99	-4.79	6.975	244	4.58	460.7
T.O. Penthouse	111.25	20.7	14.26	-4.79	3.625	127	2.42	264.5
Penthouse Parapet	114.25	20.8	31.21	-20.26	3	105	5.40	609.3
						Base Shear and M_{OT}=	**205**	**11088**

$p=qG_fC_p-q_i(GC_{pi})$

G_f=	0.863	
C_p=	0.8	Windward
	-0.274	Leeward
GC_{pn}=	1.5	Windward
	-1.0	Leeward
q_h=	20.7	ft.

MWFRS ANALYSIS: NW-SE ROOF				
Dist. H	0' to 52'	52' to 104'	104' to 208'	>208'
C_p	-0.9	-0.9	-0.5	-0.3
Pressure (PSF)	**-16.04**	**-16.04**	**-8.91**	**-5.35**

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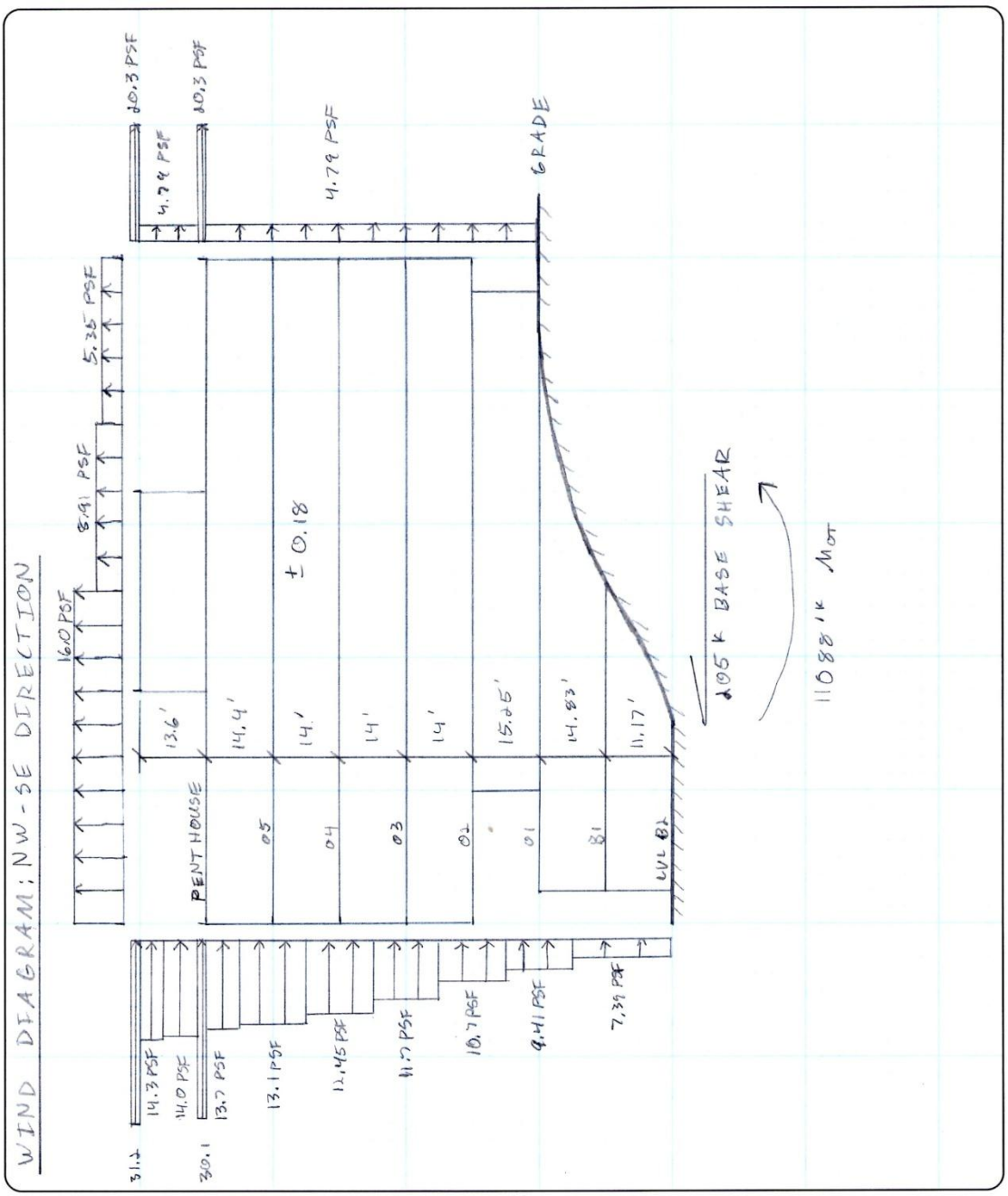

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Appendix C: As Built Seismic Calculations

COMBINED STORY WEIGHTS (k)						
	Parking Structure				Office	
Level	Walls	Columns	Slabs	Beams	Total	Total
B1	1286	431	5839	1412	0	8968
1	702	246	7201	3348	1881	13378
2	0	0	0	0	2521	2521
3	0	0	0	0	2527	2527
4	0	0	0	0	2527	2527
5	0	0	0	0	2531	2531
6	0	0	0	0	1680	1680
Penthouse	0	0	0	0	1543	1543

MODELING ADJUSTMENTS		
Level	Weight(k)	Total(k)
B1	8968	8968
1	To 2	
2	15899	
3	2527	
4	2527	
5	2531	
6	1680	
Penthouse	1543	26707

A_b=	66733	SF
h_n=	26	ft.
h_i=	26	ft.

APPROX. FUNDAMENTAL PERIOD: PARKING				
SW #	D_i	A_i	NW-SE Dir.	NE-SW Dir.
5	55.7	1447	1225.45	-
	22.7	589	-	281.70
6	23.0	598	-	290.20
10	60.0	1560	-	1349.65
Wall PV	180	4680	4600.33	-
Wall P1	134	3484	-	3378.43
		Sum=	5826	5300
		C_w=	8.730	7.942
		T_a=	**0.017**	**0.018**

k_{office}=	1.03	
$k_{parking}$=	0.5	
V_{total}=	4235	k

SEISMIC STORY FORCES

Level	w_x(k)	h_x(ft)	$w_x h_x^k$(ft-k)	C_{vx}	F_x(k)	M_{OT}(ft.-k)
B1	8968	11.2	29972	0.017	**73**	812
1	13378	26.0	Weight Lumped to Level 2			0
2	15899	41.3	733262	0.420	**1779**	73367
3	2527	55.3	157491	0.090	**382**	21106
4	2527	69.3	198740	0.114	**482**	33383
5	2531	83.3	240549	0.138	**583**	48574
Penthouse	1680	97.7	188269	0.108	**457**	44593
PH Roof	1543	111.3	197690	0.113	**480**	53346
		$\Sigma w_x h_x^k$=	1745974	1	**4235**	**275180**

MODELING ADJUSTED FORCES

Level	F_x(k)	
B1	73	
1	-	
2	1779	
3	382	
4	482	
5	583	
Penthouse	936	
Sum=	4235	ok

SEISMIC LOAD CASE ECCENTRICITIES									
Level	Force(k)	XCM(ft.)	XCR(ft.)	ex (ft.)	5%Bx(ft.)	YCM(ft.)	YCR(ft.)	ey(ft.)	5%By(ft.)
Penthouse	936	130	134.6	4.59	5.750	57.5	57.5	0	14.5
5	583	127.5	137.1	9.61	5.750	57.5	57.5	0	14.5
4	482	130	140.3	10.34	5.750	57.5	57.5	0	14.5
3	382	127.5	142.9	15.45	5.750	57.5	57.5	0	14.5
2	1779	130	144.9	14.93	5.750	57.5	57.5	0	14.5
B1	73	213.9734	330.1601	116.19	17.500	-108.5944	-103.6872	-4.9072	18.55
Sum=	4235								

Mtax=Fx(ey+5%Bx)
Mtay=Fx(ex+5%By)

100+30			
EX	30%EY	30%EX	EY
73	21.81	21.81	73

SEISMIC LOAD CASES													
	Case 1			Case 2			Case 3				Case 4			
Level	EX	Mtax(ft-k)-	Mtax(ft-k)-	EY	Mtay+	Mtay-	EX	Mtax+	Mtax-	EY	EY	Mtay+	Mtay-	EX
Penthouse	936	5383	-5383	936	17875	-9274	936	9683	-1083	936	936	9274	-17875	936
5	583	3355	-3355	583	14070	-2851	583	8964	2254	583	583	2851	-14070	583
4	482	2772	-2772	482	11974	-2006	482	7756	2212	482	482	2006	-11974	482
3	382	2197	-2197	382	11441	363	382	8098	3705	382	382	-363	-11441	382
2	1779	10227	-10227	1779	52351	772	1779	36789	16335	1779	1779	-772	-52351	1779
B1	73	916	-1629	73	9795	7098	73	10076	7531	73	73	-7455	-10152	73

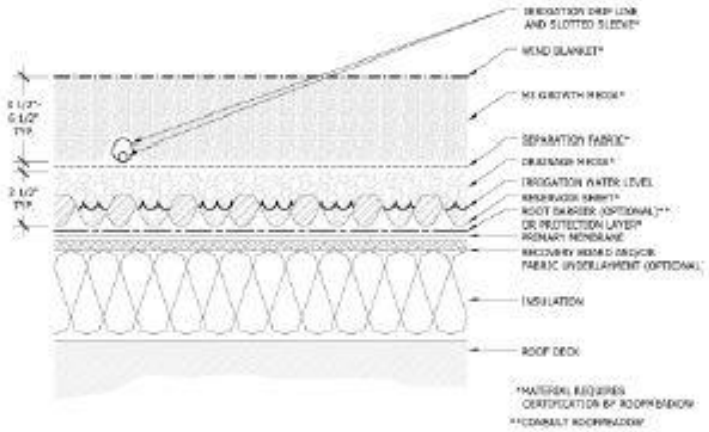
Appendix D: Roofmeadow System Information

Roofmeadow
Green roofs. For good.

Roofmeadow® Type V Data Sheet

Our experience demonstrates that the most efficient designs for the vast majority of American green roofs can be derived from five basic green roof types (Type I, II, III, IV, V). Roofmeadow® has developed assemblies for each of these types.

The selected assembly depends in part on project conditions including climate, desired plant community, performance requirements, and load bearing capacity of the building. All assemblies will include the following elements: 1) protection of the waterproofing membrane from root and biological attack, 2) protection of the waterproofing membrane from physical abuse and accident, 3) a base drainage layer, 4) a separation layer to prevent fine-grained engineered soils from fouling or clogging the drainage layer system, and 5) an engineered soil to support the vegetation.



Type V: Dual Media With Reservoir Sheet

A synthetic reservoir sheet over a protection fabric forms the base of the Type V assembly, which offers one solution to installing a three-course green roof over a PMR roofing system. A deep reservoir sheet is required; typical reservoir sheets are 2.6 to 2.4 inches (4 to 6 cm) thick and usually retain between 0.2 and 0.4 inches (0.5 to 1.0 cm) of water when filled with granular media. The coarse, large-grained granular media in the reservoir sheet cups 1) stabilizes the sheet, 2) facilitates drainage, and 3) reduces the potential for drought stress. A root-permeable separation fabric separates the fine-grained growth media from the granular media and prevents the fines from mixing with the granular media. The reservoir sheet stores captured rain or irrigation water for the root mass, and irrigation is provided by surface or sub-surface (just above the reservoir sheet) drip lines. Typical assembly thicknesses range from 6 to 10 inches (15 to 26 cm).

The profile of a Type V assembly is as follows:

Wind Erosion Stabilization System
Growth Medium
Root-permeable Separation Fabric
Light-weight Granular Drainage Media
Synthetic Reservoir Sheet (water storage layer)
Protection Fabric
Root Barrier Membrane (when required)
Waterproofing System

Roofmeadow ♦ 7135 Germantown Ave., 2nd Floor ♦ Philadelphia, PA, 19119 ♦ o. 215.247.8784 ♦ f. 215.247.4659 ♦ info@roofmeadow.com

HANOVER®
Architectural Products

PRODUCT DATA SHEET

Hanover® Prest® Pavers for Roofs & Waterproofed Decks

Hanover® Prest® Pavers, high density pressed concrete units, are manufactured to 1/8" tolerances and produced by subjecting the concrete mix to a minimum pressure of 1,000 pounds per square inch over the entire surface area. This results in a product with the density and strength of natural stone.

Hanover® Prest® Pavers provide durability and protection for the roof or waterproofed deck system from harsh weather conditions. Hanover® Pavers make roofs and decks safer for pedestrians and simplify repairs. Hanover® Support Pedestals, together with Hanover® Pavers, provide effective drainage between the pavers and the system below. Hanover® Support Pedestals make roof and deck plazas serviceable, functional and attractive.

Metric Size	Actual Size	1 1/4"	1 1/2"	2"	2 1/4"	2 1/2"	3"	4"
297mm x 297mm	11 3/4" x 11 3/4"		X	X	X	X	X	
303mm x 303mm	11 15/16" x 11 15/16"		X	X	X	X	X	
378mm x 378mm	14 7/8" x 14 7/8"		X	X	X	X	X	
297mm x 447mm	11 3/4" x 17 5/8"		X	X	X	X	X	
297mm x 597mm	11 3/4" x 23 1/2"	X	X	X	X	X	X	
447mm x 447mm	17 5/8" x 17 5/8"		X	X	X	X	X	X
447mm x 597mm	17 5/8" x 23 1/2"		X	X	X	X	X	
447mm x 899mm	17 5/8" x 35 3/8"		X	X	X	X	X	
597mm x 597mm	23 1/2" x 23 1/2"	X	X	X	X	X	X	X
597mm x 747mm	23 1/2" x 29 1/2"			X	X	X	X	
597mm x 897mm	23 1/2" x 35 3/8"			X	X	X	X	
756mm x 756mm	29 3/4" x 29 3/4"			X	X	X	X	
908mm x 908mm	*35 3/4" x 35 3/4" x 2 1/2"					X	X	

■ = Standard Thickness Weight (2" thickness): 25 lbs/sf *NOTE INCREASED THICKNESS & WEIGHT FOR THIS SIZE PAVER

RELATIVE STRENGTHS: (at 2" thickness)
Compressive: 8,500 psi at 28 days
Density: 155 lbs/cu. ft.
Flexural: 1,100 psi
Finish: Tudor®
Absorption: less than 5%
Weight: 25 lbs/sf

The test results displayed are taken from samples of Hanover's Prest® Pavers with a standard mix design. Hanover® Prest® Pavers, high density, hydraulically pressed concrete units, are manufactured to 1/8" tolerances and produced by subjecting the concrete mix to a minimum pressure of 1,000 pounds per square inch over the entire surface area. This results in a product with the density and strength of natural stone.

Pedestal® Paver

This patented paver incorporates the idea of an elevated paver drainage system with the use of an integral footed, concrete paver of the highest quality. An elevated clearance of 1/2" allows effective drainage.

Actual Size: 23 1/2" x 23 1/2" x 2 1/4"
Color: Natural
Metric Size: 597mm x 597mm x 57mm
Finish: Tudor®
Weight: 22 lbs/sf

Standard Colors:
Limestone Gray, Quarry Red, Cream, Tan, Brown, Red 15, Charcoal, and Natural
Custom color and aggregate blending is available on special order and when quantity ordered permits.

5000 Hanover Road, Hanover, PA 17331 • 717.637.0500 • Fax 717.637.7145 • www.hanoverpavers.com

Appendix E: Green Roof Calculations and Supplemental Information

Plant Image Sources

http://www.sedumphotos.net/v/sedum-pqr/Sedum+pluricaule+ezawe+compact+form+5.jpg.html

http://www.greenroofplants.com/catalog/plant-catalog/viewplant/?plantid=766

http://florafind.mainegardens.org/weboi/oecgi2.exe/INET_ECM_DispPl?NAMENUM=14716&DETAIL=1#images

http://www.qscaping.com/Content/Images/Photos/F593-18.jpg

http://www.thebattery.org/images/plants/autumn-m83.jpg

http://www.mrugala.net/Nature/Plantes/Photos/index.php?page=34

http://navigate.botanicgardens.org/weboi/oecgi2.exe/INET_ECM_DispPl?NAMENUM=47129&DETAIL=1#images

http://store.theodorepayne.org/product/SI_FESID.html

http://www.contracosta.watersavingplants.com/eplant.php?plantnum=24352&return=l5

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http://commons.wikimedia.org/wiki/File:Anthemis_April_2009-1.jpg

http://www.finegardening.com/plantguide/salvia-jurisicii-yugoslavian-cutleaf-sage.aspx

http://www.thebattery.org/plants/plantview.php?id=238

National Weather Service Climatological Report

Select Other Date ▾

These data are preliminary and have not undergone final quality control by the National Climatic Data Center (NCDC). Therefore, these data are subject to revision. Final and certified climate data can be accessed at the NCDC - http://www.ncdc.noaa.gov.

Climatological Report (Annual)

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CXUS53 KLSX 061651
CLAUIN

CLIMATE REPORT
NATIONAL WEATHER SERVICE ST LOUIS MO
1021 AM CST MON JAN 6 2014

.....................................

...THE QUINCY IL CLIMATE SUMMARY FOR THE YEAR OF 2013...

CLIMATE NORMAL PERIOD 1981 TO 2010
CLIMATE RECORD PERIOD 1901 TO 2014

WEATHER         OBSERVED          NORMAL  DEPART
                 VALUE   DATE(S)  VALUE   FROM
                                          NORMAL
.................................................
TEMPERATURE (F)
RECORD
 HIGH             114   07/15/1936
 LOW              -29   02/13/1905
HIGHEST           100   09/09
                        08/30
LOWEST                  12/24
AVG. MAXIMUM     61.7             62.1    -0.4
AVG. MINIMUM     42.1             43.3    -1.2
MEAN             51.9             52.7    -0.8
```

```
 DAYS MAX >= 90     29
 DAYS MAX <= 32     42
 DAYS MIN <= 32    127
 DAYS MIN <= 0       1

 PRECIPITATION (INCHES)
 RECORD
  MAXIMUM        66.60   1973
  MINIMUM        20.00   1953
 TOTALS          35.67            37.33   -1.66
 DAYS >= .01        93
 DAYS >= .10        56
 DAYS >= .50        21
 DAYS >= 1.00       12
 GREATEST
  24 HR. TOTAL    2.69  04/18 TO 04/18

 DEGREE_DAYS
 HEATING TOTAL    5906             5582     324
  SINCE 7/1       2316             2191     125
 COOLING TOTAL    1242             1095     147
  SINCE 1/1       1242             1094     148
 ................................................

 WIND (MPH)
 HIGHEST WIND SPEED/DIRECTION    46/320    DATE  06/23
 HIGHEST GUST SPEED/DIRECTION    77/260    DATE  04/17


 WEATHER CONDITIONS. NUMBER OF DAYS WITH
 THUNDERSTORM            47     FOG W/VIS <= 1/4 MILE     23

 -  INDICATES NEGATIVE NUMBERS.
 R  INDICATES RECORD WAS SET OR TIED.
 MM INDICATES DATA IS MISSING.
 T  INDICATES TRACE AMOUNT.


 SEE STLPNSLSX 1030 AM CST MON JAN 6 2014 FOR SUPPLEMENTAL ANNUAL CLIMATE DATA
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Plant Selection List for Hardiness Zone 6a

Begins on following page.

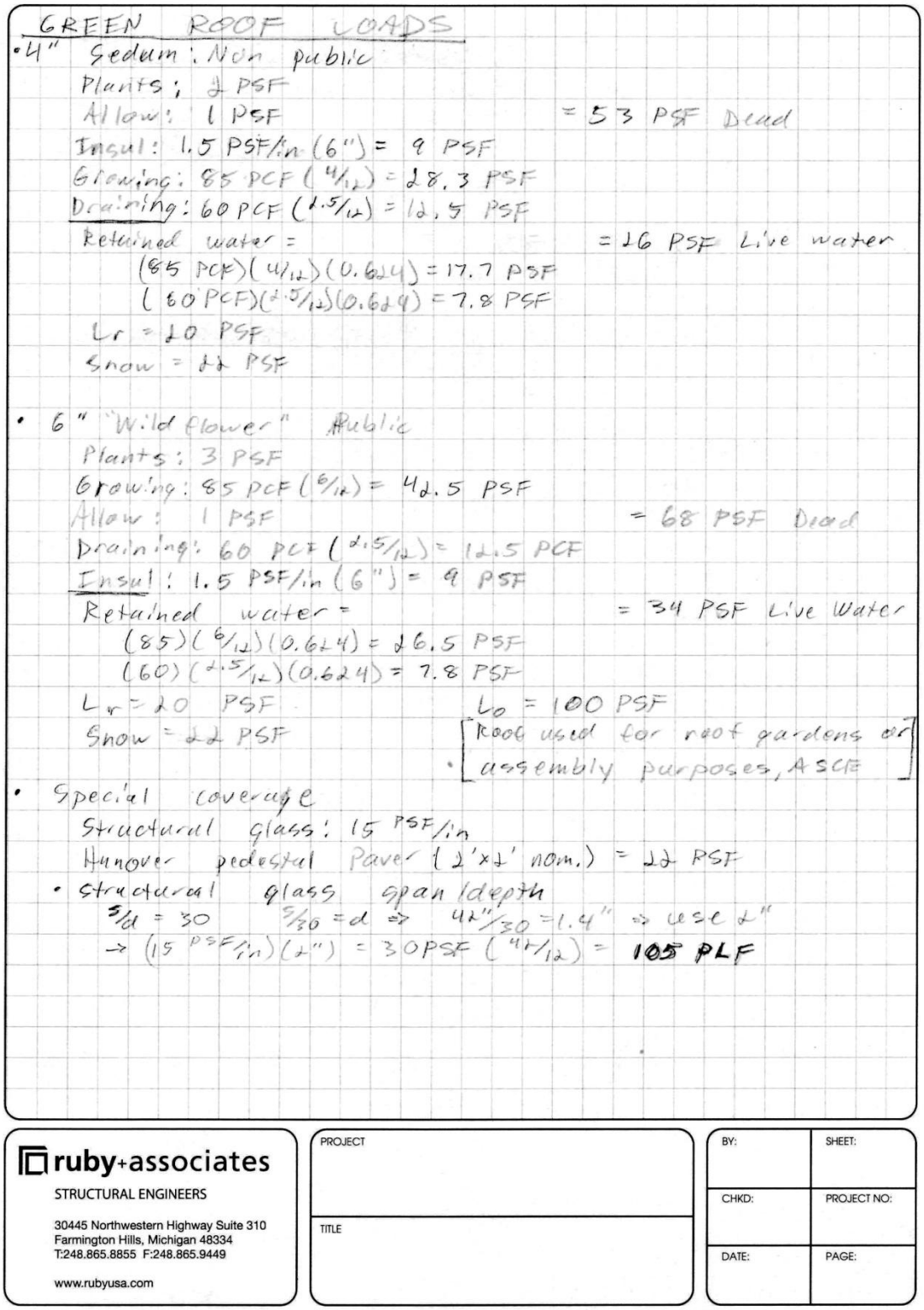
Plant	Page	Hardiness Zone	Flower/Foliage	Blooming Time	Groundcover or Accent?	Self Sowing?	Native Area	Height (Up to)	Spread	Medium Depth	Light Requirements	Notes
Agastache Rupestris	91	6	Orange flowers, blue-green foliage	Midsummer to midautumn	Accent	No	SW US	25"	10"	6"	Full sun, mixed sun/shade	Flowers attract hummingbirds, becomes shrublike
Alyssum montanum 'Berggold'	94	6	Yellow flowers, green foliage	Early summer	Groundcover	No	Europe	6"	10"	6"	Full sun	Can grow to 10,000 ft in altitude
Anacyclus pyrethrum var. depressus	95	6	White flowers w/ yellow centers, gray green foliage	Early summer	Accent	No	Spain, Morocco	4"	8"	6"	Full sun, mixed sun/shade	Red accents on flower petals, use in cooler summer locations
Anthemis tinctoria	96	6	Yellow flowers, green foliage	Midsummer	Accent	Yes	Southern Europe	19"	10"	6"	Full sun	Can be weedy, won't survive long dry periods
Delosperma basuticum 'Gold Nugget'	107	6	Yellow flowers, green foliage	Late Spring	Accent	No	South Africa	2"	4"	4"	Full sun	Flowers obscure foliage, may rebloom later in some years
Delosperma basuticum 'White Nugget'	108	6	White flowers w/ yellow centers, green foliage	Late Spring	Accent	No	South Africa	2"	4"	4"	Full sun	
Delosperma cooperi	108	6	Pink flowers, green foliage	Midsummer to midautumn	Groundcover	No	South Africa	4"	12"	4"	Full sun	Most common Delosperma, rapid growth, large flowers
Delosperma dyeri	108	6	Red flowers w/ light center, green foliage	Midsummer to midautumn	Groundcover	No	South Africa	3"	6"	4"	Full sun	Color fades with sun producting multiple shades of red
Delosperma ecklonis var. latifolia	109	6	Pink-purple flowers, green foliage	Midsummer to midautumn	Groundcover	No	South Africa	4"	10"	4"	Full sun	Reliably hardy, rapid coverage, can hang over an edge
Delosperma 'Kelaidis'	110	6	Salmon flowers, green foliage	Midsummer to midautumn	Groundcover	No	South Africa	4"	12"	4"	Full sun	Unusual flower color, rapid growth
Dianthus spiculifolius	114	6	White flowers with red eye, green foliage	Late Spring	Accent	No	Eastern Carpathians	6"	8"	6"	Full sun	Nice fragrance, dense foliage
Echium russicum	115	6	Dark red flowers, green foliage	Early to Late Summer	Accent	No	Europe, Africa, W. Asia	23"	8"	6"	Full sun	Tall red spikes, long bloom time, good plant for border
Euphorbia myrsinites	118	6	Yellow Flowers, blue green foliage	Late Spring	Accent	Yes	Mediterranean	10"	10"	6"	Full sun	Nice foliage and structure, can spread and may need controlled
Festuca idahoensis	118	6	Silver-blue flowers, blue green foliage	Late Spring	Accent	Yes	Western US	12"	8"	6"	Mixed sun/shade	Can be used in mass planting but may need divided or replanted over time
Fragaria chiloensis	118	6	White flowers, green foliage	Late Spring	Accent	No	Western US, South America	8"	10"	6"	Full sun, mixed sun/shade	Wild strawberry with edible fruit, can attract birds in habitat creation
Hieracium pilosella	121	6	Pale yellow flowers, hairy green foliage	Early to Late Summer	Groundcover	Yes	Europe, NW Siberia, Asia Minor	12"	8"	6"	Full sun	Forms tight mat and spreads by seed and stolons
Hieracium spilophaeum 'Leopard'	122	6	Yellow flowers, green foliage with purple brown	Early to Late Summer	Groundcover	Yes	Western and Central Europe	10"	8"	6"	Full sun	Colorful variegation provides more visual interest than other Hieracium outside bloom period

Hieracium villosum	122	6	Yellow flowers, hairy green foliage	Early to Late Summer	Groundcover	Yes	Alps, Carpathians, Apennines, others	12"	8"	6"	Full sun	Very hairy leaves, attractive when covered with morning due
Orostachys aggregeatum	131	6	White flowers, apple green foliage	Early autumn to midautumn	Groundcover	No	Northern Asia	6"	6"	4"	Full sun	All Orostachys send out plantlets on stolons in spring and summer creating mat of rosettes
Orostachys boehmeri	131	6	White flowers, gray foliage	Early autumn to midautumn	Groundcover	No	Northern Asia	6"	6"	4"	Full sun	Unusual gray foliage and dunce cap shaped flower stalks in the fall
Orostachys fimbriata	132	6	White flowers, gray brownish red foliage	Early autumn to midautumn	Accent	No	Northern Asia	6"	6"	4"	Full sun	More likely to die from winter wet than cold, needs sharp drainage, flowers bloom to sun
Penstemon smallii	133	6	Purple flowers, green foliage	Early to Late Summer	Accent	No	Southeastern US	22"	10"	6"	Full sun, mixed sun/shade	Native for dry shade, may need irrigation during dry periods
Petrorhagia saxifraga	134	6	Light pink flowers, green foliage	Early summer to early autumn	Groundcover	Yes	Southern Europe, Asia Minor	7"	12"	6"	Full sun	Lots of small pink flowers throughout summer, may need cut back before winter
Rosularia chrysantha	137	6	Creamy white flowers, yellow green foliage	Midsummer	Accent	No	Asia Minor, Central Asia	4"	5"	4"	Full sun	Foliage turns redish in winter, not fast growing, small mounds of rosettes provide interest in border
Rosularia muratdaghensis	138	6	White flowers, gray green foliage	Midsummer	Accent	No	Asia Minor, Central Asia	3"	4"	4"	Full sun	Foliage not as hairy as R. Chrysantha but same mounding habit
Salvia jurisicii	139	6	Pink lilac flowers, green foliage	Midsummer to late summer	Accent	No	Balkans	10"	12"	6"	Full sun	Good choice for Mediterranean conditions, fine textured foliage
Scabiosa columbaria 'Misty Butterflies'	141	6	Pink purple flowers, green foliage	Early summer to early autumn	Accent	No	Europe, Africa, Asia	10"	10"	6"	Full sun, mixed sun/shade	Colorful, another optioin is S. columbaria 'Pincushion Pink'
Sedum hispanicum	150	6	White flowers, blue green foliage	Midsummer	Groundcover	No	Sicily to Turkey	3"	8"	4"	Full sun	Rapid growing low sedum. Blues, pinks, and purples in foliage
Sedum 'Matrona'	154	6	Pink flowers, green gray foliage	Early autumn	Accent	No	Japan	12"	10"	4"	Full sun	Provides some height in plant in thin medium
Sedum pluricaule var. ezawe	157	6	Pink flowers, green to purple foliage	Midsummer to late summer	Groundcover	No	Eastern Siberia	3"	6"	4"	Full sun	Attractive tightly clustered leaves in shades of purple. Use for foliage more than flower.
Sedum sieboldii	161	6	Pink flowers, blue green foliage with pink tinges	Midautumn	Accent	No	Japan	8"	8"	4"	Full sun	Mounding. Needs more care to establish than groundcover sedums
Sedum spathulifolium	162	6	Yellow flowers, gray foliage	Midsummer to late summer	Groundcover	No	US Northwest	4"	6"	4"	Full sun, mixed sun/shade	Does not do well in the midwestern or eastern US
Sedum telephium 'Emperor's Waves'	166	6	Purple red flowers, blue green foliage	Late Spring	Accent	No	Japan	16"	8"	4"	Full sun	Exciting dark foliage. Good for contrast in both height and color.
Sedum urvillei	168	6	Yellow Flowers, blue green foliage	Late Summer	Groundcover	No	Eastern Europe, Middle East	2"	6"	4"	Full sun	Tight growth, can take the summer heat, foliage red in winter
Sesleria autumnalis	170	6	Golden brown flowers, green to golden foliage	Early autumn	Accent	Yes	Italy to Albania	16"	12"	6"	Full sun, mixed sun/shade	Not attractive as an accent, effective in mass, with golden fall color

Sporobolus heterolepis	173	6	Brown flowers, green foliage	Midsummer to early autumn	Accent	Yes	US Great Plains	30"	12"	6"	Full sun, mixed sun/shade	Graceful native grass, May need to mound medium before planting in drier locations
Talinum calycinum	173	6	Neon pink flowers, green flowers	Midsummer to midautumn	Accent	Yes	North America	4"	2"	4"	Full sun	Showiest of talinums, a favorite of honeybees, foliage disappears at the first sign of frost
Talinum parviflorum	174	6	Light pink flowers, green foliage	Midsummer to midautumn	Accent	Yes	North America	8"	4"	4"	Full sun	Suited for very dry and windy locations
Talinum teretifolium	175	6	Rose pink flowers, green foliage	Midsummer to midautumn	Accent	Yes	Appalachians, PA to GA	12"	6"	4"	Full sun	Threatened throughout the Mid-Atlantic region due to its shrinking habitat, opportunity for conservation

Yellow	Low Sedum
Green	Wild Flower
Red	Garden Area

Green Roof Load Calculations



GREEN ROOF LOADS

- 4" Sedum: Non public
  - Plants; 2 PSF
  - Allow: 1 PSF
  - Insul: 1.5 PSF/in (6") = 9 PSF
  - Growing: 85 PCF (4/12) = 28.3 PSF
  - Draining: 60 PCF (1.5/12) = 12.5 PSF

  = 53 PSF Dead

  Retained water =
  (85 PCF)(4/12)(0.624) = 17.7 PSF
  (60 PCF)(1.5/12)(0.624) = 7.8 PSF

  = 26 PSF Live water

  L_r = 20 PSF
  Snow = 22 PSF

- 6" "Wild flower" Public
  - Plants: 3 PSF
  - Growing: 85 PCF (6/12) = 42.5 PSF
  - Allow: 1 PSF
  - Draining: 60 PCF (1.5/12) = 12.5 PCF
  - Insul: 1.5 PSF/in (6") = 9 PSF

  = 68 PSF Dead

  Retained water =
  (85)(6/12)(0.624) = 26.5 PSF
  (60)(1.5/12)(0.624) = 7.8 PSF

  = 34 PSF Live Water

  L_r = 20 PSF
  Snow = 22 PSF

  L_o = 100 PSF
  - [Roof used for roof gardens or assembly purposes, ASCE]

- Special coverage
  - Structural glass: 15 PSF/in
  - Hunover pedestal Paver (2'x2' nom.) = 22 PSF
  - Structural glass span/depth
    - 5/d = 30 5/30 = d ⇒ 42"/30 = 1.4" ⇒ use 2"
    - → (15 PSF/in)(2") = 30 PSF (4'/12) = 105 PLF

ruby+associates
STRUCTURAL ENGINEERS
30445 Northwestern Highway Suite 310
Farmington Hills, Michigan 48334
T:248.865.8855 F:248.865.9449
www.rubyusa.com

PROJECT
TITLE

BY: SHEET:
CHKD: PROJECT NO:
DATE: PAGE:

- Mechanical point loads
  - Dead load: W8X18 = 16 PLF
    - Conc: = 33.8 PSF
    - Deck: = 2.14 PSF
    - SDL = 10 PSF
  - trib: 2.5' x 5'
    - Cladding = 226 PLF
  - Dead = (2.5)(5)(33.8+2.14+10) + 5(18+226) = 1.79 K, 3.58 K
  - Live = (2.5)(5)(125 PSF) = 1.56 K, 3.12 K

- New composite Deck (Public)
  - Live load = 100 PSF } SL = 168 PSF
  - SDL = 68 PSF }
  - Use composite instead of roof deck b/c a concrete slab is more compatible w/ green roof + loads
  - 1 hr fire rating: unprotected deck, 3 1/4" Ltwt conc.
  - 3VLI19 Ltwt conc t = 3.25"
    - Max unshored 3 span 14'-6" > 10' OK
    - Strength @ 10' = 168 = 168 Ffy
  - 3VLI19 Ltwt conc t = 3.50" → use this
    - Max unshored 3 span 14'-4" > 10' OK
    - Strength @ 10' = 176 PSF > 168 OK
    - System wt = 48 PSF

- New composite Deck (non public)
  - Live Load = 26 PSF
  - SDL = 53 PSF Same as previous (fire)

- Etabs Loads:
  - 4" Sedum
    - Dead: 53 + 48 = 101 PSF Live = 26 PSF
  - 6" W.B
    - Dead: 68 + 48 = 116 PSF Live = 100 PSF
  - Also: Glass, pavers, furniture, mechanical

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PROJECT
TITLE

BY: SHEET:
CHKD: PROJECT NO:
DATE: PAGE:

Appendix F: Roof Redesign ETABS Output

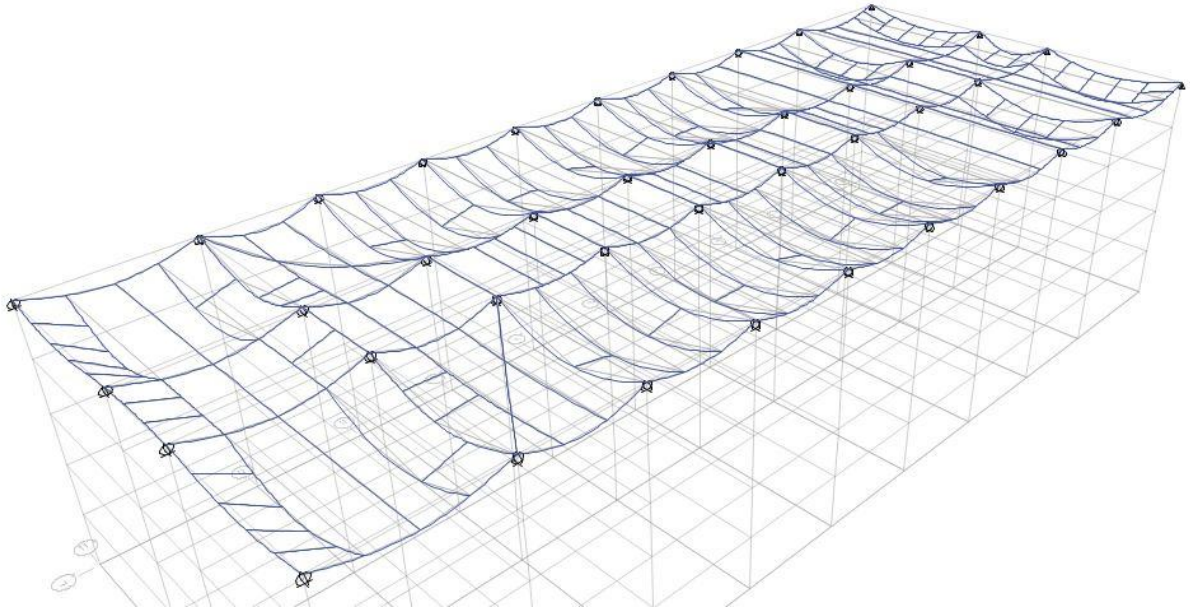


Figure 40: Gravity Roof Framing Deflected Shape

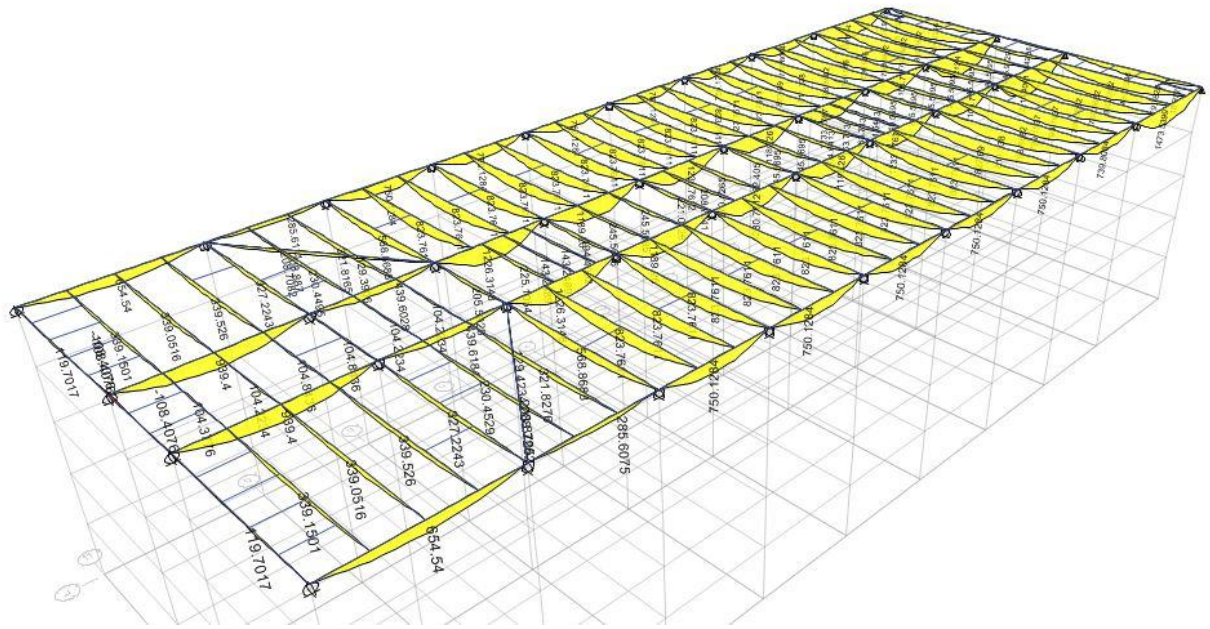


Figure 41: Gravity Roof Framing Moment Diagram

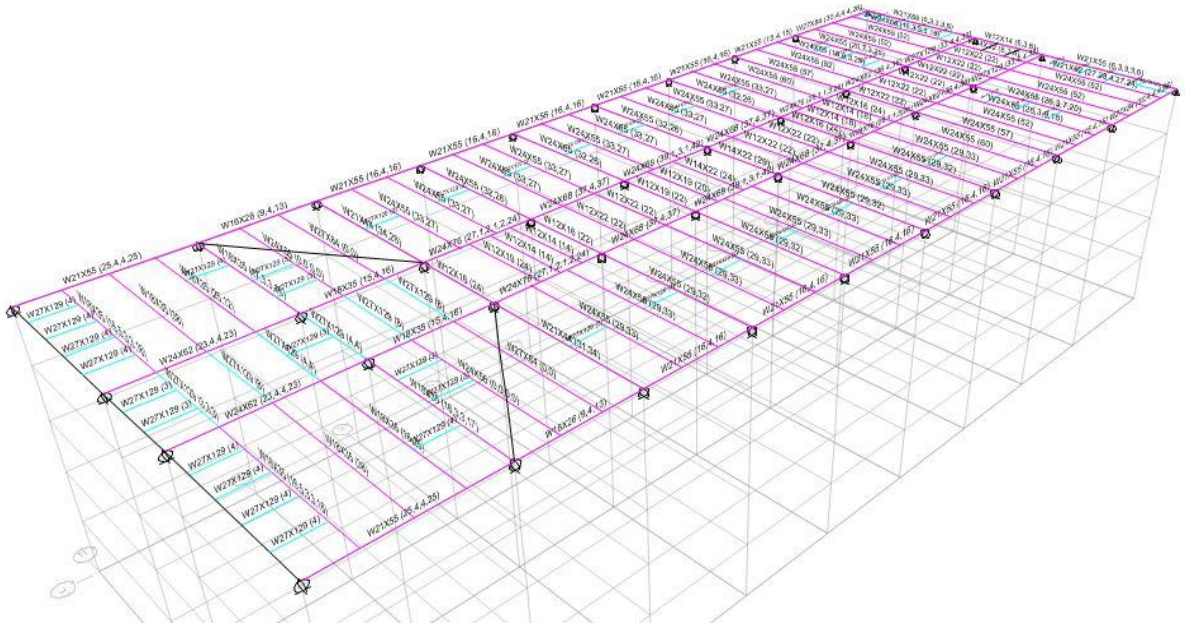


Figure 42: Gravity Roof Framing Code Check

GRAVITY ROOF FRAMING COMPOSITE BEAM SUMMARIES								
Design Section	Fy lb/in²	Stud Diameter in	Stud Layout	Pass/Fail	Left Reaction kip	Right Reaction kip	Max +Moment kip-ft	Overall Ratio
W21X55	50000	0.75	25; 4; 4; 25	Passed	53.63	53.63	695.38	0.993
W21X55	50000	0.75	25; 4; 4; 25	Passed	53.63	53.63	695.38	0.993
W24X62	50000	0.75	23; 4; 4; 23	Passed	74.235	74.235	989.8	0.998
W24X62	50000	0.75	23; 4; 4; 23	Passed	74.235	74.235	989.8	0.998
W18X35	50000	0.75	16; 3; 3; 17	Passed	27.102	31.226	344.7803	0.994
W18X35	50000	0.75	17; 3; 3; 16	Passed	31.226	27.102	344.7803	0.994
W27X129	50000	0.75	4; 4	Passed	17.675	17.675	110.4686	0.111
W18X35	50000	0.75	16; 5; 3; 3; 16	Passed	31.815	31.815	357.3459	1
W18X35	50000	0.75	38	Passed	31.815	31.815	357.2422	0.979
W18X35	50000	0.75	16; 25	Passed	31.815	31.815	357.742	0.981
W18X35	50000	0.75	16; 5; 3; 3; 16	Passed	31.815	31.815	357.3459	1
W18X35	50000	0.75	38	Passed	31.815	31.815	357.2422	0.979
W18X35	50000	0.75	25; 12	Passed	31.815	31.815	357.742	0.981
W27X129	50000	0.75	3; 3; 3	Passed	17.675	17.675	109.9775	0.125
W27X129	50000	0.75	8	Passed	17.675	17.675	109.8151	0.111
W27X129	50000	0.75	4; 4	Passed	17.675	17.675	110.4686	0.111
W27X129	50000	0.75	4	Passed	0	0	0	0.08
W27X129	50000	0.75	4	Passed	0	0	0	0.08
W27X129	50000	0.75	4	Passed	0	0	0	0.08
W27X129	50000	0.75	4	Passed	0	0	0	0.08
W27X129	50000	0.75	3	Passed	0	0	0	0.063
W27X129	50000	0.75	3	Passed	0	0	0	0.063
W27X129	50000	0.75	4	Passed	0	0	0	0.08
W27X129	50000	0.75	4	Passed	0	0	0	0.08
W27X129	50000	0.75	4	Passed	0	0	0	0.08
W27X129	50000	0.75	4	Passed	0	0	0	0.08
W27X129	50000	0.75	3	Passed	0	0	0	0.063
W27X129	50000	0.75	4	Passed	0	0	0	0.08
W27X129	50000	0.75	4	Passed	0	0	0	0.08

GRAVITY ROOF FRAMING COMPOSITE BEAM SUMMARIES								
Design Section	Fy lb/in²	Stud Diameter in	Stud Layout	Pass/Fail	Left Reaction kip	Right Reaction kip	Max +Moment kip-ft	Overall Ratio
W16X26	50000	0.75	9; 4; 13	Passed	28.391	31.84	303.6345	0.999
W16X26	50000	0.75	9; 4; 13	Passed	28.393	31.839	303.6372	0.999
W18X35	50000	0.75	15; 4; 16	Passed	45.084	46.322	463.2691	0.996
W18X35	50000	0.75	15; 4; 16	Passed	45.083	46.325	463.2532	0.996
W21X44	50000	0.75	31; 34	Passed	47.306	47.383	532.1524	0.995
W21X44	50000	0.75	34; 28	Passed	47.383	47.306	532.1524	0.995
W12X16	50000	0.75	24	Passed	30.95	30.95	192.2929	0.969
W24X55	50000	0	0; 0; 0; 0	Passed	20.51	26.166	242.134	0.926
W27X84	50000	0	0; 0	Passed	30.859	29.89	339.4096	0.953
W24X55	50000	0	0; 0; 0; 0	Passed	26.166	20.512	242.1305	0.926
W27X84	50000	0	0; 0	Passed	29.893	30.859	339.3972	0.953
W27X129	50000	0.75	8	Passed	17.675	17.675	109.8151	0.111
W27X129	50000	0.75	8	Passed	17.675	17.675	109.8151	0.111
W27X129	50000	0.75	3	Passed	0	0	0	0.063
W27X129	50000	0.75	3	Passed	0	0	0	0.063
W27X129	50000	0.75	3	Passed	0	0	0	0.063
W27X129	50000	0.75	3	Passed	0	0	0	0.063
W21X55	50000	0.75	16; 4; 16	Passed	72.15	72.15	711.8784	0.993
W21X55	50000	0.75	16; 4; 16	Passed	72.15	72.15	711.8784	0.993
W24X76	50000	0.75	27; 1; 2; 1; 2; 24	Passed	108.301	120.768	1164.8226	0.993
W24X76	50000	0.75	27; 1; 2; 1; 2; 24	Passed	108.301	120.768	1164.8226	0.993
W24X55	50000	0.75	29; 32	Passed	68.352	75.576	780.7434	0.998
W12X16	50000	0.75	22	Passed	29.608	29.608	183.9571	0.955
W24X55	50000	0.75	32; 26	Passed	75.576	68.352	780.7434	0.998
W24X55	50000	0.75	29; 33	Passed	68.352	75.576	780.7434	0.993
W24X55	50000	0.75	29; 33	Passed	68.352	75.576	780.7434	0.993
W24X55	50000	0.75	33; 27	Passed	75.576	68.352	780.7434	0.993
W24X55	50000	0.75	33; 27	Passed	75.576	68.352	780.7434	0.993
W21X55	50000	0.75	16; 4; 16	Passed	72.15	72.15	711.8784	0.993

GRAVITY ROOF FRAMING COMPOSITE BEAM SUMMARIES								
Design Section	Fy lb/in²	Stud Diameter in	Stud Layout	Pass/Fail	Left Reaction kip	Right Reaction kip	Max +Moment kip-ft	Overall Ratio
W21X55	50000	0.75	16; 4; 16	Passed	72.15	72.15	711.8784	0.993
W24X68	50000	0.75	37; 4; 37	Passed	112.976	112.976	1129.76	0.995
W24X68	50000	0.75	37; 4; 37	Passed	112.976	112.976	1129.76	0.995
W24X55	50000	0.75	29; 32	Passed	68.352	75.576	780.7434	0.998
W24X55	50000	0.75	32; 26	Passed	75.576	68.352	780.7434	0.998
W12X19	50000	0.75	22	Passed	33.66	33.66	209.1302	0.983
W24X55	50000	0.75	29; 33	Passed	68.352	75.576	780.7434	0.993
W24X55	50000	0.75	29; 33	Passed	68.352	75.576	780.7434	0.993
W24X55	50000	0.75	33; 27	Passed	75.576	68.352	780.7434	0.993
W24X55	50000	0.75	33; 27	Passed	75.576	68.352	780.7434	0.993
W21X55	50000	0.75	16; 4; 16	Passed	72.15	72.15	711.8784	0.993
W21X55	50000	0.75	16; 4; 16	Passed	72.15	72.15	711.8784	0.993
W24X55	50000	0.75	29; 32	Passed	68.352	75.576	780.7434	0.998
W24X55	50000	0.75	32; 26	Passed	75.576	68.352	780.7434	0.998
W24X68	50000	0.75	39; 1; 3; 1; 42	Passed	116.716	107.366	1169.03	0.999
W24X68	50000	0.75	39; 1; 3; 1; 42	Passed	116.716	107.366	1169.03	0.999
W14X22	50000	0.75	29	Passed	43.01	43.01	267.2219	0.989
W24X55	50000	0.75	29; 33	Passed	68.352	75.576	780.7434	0.993
W24X55	50000	0.75	29; 33	Passed	68.352	75.576	780.7434	0.993
W24X55	50000	0.75	33; 27	Passed	75.576	68.352	780.7434	0.993
W24X55	50000	0.75	33; 27	Passed	75.576	68.352	780.7434	0.993
W21X55	50000	0.75	16; 4; 16	Passed	72.15	72.15	711.8784	0.993
W21X55	50000	0.75	16; 4; 16	Passed	72.15	72.15	711.8784	0.993
W24X55	50000	0.75	32; 26	Passed	75.576	68.352	780.7434	0.998
W24X55	50000	0.75	29; 32	Passed	68.352	75.576	780.7434	0.998
W24X68	50000	0.75	37; 4; 37	Passed	112.976	112.976	1129.76	0.995
W24X68	50000	0.75	37; 4; 37	Passed	112.976	112.976	1129.76	0.995
W12X16	50000	0.75	24	Passed	31.167	31.167	193.6391	0.964
W24X55	50000	0.75	29; 33	Passed	68.352	75.576	780.7434	0.993

GRAVITY ROOF FRAMING COMPOSITE BEAM SUMMARIES								
Design Section	Fy lb/in²	Stud Diameter in	Stud Layout	Pass/Fail	Left Reaction kip	Right Reaction kip	Max +Moment kip-ft	Overall Ratio
W24X55	50000	0.75	29; 33	Passed	68.352	75.576	780.7434	0.993
W24X55	50000	0.75	33; 27	Passed	75.576	68.352	780.7434	0.993
W24X55	50000	0.75	33; 27	Passed	75.576	68.352	780.7434	0.993
W12X22	50000	0.75	22	Passed	37.4	37.4	232.3669	0.998
W24X55	50000	0.75	57	Passed	67.836	71.448	768.328	0.993
W21X55	50000	0.75	16; 4; 16	Passed	72.15	72.15	711.8784	0.993
W21X55	50000	0.75	16; 4; 16	Passed	72.15	72.15	711.8784	0.993
W24X55	50000	0.75	57	Passed	71.448	67.836	768.328	0.993
W24X76	50000	0.75	26; 1; 1; 3; 26	Passed	119.209	112.976	1171.3155	0.999
W24X76	50000	0.75	26; 1; 1; 3; 26	Passed	119.209	112.976	1171.3155	0.999
W24X55	50000	0.75	33; 27	Passed	75.576	68.352	780.7434	0.993
W24X55	50000	0.75	60	Passed	75.576	68.352	779.68	0.992
W24X55	50000	0.75	29; 33	Passed	68.352	75.576	780.7434	0.993
W24X55	50000	0.75	60	Passed	68.352	75.576	779.68	0.992
W21X55	50000	0.75	15; 4; 15	Passed	71.118	71.118	701.5584	0.995
W24X55	50000	0.75	26; 3; 7; 20	Passed	67.32	67.32	756.2263	1
W21X55	50000	0.75	15; 4; 15	Passed	71.118	71.118	701.5584	0.995
W24X55	50000	0.75	20; 7; 3; 25	Passed	67.32	67.32	756.976	1
W24X62	50000	0.75	36; 4; 36	Passed	104.72	104.72	1047.2	0.997
W24X62	50000	0.75	36; 4; 36	Passed	104.72	104.72	1047.2	0.997
W12X22	50000	0.75	22	Passed	37.4	37.4	232.3669	0.998
W24X55	50000	0.75	52	Passed	67.32	67.32	755.9183	0.993
W24X55	50000	0.75	26; 3; 9; 18	Passed	67.32	67.32	756.2263	1
W24X55	50000	0.75	52	Passed	67.32	67.32	755.9183	0.993
W24X55	50000	0.75	18; 9; 3; 25	Passed	67.32	67.32	756.976	1
W12X22	50000	0.75	22	Passed	37.4	37.4	232.3669	0.998
W12X22	50000	0.75	22	Passed	37.4	37.4	232.3669	0.998
W27X129	50000	0.75	3	Passed	0	0	0	0.063
W27X129	50000	0.75	3	Passed	0	0	0	0.063

GRAVITY ROOF FRAMING COMPOSITE BEAM SUMMARIES								
Design Section	Fy lb/in²	Stud Diameter in	Stud Layout	Pass/Fail	Left Reaction kip	Right Reaction kip	Max +Moment kip-ft	Overall Ratio
W27X129	50000	0.75	3	Passed	0	0	0	0.063
W27X129	50000	0.75	3	Passed	0	0	0	0.063
W27X129	50000	0.75	3	Passed	0	0	0	0.063
W27X129	50000	0.75	3	Passed	0	0	0	0.063
W27X84	50000	0.75	30; 4; 4; 4; 26	Passed	106.044	109.784	1397.0399	1
W27X84	50000	0.75	30; 4; 4; 4; 26	Passed	106.044	109.784	1397.04	1
W27X129	50000	0.75	33; 4; 4; 33	Passed	157.08	157.08	2094.4001	0.994
W27X129	50000	0.75	33; 4; 4; 33	Passed	157.08	157.08	2094.4	0.994
W21X55	50000	0.75	6; 3; 3; 3; 6	Passed	35.617	39.357	442.7116	0.995
W21X55	50000	0.75	6; 3; 3; 3; 6	Passed	39.357	35.617	442.7116	0.995
W12X14	50000	0.75	6; 3; 6	Passed	21.865	21.865	136.0489	0.971
W24X55	50000	0.75	52	Passed	67.32	67.32	755.9183	0.993
W24X55	50000	0.75	52	Passed	67.32	67.32	755.9183	0.993
W21X62	50000	0.75	27; 23; 4; 27; 24	Passed	63.58	67.32	757.2562	1
W24X55	50000	0.75	52	Passed	67.32	67.32	755.9183	0.993
W24X55	50000	0.75	52	Passed	67.32	67.32	755.9183	0.993
W24X68	50000	0.75	16; 3; 3; 3; 15	Passed	67.32	63.58	757.2563	0.997
W12X22	50000	0.75	22	Passed	37.4	37.4	232.3669	0.998
W12X22	50000	0.75	22	Passed	37.4	37.4	232.3669	0.998
W14X22	50000	0.75	8; 3; 8	Passed	37.4	37.4	232.7107	0.969
W27X129	50000	0.75	2; 2	Passed	3.74	3.74	18.7001	0.083
W27X129	50000	0.75	2; 2	Passed	3.74	3.74	18.7	0.083
W27X129	50000	0.75	3	Passed	0	0	0	0.063
W27X129	50000	0.75	3	Passed	0	0	0	0.063
W27X129	50000	0.75	3	Passed	0	0	0	0.063
W27X129	50000	0.75	3	Passed	0	0	0	0.063
W27X129	50000	0.75	3	Passed	0	0	0	0.063
W27X129	50000	0.75	3	Passed	0	0	0	0.063
W27X129	50000	0.75	3	Passed	7.48	7.48	17.952	0.111

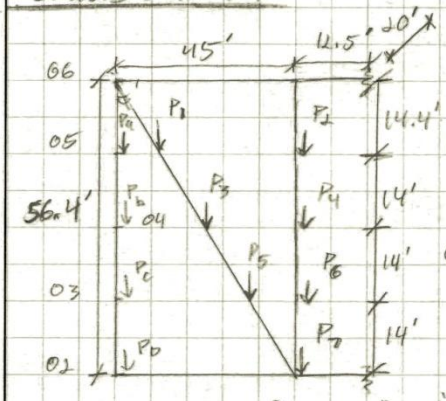
GRAVITY ROOF FRAMING COMPOSITE BEAM SUMMARIES								
Design Section	Fy lb/in²	Stud Diameter in	Stud Layout	Pass/Fail	Left Reaction kip	Right Reaction kip	Max +Moment kip-ft	Overall Ratio
W27X129	50000	0.75	3	Passed	7.48	7.48	17.952	0.111
W12X16	50000	0.75	24	Passed	31.167	31.167	193.6391	1
W12X14	50000	0.75	18	Passed	24.933	24.933	154.9112	0.952
W12X14	50000	0.75	18	Passed	24.933	24.933	154.9112	0.952
W12X22	50000	0.75	22	Passed	37.4	37.4	232.3669	0.998
W12X22	50000	0.75	22	Passed	37.4	37.4	232.3669	0.998
W12X22	50000	0.75	22	Passed	37.4	37.4	232.3669	0.998
W12X22	50000	0.75	22	Passed	37.4	37.4	232.3669	0.998
W12X19	50000	0.75	24	Passed	34.283	34.283	213.003	1
W12X14	50000	0.75	14	Passed	21.817	21.817	135.5473	0.941
W12X14	50000	0.75	14	Passed	21.817	21.817	135.5473	0.941
W12X19	50000	0.75	20	Passed	31.79	31.79	197.5118	0.969
W14X22	50000	0.75	24	Passed	41.14	41.14	255.6036	0.99
W27X129	50000	0.75	3	Passed	0	0	0	0.063
W27X129	50000	0.75	3	Passed	0	0	0	0.063
W27X129	50000	0.75	3	Passed	0	0	0	0.063
W27X129	50000	0.75	3	Passed	0	0	0	0.063
W27X129	50000	0.75	3	Passed	0	0	0	0.063
W27X129	50000	0.75	3	Passed	0	0	0	0.063
W27X129	50000	0.75	3	Passed	0	0	0	0.063
W27X129	50000	0.75	3	Passed	0	0	0	0.063
W27X129	50000	0.75	3	Passed	0	0	0	0.063
W27X129	50000	0.75	3	Passed	0	0	0	0.063
W27X129	50000	0.75	3	Passed	0	0	0	0.063
W27X129	50000	0.75	3	Passed	0	0	0	0.063
W27X129	50000	0.75	3	Passed	0	0	0	0.063
W27X129	50000	0.75	3	Passed	0	0	0	0.063

Appendix G: Truss Loading Calculations & ETABS Output

Note: All ETABS truss diagrams are shown for the controlling load case 1.2D+1.6L+.05Lr. Appendix begins on the next page.

Gravity Load Calculations

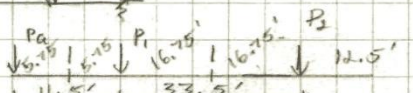
Loads on F1



From Fall:
Live Public (floor) = 50 psf
Dead Load = 69 psf
Floor = 56 psf
Frame = 13 psf
Curtain = 211 plf

$\theta = \tan^{-1}(45/56.4) = 38.6°$

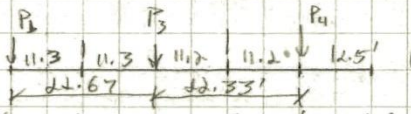
• Level 05:



14.4 tan 38.6 = 11.5'
45 - 11.5 = 33.5'
14.4/56.4 = 0.255

Pa Dead = 9.15 k
(5.75')(20')(69) + (5.75)(211)
Pa Live = (5.75)(20)(50) = 5.75 k
P1 Dead = 12.5 k
(5.75 + 16.75)(5)(69) + (5.75 + 16.75)(211)
P1 Live = (5.75 + 16.75)(5)(50) = 5.63 k
P2 Dead = 46.5 k
(16.75 + 12.5)(20)(69) + (16.75 + 12.5)(211)
P2 Live = (16.75 + 12.5)(20)(50) = 29.3 k

• Level 04:



(14.4 + 14) tan 38.6 = 22.67'
45 - 22.67 = 22.33'

Pb Dead = (11.3')(20)(69) + (11.3)(211) = 18.0 k
Pb Live = (11.3)(20)(50) = 11.3 k
P3 Dead = 12.5 k
(11.3 + 11.2)(5)(69) + (22.5)(211)
P3 Live = (22.5)(5)(50) = 5.63 k
P4 Dead = 37.7 k
(11.2 + 12.5)(20)(69) + (23.7)(211)
P4 Live = (23.7)(20)(50) = 23.7 k

$\frac{14.4 + 14}{56.4} = 0.504$

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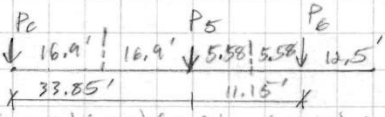
• Level 03

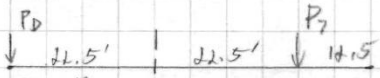


(14.4 + 2·14) tan 38.6 = 33.85
45 − 33.85 = 11.15'

P_C Dead: (16.9)(20)(69) + (16.9)(211) = 26.9 K
P_C Live: (16.9)(20)(50) = 16.9 K
P_5 Dead = 12.5 K
(16.9 + 5.58)(5)(69) + 22.48(211)
P_5 Live = (16.9 + 5.58)(5)(50) = 5.63 K
P_6 Dead = 25.2 K
(5.58 + 12.5)(20)(69) + 18.08(211)
P_6 Live = (18.08)(20)(50) = 18.1 K

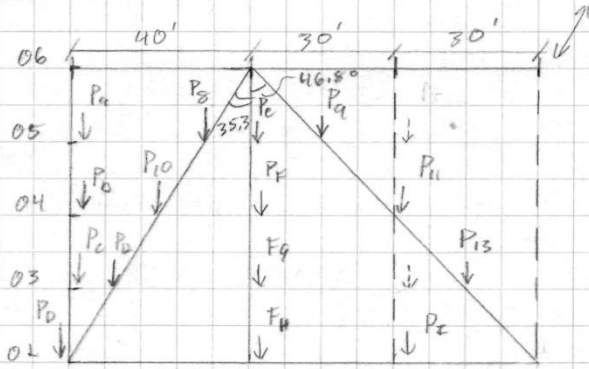
$\frac{14.4 + 2 \cdot 14}{56.4} = 0.752$

• Level 02



P_D Dead = 35.8 K
(22.5)(20)(69) + 22.5(211)
P_D Live = (22.5)(20)(50) = 22.5 K
P_7 Dead = 55.7
(22.5 + 12.5)(20)(69) + (35)(211)
P_7 Live = (35)(20)(50) = 35.0 K

LOADS ON TJ



θ = tan⁻¹(40/56.4) = 35.3°
θ = tan⁻¹(60/56.4) = 46.8°

P_I Dead = [(30)(22.5)(69) + (30)(211)](2 FLRS) = 105.8 K
P_I Live = (30)(22.5)(50)(2) = 67.50 K

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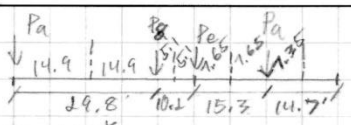
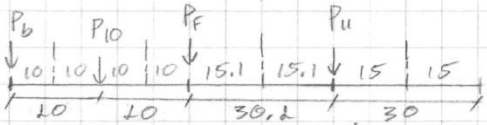
• Level 05



14.4 tan 35.3 = 10.2'
14.4 tan 46.8 = 15.3'

P_8 Dead = 35.27 K
(14.9 + 5.1)(22.5)(69) + (20)(211)
P_8 Live = (20)(22.5)(50) = 22.5 K
P_e Dead = 22.48 K
(5.1 + 7.65)(22.5)(69) + (12.75)(211)
P_e Live = (12.75)(22.5)(50) = 14.34 K
P_q Dead = 26.45 K
(7.65 + 7.35)(22.5)(69) + (15)(211)
P_q Live = (15)(22.5)(50) = 16.88 K

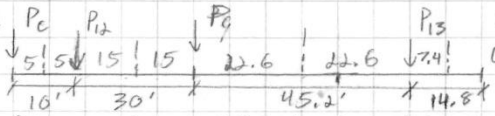
• Level 04



28.4 tan 35.3 = 20.1'
28.4 tan 46.8 = 30.2'

P_{10} Dead = (20)(22.5)(69) + (20)(211) = 35.27 K
P_{10} Live = (20)(22.5)(50) = 22.5 K
P_F Dead = (25.1)(22.5)(69) + (25.1)(211) = 44.26 K
P_F Live = (25.1)(22.5)(50) = 28.24 K
P_{11} Dead = (30.1)(22.5)(69) + (30.1)(211) = 53.08 K
P_{11} Live = (30.1)(22.5)(50) = 33.86 K

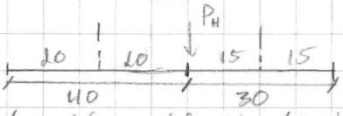
• Level 03



42.4 tan 35.3 = 30.0'
42.4 tan 46.8 = 45.2'

P_q Dead = (15 + 22.6)(22.5)(69) + (37.6)(211) = 66.31 K
P_q Live = (37.6)(22.5)(50) = 42.3 K
P_{13} Dead = (22.6 + 7.4)(22.5)(69) + (30)(211) = 52.91 K
P_{13} Live = (30)(22.5)(50) = 33.75 K

• Level 02



P_H Dead = (35)(22.5)(69) + (35)(211) = 61.72 K
P_H Live = (35)(22.5)(50) = 39.38 K

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Maximum Truss T2 Deflection Limit for Roof Truss		
Combo	UX	UZ
Dead	-0.88097	-0.50585
Live	-0.4008	-0.22712
Live Roof	-0.0608	-0.03642
Snow	-0.05132	-0.03075
WindUp	0.04853	0.02912
DStlS1	-1.23336	-0.7082
DStlS2	-1.7241	-0.98579
DStlS3	**-1.72884**	-0.98863
DStlS4	-1.54007	-0.88335
DStlS5	-1.55524	-0.89242
DStlS6	-1.40598	-0.80292
DStlS7	-1.56126	-0.89612
DStlS8	-1.41072	-0.80576
DStlS9	-1.566	-0.89895
DStlS10	-1.10045	-0.63293
DStlS11	-1.17809	-0.67953
DStlS12	-1.11562	-0.642
DStlS13	-1.19326	-0.6886
DStlS14	-0.71523	-0.40867
DStlS15	-0.87051	-0.50187
DStlD1	-0.88097	-0.50585
DStlD2	-1.28177	-0.73297
Max. Roof Deflection= 1.723		
LC=1.2D+1.6L+0.5Lr		

Roof Truss Virtual Work Member Contribution for Preliminary Member Sizes				
P=	10	k		
E=	29000	ksi		
Member	Section	L	A	L/AE
3	W14x22	30	6.49	0.0001594
4	W14x22	30	6.49	0.0001594
5	W14x22	30	6.49	0.0001594
13	W14x22	30	6.49	0.0001594
14	W14x257	45	75.6	0.0000205
15	W14x257	45	75.6	0.0000205
37	W14x90	45	26.5	0.0000586
38	W14x90	45	26.5	0.0000586
16	W14x120	25	35.3	0.0000244
39	W18x71	25	20.9	0.0000412
64	W18x86	54	25.3	0.0000736
56	W18x86	54	25.3	0.0000736

Truss T1 ETABS

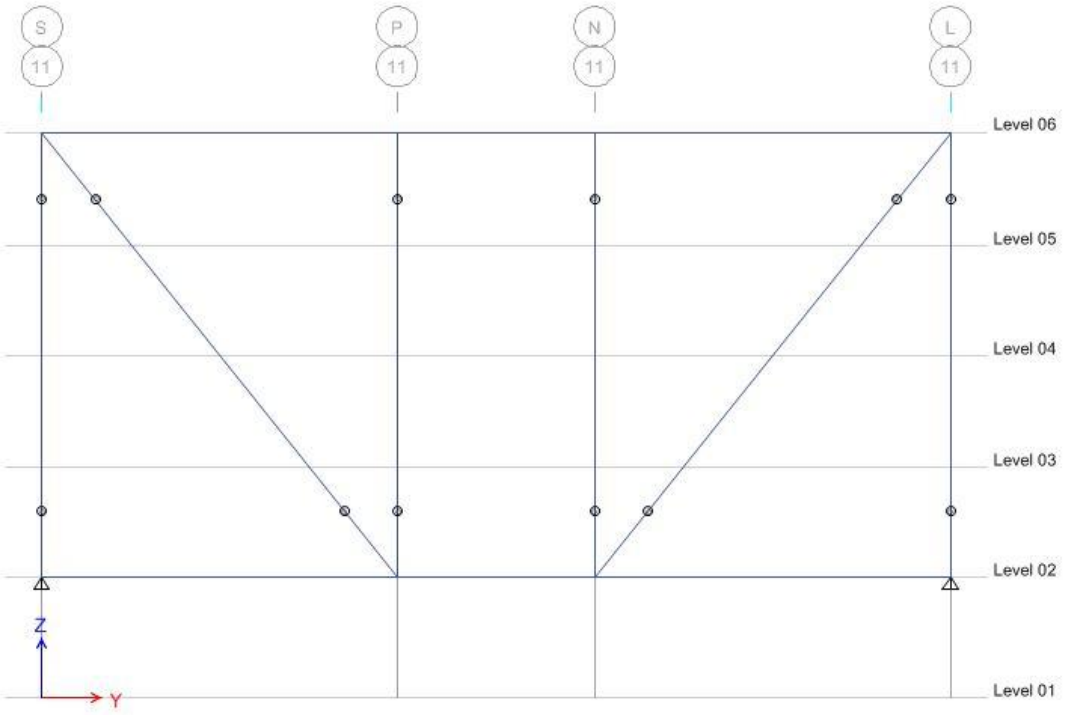


Figure 43: Truss T1 Model

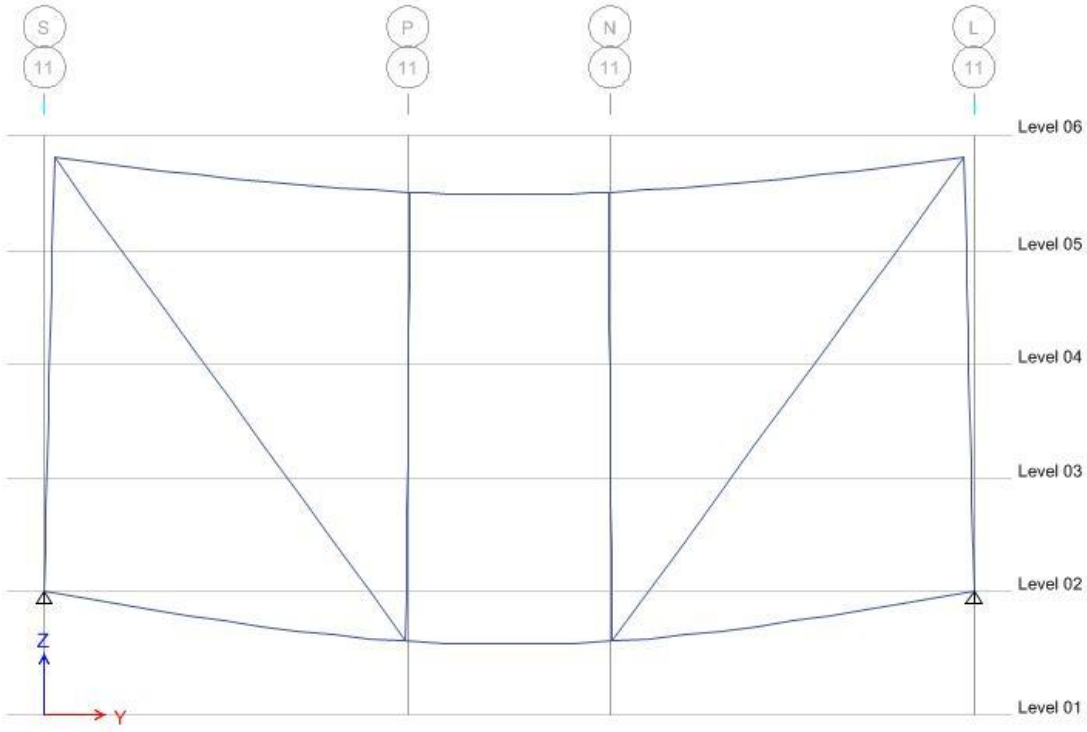


Figure 44: Truss T1 Deflected Shape

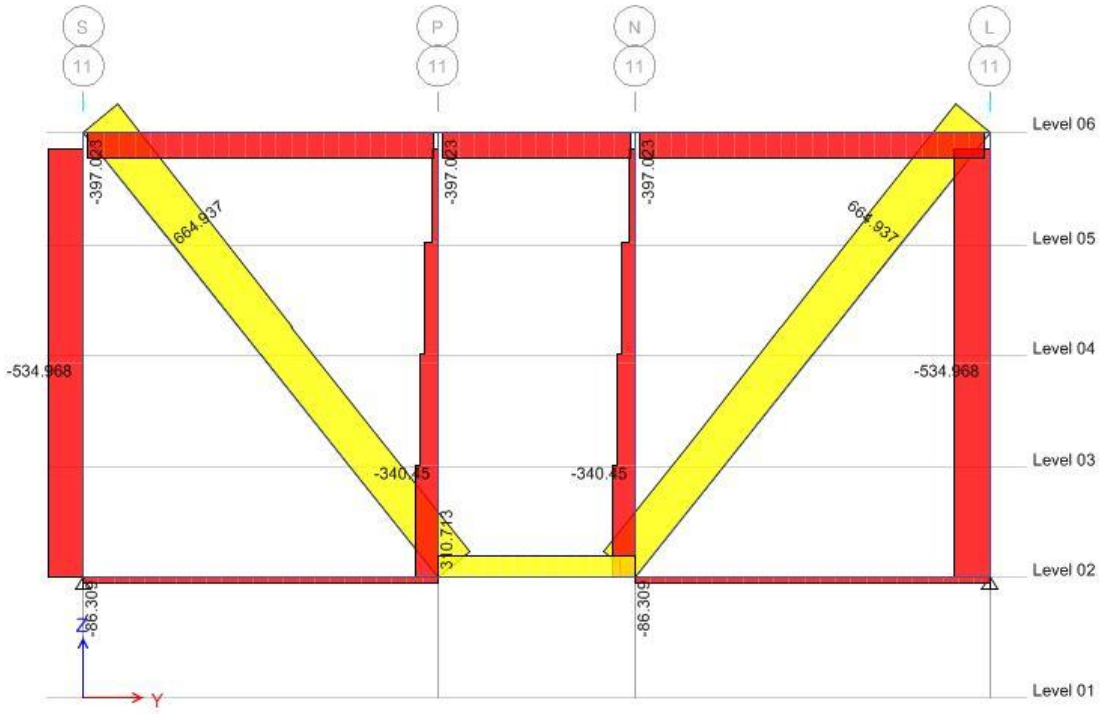


Figure 45: Truss T1 Axial Diagram

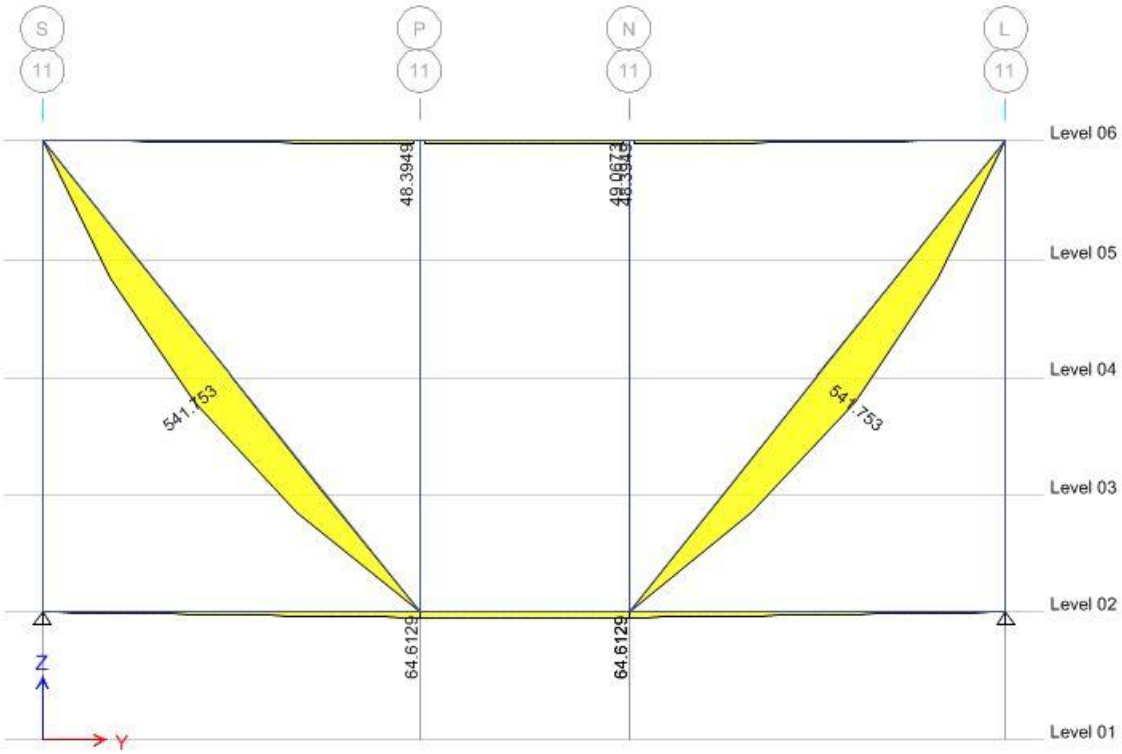


Figure 46: Truss T1 Moment Diagram

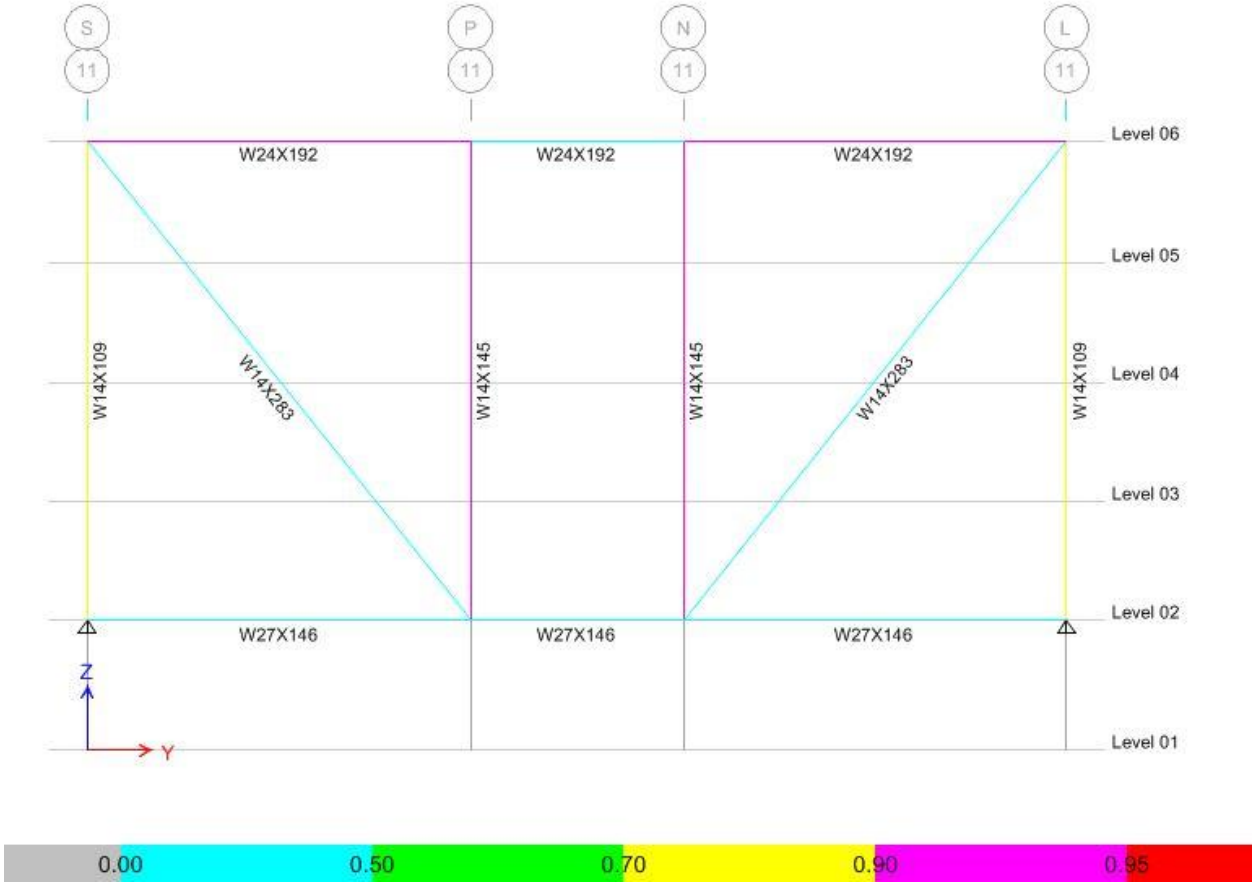


Figure 47: Truss T1 Code Check

Truss T2

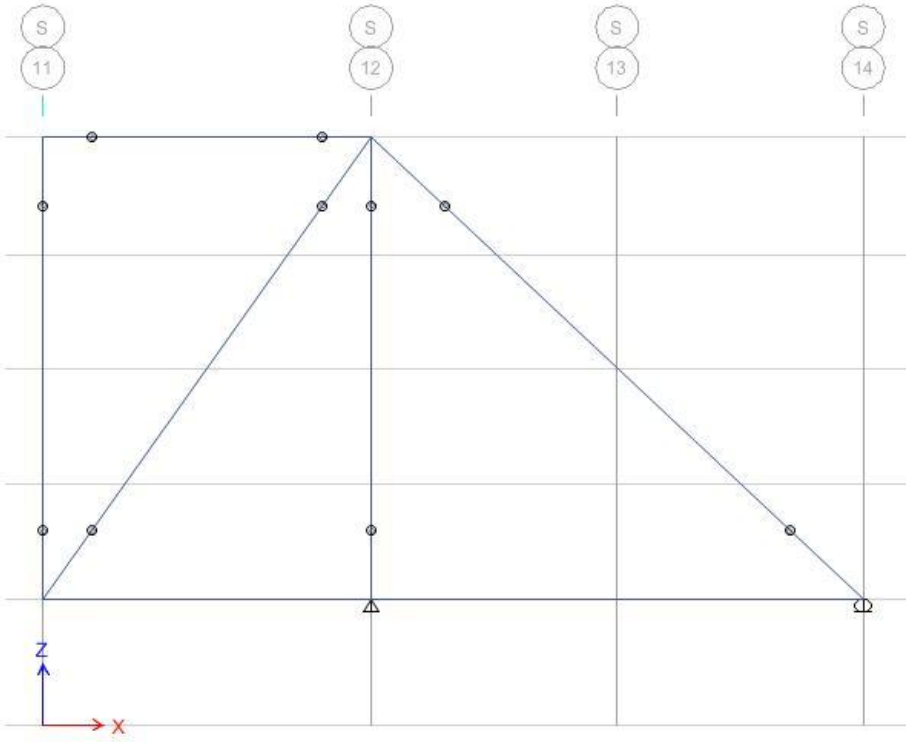


Figure 48: Truss T2 Model

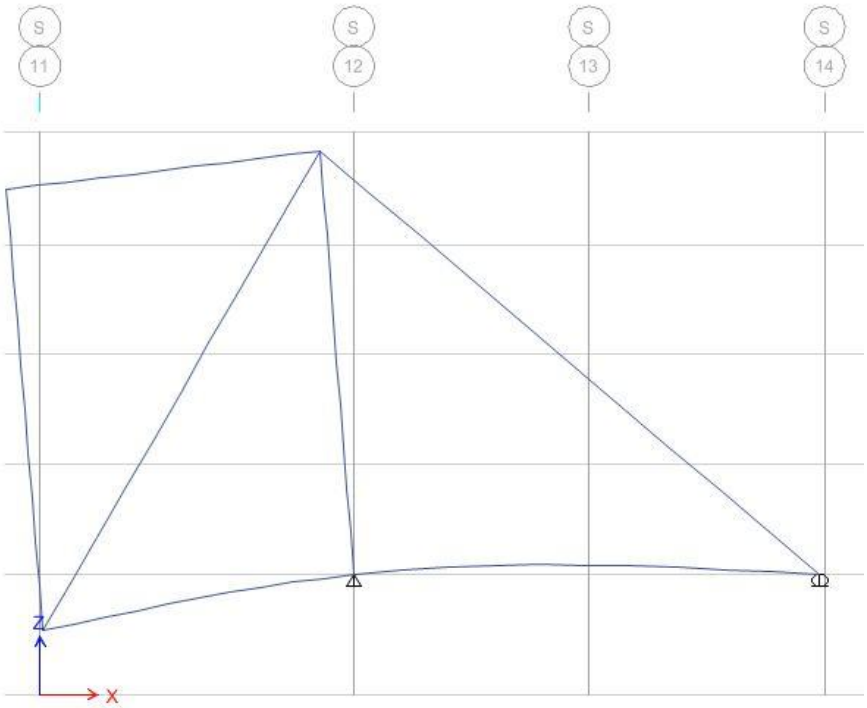


Figure 49: Truss T2 Deflected Shape

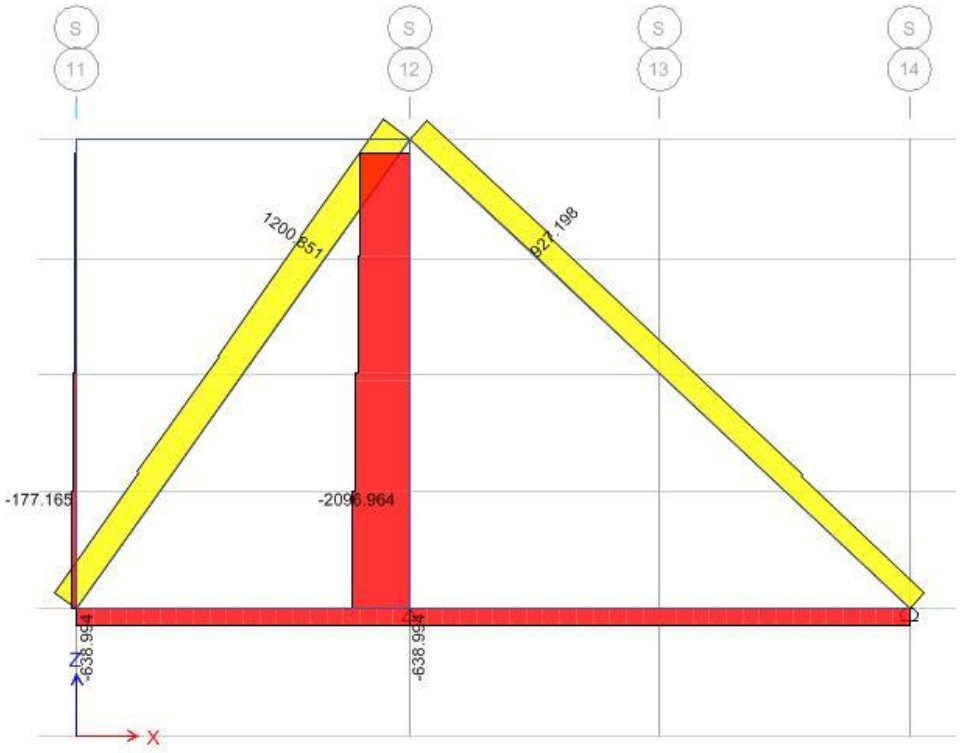


Figure 50: Truss T2 Axial Diagram

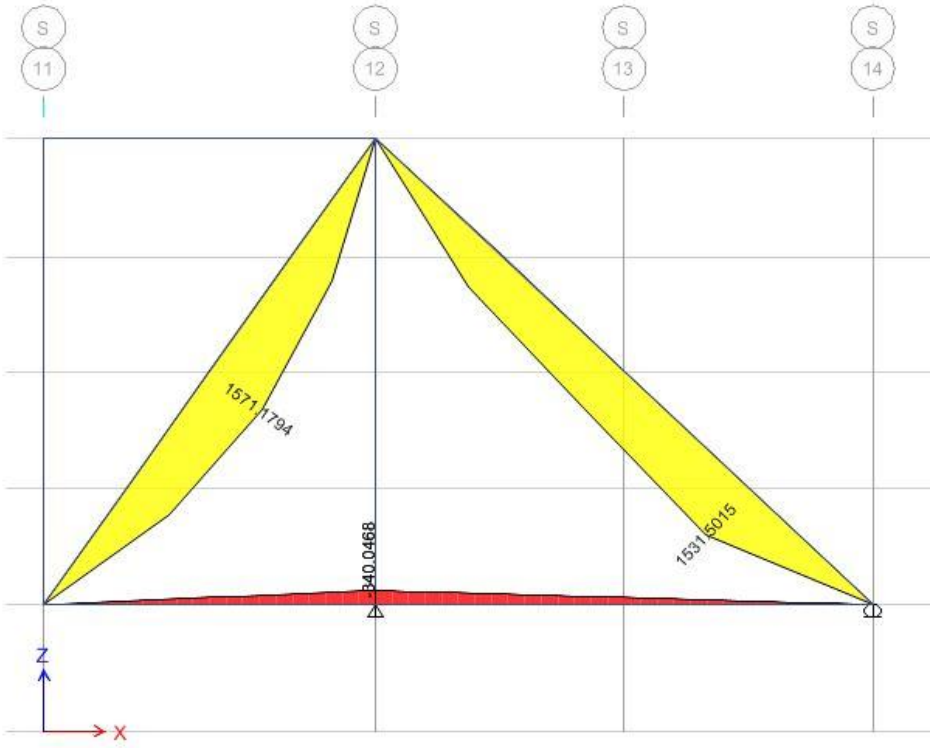


Figure 51: Truss T2 Moment Diagram

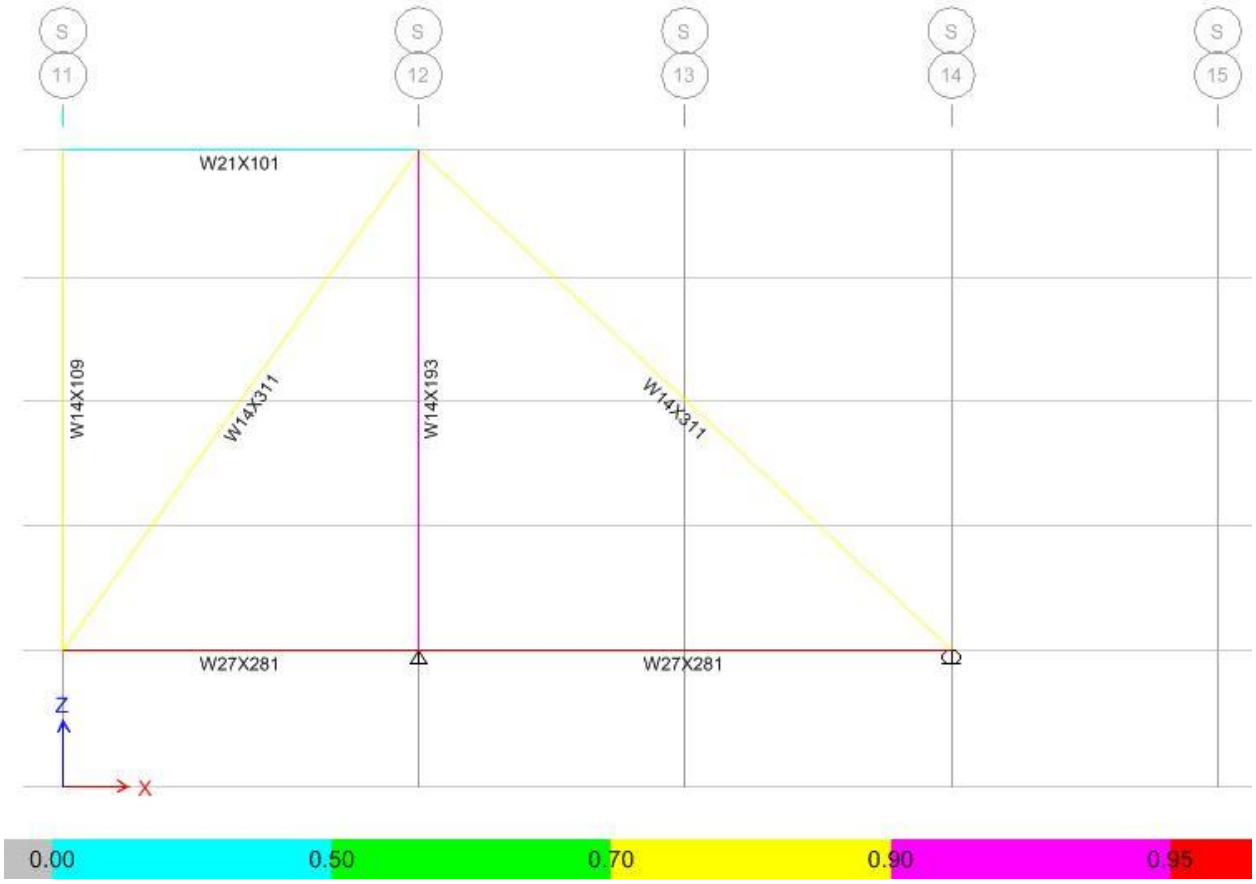


Figure 52: Truss T2 Code Check

Roof Truss

Note: Sections shown in roof model are those resulting from the truss analysis only. In all cases, the corresponding beams from the gravity roof design had a greater cross sectional area for resisting tension and compression as well as a greater flexural capacity and will pass the truss code check by inspection.

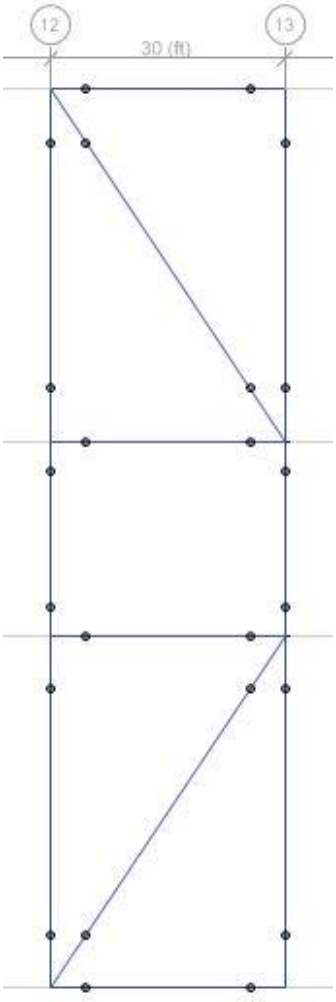


Figure 53: Roof Truss Model

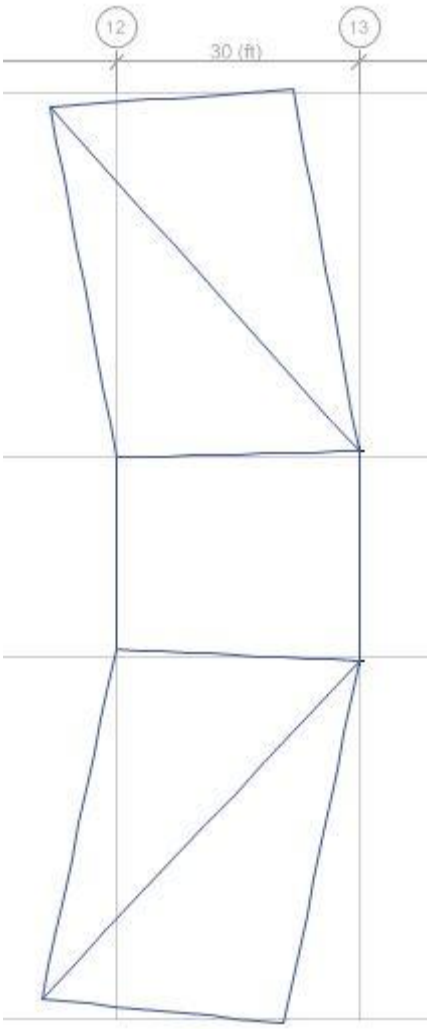


Figure 54: Roof Truss Deflected Shape

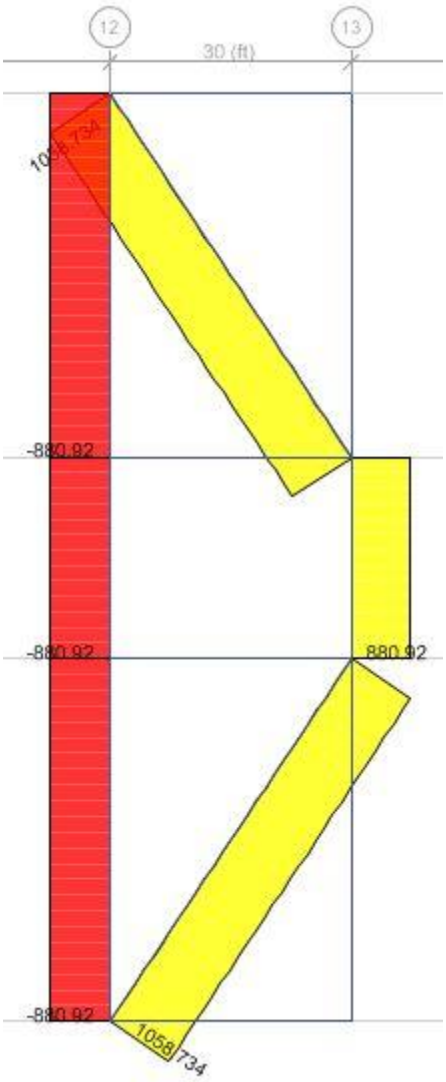


Figure 55: Roof Truss Axial Diagram

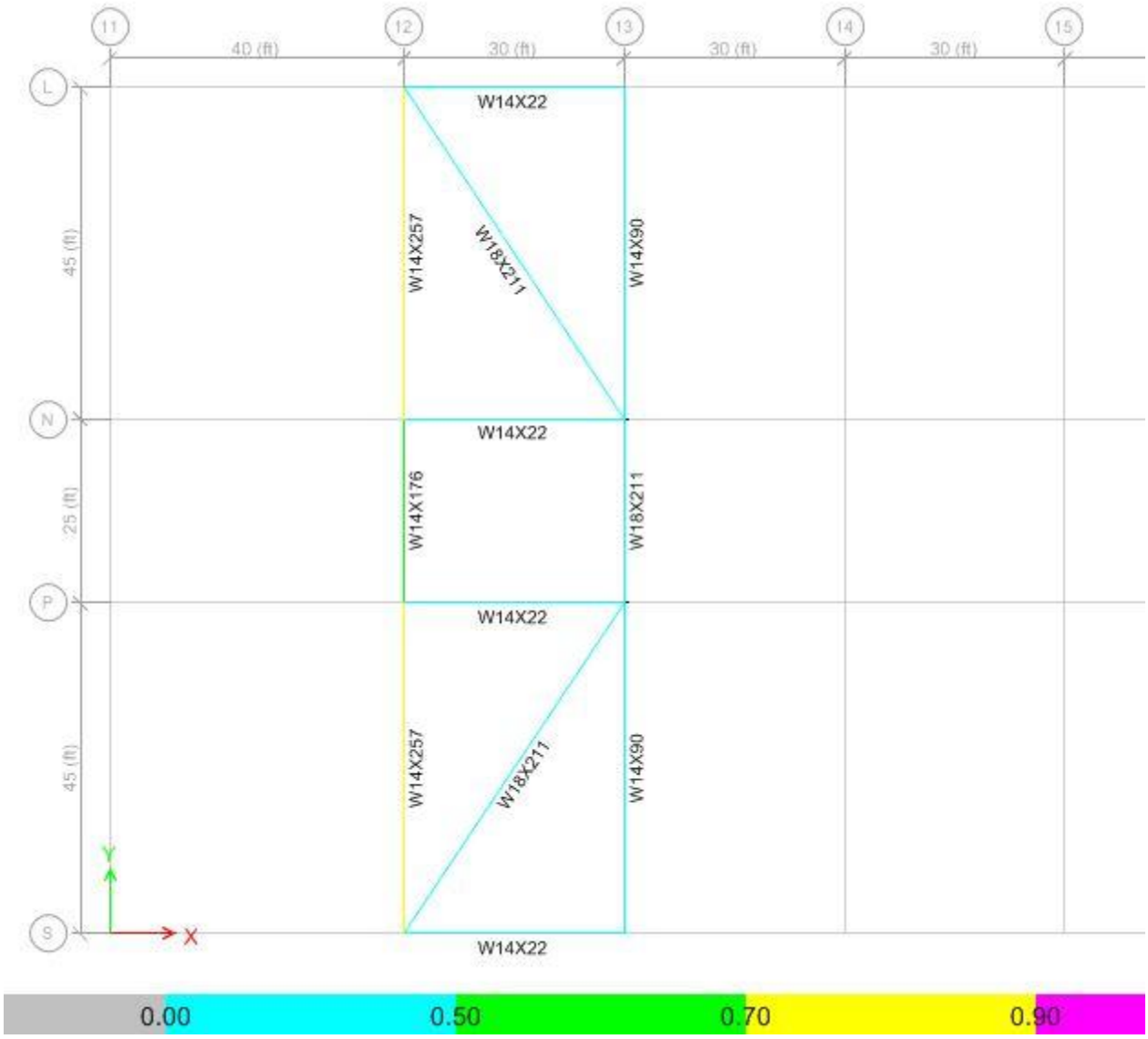


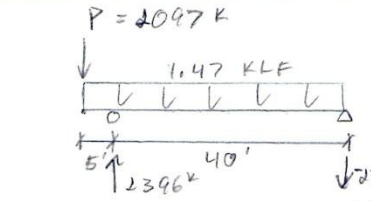
Figure 56: Roof Truss Code Check

Appendix H: Plate Girder Calculations and RISA Output

Begins on next page.

PL Girder Check 1/3

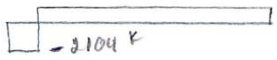
PLATE GIRDER CHECK



LOADS

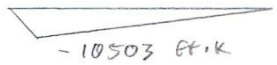
- 1.2D + 1.6L = w
  w = 1.2 (56 PSF)(10') + 1.6 (50)(10')
  w = 1.47 KLF
- P from truss T2

(V)



From RISA

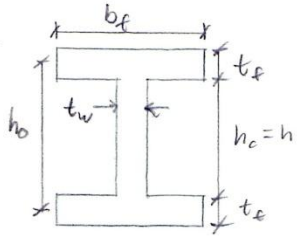
(M)



From RISA

- AS BUILT DIMENSIONS

ASTM 572 GR. 50



$h_o = 48"$
$b_f = 24"$
$t_w = 4"$
$h_c = h = 45"$
$t_f = 3"$

$E = 29000$ ksi
$F_y = 50$ ksi

- Check web slenderness

$$\lambda_w = \frac{h_c}{t_w} = \frac{45"}{4"} = 11.25$$

$$\lambda_p = 3.76\sqrt{\frac{E}{F_y}} = 3.76\sqrt{\frac{29000}{50}} = 90.6$$

$\lambda_w < \lambda_p$ ∴ AISC 360-10 Spec. Section F3

- Check unbraced length limit
  - Compression flange continuously braced by steel deck ∴ Not LTB, Compact web

- Check slenderness limits for flange local buckling

$$\lambda_f = \frac{b_f}{2t_f} = \frac{24"}{2 \cdot 3"} = 4$$

- From Table B4.1b Item 11:

$$\lambda_p = 0.38\sqrt{\frac{E}{F_y}} = 0.38\sqrt{\frac{29000}{50}} = 9.15$$

$$k_c = \frac{4}{\sqrt{h/t_w}} = \frac{4}{\sqrt{45/4}} = 1.19 > 0.76 \therefore \text{use } 0.76$$

For a symmetrical section $S_{xt}/S_{xc} = 1 > 0.7$ ∴

$F_L = 0.7 F_y = 0.7(50) = 35$

$$\lambda_{rf} = 0.95\sqrt{\frac{k_c E}{F_L}} = 0.95\sqrt{\frac{0.76 \cdot 29000}{35}} = 23.8$$

$\lambda_f < \lambda_p$ ∴ compact flanges

PL Girder Check 21 / 3

Because compact section:

$\phi M_n = \phi M_p = \phi F_y Z_x$

$Z_x = 2(24)(3)(45/2 + 3/2) + 2(45/2)(4)(45/4) = 5481 \text{ in}^3$

$\phi M_n = 0.9(50)(5481)/12 = 20554 \text{ ft·k} > M_u = 10503$ OK

- Check shear (Non Tension Field Action)

$\lambda_{wv} = \frac{h}{t_w} = \frac{45}{4} = 11.25$

$\lambda_{wvp} = 1.1\sqrt{\frac{k_v E}{F_y}}$ → Assume unstiffened, $k_v = 5.0$

$= 1.1\sqrt{\frac{5 \cdot 29000}{50}} = 59.2$

$\lambda_{wv} < \lambda_{wvp}$ ∴ $C_v = 1.0$

$V_n = 0.6 F_y A_w C_v = 0.6(50)(45.4)(1) = 5400^k$

$\phi V_n = 0.9(5400) = 4860^k > V_u = 2104^k$ OK Unstiffened

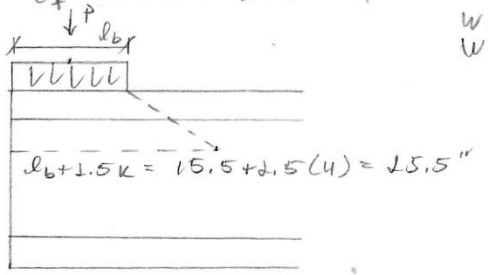
- Check Web Local Yielding Due to Point Load

57.001 Gives 1" Weld

$k = t_f + \text{weld} = 3 + 1 = 4"$

W14x193: $l_b = 15.5"$

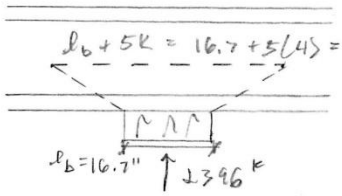
W14x283: $l_b = 16.7"$



$R_n = F_{yw} t_w (2.5k + l_b)$ $\phi = 1.0$

$= (50)(4)(25.5)(1.0) = \phi R_n = 5100^k$

$\phi R_n = 5100^k > P = 2097^k$ OK



Force applied @ 5' > 4' depth ∴

$R_n = F_{yw} t_w (5k + l_b)$ $\phi = 1.0$

$= (50)(4)(36.7)(1.0) = \phi R_n = 7340^k$

$\phi R_n = 7340^k > 2396^k$ OK

P_2 Girder Check 3/3

- Check web crippling

Point load @ $\leq d/2 = 2'$

$\frac{l_b}{d} = \frac{15.5}{48} = 0.32 > 0.2$

$$R_n = 0.40 t_w^2 \left[1 + \left(\frac{4 l_b}{d} - 0.2\right)\left(t_w/t_f\right)^{1.5}\right]\sqrt{\frac{EF_y t_f}{t_w}}$$

$$= 0.40 \cdot 4^2 \left[1 + \left(\frac{4 \cdot 15.5}{48} - 0.2\right)\left(4/3\right)^{1.5}\right]\sqrt{\frac{29000 \cdot 50 \cdot 3}{4}}$$

$$= 6.4(2.6807)(1042.8) = 17891^{K}$$

$\phi R_n = 0.75(17891) = 15418^{K} > 2097^{K}$ OK

Point load @ $> d/2$

$$R_n = 0.80 t_w^2 \left[1 + 3\left(\frac{l_b}{d}\right)\left(\frac{t_w}{t_f}\right)^{1.5}\right]\sqrt{\frac{EF_y t_f}{t_w}}$$

$$= 0.80 \cdot 4^2 \left[1 + 3\left(\frac{16.7}{48}\right)\left(\frac{4}{3}\right)^{1.5}\right]\sqrt{\frac{29000 \cdot 50 \cdot 3}{4}}$$

$$= 12.8(2.61)(1042.8) = 34838^{K}$$

$\phi R_n = 0.75(34838) = 26128^{K} > 2396^{K}$ OK

- Check deflection

- Service loads

$w = 56.16 + 50.16 = 1.06$ KLF

From ETABS: $P_{service} = 1554^{K}$

$$I = \frac{3 \cdot 24 \cdot 3^3}{12} + 2(24)(3)\left(\frac{45}{2} + \frac{3}{2}\right)^2 + \frac{4 \cdot 45^3}{12}$$

$I = 113127\ in^4$

$A = 2(24)(3) + 45(4) = 324\ in^2$

From RISA: $\Delta = -0.299" < 3/4"$ OK

3/4" limit for curtain wall attachment

∴ Current design adequate for increased loads. Additional load on this part of structure only additional 12% dead load and 18% live load.

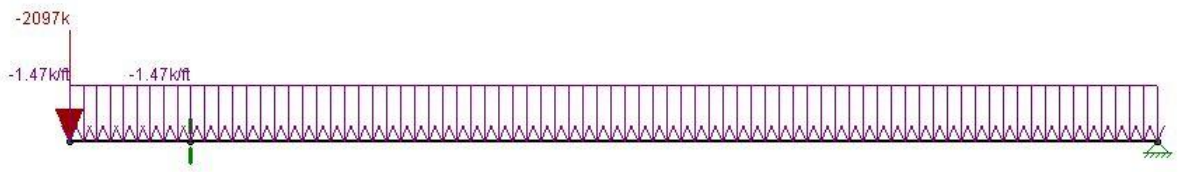


Figure 57: Plate Girder Loading

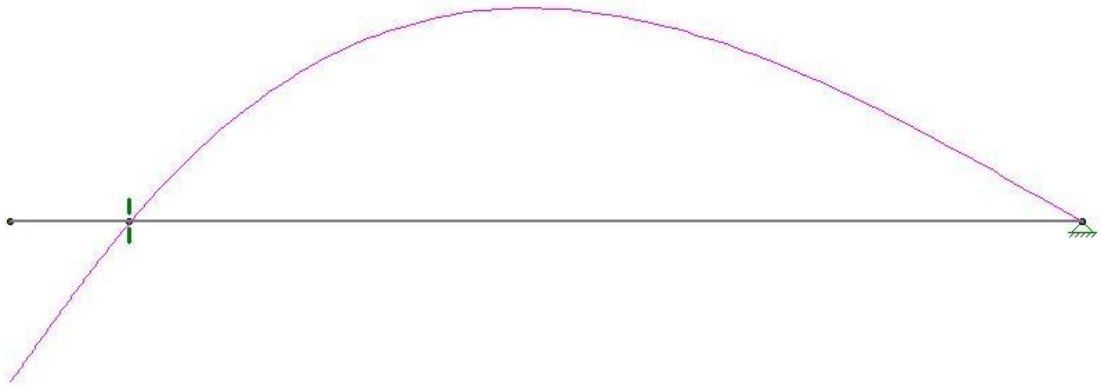


Figure 58: Plate Girder Deflected Shape

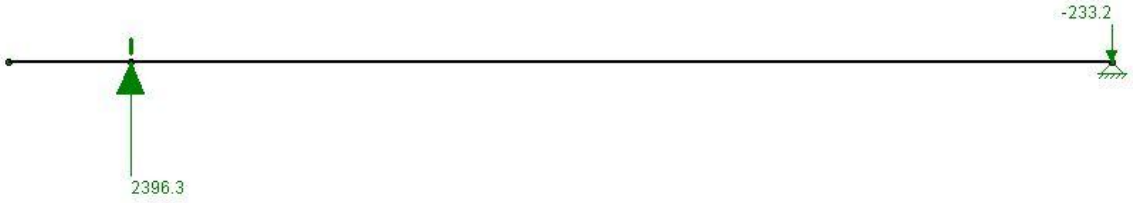


Figure 59: Plate Girder Reactions

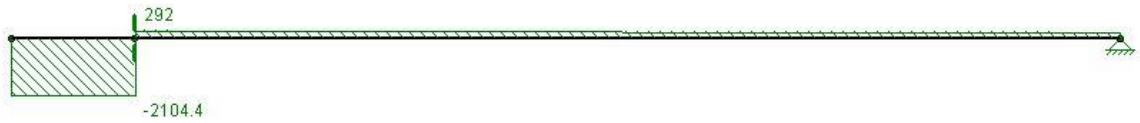


Figure 60: Plate Girder Shear Diagram

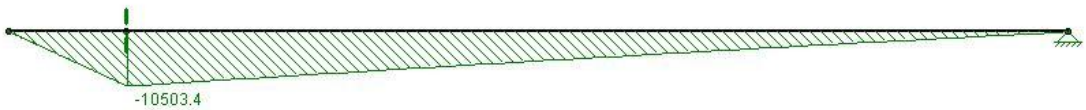


Figure 61: Plate Girder Moment Diagram

Appendix I: Seismic Loading Recalculations

COMBINED STORY WEIGHTS (k)						
	Parking Structure				Office	
Level	Walls	Columns	Slabs	Beams	Total	Total
B1	1286	431	5839	1412	0	8968
1	702	246	7201	3348	1881	13378
2	0	0	0	0	2521	2521
3	0	0	0	0	2527	2527
4	0	0	0	0	2527	2527
5	0	0	0	0	2531	2531
6	0	0	0	0	5421	5421
Penthouse	0	0	0	0	1543	1543

k_{office}=	1.03	
$k_{parking}$=	0.5	
V_{total}=	1552	k

SEISMIC STORY FORCES						
Level	w_x(k)	h_x(ft)	$w_x h_x^k$(ft-k)	C_{vx}	F_x(k)	M_{OT}(ft.-k)
B1	8968	11.2	29972	0.014	**21**	240
1	13378	26.0	Weight Lumped to Level 2			0
2	15899	41.3	733262	0.339	**526**	21680
3	2527	55.3	157491	0.073	**113**	6237
4	2527	69.3	198740	0.092	**142**	9864
5	2531	83.3	240549	0.111	**172**	14353
6	5421	97.7	607354	0.281	**435**	42509
PH Roof	1543	111.3	197690	0.091	**142**	15764
		$\Sigma w_x h_x^k$=	2165059	1	**1552**	**110647**

Seismic Overturning and Resisting Moments (ft.k.)		
Story	M_{resist}=wh	
Above B2	100173	
Above B1	347840	
Above 1	655838	
2	139632	
3	175014	
4	210665	
5	529361	
T.O. Steel	171631	
	2330154	**> 110647 OK**

SEISMIC LOAD CASE ECCENTRICITIES									
Level	Force(k)	XCM(ft.)	XCR(ft.)	ex (ft.)	5%Bx(ft.)	YCM(ft.)	YCR(ft.)	ey(ft.)	5%By(ft.)
6	577	130	134.6	4.59	5.750	57.5	57.5	0	14.5
5	172	127.5	137.1	9.61	5.750	57.5	57.5	0	14.5
4	142	130	140.3	10.34	5.750	57.5	57.5	0	14.5
3	113	127.5	142.9	15.45	5.750	57.5	57.5	0	14.5
2	526	130	144.9	14.93	5.750	57.5	57.5	0	14.5
B1	21	213.9734	330.1601	116.19	17.500	-108.5944	-103.6872	-4.9072	18.55
Sum=	1552								

Mtax=Fx(ey+5%Bx)
Mtay=Fx(ex+5%By)

100+30			
EX	30%EY	30%EX	EY
21	6.44	6.44	21

SEISMIC LOAD CASES													
	Case 1			Case 2			Case 3				Case 4			
Level	EX	Mtax(ft-k)+	Mtax(ft-k)-	EY	Mtay+	Mtay-	EX	Mtax+	Mtax-	EY	EY	Mtay+	Mtay-	EX
6	577	3318	-3318	577	11017	-5716	577	5968	-667	577	577	5716	-11017	577
5	172	991	-991	172	4158	-843	172	2649	666	172	172	843	-4158	172
4	142	819	-819	142	3538	-593	142	2292	654	142	142	593	-3538	142
3	113	649	-649	113	3381	107	113	2393	1095	113	113	-107	-3381	113
2	526	3022	-3022	526	15470	228	526	10871	4827	526	526	-228	-15470	526
B1	21	271	-481	21	2895	2098	21	2977	2225	21	21	-2203	-3000	21

Appendix J: BRBF Calculations and ETABS Output

Brace Axial Force from ETABS Analysis for BRB Sizing																
Level 6	Axial (k)	Case	Level 5	Axial (k)	Case	Level 4	Axial (k)	Case	Level 3	Axial (k)	Case	Level 2	Axial (k)	Case
D1	207	SeismicX	D1	266	SeismicX	D1	311	SeismicX	D1	345	SeismicX	D1	549	SeismicX
	-563	DStlS17		-621	DStlS17		-664	DStlS17		-696	DStlS17		-923	DStlS17
D2	559	DStlS17	D2	616	DStlS17	D2	660	DStlS17	D2	697	DStlS17	D2	923	DStlS17
	-206	SeismicX		-265	SeismicX		-309	SeismicX		-346	SeismicX		-549	SeismicX
D3	386	SeismicY-5%X	D3	448	SeismicY-5%X	D3	481	SeismicY-5%X	D3	440	SeismicY-5%X	D3	580	SeismicY-5%X
	-742	DStlS31		-804	DStlS31		-834	DStlS31		-791	DStlS31		-953	DStlS31
D4	736	DStlS31	D4	809	DStlS31	D4	836	DStlS31	D4	812	DStlS31	D4	972	DStlS31
	-383	SeismicY-5%X		-457	SeismicY-5%X		-485	SeismicY-5%X		-461	SeismicY-5%X		-598	SeismicY-5%X
D5	329	DStlS30	D7	352	DStlS55	D5	588	SeismicY-5%X	D7	397	DStlS55	D5	1257	SeismicY-5%X
	-329	DStlS31		-484	DStlS22		-680	DStlS31		-845	DStlS22		-1556	DStlS31
D6	329	DStlS31	D8	485	SeismicY-5%X	D6	438	DStlS55	D8	837	SeismicY-5%X	D6	735	DStlS55
	-329	DStlS30		-575	DStlS31		-572	DStlS22		-1142	DStlS31		-1174	DStlS22
D9	196	DStlS18	D11	247	DStlS19	D9	299	DStlS18,34,50	D11	324	DStlS19,35,51	D9	567	DStlS18,34,50
	-196	DStlS19		-247	DStlS18		-299	DStlS19,35,51		-324	DStlS18,34,50		-567	DStlS19,35,51
D10	196	DStlS19	D12	247	DStlS18	D10	299	DStlS19,35,51	D12	324	DStlS18,34,50	D10	567	DStlS19,35,51
	-196	DStlS18		-247	DStlS19		-299	DStlS18,34,50		-324	DStlS19,35,51		-567	DStlS18,34,50

Load Combination Key	
DStlS17	1.28D+L+0.2S-1.0E
DStlS31	1.28D+L+0.2S-1.0E
DStlS22	1.28D+L+0.2S+1.0E
DStlS18,34,50	1.28D+L+0.2S+1.0E
DStlS19,35,51	1.28D+L+0.2S-1.0E
DStlS22	1.28D+L+0.2S+1.0E

STEEL BEAM SUMMARY					
Label	Story	Section	PMM Controlling Ratio	PMM Combo	Class
B2	Level 06	W24X76	0.016 = 0 + 0.016 + 0	DStlS22	Seismic
B3	Level 06	W24X76	0.046 = 0 + 0.046 + 0	DStlS22	Seismic
B1	Level 06	W24X76	0.021 = 0 + 0.021 + 0	DStlS31	Seismic
B4	Level 06	W24X76	0.064 = 0 + 0.064 + 0	DStlS31	Seismic
B6	Level 06	W12X22	0.106 = 0 + 0.106 + 0	DStlS30	Seismic
B7	Level 06	W12X22	0.106 = 0 + 0.106 + 0	DStlS31	Seismic
B9	Level 06	W12X22	0.057 = 0 + 0.057 + 0	DStlS51	Seismic
B10	Level 06	W12X22	0.057 = 0 + 0.057 + 0	DStlS51	Seismic
B2	Level 05	W24X68	0.086 = 0 + 0.086 + 0	DStlS22	Compact
B3	Level 05	W24X68	0.067 = 0 + 0.067 + 0	DStlS30	Compact
B1	Level 05	W24X68	0.104 = 0 + 0.104 + 0	DStlS31	Compact
B4	Level 05	W24X68	0.07 = 0 + 0.07 + 0	DStlS31	Compact
B5	Level 05	W21X68	0.093 = 0 + 0.093 + 0	DStlS31	Seismic
B8	Level 05	W21X68	0.048 = 0 + 0.048 + 0	DStlS51	Seismic
B2	Level 04	W24X76	0.058 = 0 + 0.058 + 0	DStlS22	Seismic
B3	Level 04	W24X76	0.067 = 0 + 0.067 + 0	DStlS17	Seismic
B1	Level 04	W24X76	0.086 = 0 + 0.086 + 0	DStlS31	Seismic
B4	Level 04	W24X76	0.075 = 0 + 0.075 + 0	DStlS31	Seismic
B6	Level 04	W21X68	0.091 = 0 + 0.091 + 0	DStlS30	Seismic
B7	Level 04	W21X68	0.095 = 0 + 0.095 + 0	DStlS31	Seismic
B9	Level 04	W21X68	0.041 = 0 + 0.041 + 0	DStlS35	Seismic
B10	Level 04	W21X68	0.041 = 0 + 0.041 + 0	DStlS35	Seismic
B2	Level 03	W24X76	0.124 = 0 + 0.124 + 0	DStlS22	Seismic
B3	Level 03	W24X76	0.101 = 0 + 0.101 + 0	DStlS31	Seismic
B1	Level 03	W24X76	0.177 = 0 + 0.177 + 0	DStlS31	Seismic
B4	Level 03	W24X76	0.083 = 0 + 0.083 + 0	DStlS17	Seismic
B5	Level 03	W21X68	0.098 = 0 + 0.098 + 0	DStlS31	Seismic
B8	Level 03	W21X68	0.047 = 0 + 0.047 + 0	DStlS35	Seismic
B2	Level 02	W24X84	0.075 = 0 + 0.075 + 0	DStlS22	Seismic
B3	Level 02	W24X84	0.098 = 0 + 0.098 + 0	DStlS31	Seismic
B1	Level 02	W24X84	0.118 = 0 + 0.118 + 0	DStlS31	Seismic
B4	Level 02	W24X84	0.081 = 0 + 0.081 + 0	DStlS31	Seismic
B6	Level 02	W21X68	0.095 = 0 + 0.095 + 0	DStlS22	Seismic
B7	Level 02	W21X68	0.123 = 0 + 0.123 + 0	DStlS31	Seismic
B9	Level 02	W21X68	0.04 = 0 + 0.04 + 0	DStlS19	Seismic
B10	Level 02	W21X68	0.04 = 0 + 0.04 + 0	DStlS19	Seismic

STEEL COLUMN SUMMARY				
Story	Section	PMM Controlling Ratio	PMM Combo	Class
Level 06	W14X74	0.14 = 2.254E-04 + 0.059 + 0.081	DStlS22	Seismic
Level 06	W14X74	0.074 = 0.001 + 0.058 + 0.015	DStlS25	Seismic
Level 06	W14X74	0.172 = 1.784E-04 + 0.063 +	DStlS31	Seismic
Level 06	W14X74	0.088 = 0.002 + 0.068 + 0.018	DStlS31	Seismic
Level 06	W14X74	0.051 = 3.209E-04 + 0.031 + 0.02	DStlS29	Seismic
Level 06	W14X74	0.051 = 3.618E-04 + 0.035 +	DStlS18	Seismic
Level 05	W14X74	0.927 = 0.831 + 0.073 + 0.023	DStlS31	Seismic
Level 05	W14X74	0.499 = 0.444 + 0.026 + 0.029	DStlS22	Seismic
Level 05	W14X74	0.767 = 0.692 + 0.069 + 0.006	DStlS22	Seismic
Level 05	W14X74	0.68 = 0.605 + 0.044 + 0.03	DStlS31	Seismic
Level 05	W14X74	0.466 = 0.4 + 0.052 + 0.014	DStlS19	Seismic
Level 05	W14X74	0.466 = 0.4 + 0.052 + 0.014	DStlS18	Seismic
Level 04	W14X21	0.397 = 0.362 + 0.017 + 0.018	DStlS31	Seismic
Level 04	W14X21	0.32 = 0.297 + 0.023 + 3.721E-04	DStlS17	Seismic
Level 04	W14X21	0.304 = 0.26 + 0.002 + 0.042	DStlS17	Seismic
Level 04	W14X21	0.437 = 0.416 + 0.021 + 0.001	DStlS31	Seismic
Level 04	W14X21	0.067 = 0.06 + 0.006 + 0.001	DStlS19	Seismic
Level 04	W14X21	0.067 = 0.06 + 0.006 + 0.001	DStlS18	Seismic
Level 03	W14X21	0.796 = 0.717 + 0.046 + 0.033	DStlS31	Seismic
Level 03	W14X21	0.511 = 0.461 + 0.048 + 0.002	DStlS17	Seismic
Level 03	W14X21	0.607 = 0.556 + 0.046 + 0.005	DStlS22	Seismic
Level 03	W14X21	0.695 = 0.629 + 0.039 + 0.028	DStlS31	Seismic
Level 03	W14X21	0.34 = 0.288 + 0.037 + 0.015	DStlS19	Seismic
Level 03	W14X21	0.34 = 0.288 + 0.037 + 0.015	DStlS18	Seismic
Level 02	W14X21	0.941 = 0.903 + 0.026 + 0.012	DStlS31	Seismic
Level 02	W14X21	0.647 = 0.633 + 0.013 + 0.001	DStlS17	Seismic
Level 02	W14X21	0.689 = 0.647 + 0.024 + 0.018	DStlS22	Seismic
Level 02	W14X21	0.867 = 0.828 + 0.021 + 0.018	DStlS31	Seismic
Level 02	W14X21	0.327 = 0.295 + 0.019 + 0.013	DStlS19	Seismic
Level 02	W14X21	0.327 = 0.295 + 0.019 + 0.013	DStlS18	Seismic

STEEL BRACE SUMMARY					
Label	Story	Section	PMM Controlling Ratio	PMM Combo	Class
D1	Level 06	STARBRB-23.5	0.65 = 0.65 + 0 + 0	DStlS22	Non-Compact
D2	Level 06	STARBRB-23.5	0.644 = 0.644 + 0 + 0	DStlS22	Non-Compact
D3	Level 06	STARBRB-23.5	0.886 = 0.886 + 0 + 0	DStlS31	Non-Compact
D4	Level 06	STARBRB-23.5	0.877 = 0.877 + 0 + 0	DStlS31	Non-Compact
D5	Level 06	STARBRB-10.0	0.83 = 0.83 + 0 + 0	DStlS31	Non-Compact
D6	Level 06	STARBRB-10.0	0.83 = 0.83 + 0 + 0	DStlS30	Non-Compact
D9	Level 06	STARBRB-10.0	0.442 = 0.442 + 0 + 0	DStlS51	Non-Compact
D10	Level 06	STARBRB-10.0	0.442 = 0.442 + 0 + 0	DStlS50	Non-Compact
D1	Level 05	STARBRB-23.5	0.644 = 0.644 + 0 + 0	DStlS17	Non-Compact
D2	Level 05	STARBRB-23.5	0.639 = 0.639 + 0 + 0	DStlS17	Non-Compact
D3	Level 05	STARBRB-23.5	0.84 = 0.84 + 0 + 0	DStlS31	Non-Compact
D4	Level 05	STARBRB-23.5	0.848 = 0.848 + 0 + 0	DStlS31	Non-Compact
D7	Level 05	STARBRB-21.5	0.63 = 0.63 + 0 + 0	DStlS22	Non-Compact
D8	Level 05	STARBRB-21.5	0.758 = 0.758 + 0 + 0	DStlS31	Non-Compact
D11	Level 05	STARBRB-21.5	0.246 = 0.246 + 0 + 0	DStlS50	Non-Compact
D12	Level 05	STARBRB-21.5	0.246 = 0.246 + 0 + 0	DStlS51	Non-Compact
D1	Level 04	STARBRB-25.5	0.635 = 0.635 + 0 + 0	DStlS17	Non-Compact
D2	Level 04	STARBRB-25.5	0.631 = 0.631 + 0 + 0	DStlS17	Non-Compact
D3	Level 04	STARBRB-25.5	0.827 = 0.827 + 0 + 0	DStlS31	Non-Compact
D4	Level 04	STARBRB-25.5	0.827 = 0.827 + 0 + 0	DStlS31	Non-Compact
D5	Level 04	STARBRB-24.5	0.761 = 0.761 + 0 + 0	DStlS31	Non-Compact
D6	Level 04	STARBRB-24.5	0.634 = 0.634 + 0 + 0	DStlS22	Non-Compact
D9	Level 04	STARBRB-24.5	0.27 = 0.27 + 0 + 0	DStlS19	Non-Compact
D10	Level 04	STARBRB-24.5	0.27 = 0.27 + 0 + 0	DStlS50	Non-Compact
D1	Level 03	STARBRB-22.5	0.751 = 0.751 + 0 + 0	DStlS17	Non-Compact
D2	Level 03	STARBRB-22.5	0.752 = 0.752 + 0 + 0	DStlS17	Non-Compact
D3	Level 03	STARBRB-22.5	0.859 = 0.859 + 0 + 0	DStlS31	Non-Compact
D4	Level 03	STARBRB-22.5	0.878 = 0.878 + 0 + 0	DStlS31	Non-Compact
D7	Level 03	STARBRB-36.0	0.625 = 0.625 + 0 + 0	DStlS22	Non-Compact
D8	Level 03	STARBRB-36.0	0.849 = 0.849 + 0 + 0	DStlS31	Non-Compact
D11	Level 03	STARBRB-36.0	0.099 = 0.099 + 0 + 0	DStlS50	Non-Compact
D12	Level 03	STARBRB-36.0	0.099 = 0.099 + 0 + 0	DStlS19	Non-Compact
D1	Level 02	STARBRB-30.0	0.748 = 0.748 + 0 + 0	DStlS17	Non-Compact
D2	Level 02	STARBRB-30.0	0.746 = 0.746 + 0 + 0	DStlS17	Non-Compact
D3	Level 02	STARBRB-30.0	0.777 = 0.777 + 0 + 0	DStlS31	Non-Compact

STEEL BRACE SUMMARY					
Label	Story	Section	PMM Controlling Ratio	PMM Combo	Class
D4	Level 02	STARBRB-30.0	0.788 = 0.788 + 0 + 0	DStlS31	Non-Compact
D5	Level 02	STARBRB-48.0	0.846 = 0.846 + 0 + 0	DStlS31	Non-Compact
D6	Level 02	STARBRB-48.0	0.636 = 0.636 + 0 + 0	DStlS22	Non-Compact
D9	Level 02	STARBRB-48.0	0.271 = 0.271 + 0 + 0	DStlS51	Non-Compact
D10	Level 02	STARBRB-48.0	0.271 = 0.271 + 0 + 0	DStlS50	Non-Compact

Buckling-Restrained Brace Frames 5 and 6

All of the following diagrams for BRBF 5 and 6 are representative of the controlling load combination 1.28D+L+0.2S+1.0E.

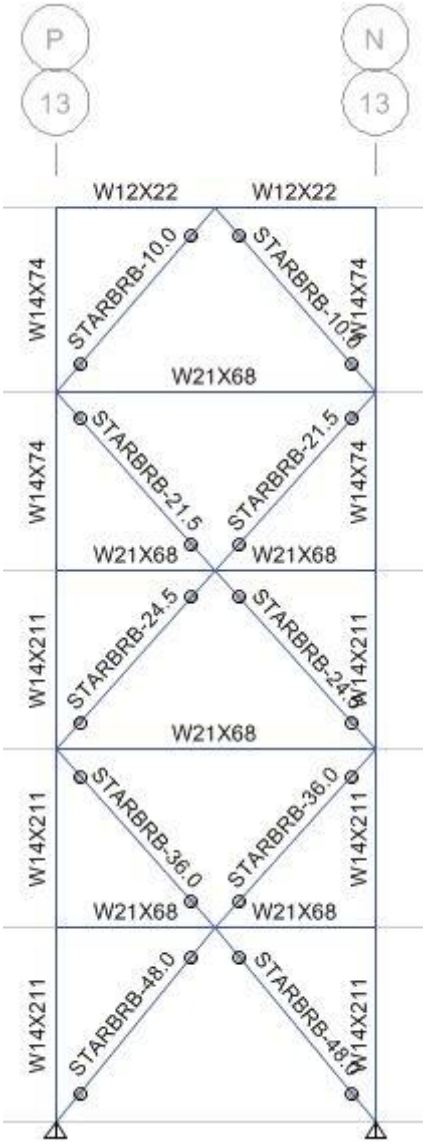


Figure 62: BRBF 5 and 6 Model

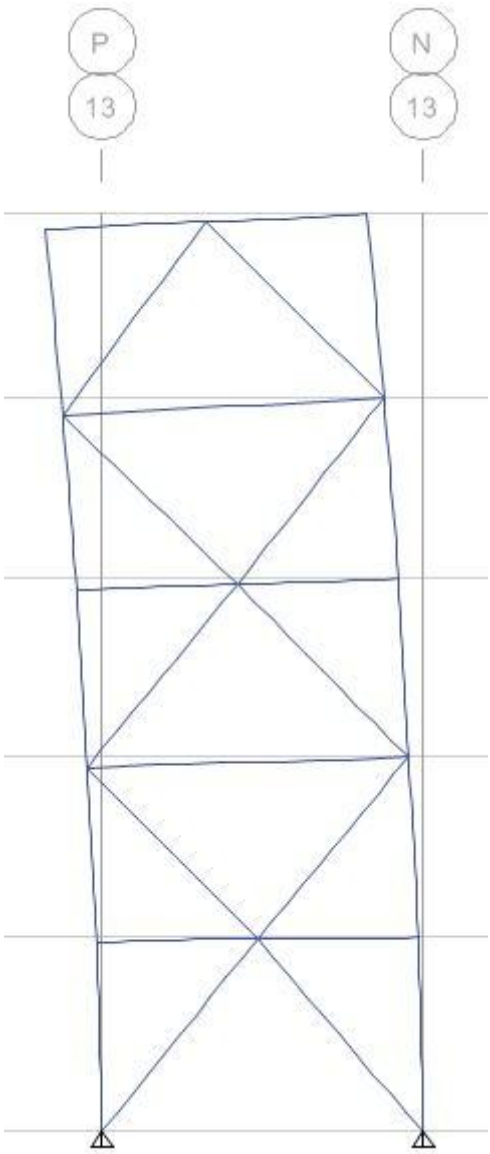


Figure 63: BRBF 5 and 6 Deflected Shape

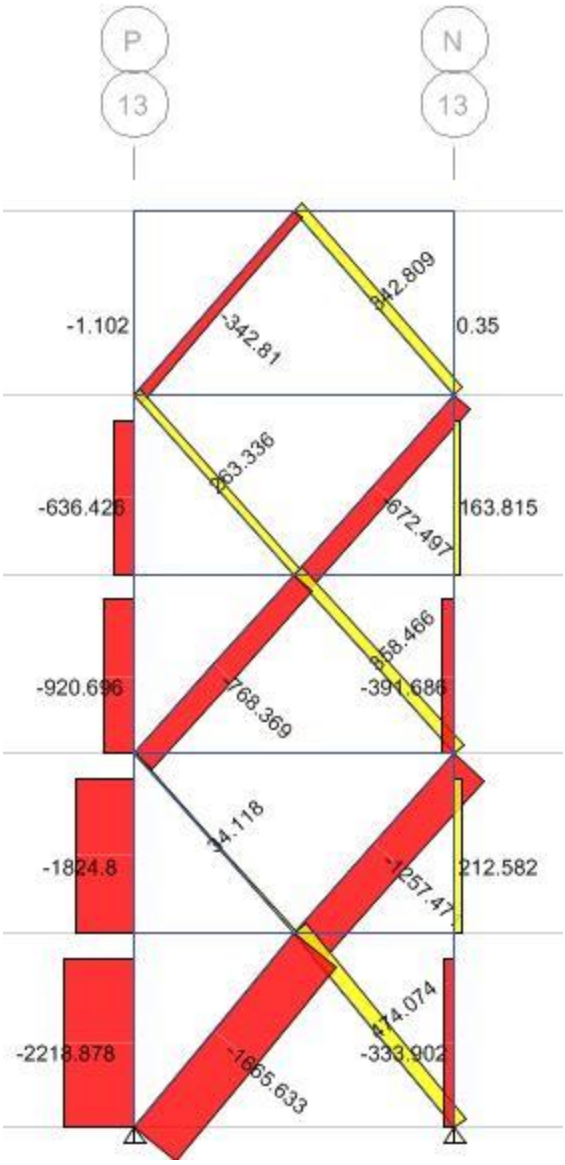


Figure 64: BRBF 5 and 6 Axial Force Diagram

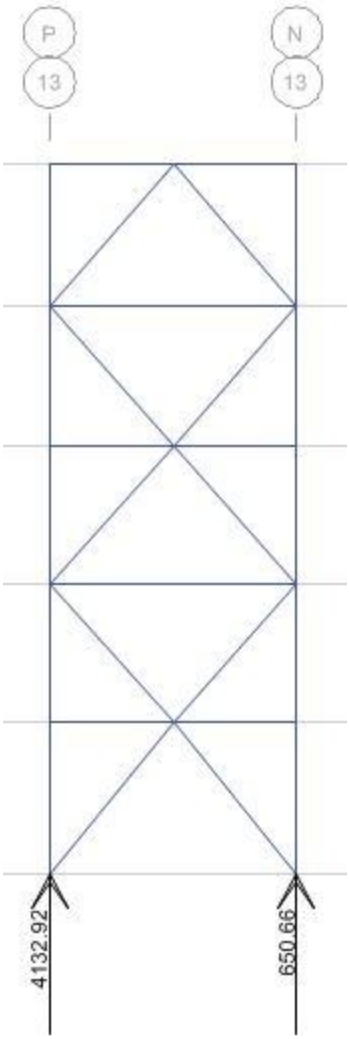


Figure 65: BRBF 5 and 6 Vertical Reactions under Controlling Load Combination

Buckling-Restrained Brace Frames 7 and 8

All of the following diagrams for BRBF 5 and 6 are representative of the controlling load combination 1.28D+L+0.2S+1.0E.

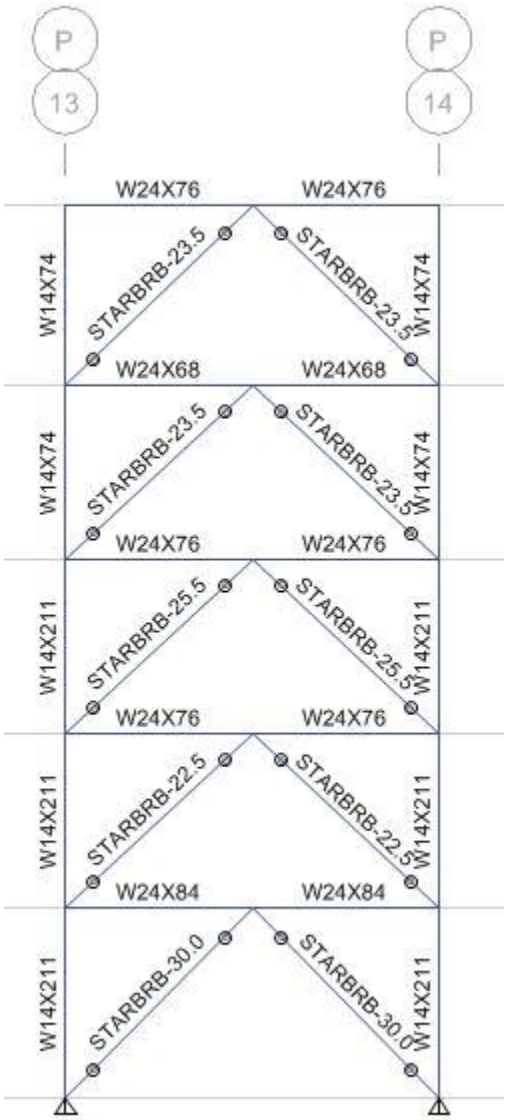


Figure 66: BRBF 7 and 8 ETABS Model

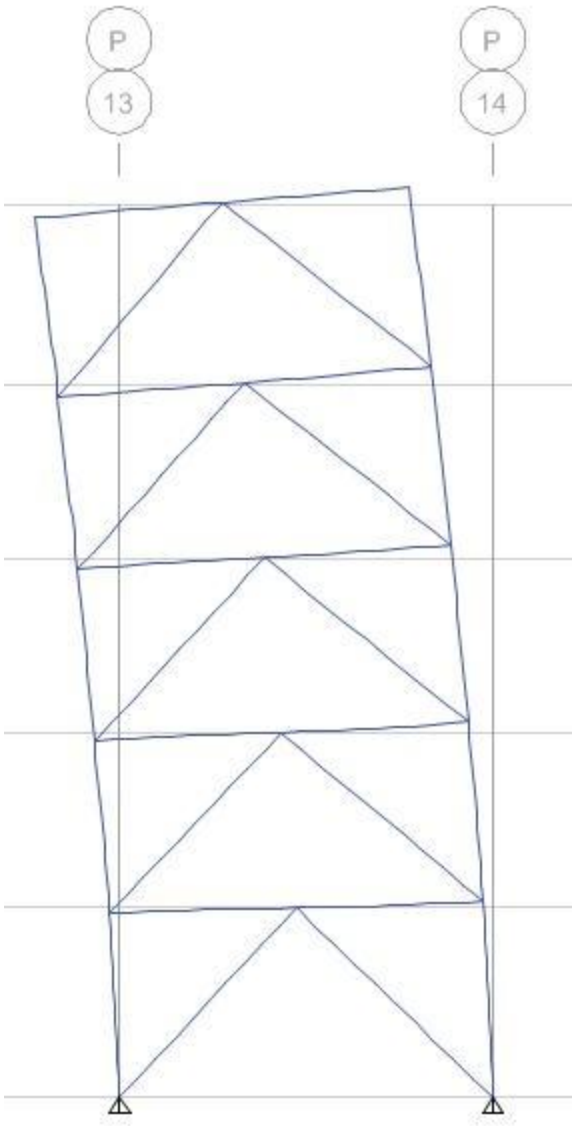


Figure 67: BRBF 7 and 8 Deflected Shape

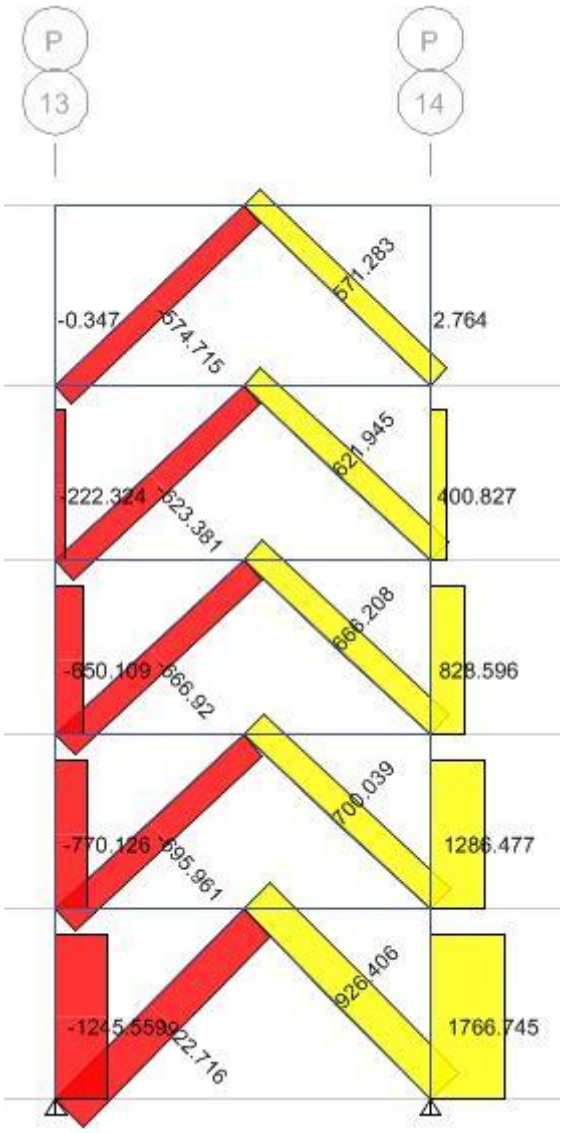


Figure 68: BRBF 7 and 8 Axial Diagram

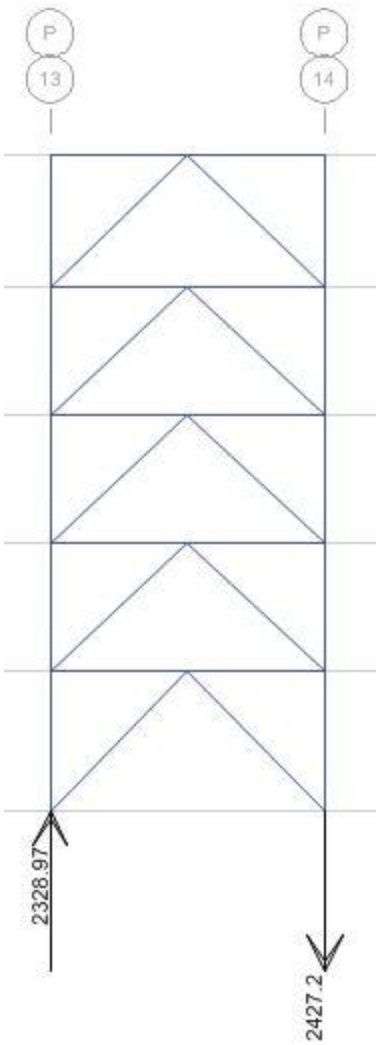


Figure 69: BRBF 7 and 8 Vertical Reactions under Controlling Load Combination

Appendix K: Construction Breadth Calculations

As Built Project

Schedule Duration for As Built Truss Assemblies							
Assembly	Item	Units	Quantity	Crew	Daily Output	Labor Hours	Duration (Days)
Truss T1	W14X90	LF	113	E-2	740	0.076	0.152
Truss T1	W24X94	LF	115	E-2	1080	0.074	0.106
Truss T1	W27X129	LF	115	E-2	1150	0.07	0.100
Truss T1	W14X159	LF	144	E-2	700	0.08	0.206
Truss T2	W14X120	LF	113	E-2	720	0.078	0.157
Truss T2	W21X73	LF	280	E-2	1024	0.078	0.273
Truss T2	W14X176	LF	303	E-2	683	0.082	0.443
Truss T2	W14X193	LF	113	E-2	671	0.083	0.168
Truss T2	W27X94	LF	200	E-2	1190	0.067	0.168
						Total=	**1.77**

Schedule Duration for As Built Roof System										
Assembly	Item	Units	Quantity	Crew	Daily Output	Labor Hours	Duration (Days)	# Crews	New Daily Output	New Duration
Deck & Insul.	3N20	SF	28450	E-4	3600	0.009	7.903	5	18000	1.58
TPO Single Ply Sheet	Roofing	Sq	285	G-5	25	1.6	11.400	5	125	2.28
Precast Conc. Unit Paving	Roof Pavers	SF	28450	2 Bric	250	0.064	113.800	18	4500	6.32
						Total=	**133**		**Total=**	**10.18**

Time Factor Calculation			
Month/Year	BCI	Modifier	
March '14	5335.54	1.074	>1 OK
Jan. '11	4968.61		
Assume 3% Inflation		1.03	
Time Factor=		**1.106**	

Schedule Duration for As Built Roof Framing							
Assembly	Item	Units	Quantity	Crew	Daily Output	Labor Hours	Duration (Days)
Roof Framing	W24X94	LF	115	E-2	1080	0.074	0.106
Roof Framing	W24X62	LF	30	E-2	1110	0.072	0.027
Roof Framing	W21X68	LF	90	E-2	1036	0.077	0.087
Roof Framing	W21X57	LF	60	E-2	1048	0.076	0.057
Roof Framing	W24X68	LF	220	E-2	1110	0.072	0.198
Roof Framing	W24X55	LF	200	E-2	1110	0.072	0.180
Roof Framing	W21X50	LF	165	E-2	1064	0.075	0.155
Roof Framing	W21X44	LF	2625	E-2	1064	0.075	2.467
Roof Framing	W18X46	LF	25	E-2	960	0.083	0.026
Roof Framing	W18X35	LF	25	E-2	960	0.083	0.026
Roof Framing	W16X26	LF	50	E-2	1000	0.056	0.050
Roof Framing	W14X34	LF	108	E-2	810	0.069	0.133
Roof Framing	W14X30	LF	25	E-2	900	0.062	0.028
Roof Framing	W14X22	LF	375	E-2	1080	0.052	0.347
Roof Framing	W12X19	LF	250	E-2	880	0.064	0.284
Roof Framing	W12X14	LF	160	E-2	880	0.064	0.182
Roof Framing	W16X45	LF	25	E-2	800	0.07	0.031
Roof Framing	C12X20.7	LF	310	E-2	600	0.093	0.517
Roof Framing	W21X48	LF	180	E-2	1064	0.075	0.169
Roof Framing	W8X10	LF	20	E-2	600	0.093	0.033
Roof Framing	W8X18	LF	280	E-2	600	0.093	0.467
						Total=	**5.57**

COST ESTIMATE FOR THE AS BUILT PROJECT FOR SOUTH OFFICE TOWER											
Cost Code	Assembly	Item	Units	Quantity	Waste/Accessory	Mat'l Unit Cost	Labor Unit Cost	Equip. Unit Cost	Unit Total	O&P Unit Total	Total Cost
05 12 23.75 2380	Truss T1	W14X90	LF	113	1.1	124	3.65	2.02	129.67	144	17867.52
05 12 23.75 5720	Truss T1	W24X94	LF	115	1.1	129	3.61	1.5	134.11	150	18975
(Interpolate)	Truss T1	W27X129	LF	115	1.1	179	3.39	1.41	183.8	203.5	25742.75
(Interpolate)	Truss T1	W14X159	LF	144	1.1	206	3.85	2.14	211.99	238	37751.56
05 12 23.75 2500	Truss T2	W14X120	LF	113	1.1	165	3.75	2.08	170.83	191	23699.28
(Interpolate)	Truss T2	W21X73	LF	280	1.1	100	3.81	1.58	105.72	119	36652
(Interpolate)	Truss T2	W14X176	LF	303	1.1	242	3.94	2.19	247.66	279	92929.32
(Interpolate)	Truss T2	W14X193	LF	113	1.1	265	3.99	2.23	270.99	305	37844.4
05 12 23.75 5900	Truss T2	W27X94	LF	200	1.1	129	3.28	1.36	133.64	149	32780
05 12 23.75 5720	Roof Framing	W24X94	LF	115	1.1	129	3.61	1.5	134.11	150	18975
05 12 23.75 5100	Roof Framing	W24X62	LF	30	1.1	85.5	3.52	1.46	90.48	102	3366
05 12 23.75 4700	Roof Framing	W21X68	LF	90	1.1	93.5	3.77	1.56	98.83	111	10989
(Interpolate)	Roof Framing	W21X57	LF	60	1.1	78.63	3.73	1.54	83.9	94	6204
05 12 23.75 5300	Roof Framing	W24X68	LF	220	1.1	93.5	3.52	1.46	98.48	111	26862
05 12 23.75 4900	Roof Framing	W24X55	LF	200	1.1	75.5	3.52	1.46	80.48	90.5	19910
05 12 23.75 4300	Roof Framing	W21X50	LF	165	1.1	69	3.67	1.52	74.19	83.5	15155.25
05 12 23.75 4100	Roof Framing	W21X44	LF	2625	1.1	60.5	3.67	1.52	65.69	74.5	215118.75
05 12 23.75 3520	Roof Framing	W18X46	LF	25	1.1	63.5	4.07	1.69	69.26	78.5	2158.75
05 12 23.75 3300	Roof Framing	W18X35	LF	25	1.1	48	4.07	1.69	53.76	62	1705
05 12 23.75 2700	Roof Framing	W16X26	LF	50	1.1	36	2.7	1.5	40.2	46	2530
05 12 23.75 2300	Roof Framing	W14X34	LF	108	1.1	47	3.34	1.85	52.19	59	7009.2
05 12 23.75 2100	Roof Framing	W14X30	LF	25	1.1	41.5	3	1.66	46.16	52.5	1443.75
(Interpolate)	Roof Framing	W14X22	LF	375	1.1	30.5	2.46	1.36	34.32	39.5	16293.75
(Interpolate)	Roof Framing	W12X19	LF	250	1.1	26.25	3.07	1.7	31.02	35.75	9831.25
(Interpolate)	Roof Framing	W12X14	LF	160	1.1	19.17	3.07	1.7	23.94	27.83	4898.08
(Interpolate)	Roof Framing	W16X45	LF	25	1.1	62	3.38	1.87	67.25	76	2090
(Interpolate)	Roof Framing	C12X20.7	LF	310	1.1	12.4	4.5	2.49	19.39	24	8184
(Interpolate)	Roof Framing	W21X48	LF	180	1.1	66	3.67	1.52	71.36	81	16038
05 12 23.75 0300	Roof Framing	W8X10	LF	20	1.1	13.75	4.5	2.49	20.74	25.5	561
(Interpolate)	Roof Framing	W8X18	LF	280	1.1	24.75	4.5	2.49	31.74	37.75	11627
05 31 23.50 3350	Deck & Insul.	3N20	SF	28450	1.1	2.775	0.44	0.03	3.25	3.80	118764.525
07 54 23.10 0200	TPO Single Ply Sheet	Roofing	Sq	285	1.1	79	54.5	7.15	140.65	186	58311
32 14 13.16 0800	Precast Conc. Unit Paving	Roof Pavers	SF	28450	1	7.1	2.82	0	10.02	12.58	357901

Green Roof Garden

Schedule Duration for Green Roof Garden System										
Assembly	Item	Units	Quantity	Crew	Labor Hours	Daily Output	Duration (Days)	# Crews	New Daily Output	New Duration
Deck	3VLI19	SF	28450	E-4	0.011	2850	9.98	5	14250	2.00
Concrete Topping	ltwt, 3.5" Top	CY	439	-	-	-				
Concrete Formwork	4 use	SF	28450	C-2	0.086	560	50.80	10	5600	5.08
Concrete Placement	Elev., crane & bucket	CY	439	C-7	0.758	95	4.62	2	190	2.31
Concrete Finishing	Ride on screed...	SF	28450	C-10E	0.006	4000	7.11	5	20000	1.42
Welded Wire Fabric	6x6-W2.1xW2.1	CSF	28450	2 Rodm	0.516	31	917.74	50	1550	18.35
Expanded Polystyrene Insulation	6" Thick	SF	28450	1 Rofc	0.008	1000	28.45	10	10000	2.85
Waterproof Membrane	215 mil, reinf	SF	28450	G-5	0.114	350	81.29	20	7000	4.06
Root Barrier	-	SF	28450	2 Rofc	0.021	775	36.71	10	7750	3.67
Moisture Retention Barrier and Resevoir		SF	15672	2 Rofc	0.18	900	17.41	10	9000	1.74
Separation Fabric	-	SF	15672	2 Rofc	0.021	775	20.22	10	7750	2.02
M3 Growth and Drainage Media	10" Thick	SF	15672	B-13C	0.035	1600	9.80	2	3200	4.90
M3 Growth and Drainage Media	12" Thick	SF	15672	B-13C	0.042	1335	11.74	2	2670	5.87
Wind Blanket	-	SF	15672	2 Rofc	0.021	775	20.22	10	7750	2.02
55 ton crane mobilization	-	Ea.	1	1 Eqhv	2.222	3.6	0.28	1	3.6	0.28
Roof edging, treated lumber	4"x6"	LF	1278	2 Carp	0.04	400	3.20	5	2000	0.64
pedestal pavers		SF	6470	D-1	0.178	90	71.89	18	1620	3.99
planting sedum	-	SF	5974	1 Clab	0.019	420	14.22	10	4200	1.42
Planting Wildflower	Ajuga, 1 yr	C (100)	119	B-1	2.667	9	13.22	5	45	2.64
Planting Garden	Vinca Minor, 1 yr	C (100)	113	B-1	2.4	10	11.30	5	50	2.26
Fence	3 rail	LF	115	B-1	0.16	150	0.77	1	150	0.77
Fence	fence pole	Ea.	24	B-1	0.25	96	0.25	1	96	0.25
						Total=	1331.22		Total=	68.55

Schedule Duration for Green Roof Garden Truss Assemblies							
Assembly	Item	Units	Quantity	Crew	Labor Hours	Daily Output	Duration (Days)
Truss T1	W14X145	LF	113	E-2	0.08	703	0.161
Truss T1	W24X192	LF	115	E-2	0.076	1050	0.110
Truss T1	W27X146	LF	115	E-2	0.07	1150	0.100
Truss T1	W14X283	LF	144	E-2	0.089	611	0.236
Truss T2	W21X101	LF	80	E-2	0.08	1000	0.080
Truss T2	W14X311	LF	303	E-2	0.091	593	0.511
Truss T2	W14X193	LF	113	E-2	0.083	671	0.168
Truss T2	W27X281	LF	200	E-2	0.07	1150	0.174
						Total=	1.54

Schedule Duration for Green Roof Garden Roof Framing							
Assembly	Item	Units	Quantity	Crew	Labor Hours	Daily Output	Duration (Days)
Roof Framing	W27X129	LF	700	E-2	0.07	1150	0.609
Roof Framing	W24X76	LF	120	E-2	0.072	1110	0.108
Roof Framing	W24X62	LF	230	E-2	0.072	1110	0.207
Roof Framing	W21X55	LF	380	E-2	0.076	1050	0.362
Roof Framing	W27X84	LF	170	E-2	0.067	1190	0.143
Roof Framing	W24X68	LF	180	E-2	0.072	1110	0.162
Roof Framing	W24X55	LF	1890	E-2	0.072	1110	1.703
Roof Framing	W21X44	LF	240	E-2	0.075	1064	0.226
Roof Framing	W18X40	LF	45	E-2	0.083	960	0.047
Roof Framing	W18X35	LF	528	E-2	0.083	960	0.550
Roof Framing	W16X26	LF	110	E-2	0.056	1000	0.110
Roof Framing	W14X30	LF	25	E-2	0.062	900	0.028
Roof Framing	W12X22	LF	175	E-2	0.064	880	0.199
Roof Framing	W14X22	LF	325	E-2	0.057	990	0.328
Roof Framing	W12X14	LF	25	E-2	0.064	880	0.028
Roof Framing	W8X18	LF	280	E-2	0.093	600	0.467
Roof Framing	W18X46	LF	25	E-2	0.083	960	0.026
Roof Framing	W14X257	LF	90	E-2	0.087	629	0.143
Roof Framing	W18X211	LF	133.2	E-2	0.089	900	0.148
Roof Framing	W14X176	LF	25	E-2	0.082	683	0.037
						Total=	5.63

COST ESTIMATE FOR THE GREEN ROOF GARDEN FOR SOUTH OFFICE TOWER											
Cost Code	Assembly	Item	Units	Quantity	Waste/Accessory	Mat'l Unit Cost	Labor Unit Cost	Equip. Unit Cost	Unit Total	O&P Unit Total	Total Cost
(Extrapolate)	Truss T1	W14X145	LF	113	1.1	181	3.76	2.3	186.73	206	25605.8
(Extrapolate)	Truss T1	W24X192	LF	115	1.1	238	3.65	1.65	243.38	270	34155
05 12 23.75 5940	Truss T1	W27X146	LF	115	1.1	181	3.33	1.51	185.84	206	26059
(Extrapolate)	Truss T1	W14X283	LF	144	1.1	355	4.22	2.58	362.27	395	62568
05 12 23.75 4760	Truss T2	W21X101	LF	80	1.1	125	3.83	1.73	130.56	146	12848
(Extrapolate)	Truss T2	W14X311	LF	303	1.1	391	4.32	2.63	397.88	433	144223.64
(Extrapolate)	Truss T2	W14X193	LF	113	1.1	241	3.92	2.4	247.79	272	33749.76
(Extrapolate)	Truss T2	W27X281	LF	200	1.1	343	3.33	1.51	347.84	386	84920
(Extrapolate)	Roof Framing	W27X129	LF	700	1.1	161	3.33	1.51	165.84	184	141680
05 12 23.75 5500	Roof Framing	W24X76	LF	120	1.1	94	3.45	1.56	99.01	111	14652
05 12 23.75 5100	Roof Framing	W24X62	LF	230	1.1	76.5	3.45	1.56	81.51	92	23276
(Extrapolate)	Roof Framing	W21X55	LF	380	1.1	69.5	3.65	1.65	74.55	82.5	34485
05 12 23.75 5800	Roof Framing	W27X84	LF	170	1.1	104	3.22	1.45	108.67	121	22627
05 12 23.75 5300	Roof Framing	W24X68	LF	180	1.1	84	3.45	1.56	89.01	100	19800
05 12 23.75 4900	Roof Framing	W24X55	LF	1890	1.1	68	3.45	1.56	73.01	82.5	171517.5
05 12 23.75 4100	Roof Framing	W21X44	LF	240	1.1	54.5	3.6	1.63	59.73	68	17952
05 12 23.75 3500	Roof Framing	W18X40	LF	45	1.1	49.5	3.99	1.8	55.29	63.5	3143.25
05 12 23.75 3300	Roof Framing	W18X35	LF	528	1.1	43.5	3.99	1.8	49.29	56.5	32815.2
05 12 23.75 2700	Roof Framing	W16X26	LF	110	1.1	32	2.65	1.62	36.27	42	5082
05 12 23.75 2100	Roof Framing	W14X30	LF	25	1.1	37	2.95	1.8	41.75	48	1320
05 12 23.75 1300	Roof Framing	W12X22	LF	175	1.1	27	3.01	1.84	31.85	37	7122.5
05 12 23.75 1900	Roof Framing	W14X22	LF	325	1.1	32	2.68	1.64	36.32	42	15015
05 12 23.75 1100	Roof Framing	W12X14	LF	25	1.1	19.8	3.01	1.84	24.65	29	797.5
05 12 23.75 0350	Roof Framing	W8X18	LF	280	1.1	26	4.42	2.7	33.12	39	12012
6 12 23.75 3520	Roof Framing	W18X46	LF	25	1.1	57	3.99	1.8	62.79	71.5	1966.25
(Extrapolate)	Roof Framing	W14X257	LF	90	1.1	323	4.14	2.52	329.19	359	35541
(Extrapolate)	Roof Framing	W18X211	LF	133.2	1.1	262	4.26	1.92	268.43	295	43223.4
(Extrapolate)	Roof Framing	W14X176	LF	25	1.1	220	3.87	2.36	226.16	249	6847.5

COST ESTIMATE FOR THE GREEN ROOF GARDEN FOR SOUTH OFFICE TOWER											
Cost Code	Assembly	Item	Units	Quantity	Waste/Accessory	Mat'l Unit Cost	Labor Unit Cost	Equip. Unit Cost	Unit Total	O&P Unit Total	Total Cost
05 31 13.50 5900	Deck	3VLI19	SF	28450	1.1	2	0.55	0.04	2.59	3.21	100456.95
03 31 16.10 0820	Concrete Topping	ltwt, 3.5" Top	CY	439	1.1	141	0	0	141	155	74849.5
03 11 13.35 1150	Concrete Formwork	4 use	SF	28450	1.1	1.03	3.59	0	4.62	6.65	208111.75
03 31 05.70 1450	Concrete Placement	Elev., crane & bucket	CY	439	1	0	28	13.45	41.45	57.5	25242.5
03 35 29.30 0350	Concrete Finishing	Ride on screed...	SF	28450	1	0	0.23	0.06	0.29	0.4	11380
03 22 05.50 0200	Welded Wire Fabric	6x6-W2.1xW2.1	CSF	28450	1.1	18.9	25	0	43.9	61	1908995
07 22 16.10 1932	Expanded Polystyrene Insulation	6" Thick	SF	28450	1	1.52	0.29	0	1.81	2.16	61452
07 33 63.10 0560	Waterproof Membrane	215 mil, reinf	SF	28450	1	0.26	3.79	0.48	4.53	7.1	201995
07 33 63.10 0570	Root Barrier	-	SF	28450	1	0.7	0.75	0	1.45	2.03	57753.5
07 33 63.10 0580	Moisture Retention Barrier and Resevoir		SF	15672	1	2.7	0.65	0	3.35	4.05	63471.6
07 33 63.10 0570	Separation Fabric	-	SF	15672	1	0.7	0.75	0	1.45	2.03	31814.16
07 33 63.10 0385	M3 Growth and Drainage Media	10" Thick	SF	15672	1	6	1.3	1.03	2.93	3.78	59240.16
07 33 63.10 0390	M3 Growth and Drainage Media	12" Thick	SF	15672	1	0.72	1.56	1.24	3.52	4.52	70837.44
07 33 63.10 0570	Wind Blanket	-	SF	15672	1	0.7	0.75	0	1.45	2.03	31814.16
07 33 63.10 0350	55 ton crane mobilization	-	Ea.	1	1	0	103	0	103	154	154
07 33 63.10 0365	hoisting cost 6-10 stories/day	avg 21 picks/day	Day	14	1	0	2075	1650	3725	5000	70000
07 33 63.10 0410	Roof edging, treated lumber	4"x6"	LF	1278	1	2.46	1.72	0	4.18	5.35	6837.3
09 63 13.10 0590	pedestal pavers		SF	6470	1	5.55	6.95	0	12.5	16.5	106755
07 33 63.10 0600	planting sedum	-	SF	5974	1.1	4.5	0.65	0	5.15	5.95	39099.83
32 93 13.20 0100	Planting Wildflower	Ajuga, 1 yr	C (100)	119	1.1	130	93.5	0	223.5	286	37437.4
32 93 13.20 0800	Planting Garden	Vinca Minor, 1 yr	C (100)	113	1.1	110	84	0	194	250	31075
32 31 23.20 9018	Fence	3 rail	LF	115	1.05	6.25	5.6	0	11.85	15.5	1871.625
33 31 23.20 9030	Fence	fence pole	Ea.	24	1	17.75	8.75	0	26.5	33	792