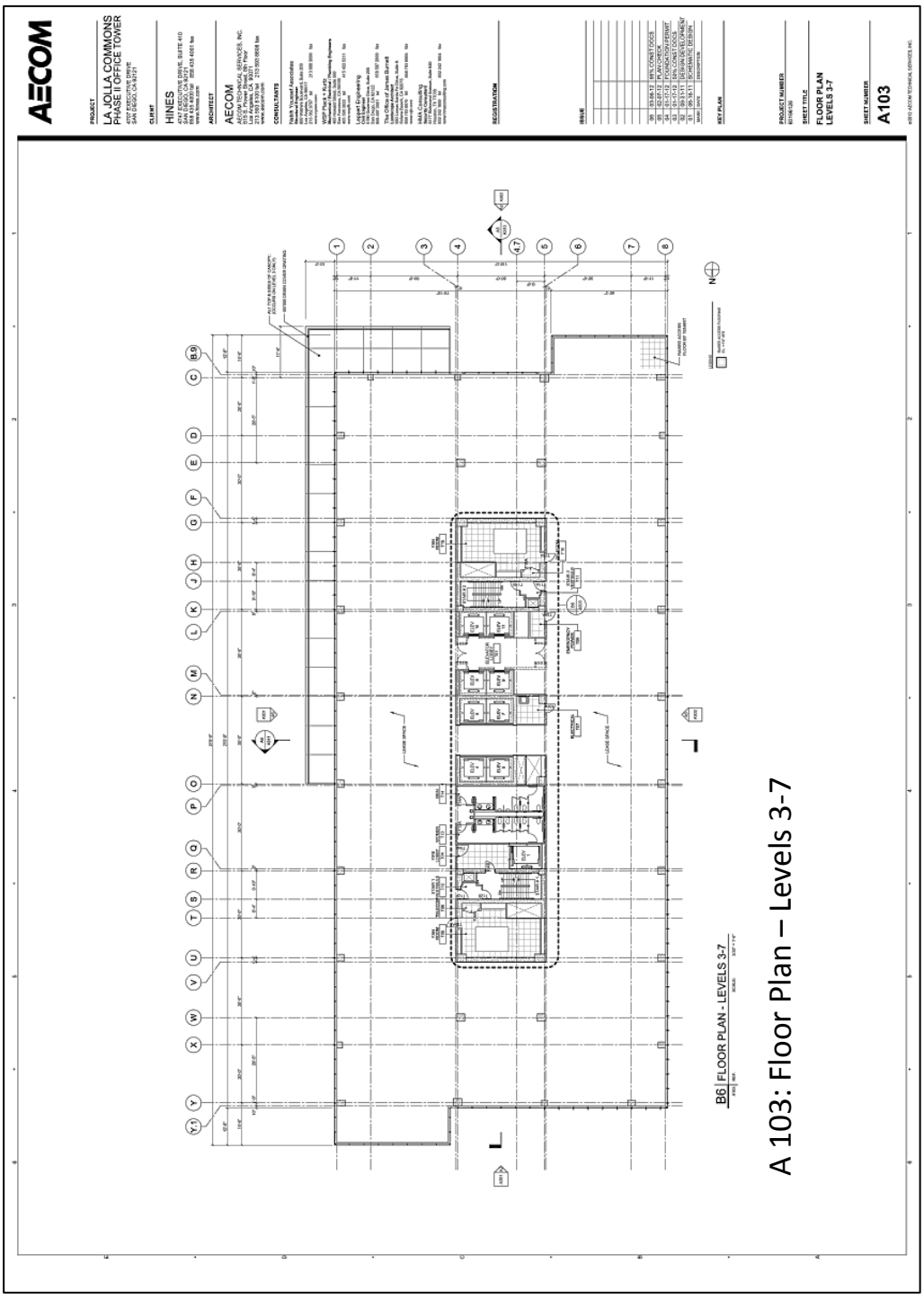
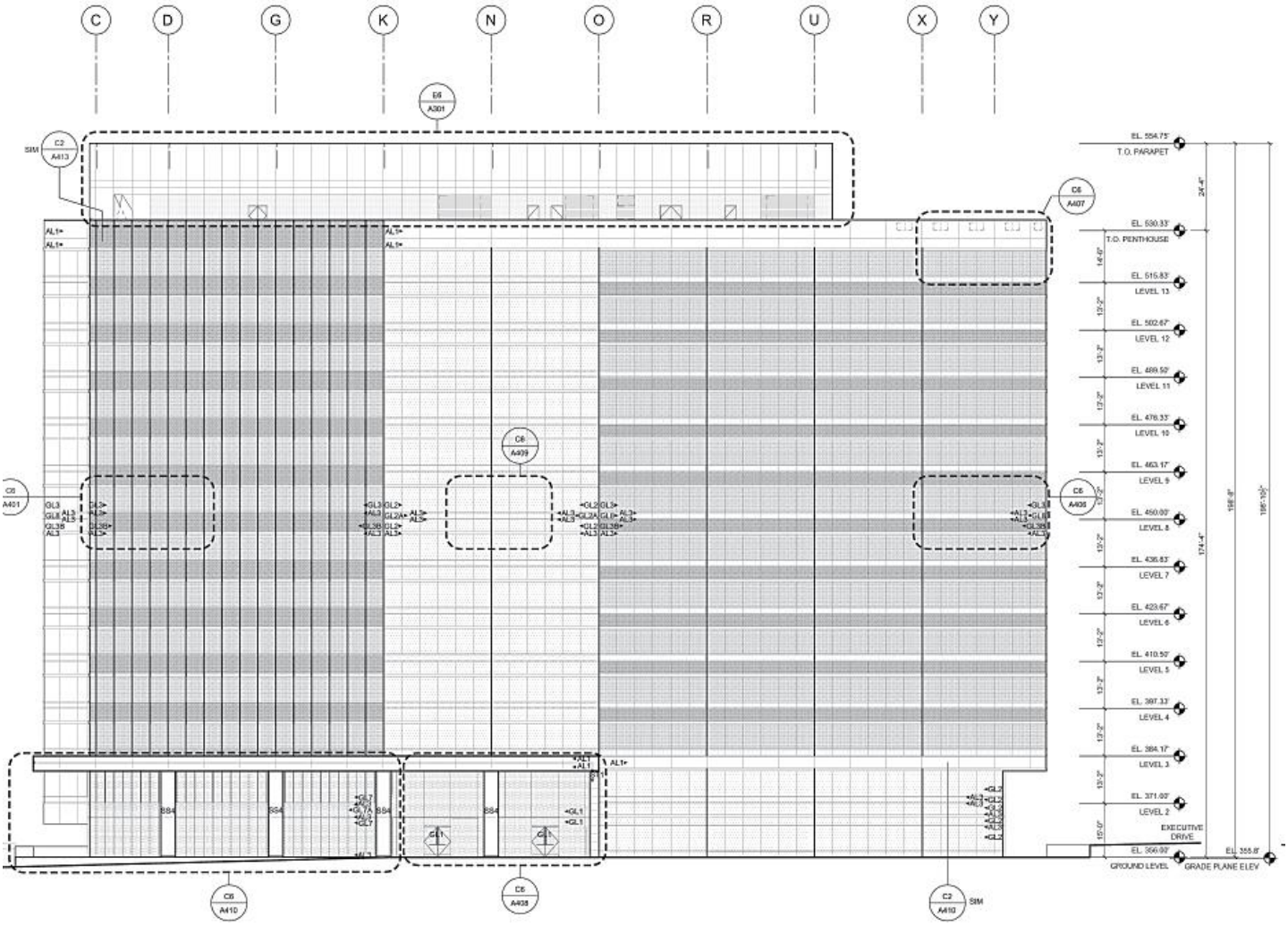
Appendices

Appendix A – Typical Architectural Plan and Elevations

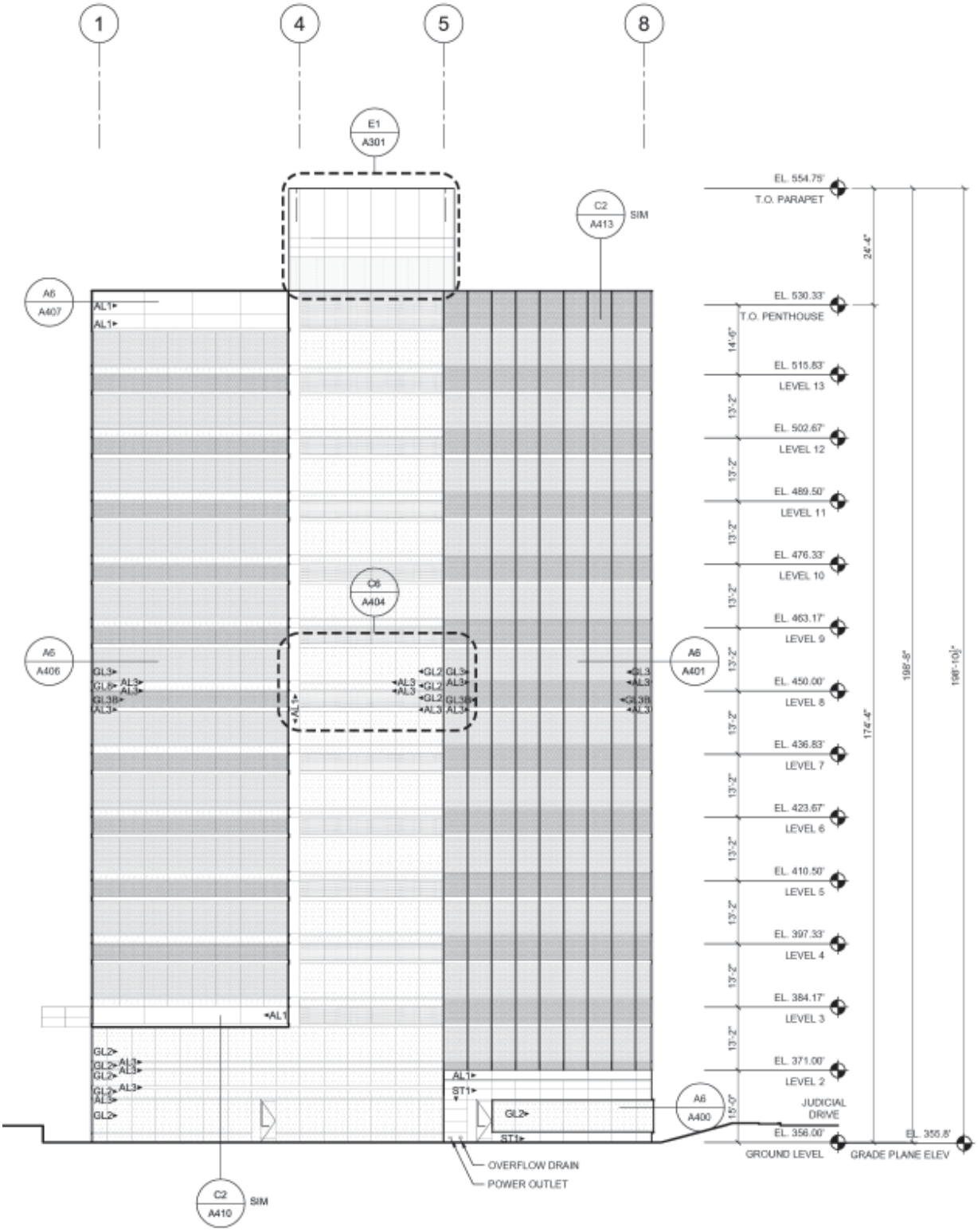


A 103: Floor Plan – Levels 3-7



A6 | BUILDING ELEVATION EAST

A301 REF. SCALE: 1/16" = 1'-0"

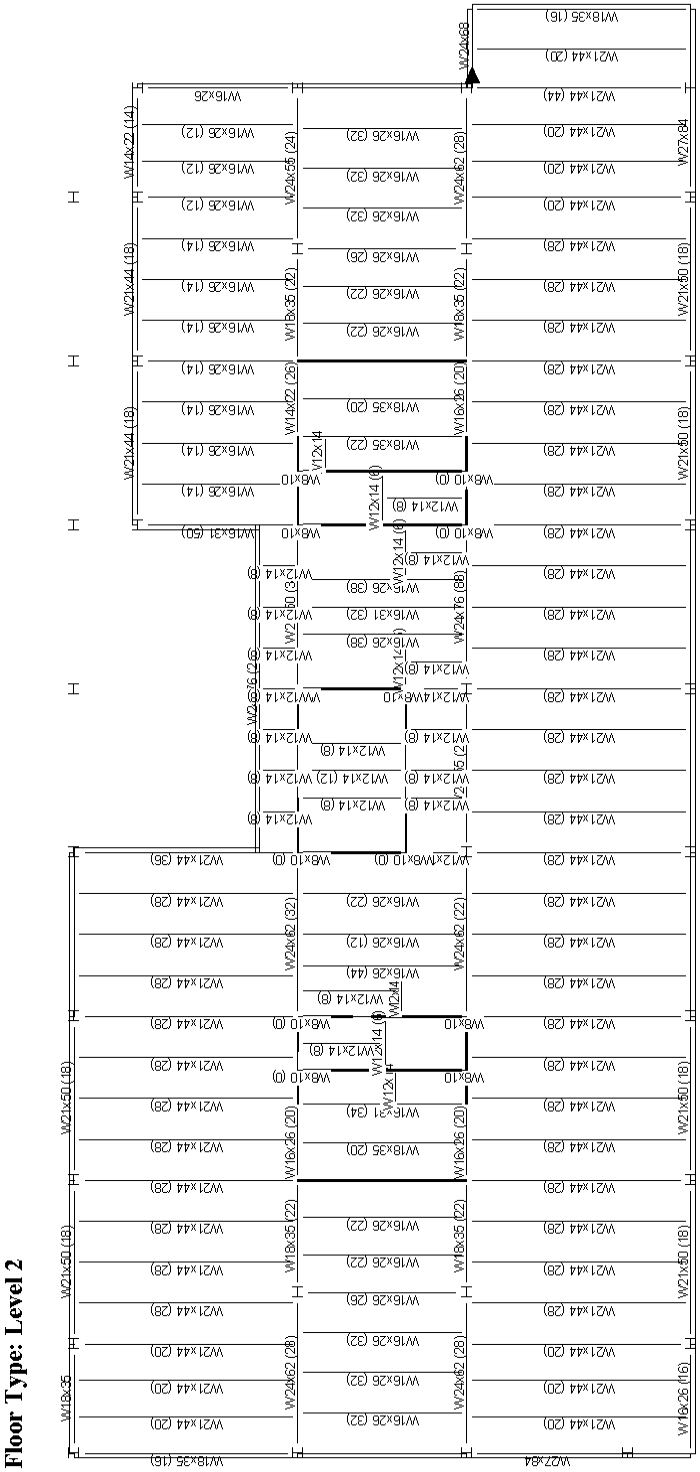


A2 | BUILDING ELEVATION NORTH

A301 REF. SCALE: 1/16" = 1'-0"

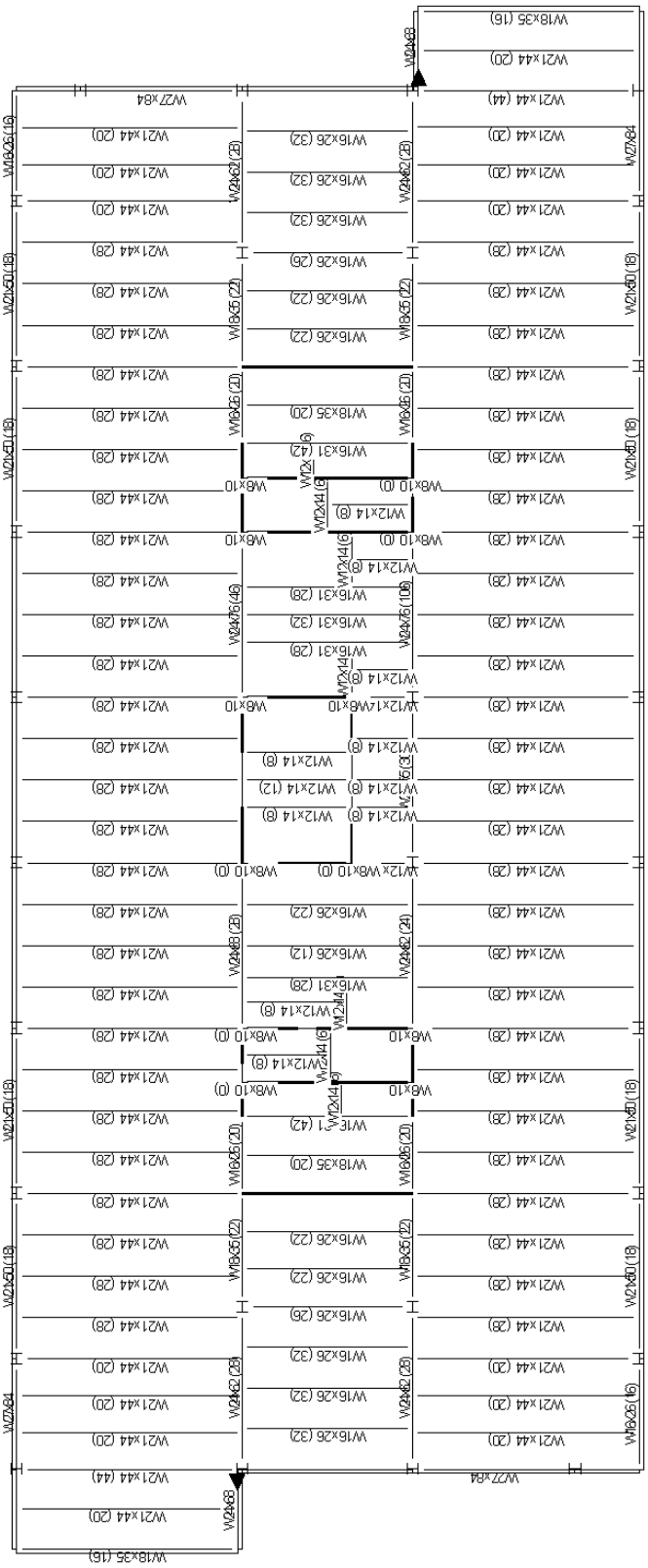
Appendix B – Final Gravity Design Plans

Level 2



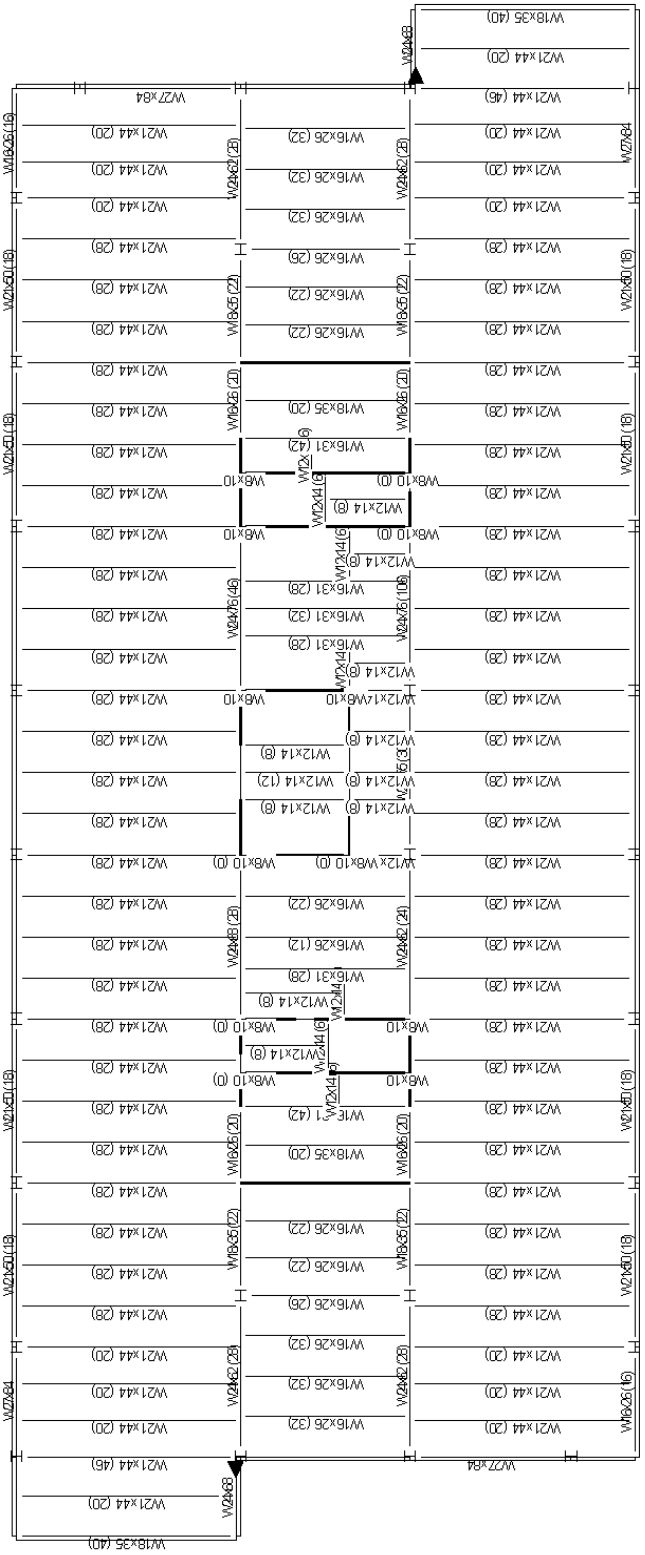
Floor Type: Level 2

Level 3 – 7

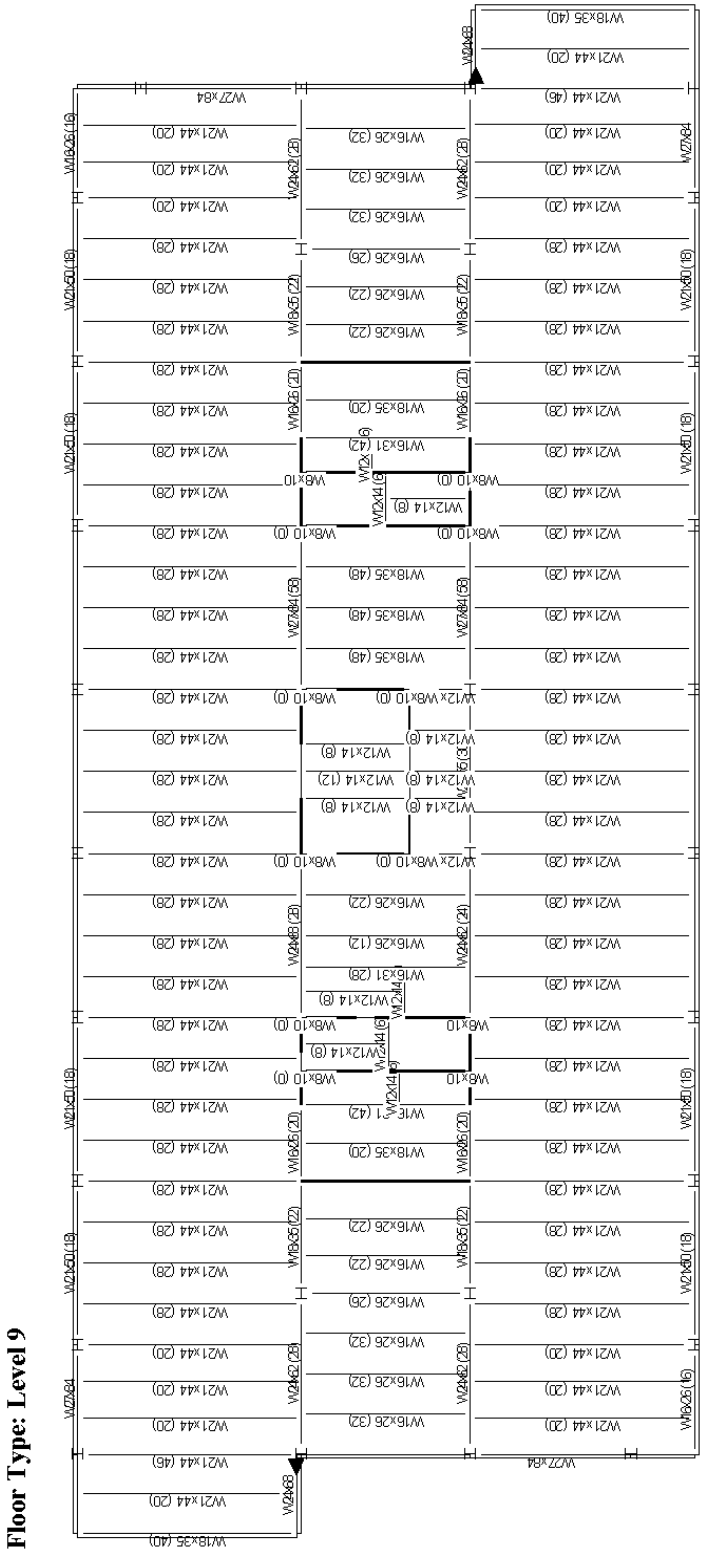


Floor Type: Level 3-7

Level 8

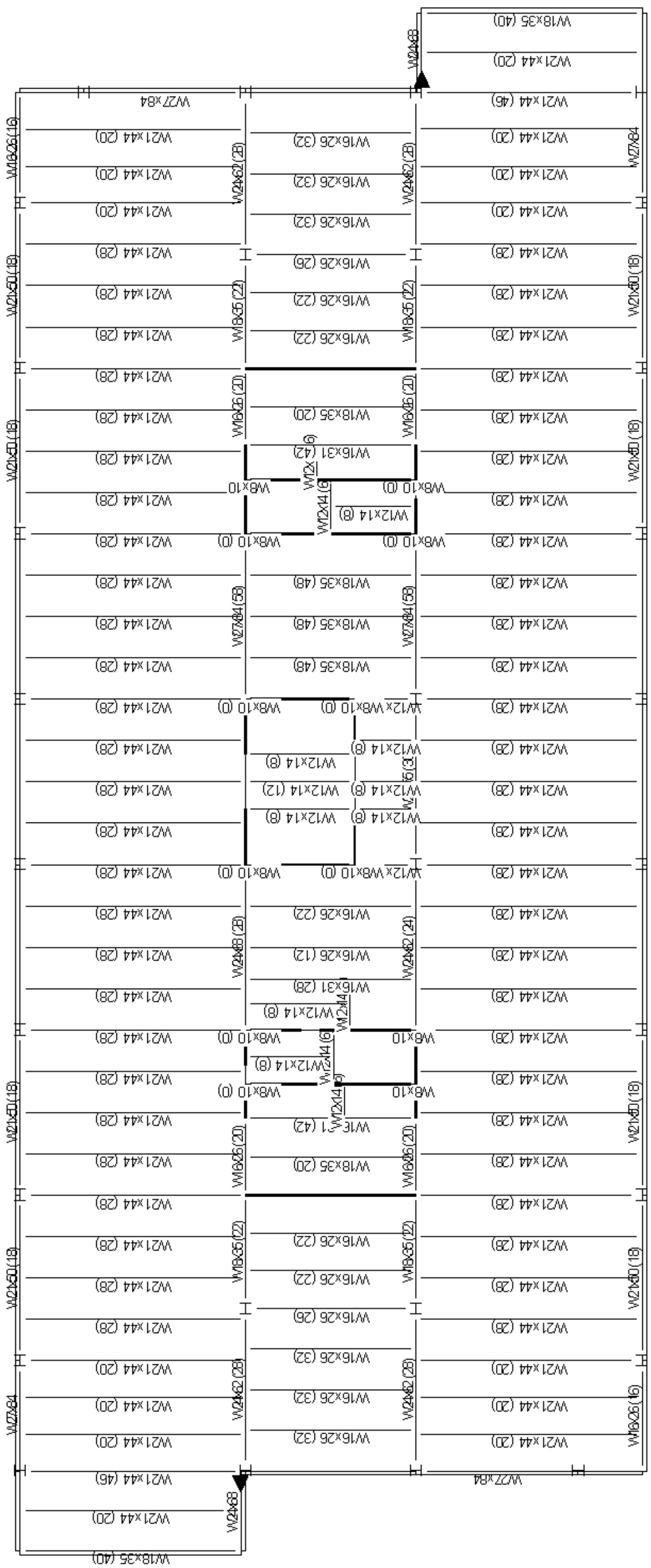


Level 9



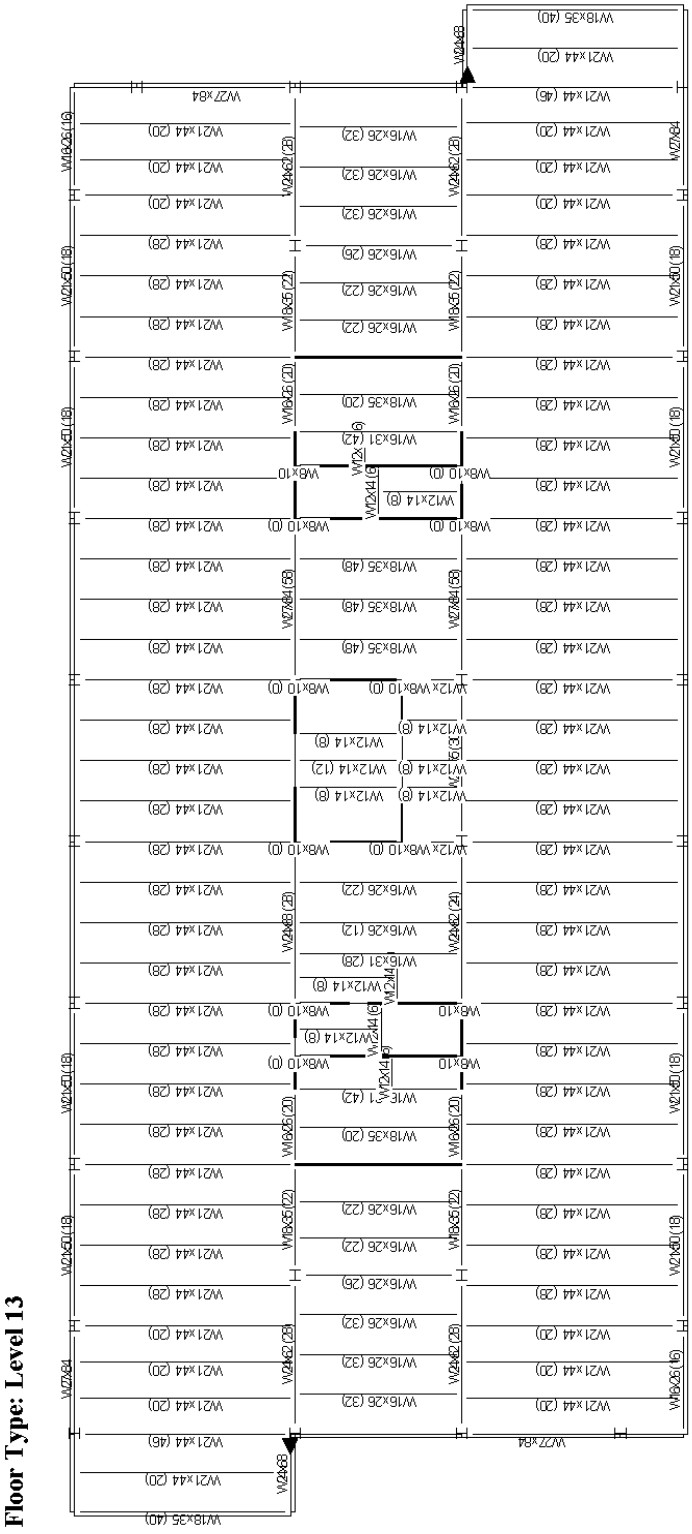
Floor Type: Level 9

Level 10-12

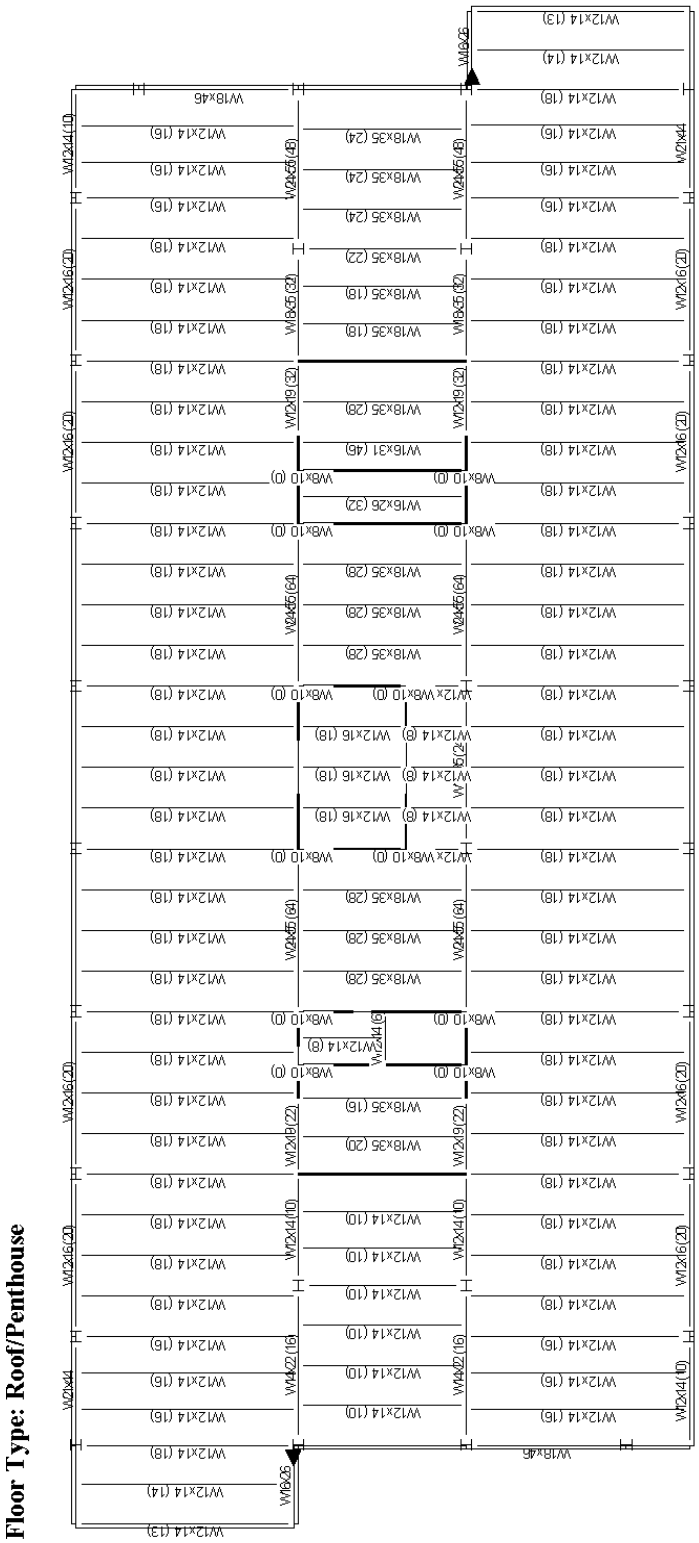


Floor Type: Level 10-12

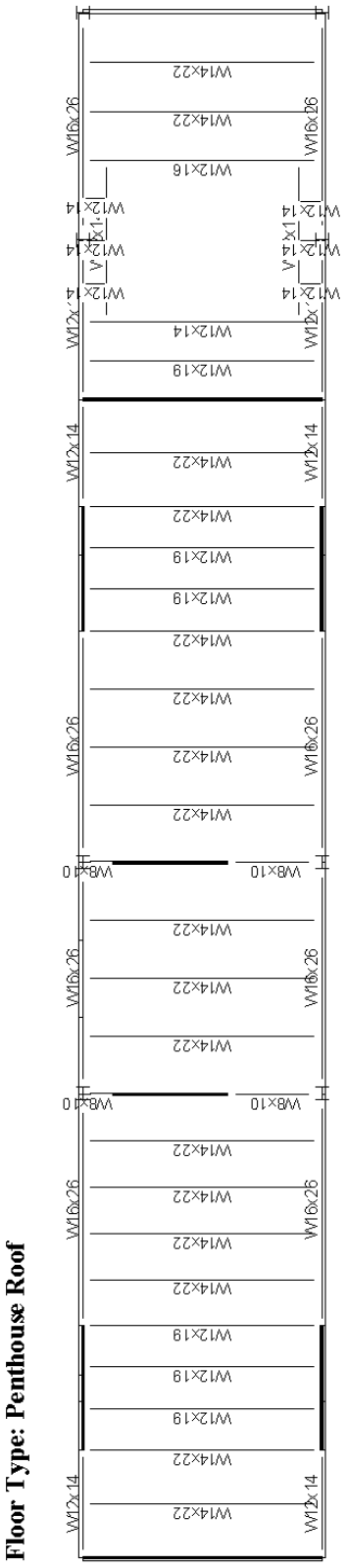
Level 13



Penthouse



Penthouse Roof



Appendix C – Preliminary Vibrations Analysis Spreadsheet

Source: Preliminary Assessment for Walking-Induced Vibrations in Office Environment

# Bays	Span (ft)		
8	30	Girder	ok #11
3	41	Beam	ok #11

U = Unacceptable

Layout Attempt 1:

Concrete Strength:	3000
Steel Grade:	50
Deck Type:	2VLI22
Topping (in):	3.25
LW/NW?	LW
Total Slab Thickness (in):	5.25
Class from Table 1:	4
Select C1 from Table 2:	U
Select C2 from Table 4:	
Evaluate C1+C2:	
Proceed?	NO

Layout Attempt 2:

Concrete Strength:	3000
Steel Grade:	50
Deck Type:	1.5VLR20
Topping (in):	3.25
LW/NW?	LW
Total Slab Thickness (in):	4.75
Class from Table 1:	4
Select C1 from Table 2:	U
Select C2 from Table 4:	
Evaluate C1+C2:	
Proceed?	NO

Layout Attempt 3:

Concrete Strength:	3000
Steel Grade:	50
Deck Type:	2VLI22
Topping (in):	3.25
LW/NW?	NW
Total Slab Thickness (in):	5.25
Class from Table 1:	3
Select C1 from Table 2:	n/a
Select C2 from Table 4:	
Evaluate C1+C2:	

Layout Attempt 4:

Concrete Strength:	3000
Steel Grade:	50
Deck Type:	1.5VLR20
Topping (in):	3.25
LW/NW?	NW
Total Slab Thickness (in):	4.75
Class from Table 1:	3
Select C1 from Table 2:	n/a
Select C2 from Table 4:	
Evaluate C1+C2:	

Proceed?	NO	Proceed?	NO

Layout Attempt 7:		Layout Attempt 8:	
Concrete Strength:	3000	Concrete Strength:	3000
Steel Grade:	50	Steel Grade:	50
Deck Type:	1.5VLR20	Deck Type:	2VLR20
Topping (in):	4.25	Topping (in):	3.5
LW/NW?	LW	LW/NW?	LW
Total Slab Thickness (in):	5.75	Total Slab Thickness (in):	5.5
Class from Table 1:	4	Class from Table 1:	4
Select C1 from Table 2:	0.413	Select C1 from Table 2:	0.472
Select C2 from Table 4:	0.019	Select C2 from Table 4:	0.019
Evaluate C1+C2:	0.432	Evaluate C1+C2:	0.491
C1+C2 < 0.5?	GOOD	C1+C2 < 0.5?	GOOD
Proceed?	YES	Proceed?	MAYBE

Appendix D – Floor and Roof Deck Designs

A. Stangl

Deck Design @ Typical Level in Typical Bay:

- Deck selected based on preliminary vibrations assessment

Try 1.5VLR20 w/ 4.25" LW topping:

LL = 80 PSF

Misc DL = 39.5 PSF

Superimposed LL = 120 PSF

Allowable 3 span: 8'-3"

Try 8'-0" span @ loading:

1. Unshored Const. 3 span

   8' < 8'-3" ✓

2. $W_{LL} + W_{misc\ DL} \leq$ S.I live load

   120 PSF ≤ 270 PSF ✓

1.5VLR20 w/ 4.25" LW topping

WT = 50 PSF

Office DL = 90 PSF
Office LL = 80 PSF

- Deck Properties:

3/4" Stud diameter

I8.2: Stud length ≥ 4 d_{stud}
≥ 4 (3/4) = 3"

1.0" cover required

5.75" total - 1" = 4.75"

Use 4" studs

A. Stangl

Deck Design @ building core:

LL = 250 PSF
Misc DL = 39.5 PSF
Superimposed LL = 290 PSF

Try 1.5 VLR 18 w/ 4.25" LW Topping:

1. 2 span or 3 span condition possible
   2 span = 9'-4" > 8' ✓
   3 span = 9'-8" > 8' ✓
2. $W_{LL} + W_{misc\,DL} \leq$ S.I. live load
   290 PSF ≤ 311 PSF ✓

X **Use 1.5 VLR 18 w/ 4.25" LW Topping**

WT = 50 PSF

Core DL = 90 PSF
Core LL = 250 PSF

Deck Properties:

3/4" stud diameter, 4" stud length

OR

Try 1.5 VLR 20 w/ 4.25" LW Topping:

1. 2 span = 8' > 7'-6"
   3 span = 8'-3" > 7'-6"
2. 290 PSF < 295 PSF @ 7'-6" span

1.5 VLR 20 w/ 4.25" LW Topping possible w/ span limited to 7'-6"

A. Stangl

Roof / Penthouse Roof Area deck:

L_r = 20 PSF

Misc DL = 11 + 6 + 2 + 2 = 21 PSF
(11: ceiling, MEP, sprinklers; 6: insulation; 2: membrane; 2: cover board)

Total Load = 20 PSF + 21 PSF = 41 PSF

Max span = 7'-6"

Try 1.5B20 for 3 span condition:

1. 7'-6" < Max SDI Const Span of 7'-9" ✓
2. W_{TL} = 41 PSF ≤ 72 PSF @ 7'-6" ✓
3. $W_{TL} = 41\left(\frac{180}{240}\right) = 30.75 \leq 62$ PSF ✓

Use 1.5B20 roof deck for exposed roof areas

L_R = 20 PSF

DL_R = 21 + 2.5 PSF = 23.5 PSF

A. Stangl

Penthouse Floor Deck:

LL = 250 PSF

Misc DL = 39.5 PSF

Superimposed LL = 290 PSF

span = 7'-6" max

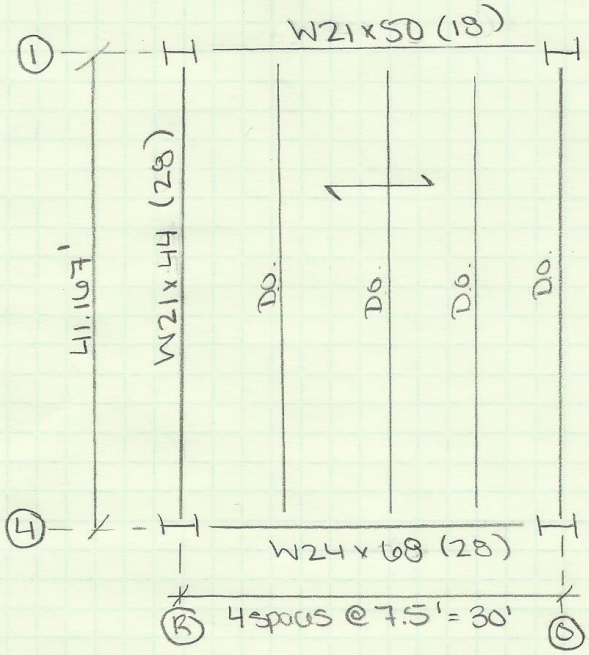
Use 1.5VLR 20 w/ 4.75" LW Topping

Appendix E – Hand Checks of Gravity System Designs

Gravity Beam Design Checks

A. Stangl 1

Verify Loads & designs of Random Gravity Beams



Deck:
1.5 VLR 20
w/ 4¼" LW Topping

DL = 90 PSF

LL = 80 PSF (Reduced)
(LLR allowed)

Const. LL = 20 PSF
Const. DL = 90 PSF

Wall load = 0.118 k/ft

Check W21x44 (28) Beams:

span = 41.167'
spacing = 7.5'

$$LL = 80 \times \left| 0.25 + \frac{15}{\sqrt{(41.167 \times 15)}} \right|^{0.5} = 0.85$$

625 > 400 ✓

LL = 80(0.85) = 68 PSF

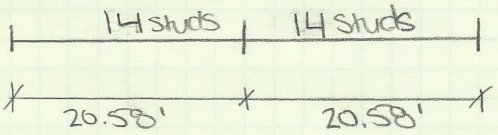
DL = 90 PSF

$$w_u = [1.2(90) + 1.6(68)](7.5) = 1626 \text{ plf} = 1.626 \text{ k/ft}$$

$$M_u = \frac{w_u l^2}{8} = \frac{(1.626 \text{ k/ft})(41.167 \text{ ft})^2}{8} = 344.5 \text{ ft-k}$$

2

Strength of member:



Qn:

Deck ⊥, weak studs (conservative), 3/4" ∅, f'c = 3ksi
1 stud / rib
↳ Qn = 17.2^k

$\Sigma Qn = (17.2^k)(14 \text{ studs}) = \underline{240.8^k}$

b_{eff} = min { $(41.167)(12)/8 = 62"$; $\frac{1}{2}(7.5)(12) = 45"$ }

$b_{eff} = 2 \times 45" = 90"$

$V_{s,max} = A_s F_y = (13.0)(50) = 650^k$ > $\Sigma Qn = 240.8^k$
$V_{c,max} = 0.85(3)(90)(5.75") = 1320^k$

$a = \frac{240.8^k}{0.85(3)(90)} = 1.05" \Rightarrow Y_2 = t - a/2$

$Y_2 = 5.75 - 1.05/2$

$Y_2 = 5.23"$

From Table 3-19:

@ $\Sigma Qn = 184$ & $Y_2 = 5"$ → $\phi M_n = 591 > M_u = 345^k$ ✓

PASSES Composite strength

Check unshored strength:

W21x44, bare beam strength; $\phi M_n = 358^{k}$

$w_u = 1.4(50 \times 7.5) + 1.4(44) = 0.595^{k/ft}$

$w_u = 1.2(50 \times 7.5 + 50) + 1.6(20 \times 7.5) = 0.75^{k/ft}$

$M_u = \frac{(0.75)(41.167)^2}{8} = 159^{k} < \phi M_n$ ✓

No shoring - OK!

Check wet concrete deflection:

$w_{wc} = (50)(7.5) + 50 = 425 \text{ lb/ft} = 0.425^{k/ft}$

$\Delta_{wc} = \frac{5(0.425)(41.167)^4 (1728)}{384(29000)(843)} = 1.12"$

$\Delta_{wc,max} = \frac{(41.167)(12)}{240} = 2.06" > 1.12"$ ✓

Wet conc. deflection OK

Check Live Load Deflection:

$w_{LL} = (68 \text{ PSF})(7.5) = 0.510 \text{ k/ft}$

$I_{LB} = 1460 \text{ in}^4$ (conservative choice from Table 3-20)

$\Delta_{LL} = \frac{5(0.51)(41.167)^4 (1728)}{384(29000)(1460)} = 0.778"$

$\Delta_{LL\,max} = L/360 = \frac{(41.167)(12)}{360} = 1.37" > 0.778"$ ✓

Live Load deflection OK

Summary:

Typical W21x50 (28) beam passes checks for strength and deflections

4

Check W21x50 (18) Edge Girder:

Span = 30'

$$LL = 80 \times \left| \max \left(0.5,\ 0.25 + \frac{15}{\sqrt{41.167 \times 30}} \right) \right. = 0.674$$

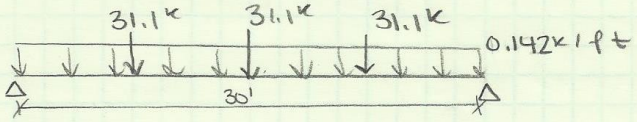
$LL = (54\ PSF)(7.5) = 405\ lb/ft$

$DL = (90)(7.5) + 44 = 719\ lb/ft$

$W_u = 1.2(719) + 1.6(405) = 1.51\ k/ft$

$P_u = (1.51\ k/ft)(1/2)(41.167) = 31.1^k$

$W_{u,wall} = 1.2(0.118) = 0.142\ k/ft$



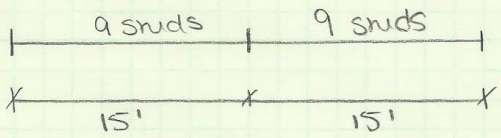
$$M_u = \frac{wl^2}{8} + 0.5Pl$$

$$= \frac{(0.142)(30)^2}{8} + 0.5(31.1)(30)$$

$$= 482.5\ ft\text{-}k$$

5

Member Strength:



Qn:

Deck parallel, $\frac{w_c}{h_r} = \frac{1.75}{1.5} = 1.17 < 1.5$

$Q_n = 17.1^k$

$\Sigma Q_n = (17.1^k)(9 \text{ studs}) = 154^k$

$b_{eff} = \min \left| \begin{array}{l} (30)(12)/8 = 45" \\ 10" \end{array} \right. + \min \left| \begin{array}{l} 45" \\ \frac{1}{2}(41.167)(12) = 247 \end{array} \right.$

$b_{eff} = 10" + 45" = 55"$

$V_{s,max} = A_s F_y = (14.5)(50) = 725^k$

$V_{c,max} = 0.85(3)(55)(5.75) = 806^k > \Sigma Q_n = 154^k$

$a = \frac{154^k}{0.85(3)(55)} = 1.10" \rightarrow y_2 = t - a/2$

$= 5.75 - 1.10/2$

$y_2 = 5.2"$

From Table 3-19:

$\phi M_n = 591^{ik} > M_u = 483^{ik}$ ✓

Passes Composite Strength

Check unshored strength:

W21 x 50, bare beam $\phi M_n = 413^{k}$

$DL = (50)(7.5) + 44 = 419$ lb/ft

$LL = (20)(7.5) = 150$ lb/ft

$w_u = 1.2(419) + 1.6(150) = 742.8$ lb/ft

$P_u = (742.8)(\frac{1}{2})(41.167)/1000 = 15.29^{k}$

$M_u = 0.5(15.29)(30') = 229.4^{k} < \phi M_n$ ✓

No shoring – OK!

Check Wet Conc. Deflection:

$P_{u,wc} = [(50)(7.5) + 44](41.167/2) = 8.62^{k}$

$\Delta_{wc} = \frac{0.05 P l^3}{EI} = \frac{0.05(8.62)(30)^3(1728)}{(29000)(984)}$

$= 0.71"$

$\Delta_{wc,max} = \frac{(30)(12)}{240} = 1.5" > 0.71"$ ✓

Wet concrete deflection OK

Check Live Load Defletion:

$P_{LL} = [(54)(7.5)(\frac{1}{2})(41.167)]/1000 = 8.34^{k}$

$I_{LB} = 1680\ in^4$

$\Delta_{LL} = \frac{0.05(8.34)(30)^3(1728)}{(29000)(1680)} = 0.40"$

$\Delta_{LL,max} = \frac{(30)(12)}{300} = 1" > 0.40"$ ✓

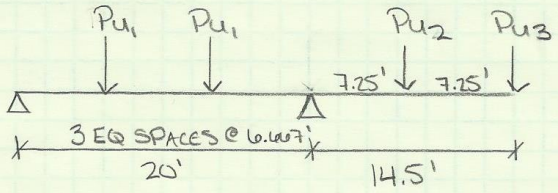
Live Load deflection OK

Summary:

Exterior edge, typical girder W21x50 (19) passes checks for strength and deflection.

7

Check W27x84 propped cantilever:



LL = 80 PSF
DL = 90 PSF + 5 PSF = 95 PSF
↑ framing allowance

$$LL = 80 \times \left| \max \frac{0.5}{0.25 + \frac{15}{\sqrt{(34.5 \times \frac{41.167}{2})}}} \right. = 0.81$$

LL = 65 PSF

$W_u = 1.2(95) + 1.6(65) = 218$ PSF

$P_{u_1} = (218)(6.667)(1/2)(41.167)/1000 = 30.0^k$

$P_{u_2} = (218)(7.25)(1/2)(40.167)/1000 = 31.7^k$

$P_{u_3} = (218)(1/2)(7.25)\,1/2(40.167)/1000 = 15.9^k$

Using RISA 2D:

$M_u = -460.4^{ik}$

$\phi M_n = 915^{ik}$, $L_p = 7.31' > L_b = 7.25'$ ✓

$\phi M_n = 915^k > 460.4^{ik}$ ✓

Gravity Column Rough Design Checks

A. Stangl

Rough Check - Gravity Column Design from RAM:

Column Line N-L9 @ Story 2 (interior column)

Floor LL = 80 PSF
Floor DL = 90 PSF
Roof LL = 20 PSF

W12x279

$P_u = 1.2D + 1.6L + 0.5L_r$

$P_D = 1102.68^k$
$P_L = 1038.71^k$
$P_{Lr} = 12.33^k$

} loads & LL Reduction verified in Beam check, RAM loads used for this check.

$P_u = 1.2(1102.68) + 1.6(1038.71) + 0.5(12.33) = 2991^k$

From table 4-1:

$l_u = 15' \rightarrow \phi P_n = 3000^k$

$P_u / \phi P_n = 2991^k / 3000^k = 0.997 \leq 1.0$ ✓

Column Line C-8 @ Story 2 (Exterior Column)

W14x145

$P_D = 896.2^k$
$P_L = 244.68^k$
$P_{Lr} = 8.74^k$

$P_u = 1.2(896.2) + 1.6(244.68) + 0.5(8.74) = 1471.3^k$

From table 4-1:

$l_u = 15' \rightarrow \phi P_n = 1650^k$

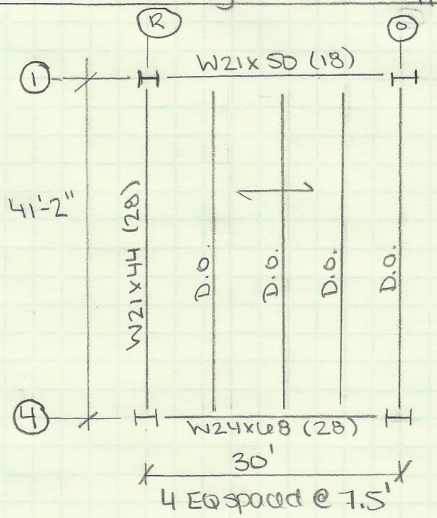
$P_u / \phi P_n = 1471.3 / 1650 = 0.892 \leq 1.0$ ✓

Note: A quick verification of capacity has been done here to make sure that RAM column designs are reasonable. RAM performed a more detailed analysis including P-Δ effects. This was done to simply make sure RAM is producing designs w/ in reason. Ram includes P-Δ and skip loading.

Appendix F – Vibrations Analysis of a Typical Bay

A. Stangl 1

Vibrations Analysis of a Typical Bay:



Deck: 1.5 VLR 20
4.25" LW Conc. Topping

Criteria: $\frac{a_o}{g} \geq \frac{a_p}{g} = \frac{P_o \exp^{(-0.35 f_n)}}{\beta W}$

$P_o = 65$ lb
$\beta = 0.03$
$a_o/g = 0.5\%$
} From AISC DG 11, Table 4.1

Need to determine f_n and W for the system to evaluate performance.

LL = 11 psf (as suggested by Section 3.3 of DG 11)

Superimposed DL = 40 PSF

Deck Properties:

Concrete: $w_c = 110$ pcf
$f'_c = 3000$ psi

Floor thickness = 1.5" + 4.25" = 5.75"

Slab + Deck Weight = 50 PSF

Beam Properties:

W21x44
$A = 13.0\ in^2$
$I_x = 843\ in^4$
$d = 20.7$ in

Girder Properties:

W24x68
$A = 20.1\ in^2$
$I_x = 1830\ in^4$
$d = 23.7$ in

Beam Mode Properties:

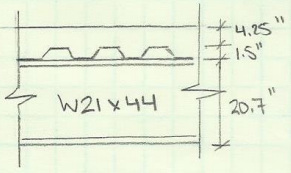
Effective Slab width = min { 7.5' ; 0.4L = 0.4(41.167) = 16.47' }

Effective Slab width = 7.5' = 90"

$E_c = w^{1.5}\sqrt{f'_c} = (110)^{1.5}\sqrt{3}' = 1998$ ksi

$n = E_s/E_c = \frac{29000}{(1.35)1998} = 10.75$

↑ concrete dynamic modulus increase



$\bar{y} = \frac{(13.0)(1.5 + 20.7/2) - (90/10.75)(4.25)(4.25/2)}{13.0 + (90/10.75)(4.25)}$

$\bar{y} = 1.614$" below top of form deck

$$I_j = 843 + (13.0)(1.5 + 20.7/2 - 1.614)^2 + (90/10.75)(4.25)^3/12 + (90/10.75)(4.25)(1.614 + 4.25/2)^2$$

$$= 2756 \text{ in}^4$$

For each beam, the uniform dist. load:

$$w_j = (7.5')(11 + 50 + 40 + 44/7.5) = 801.5 \text{ lb/ft}$$

$$\Delta_j = \frac{5 w_j L^4}{384 E_s I} = \frac{5(801.5)(41.167)^4(1728)}{384(29000000)(2756)} = 0.648''$$

$$\underline{\Delta_j = 0.648''}$$

$$f_j = 0.18\sqrt{\frac{g}{\Delta_j}} = 0.18\sqrt{\frac{386}{0.648}} = 4.39 \text{ Hz}$$

FIND W_j: $W_j = w_j B_j L$

$$B_j = C_j (D_s/D_j)^{1/4} L$$

$d_e = 4.25'' + \frac{1}{2}(1.5) = 5''$

$$D_s = \frac{12 d_e^3}{12n} = \frac{12(5)^3}{12(10.75)} = 11.63 \text{ in}^4/\text{ft}$$

$$D_j = I_j/s = \frac{2756 \text{ in}^4}{7.5} = 367.47 \text{ in}^4/\text{ft}$$

$L = 41.167$ ft

$C_j = 2.0$

$$B_j = (2.0)\left(\frac{11.63}{367.47}\right)^{1/4}(41.167) = 34.73 \text{ ft}$$

$34.73' < 2/3(3)(30) = 60'$ ✓

$$W_j = (801.5/75)(34.73)(41.167)/1000$$

$$\underline{W_j = 152.8 \text{ kips}}$$

Interior Girder Mode Properties:

Effective slab width = min { 36'(12) = 427.2 in ; 0.4(30) = 12' = 144 in }

Effective slab width = 144 in

Avg. Concrete Depth = 4.25 + ½(1.5) = 5"

$$\bar{y} = \frac{(20.1)(0.75 + 23.7/2) - (144/10.75)(5)(5/2)}{20.1 + (144/10.75)(5)}$$

$\bar{y}$ = 0.986 in below effective slab

$$I_g = 984 + (20.1)(0.75 + 23.7/2 - 0.986)^2 + (144/10.75)(5)^3/12 + (144/10.75)(5)(0.986 + 5/2)^2$$

$= 4649 \text{ in}^4$

$w_g = L_j w_j / S$ + girder weight

$= (36)(801.5/7.5) + 68$

$= 3915.2$ lb/ft

$$\Delta_g = \frac{5(3915.2)(30)^4(1728)}{384(29000000)(4649)} = 0.53"$$

$$f_g = 0.18\sqrt{\frac{386}{0.53}} = 4.86 \text{ Hz}$$

$W_g = (w_g/L_j) B_g L_g$, $B_g = C_g (D_j/D_g)^{1/4} L_g$

$D_j = 367.47 \text{ in}^4/\text{ft}$

$D_g = I_g/L_j = 4649/41.167 = 113 \text{ in}^4/\text{ft}$

$C_g = 1.8$ (for girders supporting beams connected to the girder web)

5

$B_g = (1.8)(307.47/113)^{1/4}(30) = 71.97$ ft

$W_g = (3915.2/41.167)(71.97)(30)/1000$

$W_g = 205.3$ kip

Combined Mode Properties:

Girder span = 30'
Joist panel width = 34.73'

30' < 34.73' → Δ_g may be reduced

$\Delta'_g = \frac{L_g}{B_j}\Delta_g = \frac{(30)}{34.73}(0.53") = 0.458"$

$f_n = 0.18\sqrt{g/(\Delta_j + \Delta_g')}$

$= 0.18\sqrt{386/(0.048+0.458)} = 3.30$ Hz

$W = \frac{\Delta_j}{\Delta_j+\Delta_g'}W_j + \frac{\Delta_g'}{\Delta_j+\Delta_g'}W_g$

$= \frac{(0.048)}{(0.048+0.458)}(152.8) + \frac{0.458}{0.048+0.458}(205.3)$

$= 89.52^k + 85.0^k = 174.5^k$

$\frac{a_p}{g} = \frac{65\exp(-0.35\times 3.30)}{(0.03)(174500)} = 0.00383$

$= 0.38\%$

$0.5\% > 0.38\%$ ✓

Investigated bay is acceptable for human induced vibrations according to AISC DG 11.

Appendix G – Wind and Seismic Load Calculations

Alyssa Stangl | Wind Loads | Tech Report 2 | 18

WIND LOAD CALCULATIONS

- ASCE 7-05 Section 6.5 - Method 2 - Analytical Procedure

1. Occupancy Category (Table 1-1)

II , All buildings except those in I, III, IV

2. Wind Load Importance Factor (Table 6-1, §6.5.5)

I = 1.00 , for Category II Non-Hurricane prone

3. Basic Wind Speed (Figure 6-1)

V = 85 mph

4. Wind Load Parameters

a. Wind Directionality Factor, Kd (Table 6-4)

Kd = 0.85

b. Exposure Category (§6.5.6.3)

Exposure C

c. Topographic Factor, K_{zt} (Figure 6-4)

No hill, K_{zt} = 1.0

d. GUST EFFECT FACTOR (§ 6.5.8)

i. Building Natural Frequency (§C6.5.8)

- 26.9.2.1 Limitations for approx. natural frequency:

① $h = 198'-8'' < 300'$ ✓
② $4(115') = 460' > 198'-8''$ ✓

Limits are met.

- Approx. natural period for concrete shearwall systems:

$$n_1 = 385(C_w)^{0.5} / H$$

$$C_w = \frac{100}{A_B} \sum_{i=1}^{n} \left(\frac{H}{h_i}\right)^2 \frac{A_i}{\left[1 + 0.83\left(\frac{h_i}{D_i}\right)^2\right]}$$

$H = 198.07$ ft
$A_B = (315')(123.07') = 39{,}000$ SF

SW 4,6: $h_i = 198.07$ ft
$D_i = 30$ ft
$A_i = (30')(14''/12'') = 35$ ft^2

$$\left(\frac{198.07}{198.07}\right)^2 \frac{35}{1 + 0.83\left(\frac{198.07}{30}\right)^2} = 5.60$$

SW S, R, K, J: $h_i = 174.34$ ft
$D_i = 30$ ft
$A_i = (30')(18''/12'') = 45$ ft^2

$$\left(\frac{198.07}{174.34}\right)^2 \frac{(45)}{\left[1 + 0.83\left(\frac{174.34}{30}\right)^2\right]} = 2.01$$

SW O, N: $h_i = 198.07$ ft
$D_i = 20$ ft
$A_i = (20')(12''/12'') = 20$ ft^2

$$\left(\frac{198.07}{198.07}\right)^2 \frac{20}{\left[1 + 0.83\left(\frac{198.07}{20}\right)^2\right]} = 0.241$$

Alyssa Stangl | WIND LOADS | TECH REPORT 2 | 20

SW 5. NORTH & 4 SOUTH: $h_i = 198.07$ ft, $D_i = 17$ ft

$A_i = (17\text{ ft})(18''/12'') = 25.5\text{ ft}^2$

$$\left(\frac{198.07}{198.07}\right)^2 \frac{25.5}{\left[1 + 0.83\left(\frac{198.07}{17}\right)^2\right]} = 0.223$$

SW 5 SOUTH & 4 NORTH: $h_i = 198.07$ ft, $D_i = 17$ ft

$A_i = (17\text{ ft})(26''/12'') = 36.83\text{ ft}^2$

$$\left(\frac{198.07}{198.07}\right)^2 \frac{36.83}{\left[1 + 0.83\left(\frac{198.07}{17}\right)^2\right]} = 0.322$$

SW 4 and 4.7: $h_i = 174.34$ ft, $D_i = 30$ ft

$A_i = (30')(14''/12'') = 35\text{ ft}^2$

$$\left(\frac{198.07}{174.34}\right)^2 \frac{35}{\left[1 + 0.83\left(\frac{174.34}{30}\right)^2\right]} = 1.57$$

NORTH-SOUTH:

$$\Sigma (H/h_i)^2 \frac{A_i}{[1+0.83(h_i/D_i)^2]}$$

$= 2(0.223) + 2(0.322) + 2(1.57) = 4.23$

$C_w = \frac{100}{39000\text{ SF}}(4.23) = 0.01085$

$n_{N\text{-}S} = 385(0.01085)^{0.5}/198.07$

$\boxed{n_{N\text{-}S} = 0.202\text{ Hz}}$

EAST-WEST:

$$\Sigma (H/h_i)^2 \frac{A_i}{[1+0.83(h_i/D_i)^2]}$$

$= 2(5.6) + 4(2.01) + 2(0.241) = 19.72$

$C_w = \frac{100}{39000\text{ SF}}(19.72) = 0.05057$

$n_{E\text{-}W} = 385(0.05057)^{0.5}/198.07$

$\boxed{n_{E\text{-}W} = 0.436\text{ Hz}}$

$\therefore$ Flexible ($n_a < 1$ Hz) in both directions

Alyssa Stangl | WIND LOADS | TECH REPORT 2 | 21

ii. Flexible Structures (§6.5.8.2)

$$G_f = 0.925\left[\frac{1 + 1.7\,I_{\bar{z}}\sqrt{g_Q^2 Q^2 + g_R^2 R^2}}{1 + 1.7\,g_v I_{\bar{z}}}\right]$$

NORTH - SOUTH: $g_Q = g_v = 3.4$

$\bar{z} = \max \begin{cases} 0.6h = 0.6(198.07\text{ ft}) = 119.2\text{ ft} \\ z_{min} = 15\text{ ft} \end{cases}$

$\bar{z} = 119.2$ ft

$I_{\bar{z}} = c\left(\frac{33}{\bar{z}}\right)^{1/6}$, $c = 0.20$

$= 0.20\left(\frac{33}{119.2}\right)^{1/6}$

$I_{\bar{z}} = 0.161$

$L_{\bar{z}} = l\left(\frac{\bar{z}}{33}\right)^{\bar{\varepsilon}}$, $\bar{\varepsilon} = 1/5$, $l = 500$ ft

$= (500)\left(\frac{119.2}{33}\right)^{1/5}$

$L_{\bar{z}} = 646.43$

$\bar{V}_{\bar{z}} = \bar{b}\left(\frac{\bar{z}}{33}\right)^{\bar{\alpha}} V\left(\frac{88}{60}\right)$, $\bar{b} = 0.65$, $\bar{\alpha} = 1/6.5$

$= 0.65\left(\frac{119.2}{33}\right)^{1/6.5}(90)\left(\frac{88}{60}\right)$

$\bar{V}_{\bar{z}} = 104.54$ ft/s

$Q_{NS} = \sqrt{\frac{1}{1 + 0.63\left(\frac{B+h}{L_{\bar{z}}}\right)^{0.63}}}$, $B = 115$ ft, $h = 198.07$ ft

$= \frac{1}{1 + 0.63\left(\frac{115 + 198.07}{646.43}\right)^{0.63}}$

$Q_{NS} = 0.715$

Alyssa Stangl | WIND LOADS | TECH REPORT 2 | 22

North-South Gust Factor Cont.

$$g_Q = \sqrt{2\ln(3600 n_1)} + \frac{0.577}{\sqrt{2\ln(3600 n_1)}}$$

$$= \sqrt{2\ln(3600 \times 0.202)} + \frac{0.577}{\sqrt{2\ln(3600 \times 0.202)}}$$

$g_Q = 3.79$

$$N_1 = \frac{n_1 L_{\bar{z}}}{\bar{V}_{\bar{z}}} = \frac{(0.202)(646.43)}{104.54}$$

$N_1 = 1.25$

$$R_n = \frac{7.47 N_1}{(1+10.3N_1)^{5/3}} = \frac{7.47(1.25)}{(1+10.3(1.25))^{5/3}}$$

$R_n = 0.117$

$$\eta(R_n) = 4.6 n_1 h / \bar{V}_{\bar{z}} = 4.6(0.202)(198.67)/104.54$$

$$= 1.766$$

$$\eta(R_B) = 4.6 n_1 B / \bar{V}_{\bar{z}} = 4.6(0.202)(115)/104.54$$

$$= 1.022$$

$$\eta(R_L) = 15.4 n_1 L / \bar{V}_{\bar{z}} = 15.4(0.202)(279)/104.54$$

$$= 8.30$$

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

$$= \frac{1}{1.766} - \frac{1}{2(1.766)^2}(1-e^{-2(1.766)})$$

$R_n = 0.411$

$$R_B = \frac{1}{1.022} - \frac{1}{2(1.022)^2}(1-e^{-2(1.022)})$$

$R_B = 0.562$

Alyssa Stangl | WIND LOADS | TECH REPORT 2 | 23

North-South Gust Factor Cont.

$$R_L = \frac{1}{8.30} - \frac{1}{2(8.3)^2}\left(1 - e^{-2(8.3)}\right)$$

$$R_L = 0.113$$

β = damping ratio, unknown however from AE 538 most buildings have a β of 5-7%.

$$\beta = 0.05$$

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

$$= \sqrt{\frac{1}{0.05}(0.117)(0.411)(0.562)(0.53 + 0.47(0.113))}$$

$$R = 0.561$$

$$G_{f,N-S} = 0.925\left[\frac{1 + 1.7(0.1161)\sqrt{(3.4)^2(.715)^2 + (3.79)^2(0.561)^2}}{1 + 1.7(3.4)(0.1161)}\right]$$

$$\boxed{G_{f,N-S} = 0.903}$$

Alyssa Stangl | WIND LOADS | TECH REPORT 2 | 24

EAST-WEST GUST FACTOR:

$\bar{z} = 119.2$ ft

$I_{\bar{z}} = 0.161$ ft

$L_{\bar{z}} = 646.43$

$\bar{V}_{\bar{z}} = 104.54$ ft/s

$$Q_{EW} = \sqrt{\frac{1}{1 + 0.63\left(\frac{B+h}{L_{\bar{z}}}\right)^{0.63}}}$$

B = 279 ft
h = 198.67 ft

$$= \sqrt{\frac{1}{1 + 0.63\left(\frac{279 + 198.67}{646.43}\right)^{0.63}}}$$

$Q_{EW} = 0.811$

$$g_R = \sqrt{2\ln(3600 \times 0.436)} + \frac{0.577}{\sqrt{2\ln(3600 \times 0.436)}}$$

$g_R = 3.99$

$$N_1 = \frac{n_1 L_{\bar{z}}}{\bar{V}_{\bar{z}}} = \frac{(0.436)(646.43)}{104.54}$$

$N_1 = 2.70$

$$R_n = \frac{7.47\,N_1}{(1 + 10.3\,N_1)^{5/3}} = \frac{7.47(2.7)}{(1 + 10.3(2.7))^{5/3}}$$

$R_n = 0.0745$

$\eta(R_B) = 4.6(0.436)(279) / 104.54$

$= 5.35$

$\eta(R_L) = 15.4(0.436)(115) / 104.54$

$= 7.39$

$\eta(R_n) = 4.6\,n_1 h / \bar{V}_{\bar{z}} = 4.6(0.436)(198.67) / 104.54$

$= 3.81$

East west gust factor cont.

$$R_n = \frac{1}{3.81} - \frac{1}{2(3.81)^2}\left(1-e^{-2(3.81)}\right)$$

$R_n = 0.228$

$$R_B = \frac{1}{5.35} - \frac{1}{2(5.35)^2}\left(1-e^{-2(5.35)}\right)$$

$R_B = 0.169$

$$R_L = \frac{1}{7.39} - \frac{1}{2(7.39)^2}\left(1-e^{-2(7.39)}\right)$$

$R_L = 0.126$

$\beta = 0.05$ (for same reason as NS direction)

$$R = \sqrt{\frac{1}{0.05}(0.0745)(0.228)(0.169)(0.53+0.47(0.126))}$$

$R = 0.184$

$$G_{f,EW} = 0.925\left[\frac{1+1.7(0.161)\sqrt{(3.4)^2(0.811)^2+(3.99)^2(0.184)^2}}{1+1.7(3.4)(0.161)}\right]$$

$$\boxed{G_{f,EW} = 0.853}$$

e. Enclosure Classification (§6.5.9)

Enclosed (§6.2)

f. Internal pressure coefficient (Fig. 6-5)

$GC_{pi} = \pm 0.18$

Interpolation for Roof Cp Values: (Fig. 6-6)

NORTH-SOUTH $h/L = 0.712$

0 to 99.34 ft:

-0.9	0.5
?	0.712
$-1.3(0.8) = 1.04$	1.0

$(99.34)(115) = 11424.1 > 1000 \rightarrow 0.8$ reduction

$Cp = -1.2194$

99.34 ft to 198.67 ft:

-0.9	0.5
?	0.712
-0.7	1.0

$Cp = -0.8152$

198.67 ft to 279 ft:

-0.5	0.5
?	0.712
-0.7	1.0

$Cp = -0.5848$

EAST - WEST $h/L = 1.728 > 1.0$

0 to 99.34 ft :

$C_p = -1.3$

$A = (99.34)(279) = 27716\ ft^2 > 1000\ ft^2$

$C_p = -1.3(0.8) = \underline{-1.04}$

99.34 ft to 115 ft :

$C_p = -0.7$

Interpolation for Wall Cp Values: (Fig. 6-6)

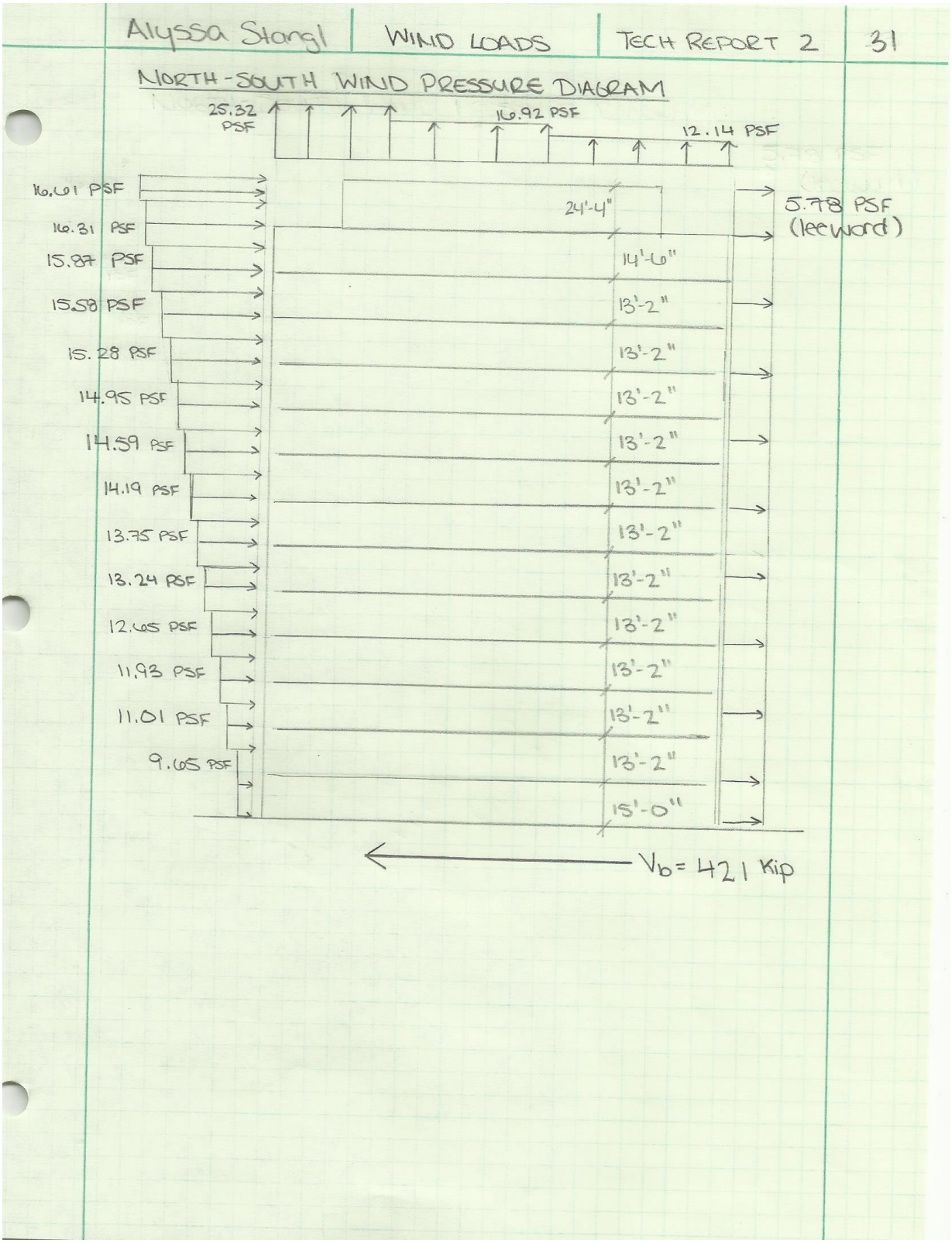
NORTH - SOUTH

$L/B = 2.43$

-0.3	2
2	2.43
-0.2	4

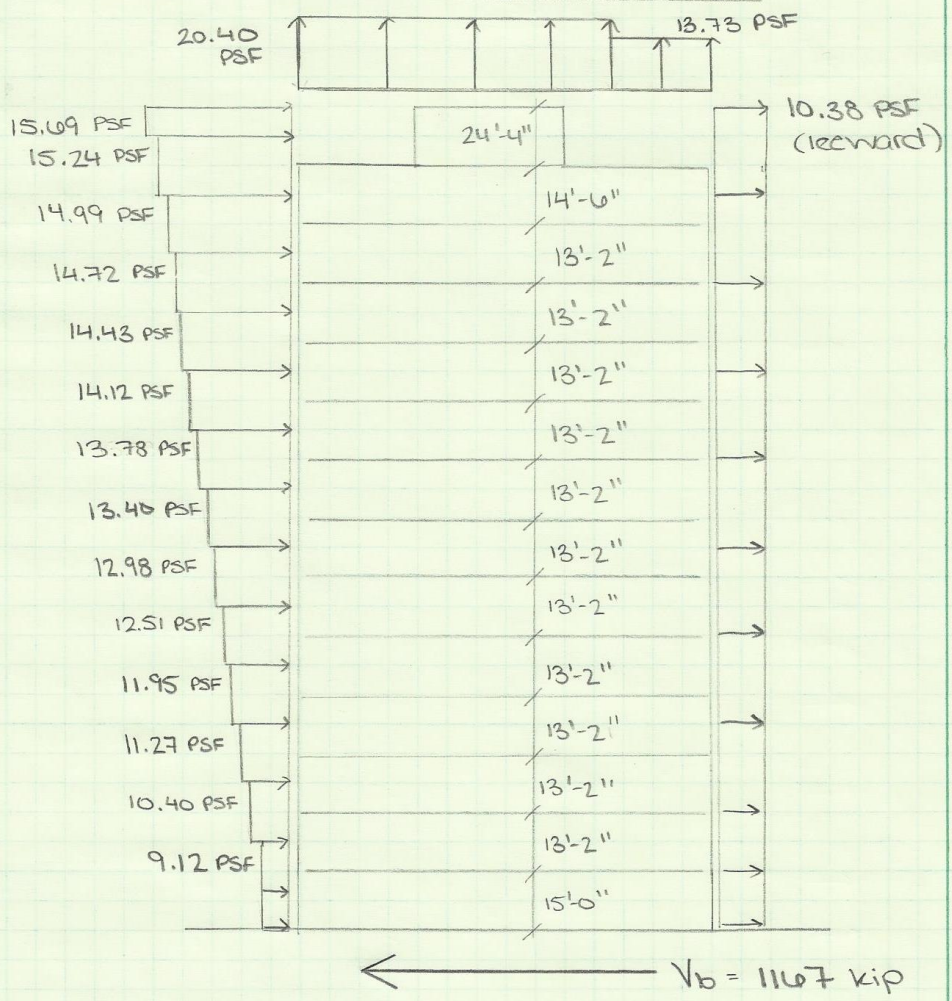
$C_p = -0.279$

* No other Cp values were interpolated


Alyssa Stangl
WIND LOADS
TECH REPORT 2
31
NORTH-SOUTH WIND PRESSURE DIAGRAM
25.32 PSF
16.92 PSF
12.14 PSF
16.61 PSF
16.31 PSF
15.87 PSF
15.58 PSF
15.28 PSF
14.95 PSF
14.59 PSF
14.19 PSF
13.75 PSF
13.24 PSF
12.65 PSF
11.93 PSF
11.01 PSF
9.65 PSF
24'-4"
14'-6"
13'-2"
13'-2"
13'-2"
13'-2"
13'-2"
13'-2"
13'-2"
13'-2"
13'-2"
13'-2"
13'-2"
15'-0"
5.78 PSF
(leeward)
V_b = 421 Kip

Alyssa Stangl | Wind Loads | Tech Report 2 | 32

EAST-WEST WIND PRESSURE DIAGRAM



Alyssa Stangl | Seismic Loads | Tech Report 2 | 34

Seismic Load Calculations

1. Building not exempt. (§ 11.1.2)
2. Design Spectral Response Acceleration (§11.4)
   a) Site Class Definition = C
   b) Acceleration Parameters

$S_S = 1.418\,g$

$S_1 = 0.527\,g$

   c) Site Class Effects (§11.4.3)

$F_a = 1.0$
$F_v = 1.3$

$S_{MS} = (1.0)(1.418g) \rightarrow S_{MS} = 1.418g$

$S_{M1} = (1.3)(0.527\,g) \rightarrow S_{M1} = 0.6851g$

   d) Determine Spectral Acceleration Parameters (§11.4.4)

$S_{DS} = \frac{2}{3} S_{MS} = \frac{2}{3}(1.418g) \rightarrow S_{DS} = 0.9453$

$S_{D1} = \frac{2}{3} S_{M1} = \frac{2}{3}(0.6851g) \rightarrow S_{D1} = 0.4567$

3. Find Seismic Design Category (§11.5 + §11.6)

Occupancy Category = II

$I = 1.0$

$S_{DS} = 0.9453 \geq 0.5 \rightarrow$ SDC = D

4. Analysis Procedure Selection

(Table 12.6-1)

Equivalent Lateral Force Procedure

5. Determine Response Modification Factor

B.5 - Special reinforced concrete shear walls

$R = 6$

6. Find Period (T) (§ 12.8.2)

$$T_a = C_t h_n^x$$

$C_t = 0.02$
$h_n = 198.17$ ft
$x = 0.75$

$$T_a = 0.02(198.17)^{0.75} \rightarrow T_a = 1.0568$$

7. Determine, T_L (Fig. 22-15)

$T_L = 8$ s

8. Find C_s (seismic response coefficient) (§12.8.1.1)

$$C_s = \frac{S_{DS}}{(R/I)} = \frac{0.9453}{(6/1.0)} \rightarrow C_s = 0.1576$$

$T_a = 1.0568$ s $< T_L = 8$ s

$$C_s = \frac{S_{D1}}{T(R/I)} = \frac{0.4561}{(1.0568)(6/1.0)} = 0.0720$$

$$C_s = \begin{vmatrix} 0.1576 \\ 0.0720 \end{vmatrix}_{min} = 0.0720 > 0.01 \checkmark$$

$C_s = 0.0720$

Alyssa Stangl | SEISMIC LOADS | TECH REPORT 2 | 36

9. Weight Calculation: See excel sheet Page. 28 of this document.

10. Calculate Base Shear (Eq. 12.8-1)

$V = C_s W$

$= (0.0720)(88979\ k)$

$V = 6406.5\ k$

11. Determine Story Forces

Find k:

0.5s	k = 1
T = 1.056s	k = ?
2.5s	k = 2

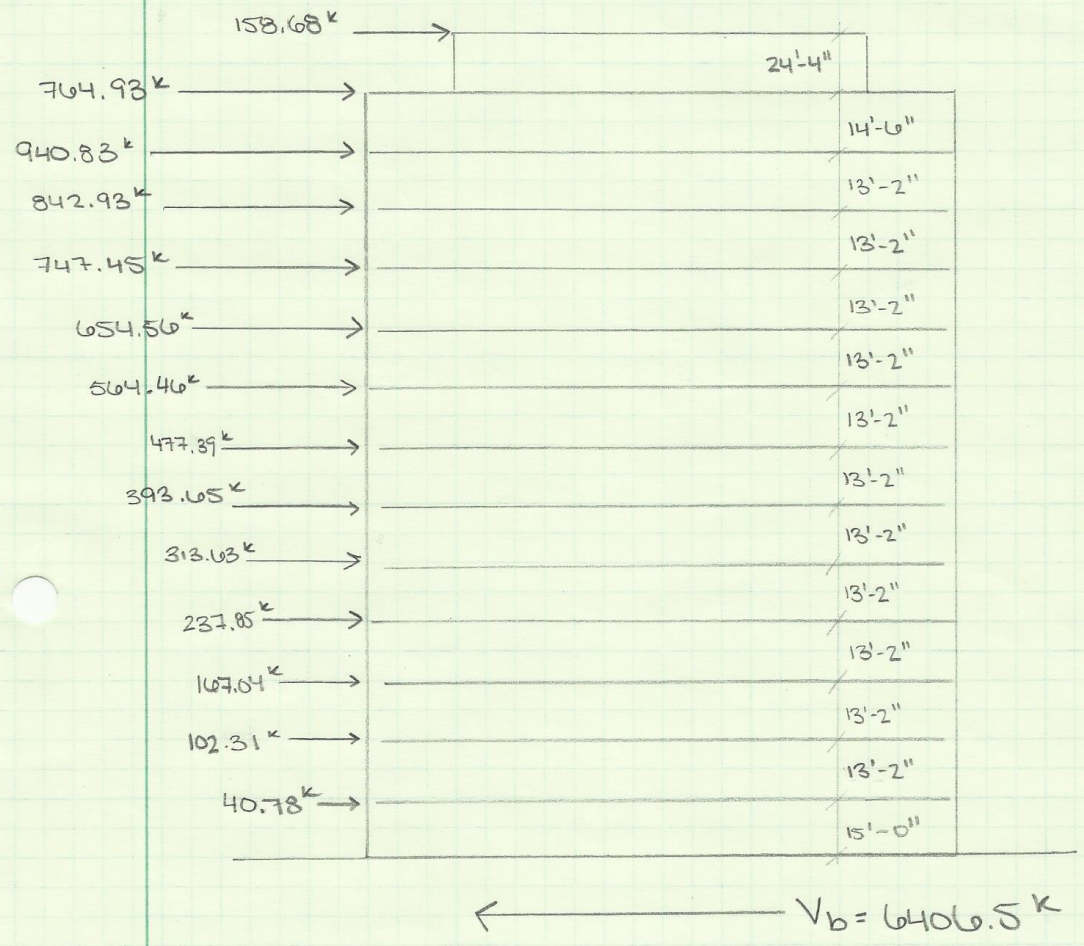
$$\frac{2-1}{2.5-0.5} = \frac{k-1}{1.056-0.5}$$

$$k = 1.278$$

* See excel sheet for the rest of the seismic force calculation. (Pg. 29 of this document) *

Alyssa Stangl | Seismic Loads | Tech Report 2 | 39

Seismic Load vs. Height Diagram



Appendix H – Model Verification Spreadsheets

Center of Mass Comparison

Levels 3-7 Center of Mass									
Item	Thickness	Length	Height	Area	Weight	X-Location (from NW corner)	Y-Location (from NW corner)	Weight * X-Location	Weight * Y-Location
1.5VLR20	10	253.667	83.334	21139	1902518	126.833	57.5	241302030	109394769
1.5VRL20	10	253.667	30	7610.01	684900.9	126.833	57.5	86868036	39381802
SW from 4 to 5, line U	18	30	13.17	395	88898	50	57.5	4444875	5111606
SW from 4 to 5, Line S	16	30	13.17	395.1	79020	63.833	57.5	5044084	4543650
SW from 4 to 5, Line R	16	26.5	13.17	349	69801	80	57.5	5584080	4013558
SW from 4 to 4.7, Line O	14	20.5	13.17	269.985	47247.375	110	62	5197211	2929337
SW from 4 to 4.7, Line N	14	20.5	13.17	270	47247	140	62	6614633	2929337
SW from 4 to 5, Line K	16	30	13.17	395.1	79020	170	57.5	13433400	4543650
SW from 4 to 4.7, Line J	16	30	13.17	395	79020	179.833	57.5	14210404	4543650
SW from 4 to 4.7, Line G	18	30	13.17	395.1	88897.5	200	57.5	17779500	5111606
SW from T to R, Line 4	26	12.667	13.17	167	54218	72.333	71.667	3921745	3885636
SW from T to R, Line 5	18	16.167	13.17	212.91939	47906.863	72.333	41.667	3465247	1996135
SW from O to N, Line 4	16	21	13.17	277	55314	125	71.667	6914250	3964188
SW from O to N, Line 4.7	16	21	13.17	276.57	55314	125	41.667	6914250	2304768
SW from K to H, Line 4	18	16.167	13.17	213	47907	178.5	71.667	8551375	3433341
SW from K to H, Line 5	26	12.667	13.17	166.82439	54217.927	178.5	41.667	9677900	2259098
Opening 1	10	-	-	63	-12600	67.5	48.5	-850500	-611100
Opening 2	10	-	-	124	-24800	75.5	50	-1872400	-1240000
Opening 3	10	-	-	79	-15800	86	48.5	-1358800	-766300
Opening 4	10	-	-	169	-33800	117	62	-3954600	-2095600
Opening 5	10	-	-	169	-33800	117	47	-3954600	-1588600
Opening 6	10	-	-	169	-33800	136	62	-4596800	-2095600
Opening 7	10	-	-	169	-33800	146.5	62	-4951700	-2095600
Opening 8	10	-	-	169	-33800	166.5	62	-5627700	-2095600
Opening 9	10	-	-	124	-24800	178	64	-4414400	-1587200
Opening 10	10	-	-	63	-12600	185	64	-2331000	-806400
					3221847			406010519	185364133

Comparison to RAM for Level 3:

	RAM	By Hand	% Difference
XCM	125.66	126.018	0.284%
YCM	56.81	57.534	1.265%

Center of Rigidity Comparison

Level 3-7 Center of Rigidity										
X-Direction										
WALL	Thickness, t	Length, b	Height, h	Cross Sectional Area (in^2)	Moment of Intertia (in^4)	E (ksi)	G (ksi)	K of wall	Xi	Ki * Xi
SW from 4 to 5, line U	18	360	158.04	6480	69984000	4415.2	1766.1	3171	50	158569
SW from 4 to 5, Line S	16	360	158.04	69120	62208000	4415.2	1766.1	3150	64	201081
SW from 4 to 5, Line R	16	318	158.04	61056	42876576	4415.2	1766.1	2736	80	218887
SW from 4 to 4.7, Line O	14	246	158.04	41328	17368092	4415.2	1766.1	1980	110	217756
SW from 4 to 4.7, Line N	14	246	158.04	41328	17368092	4415.2	1766.1	1980	140	277144
SW from 4 to 5, Line K	16	360	158.04	69120	62208000	4415.2	1766.1	3150	170	535518
SW from 4 to 5, Line J	16	360	158.04	69120	62208000	4415.2	1766.1	3150	180	566493
SW from 4 to 5, Line G	18	360	158.04	77760	69984000	4415.2	1766.1	3171	200	634275
FRAME	Risa Deflection (in)	K = P/Δ	Xi					K of Frame		Ki * Xi
Frame 3	0.011	91	0					91		0
Frame 4	0.011	91	115					91		10455
								22670		2820177

Y Direction										
Item	Thickness, t	Length, b	Height, h	Cross Sectional Area (in^2)	Moment of Intertia (in^4)	E (ksi)	G (ksi)	K of wall	Yi	Ki * Yi
SW from T to R, Line 4	26	152	158.04	3952	7609518	4415.2	1766.1	1159	71.667	83034
SW from T to R, Line 5	18	194	158.04	41905	10952753	4415.2	1766.1	1510	41.667	62908
SW from O to N, Line 4	16	252	158.04	48384	21337344	4415.2	1766.1	2075	71.667	148689
SW from O to N, Line 4.7	16	252	158.04	48384	21337344	4415.2	1766.1	2075	41.667	86448
SW from K to H, Line 4	18	194	158.04	41905	10952753	4415.2	1766.1	1510	71.667	108202
SW from K to H, Line 5	26	152	158.04	47425	7609518	4415.2	1766.1	1159	41.667	48276
FRAME	Risa Deflection (in)	K = P/Δ	Xi					K of Frame		Ki * Xi
Frame 1	0.004	250	0					250		0
Frame 2	0.004	250	115					250		28750
								9986		566307

Comparison to RAM Center of Rigidity output:

	RAM	By Hand	% Difference
Xcr	127.95	124.400	2.813%
Ycr	57.67	56.709	1.681%

Floor Mass Comparison

Story Masses							
Floor Number	Floor Weight (kip)	Shear Wall Weight (kip)	Curtain Wall Weight (kip)	Total Level Weight (kip)	Total Level Mass (lb-s2/ft)	RAM Mass (lb-s2/ft)	% Error (assuming RAM to be accurate)
PH Roof	194	164	93	452	14.04	18.38	24%
PH	2822	969	93	3883	120.73	110.27	9%
13	3416	1271	93	4780	148.60	169.29	12%
12	3416	1271	93	4780	148.60	167.75	11%
11	3416	1271	93	4780	148.60	167.85	11%
10	3416	1271	93	4780	148.60	167.96	12%
9	3416	1271	93	4780	148.60	169.29	12%
8	3416	1271	93	4780	148.60	168.75	12%
7	3416	1271	93	4780	148.60	166.83	11%
6	3416	1271	93	4780	148.60	167.18	11%
5	3416	1271	93	4780	148.60	167.30	11%
4	3416	1273	93	4782	148.66	167.42	11%
3	3416	1271	93	4780	148.60	167.58	11%
2	3047	1559	95	4701	146.15	152.73	4%

Seismic Load Comparison

Seismic Story Forces					
Floor Number	Story Forces Fi (kip)	RAM Story Forces X (kip)	% ERROR X	RAM Story Forces Y (kip)	% Error Y
Penthouse Roof	106.21	84.78	25%	98.19	8%
Penthouse Floor	539.19	418.6	29%	494.37	9%
13	740.83	564.61	31%	675.49	10%
12	657.71	492.17	34%	596.42	10%
11	583.59	428.04	36%	526.03	11%
10	511.39	366.88	39%	457.91	12%
9	444.48	311.11	43%	395.07	13%
8	374.72	255.06	47%	330.28	13%
7	305.47	201.35	52%	266.66	15%
6	243.89	154.79	58%	210.5	16%
5	185.10	112.18	65%	157.57	17%
4	130.08	74.33	75%	108.8	20%
3	79.75	42	90%	65.09	23%
2	32.48	14.96	117%	25.47	28%
Base Shear [k] =	**4935**	**3521**		**4408**	

Wind Load Comparison

Wind Pressures | North-South Direction					
Level	**Height above ground (z)**	**Force (k)**	**Story Shear (K)**	**RAM Story Forces (K)**	**% Difference**
Ground	0.00	0.00	538.60	0.00	0.0%
2	15.00	34.61	538.60	35.12	1.5%
3	28.17	35.20	504.00	34.90	0.9%
4	41.34	37.14	468.80	36.87	0.7%
5	54.51	38.64	431.66	38.39	0.6%
6	67.68	39.87	393.02	39.64	0.6%
7	80.85	40.93	353.14	40.70	0.6%
8	94.02	41.86	312.21	41.63	0.6%
9	107.19	42.70	270.35	42.46	0.6%
10	120.36	43.45	227.65	43.21	0.6%
11	133.53	44.14	184.20	43.90	0.6%
12	146.70	44.78	140.06	44.54	0.5%
13	159.87	47.67	95.27	47.44	0.5%
PH	173.04	36.29	47.60	36.79	1.4%
PH Roof	198.67	11.31	11.31	11.67	3.0%
Base Shear [k] =	**539**			**537.26**	0.25%

Wind Pressures | East-West Direction					
Floor Number	**Height above ground (z)**	**Force (k)**	**Story Shear (K)**	**RAM Story Forces (K)**	**% Difference**
1	0.00	0.00	1677.73	0	0.00
2	15.00	106.06	1677.73	98.25	7.95%
3	28.17	105.68	1571.67	104.88	0.76%
4	41.34	110.13	1465.99	106.52	3.39%
5	54.51	113.57	1355.86	110.01	3.23%
6	67.68	116.40	1242.29	112.86	3.14%
7	80.85	118.82	1125.89	115.30	3.06%
8	94.02	120.96	1007.07	117.43	3.00%
9	107.19	122.86	886.11	119.34	2.95%
10	120.36	124.59	763.25	121.06	2.92%
11	133.53	126.18	638.65	122.65	2.88%
12	146.70	127.65	512.47	124.11	2.85%
13	159.87	135.53	384.82	131.85	2.79%
PH	173.04	161.03	249.29	154.30	4.36%
PH Roof	198.67	88.26	88.26	85.47	3.27%
Base Shear [k]=	**1678**			**1624.03**	3.31%

2D Analysis Comparison

Note: X Direction Shear of 1105 kip applied at Center of Mass

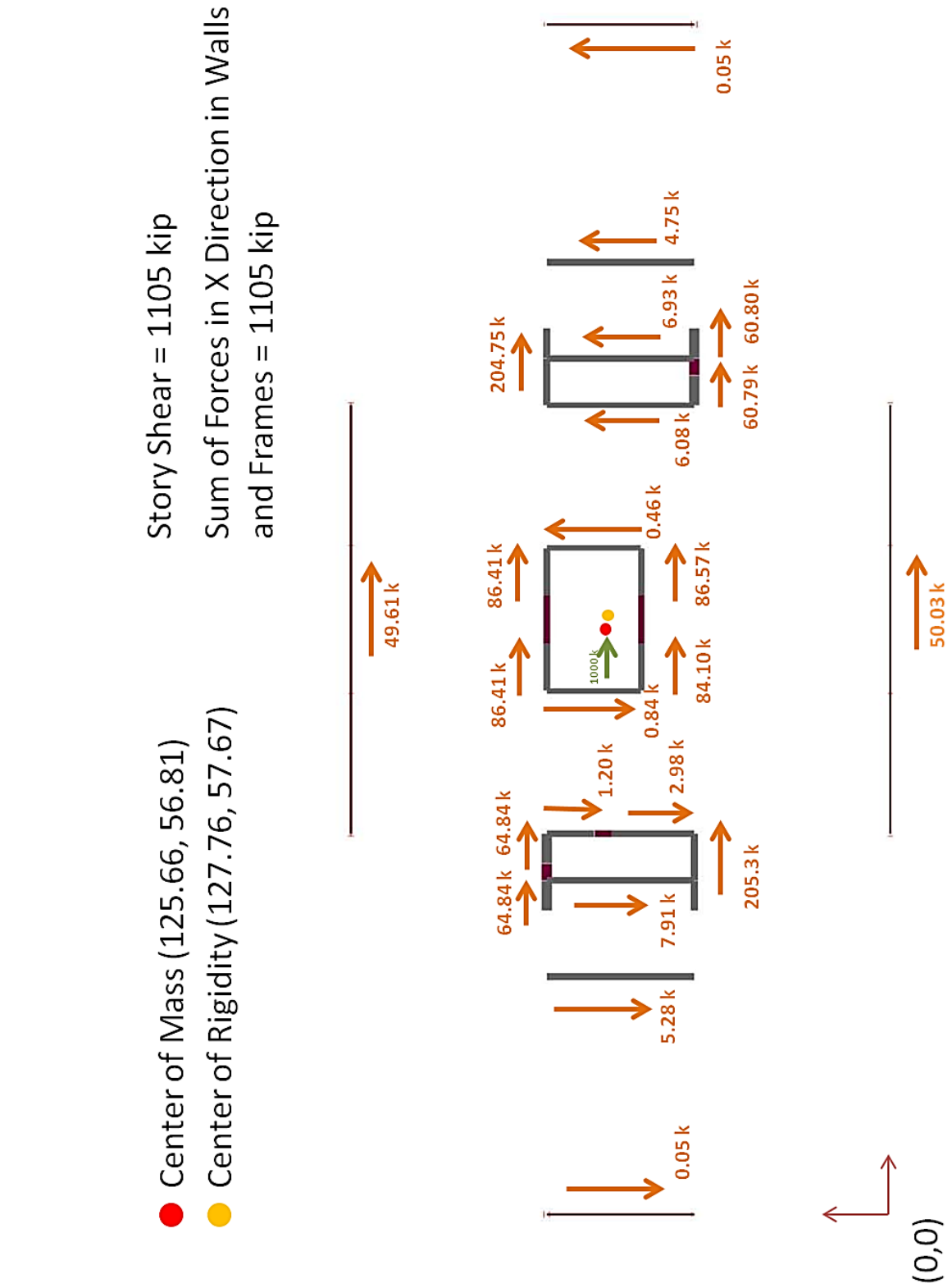
Direct Shear				
Wall	**Stiffness**	**Relative Stiffness**	**Total Shear**	**Direct Shear in Wall**
SW from R.1 to R, Line 4	580	0.064984087	1105	71.81
SW from T to S, Line 4	580	0.064984087	1105	71.81
SW from T to R, Line 5	1510	0.169304449	1105	187.08
SW from O to O.1, Line 4	770	0.086346414	1105	95.41
SW from O.2 to N, Line 4	770	0.086346414	1105	95.41
SW from O to O.1, Line 4.7	770	0.086346414	1105	95.41
SW from O.2 to N, Line 4.7	770	0.086346414	1105	95.41
SW from K to H, Line 4	1510	0.169304449	1105	187.08
SW from K to K.1, Line 5	580	0.064984087	1105	71.81
SW from K to H, Line 5	580	0.064984087	1105	71.81
Frame 1	250	0.02803455	1105	30.98
Frame 2	250	0.02803455	1105	30.98
	8918			

Torsional Shear							
Wall	**Rigidity, R**	**Distance from CR to Wall, d**	**R*d**	**d^2**	**R*d^2**	**Total Moment, Ve**	**Torsional Shear in Wall**
SW from 4 to 5, line U	3171	75.72	240108.12	5733.52	18180987	1072	3.43
SW from 4 to 4.7, Line O	1980	13.887	27496.26	192.85	381841	1072	0.39
SW from 4 to 4.7, Line N	1980	16.113	31903.74	259.63	514065	1072	0.46
SW from 4 to 5, Line S	3150	57.65	181603.54	3323.52	10469444	1072	2.59
SW from 5 - 4.7, Line R	1368	46.93	64202.24	2202.42	3013011	1072	0.92
SW from 4.1 - 4, Line R	1368	46.93	64202.24	2202.42	3013011	1072	0.92
SW from 4 to 5, Line J	3150	57.65	181603.54	3323.52	10469444	1072	2.59
SW from 4 to 5, Line K	3150	46.93	147834.41	2202.42	6937869	1072	2.11
SW from 4 to 5, Line G	3171	74.08	234907.68	5487.85	17401961	1072	3.35

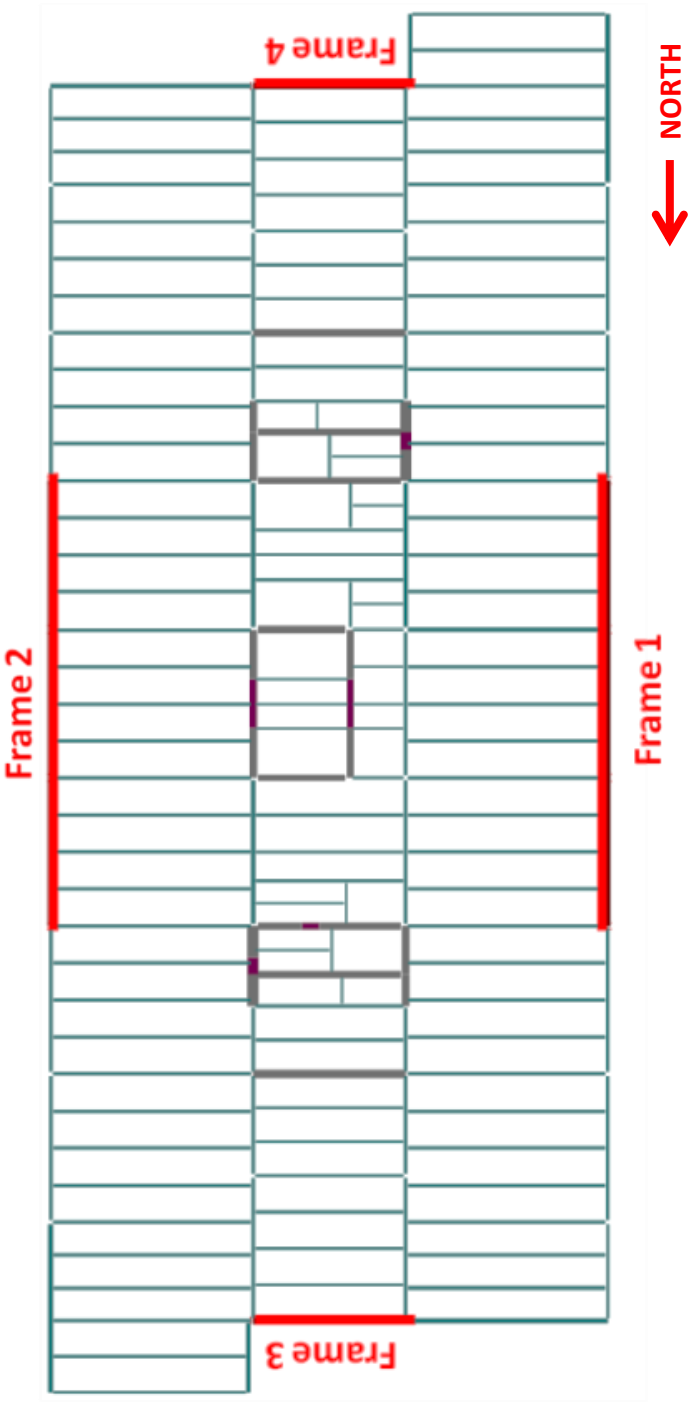
SW from T to S, Line 4	375	7.217	2706.38	52.09	19532	1072	0.04
SW from R.1 to R, Line 4	375	7.217	2706.38	52.09	19532	1072	0.04
SW from T to R, Line 5	1510	22.783	34397.41	519.07	783676	1072	0.49
SW from O to N, Line 4	2075	7.217	14973.30	52.09	108062	1072	0.21
SW from O to N, Line 4.7	2075	13.254	27498.42	175.67	364464	1072	0.39
SW from K to H, Line 4	1510	7.217	10896.11	52.09	78637	1072	0.16
SW from K to K.1, Line 5	368	22.783	8387.70	519.07	191097	1072	0.12
SW from J to H, Line 5	375	7.217	2706.94	52.09	19536	1072	0.04
Frame 1	250	56.7	14175.00	3214.89	803723	1072	0.20
Frame 2	250	56.7	14175.00	3214.89	803723	1072	0.20
Frame 3	91	127.95	11643.45	16371.20	1489779	1072	0.17
Frame 4	91	138.22	12578.02	19104.77	1738534	1072	0.18
				J=	75063393		

Total Shears

Wall	Direct Shear	Torsional Shear	Total Shear	RAM TOTAL SHEARS
1	0	3.43	3.429	5.28
5	0	0.39	0.393	0.84
6	0	0.46	0.456	0.46
2	0	2.59	2.593	7.91
3	0	0.92	0.917	1.2
4	0	0.92	0.917	2.98
8	0	2.59	2.593	6.93
7	0	2.11	2.111	6.08
9	0	3.35	3.354	4.75
12	71.8	0.04	71.769	64.84
13	71.8	0.04	71.769	64.84
10	187.1	0.49	187.573	205.3
14	95.4	0.11	95.306	86.41
15	95.4	0.11	95.306	86.41
16	95.4	0.20	95.609	84.1
17	95.4	0.20	95.609	86.57
11	187.1	0.16	186.926	204.75
18	71.8	0.12	71.688	60.79
19	71.8	0.04	71.846	60.8
Frame 1	31.0	0.20	31.181	47.53
Frame 2	31.0	0.20	30.776	47.11
Frame 3	0.0	0.17	0.166	0.05
Frame 4	0.0	0.18	0.180	0.05


Story Shear = 1105 kip
Sum of Forces in X Direction in Walls and Frames = 1105 kip
Center of Mass (125.66, 56.81)
Center of Rigidity (127.76, 57.67)
49.61 k
0.05 k
4.75 k
6.93 k
204.75 k
60.80 k
60.79 k
6.08 k
0.46 k
86.41 k
86.57 k
86.41 k
84.10 k
0.84 k
1.20 k
2.98 k
64.84 k
64.84 k
205.3 k
7.91 k
5.28 k
0.05 k
50.03 k
(0,0)

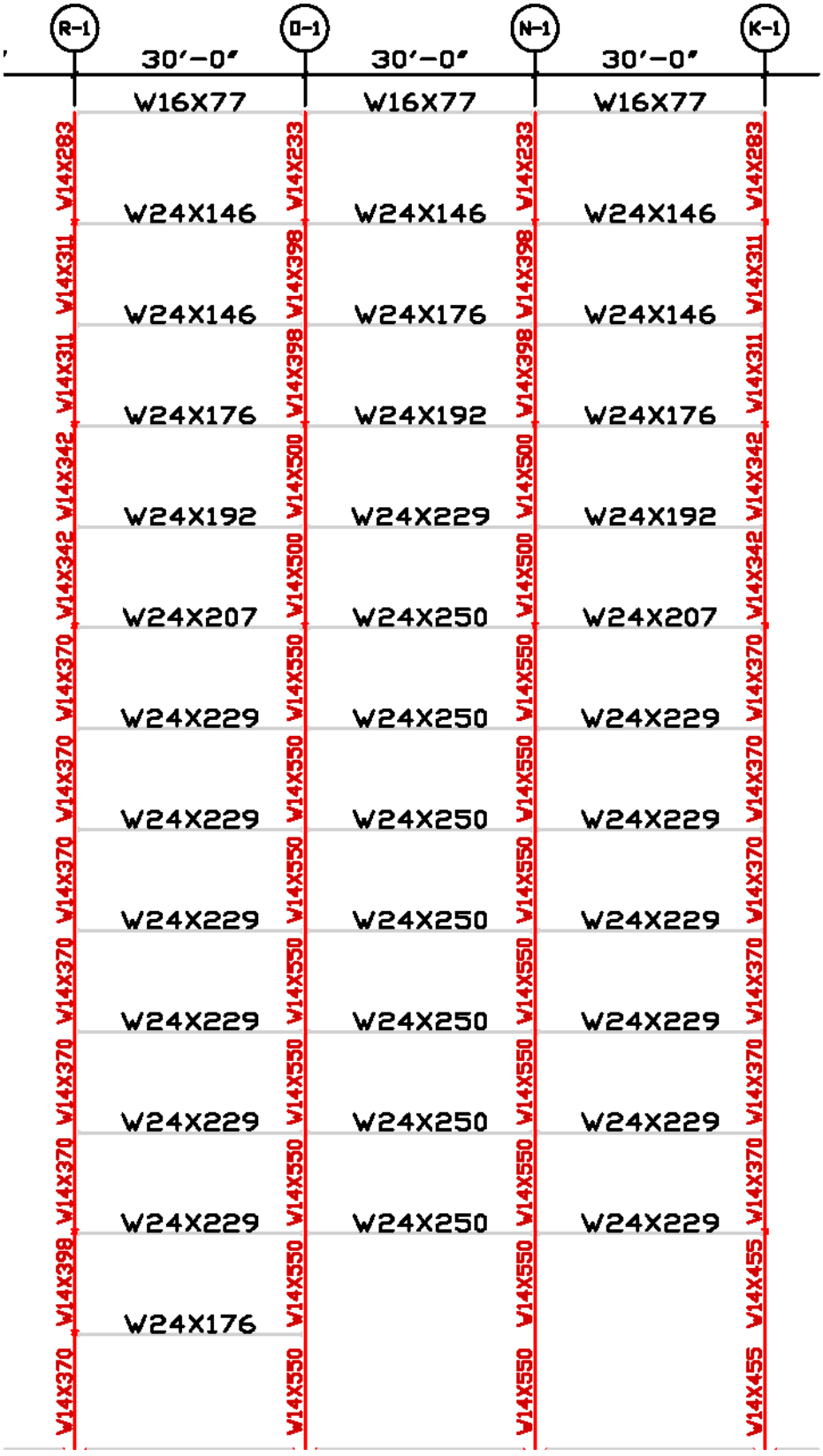
Appendix I – Moment Frame Final Designs



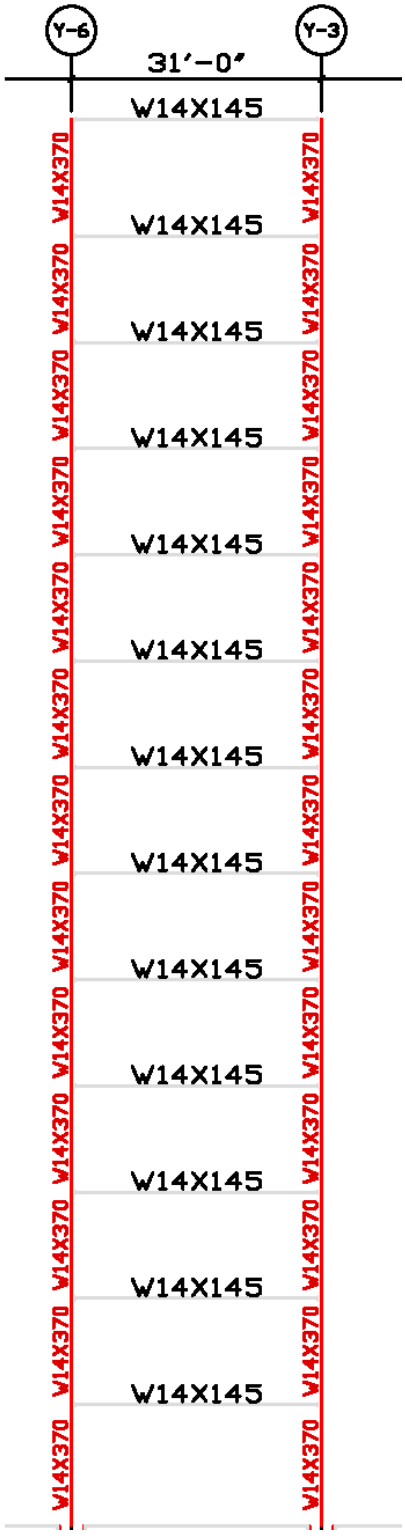
Frame 1


R-8
D-8
N-8
K-8
30'-0"
30'-0"
30'-0"
W16X77
W16X77
W16X77
W14X233
W14X233
W14X233
W14X233
W24X131
W24X131
W24X131
W14X311
W14X398
W14X398
W14X311
W24X146
W24X176
W24X146
W14X311
W14X398
W14X398
W14X311
W24X162
W24X207
W24X162
W14X342
W14X500
W14X500
W14X342
W24X192
W24X229
W24X192
W14X342
W14X500
W14X500
W14X342
W24X192
W24X250
W24X192
W14X342
W14X500
W14X500
W14X342
W24X207
W24X250
W24X207
W14X342
W14X500
W14X500
W14X342
W24X207
W24X250
W24X207
W14X342
W14X500
W14X500
W14X342
W24X207
W24X250
W24X207
W14X342
W14X500
W14X500
W14X342
W24X207
W24X250
W24X207
W14X370
W14X500
W14X500
W14X370
W24X229
W24X250
W24X229
W14X370
W14X500
W14X500
W14X370
W24X229
W24X250
W24X229
W14X370
W14X500
W14X500
W14X370
W24X229
W24X250
W24X229
W14X370
W14X500
W14X500
W14X370

Frame 2


R-1
D-1
N-1
K-1
30'-0"
30'-0"
30'-0"
W16X77
W16X77
W16X77
W24X146
W24X146
W24X146
W24X146
W24X176
W24X146
W24X176
W24X192
W24X176
W24X192
W24X229
W24X192
W24X207
W24X250
W24X207
W24X229
W24X250
W24X229
W24X229
W24X250
W24X229
W24X229
W24X250
W24X229
W24X229
W24X250
W24X229
W24X229
W24X250
W24X229
W24X229
W24X250
W24X229
W24X176
V14X283
V14X311
V14X311
V14X342
V14X342
V14X370
V14X370
V14X370
V14X370
V14X370
V14X398
V14X370
V14X233
V14X398
V14X398
V14X500
V14X500
V14X550
V14X550
V14X550
V14X550
V14X550
V14X550
V14X550
V14X550
V14X550
V14X283
V14X311
V14X311
V14X342
V14X342
V14X370
V14X370
V14X370
V14X370
V14X370
V14X455
V14X455

Frames 3 and 4



Appendix J – Shear Wall Strength Verification and Redesign

Existing Shear Wall U – Strength Check

A. Stangl | Shear Wall Check | Final Report | 1

(§ Referenced sections of ACI 318-11)

Check Shear Wall U @ Level 2:

@ level 2 to avoid shear reversal from foundation walls

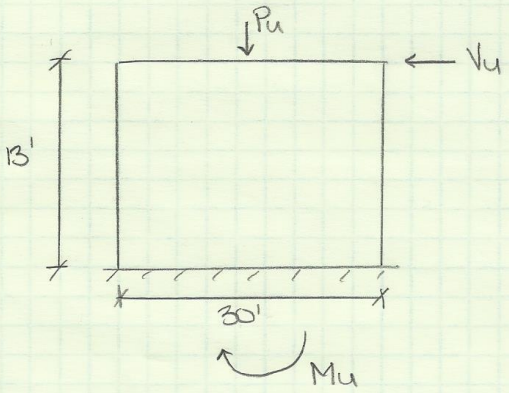
Controlling Load Case: E4 → E4 - E4T

Controlling Load Combination: 1.36D - 1.3E4

$V_u = 872.4^k$

$P_u = 3545^k$

$M_u = (872.4^k)(13') = 11341^{'k}$



$f'c = 7000$ psi
length = 30'
height = 13'
thickness = 18"

Reinforcement:

H = #6 @ 9" } each face
V = #6 @ 12" }

Special Shear Wall Requirements:

$V_{n,max} = A_{cv}[\alpha_c \lambda \sqrt{f'_c} + \rho_t f_y]$ §21.9.4.1

$h_w/l_w = 13'/30' = 0.433 < 1.5 \rightarrow \alpha_c = 3.0$

$\rho_t = \frac{2\,(17 \times 0.44\,in^2)}{(13 \times 12)(18)} = 0.00533$

$\rho_t = 0.00533 > 0.0025$ ✓ (§21.9.2.1)

$A_{cv} = (18\,in)(30' \times 12\,in/ft) = 6480\,in^2$

$V_{n,max} = (6480)[(3.0)(1.0)\sqrt{7000} + (0.00533)(60{,}000)]$

$V_{n,max} = 3699^k$

$V_{n,max} < V_n = 10 A_{cv} \sqrt{f'_c}$ §21.9.4.4

$= (10)(6480)\sqrt{7000} = 5422^k < 3699^k$

∴ $V_{n,max} = 3699^k$

A. Stangl | SW Check | Final Report 2

$\phi = 0.6$ (for special shear walls) §9.3.3

$\phi V_n = 0.6(3699^k) = 2219.4^k > 872.4^k$ ✓

→ Check other requirements but possibility of adequacy for strength

$\rho_v = \frac{2(30 \times 0.44\ in^2)}{(30\times12)(18)} = 0.00407 > 0.0025$ ✓ (§21.9.2.1)

Check V_c: (§11.9.6)

$$V_c = \min \begin{cases} 3.3\lambda\sqrt{f'c}\ hd + \frac{N_u d}{4l_w} \\ 0.6\lambda\sqrt{f'c} + \left[\frac{l_w(1.25\lambda\sqrt{f'c} + 0.2\frac{N_u}{l_w h})}{\frac{M_u}{V_u} - \frac{l_w}{2}}\right] hd \end{cases}$$

109

$l_w = 30' \times 12 = 360$ in

$d = 0.8 l_w = 0.8(360\ in) = 288$ in (§11.9.4)

$N_u = 3545^k$

$M_u = 11341$ ft-k

$V_u = 873^k$

$\frac{M_u}{V_u} - \frac{l_w}{2} = \frac{11341}{873} - \frac{30}{2} = -2.01$

∴ Eq 11-28 does not apply

$V_c = 3.3\lambda\sqrt{f'c}\ hd + \frac{N_u d}{4l_w}$

$= 3.3(1.0)\sqrt{7000}\,(18")(288") + \frac{(3545)(288)}{4(30\times12)}$

$= 1432^k$

$V_{c,max} = 2\lambda\sqrt{f'c}\ h\cdot d$ (§11.9.5)

$= 2(1.0)\sqrt{7000}\,(18")(288")$

$= 867^k$

$V_s = \frac{A_v f_y d}{s} = \frac{(0.44\ in^2)(2)(60{,}000)(288)}{9"}$

$= 1690^k$

A. Stangl | Shear Wall Check | Final Report 3

$V_n = V_c + V_s = 807^k + 1090^k = 2557^k < V_{n,max}$ ✓

$\phi V_n = 0.6(2557^k) = 1534^k$

$\phi V_n = 1534^k << V_u = 872.4^k$ ✓

* See the following page for the interaction diagram for shear wall U under combined loading, Axial and bending

Two Curtains Required:

$2 A_{cv} \lambda \sqrt{f'c} = 2(6480)(1.0)\sqrt{7000} = 1084^k$

$V_u = 872.4^k < 1084^k$

According to §21.9.2.2 → two curtains not required

↳ However, if two curtains is not used, spacing of vertical and horizontal rebar would need to be reduced to meet ρ_t and ρ_l requirements

∴ Although not required, existing design includes two curtains.

Check Reinf. Ratios:

$\rho_t = 0.00533 > 0.0025$ ✓ (§21.9.2.1)

$\rho_l = 0.00407 > 0.0025$ ✓

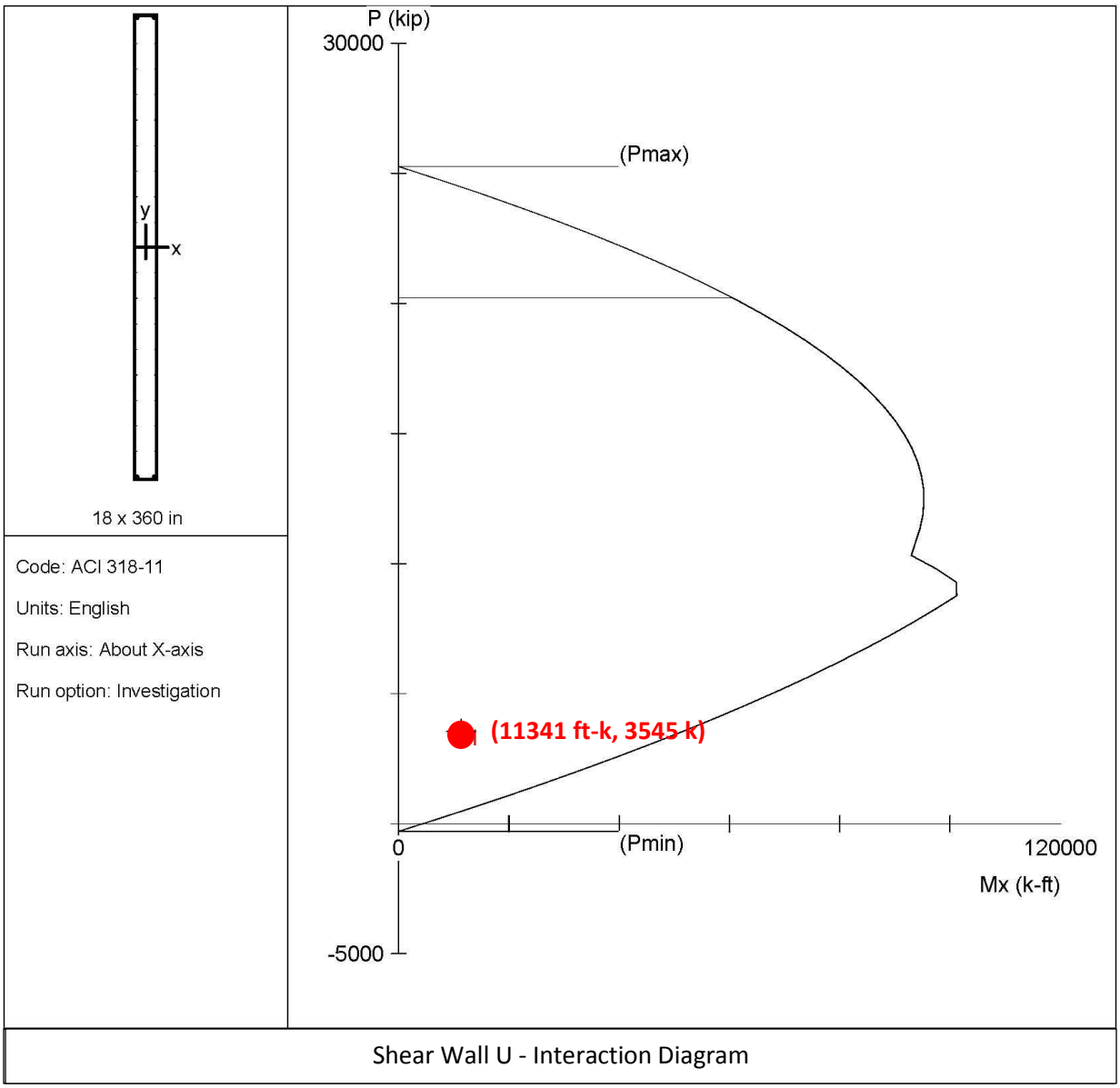
Check Spacing:

Vertical: $S_{max} = \min \begin{cases} l_w/3 = 30(12)/3 = 120" \\ 3h = 3(18) = 54" \\ 18" \end{cases}$

$S_{max} = 18" > S = 12"$ ✓

Horizontal: $S_{max} = \begin{cases} l_w/5 = 72" \\ 3h = 54" \\ 18" \end{cases}$

$S_{max} = 18" < S = 9"$ ✓



Shear Wall U - Interaction Diagram

A. Stangl | Shear Wall Check | Final Report | 5

Conclusion:

Shear wall U is adequate for strength and meets the requirements of special reinforced concrete shear walls.

As shown, the $\phi V_n >> V_u$ and two curtains of reinforcing are no longer required under the new seismic loads.

∴ Shear walls could be thinner and/or require less reinforcement

Shear Wall U – Redesign

A. Stangl | SHEAR WALL DESIGN | Final Report | 6

Modify Shear wall U reinforcing design:

Horizontal:

1 Curtain #6 @ 9"

$\rho_t = \frac{17(0.44\,in^2)}{(13\times12)(18)} = 0.00266 > 0.0025$ ✓

Vertical:

1 Curtain #6 @ 9"

$\rho_v = \frac{40(0.44\,in^2)}{(30\times12)(18)} = 0.00272 > 0.0025$ ✓

$V_c = 807^k$ (unchanged)

$V_s = \frac{A_v f_y d}{s} = \frac{(0.44\,in^2)(60{,}000)(288)}{9"}$

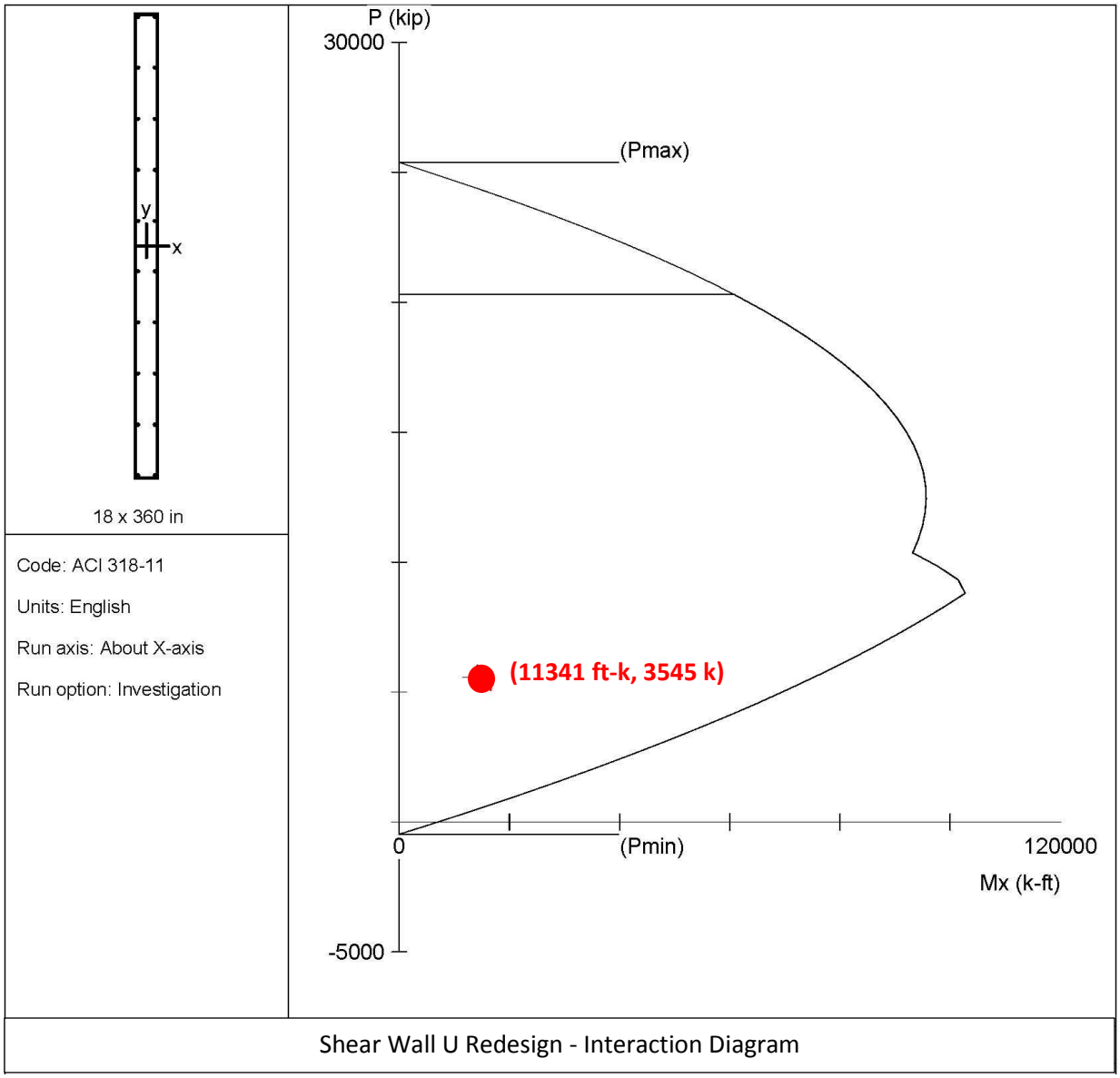
$V_s = 845^k$

$\phi V_n = (807^k + 845^k)(0.6) = 1027^k > V_u = 873^k$ ✓

- Spacing requirements OK by inspection

New Design Summary: SW U

18" Thick 7000 PSI NW CONC.
Vertical: #6 @ 9" } 1 Curtain only
Horizontal: #6 @ 9" }



Shear Wall U Redesign - Interaction Diagram

Appendix K – Overall Building Stability Checks

Base Shear and Overturning Moment | Wind				
Load Combination	Base Shear (k)		Overturning Moment (ft-k)	
	Vx	Vy	Mx	My
Type: Wind_ASCE710_1_X	568	0	56539	0
Type: Wind_ASCE710_1_Y	0	1673	0	174930
Type: Wind_ASCE710_2_X+E	426	0	42405	0
Type: Wind_ASCE710_2_X-E	426	0	42405	0
Type: Wind_ASCE710_2_Y+E	0	1254	0	131199
Type: Wind_ASCE710_2_Y-E	0	1254	0	131199
Type: Wind_ASCE710_3_X+Y	426	1254	42405	131199
Type: Wind_ASCE710_3_X-Y	426	-1254	42405	-131199
Type: Wind_ASCE710_4_X+Y_CW	319	941	31805	98399
Type: Wind_ASCE710_4_X+Y_CCW	319	941	31805	98399
Type: Wind_ASCE710_4_X-Y_CW	319	-941	31805	-98399
Type: Wind_ASCE710_4_X-Y_CCW	319	-941	31805	-98399

Base Shear and Overturning Moment | Seismic				
Load Combination	Base Shear (k)		Overturning Moment (ft-k)	
	Vx	Vy	Mx	My
Type: EQ_ASCE710_X_+E_F	3216	0	381110	0
Type: EQ_ASCE710_X_-E_F	3216	0	381110	0
Type: EQ_ASCE710_Y_+E_F	0	3216	0	381110
Type: EQ_ASCE710_Y_-E_F	0	3216	0	381110
Type: EQ_ASCE710_X_+E_0.3Y_+E_F	3216	965	381110	114334
Type: EQ_ASCE710_X_+E_-0.3Y_+E_F	3216	-965	381110	-114334
Type: EQ_ASCE710_-X_+E_0.3Y_+E_F	-3216	965	-381110	114334
Type: EQ_ASCE710_-X_+E_-0.3Y_+E_F	-3216	-965	-381110	-114334
Type: EQ_ASCE710_0.3X_+E_Y_+E_F	965	3216	114334	381110
Type: EQ_ASCE710_0.3X_+E_-Y_+E_F	965	-3216	114334	-381110
Type: EQ_ASCE710_-0.3X_+E_Y_+E_F	-965	3216	-114334	381110
Type: EQ_ASCE710_-0.3X_+E_-Y_+E_F	-965	-3216	-114334	-381110
Type: EQ_ASCE710_X_+E_0.3Y_-E_F	3216	965	381110	114334
Type: EQ_ASCE710_X_+E_-0.3Y_-E_F	3216	-965	381110	-114334
Type: EQ_ASCE710_-X_+E_0.3Y_-E_F	-3216	965	-381110	114334
Type: EQ_ASCE710_-X_+E_-0.3Y_-E_F	-3216	-965	-381110	-114334
Type: EQ_ASCE710_0.3X_+E_Y_-E_F	965	3216	114334	381110
Type: EQ_ASCE710_0.3X_+E_-Y_-E_F	965	-3216	114334	-381110
Type: EQ_ASCE710_-0.3X_+E_Y_-E_F	-965	3216	-114334	381110

Type: EQ_ASCE710_-0.3X_+E_-Y_-E_F	-965	-3216	-114334	-381110
Type: EQ_ASCE710_X_-E_0.3Y_+E_F	3216	965	381110	114334
Type: EQ_ASCE710_X_-E_-0.3Y_+E_F	3216	-965	381110	-114334
Type: EQ_ASCE710_-X_-E_0.3Y_+E_F	-3216	965	-381110	114334
Type: EQ_ASCE710_-X_-E_-0.3Y_+E_F	-3216	-965	-381110	-114334
Type: EQ_ASCE710_0.3X_-E_Y_+E_F	965	3216	114334	381110
Type: EQ_ASCE710_0.3X_-E_-Y_+E_F	965	-3216	114334	-381110
Type: EQ_ASCE710_-0.3X_-E_Y_+E_F	-965	3216	-114334	381110
Type: EQ_ASCE710_-0.3X_-E_-Y_+E_F	-965	-3216	-114334	-381110
Type: EQ_ASCE710_X_-E_0.3Y_-E_F	3216	965	381110	114334
Type: EQ_ASCE710_X_-E_-0.3Y_-E_F	3216	-965	381110	-114334
Type: EQ_ASCE710_-X_-E_0.3Y_-E_F	-3216	965	-381110	114334
Type: EQ_ASCE710_-X_-E_-0.3Y_-E_F	-3216	-965	-381110	-114334
Type: EQ_ASCE710_0.3X_-E_Y_-E_F	965	3216	114334	381110
Type: EQ_ASCE710_0.3X_-E_-Y_-E_F	965	-3216	114334	-381110
Type: EQ_ASCE710_-0.3X_-E_Y_-E_F	-965	3216	-114334	381110
Type: EQ_ASCE710_-0.3X_-E_-Y_-E_F	-965	-3216	-114334	-381110

Maximum Base Shears (k)			
Wind		Seismic	
X	Y	X	Y
568	1673	3216	3216

Maximum Overturning Moments (ft-k)			
Wind		Seismic	
X	Y	X	Y
56539	174930	381110	381110

Worst Case Moment for Building Overturning
Seismic Y Direction - Load Case: Y + YET
381110 ft-k

Building Resisting Moment		
Worst Case Resistance - Y Direction		
Total Building Weight =	82296	kip
Moment Arm =	57.5	ft
Factory of Safety=	0.67	
$M_{resisting}$ =	3170446	ft-k

Check Overturning		
Worst Case Resistance - Y Direction		
Overturning Moment =	381,110	ft-kip
Resisting Moment =	3,170,446	ft-kip
Okay?	Pass	

Controlling Base Shear		
Seismic X and Y - Multiple EQ Load Cases		
Base Shear V_b =	3,216	kip

Determine Controlling Load Combination for Foundations			
Possible Combinations:		**$V_{b,\ max}$**	**M_{max}**
1.2D + 1.0W	$1.0W_y$	1673	174930
1.2D + 1.0E	1.0E	3216	381110

Conclusion: Earthquake loads will control foundation design

Appendix L– Cost Analysis Spreadsheets

Concrete Cost Estimate

Original Concrete Structure Cost Summary		
Cost Per SF	$	61.46
Structural Square Footage		462301
% General Conditions		14%
Total Original Structure Cost	$	28,413,019.46
General Conditions Cost	$	3,977,822.72
Original Structure Cost w/ out General Conditions	$	24,435,196.74

Steel Cost Estimate

Steel Deck Estimate

Steel Deck - 05 31 13.50 (5200)						
Level	SF	Material	Labor	Equipment	Total	Total Including O&P
		2.71	0.4	0.04	3.15	3.74
2nd	26494	71798.74	10597.6	1059.76	83456.1	99087.56
3rd	29703	80495.13	11881.2	1188.12	93564.45	111089.22
4th	29703	80495.13	11881.2	1188.12	93564.45	111089.22
5th	29703	80495.13	11881.2	1188.12	93564.45	111089.22
6th	29703	80495.13	11881.2	1188.12	93564.45	111089.22
7th	29703	80495.13	11881.2	1188.12	93564.45	111089.22
8th	29703	80495.13	11881.2	1188.12	93564.45	111089.22
9th	29703	80495.13	11881.2	1188.12	93564.45	111089.22
10th	29703	80495.13	11881.2	1188.12	93564.45	111089.22
11th	29703	80495.13	11881.2	1188.12	93564.45	111089.22
12th	29703	80495.13	11881.2	1188.12	93564.45	111089.22
13th	29703	80495.13	11881.2	1188.12	93564.45	111089.22
PH	29703	80495.13	11881.2	1188.12	93564.45	111089.22
PH Roof	6704	18167.84	2681.6	268.16	21117.6	25072.96
Total	389634	$ 1,055,910.85	$155,854.00	$ 15,585.40	$ 1,227,350.25	$ 1,457,234.90

Placing Concrete - 03 31 05.70 (1400)						
Level	CY	Material	Labor	Equipment	Total	Total Including O&P
		0	15.5	5.65	21.15	29.5
2nd	367.97	0	5703.57	2079.04	7782.61	10855.18
3rd	412.54	0	6394.40	2330.86	8725.26	12169.98
4th	412.54	0	6394.40	2330.86	8725.26	12169.98
5th	412.54	0	6394.40	2330.86	8725.26	12169.98
6th	412.54	0	6394.40	2330.86	8725.26	12169.98
7th	412.54	0	6394.40	2330.86	8725.26	12169.98
8th	412.54	0	6394.40	2330.86	8725.26	12169.98
9th	412.54	0	6394.40	2330.86	8725.26	12169.98
10th	412.54	0	6394.40	2330.86	8725.26	12169.98
11th	412.54	0	6394.40	2330.86	8725.26	12169.98
12th	412.54	0	6394.40	2330.86	8725.26	12169.98
13th	412.54	0	6394.40	2330.86	8725.26	12169.98
PH	412.54	0	6394.40	2330.86	8725.26	12169.98
PH Roof	93.11	0	1443.22	526.08	1969.30	2746.78
Total	5412	$ -	$ 83,895.04	$ 30,581.10	$ 114,476.14	$ 159,671.21

Finishing Concrete - 03 35 29.30 (0250)						
Level	SF	Material	Labor	Equipment	Total	Total Including O&P
		0	0.5	0.02	0.52	0.78
2nd	26494.00	0	13247.00	529.88	13776.88	20665.32
3rd	29703.00	0	14851.50	594.06	15445.56	23168.34
4th	29703.00	0	14851.50	594.06	15445.56	23168.34
5th	29703.00	0	14851.50	594.06	15445.56	23168.34
6th	29703.00	0	14851.50	594.06	15445.56	23168.34
7th	29703.00	0	14851.50	594.06	15445.56	23168.34
8th	29703.00	0	14851.50	594.06	15445.56	23168.34
9th	29703.00	0	14851.50	594.06	15445.56	23168.34
10th	29703.00	0	14851.50	594.06	15445.56	23168.34
11th	29703.00	0	14851.50	594.06	15445.56	23168.34
12th	29703.00	0	14851.50	594.06	15445.56	23168.34
13th	29703.00	0	14851.50	594.06	15445.56	23168.34
PH	29703.00	0	14851.50	594.06	15445.56	23168.34
PH Roof	6704.00	0	3352.00	134.08	3486.08	5229.12
Total	389634	$ -	$194,817.50	$ 7,792.70	$ 202,610.20	$ 303,915.30

Concrete Topping - 03 30 53.40 (3300)						
Level	SF	Material	Labor	Equipment	Total	Total Including O&P
		1.17	0.76	0.29	2.22	2.76
2nd	26494.00	30997.98	20135.44	7683.26	58816.68	73123.44
3rd	29703.00	34752.51	22574.28	8613.87	65940.66	81980.28
4th	29703.00	34752.51	22574.28	8613.87	65940.66	81980.28
5th	29703.00	34752.51	22574.28	8613.87	65940.66	81980.28
6th	29703.00	34752.51	22574.28	8613.87	65940.66	81980.28
7th	29703.00	34752.51	22574.28	8613.87	65940.66	81980.28
8th	29703.00	34752.51	22574.28	8613.87	65940.66	81980.28
9th	29703.00	34752.51	22574.28	8613.87	65940.66	81980.28
10th	29703.00	34752.51	22574.28	8613.87	65940.66	81980.28
11th	29703.00	34752.51	22574.28	8613.87	65940.66	81980.28
12th	29703.00	34752.51	22574.28	8613.87	65940.66	81980.28
13th	29703.00	34752.51	22574.28	8613.87	65940.66	81980.28
PH	29703.00	34752.51	22574.28	8613.87	65940.66	81980.28
PH Roof	6704.00	7843.68	5095.04	1944.16	14882.88	18503.04
Total	389634	$ 455,872.95	$296,122.60	$112,994.15	$ 864,989.70	$ 1,129,162.23

Structural Steel Framing Estimate

GRAVITY SYSTEM COST

Structural Steel Columns 05 12 23.77 (0900 - Offices 7-15 Stories)

Member Size	#	Length	Lbs	Tons	Material	Labor	Equipment	Total	Total Including O&P
					3125	395	144	3664	4275
W10X33	7	126.7	4186	2.09	6540.63	826.74	301.39	7668.75	8947.58
W10X39	2	52.7	2061	1.03	3220.31	407.05	148.39	3775.75	4405.39
W12X40	13	283.9	11302	5.65	17659.38	2232.15	813.74	20705.26	24158.03
W14X43	13	308.9	13242	6.62	20690.63	2615.30	953.42	24259.34	28304.78
W10X49	4	101.3	4966	2.48	7759.38	980.79	357.55	9097.71	10614.83
W12X50	2	52.7	2617	1.31	4089.06	516.86	188.42	4794.34	5593.84
W12X53	4	105.4	5593	2.80	8739.06	1104.62	402.70	10246.38	11955.04
W14X53	2	52.7	2796	1.40	4368.75	552.21	201.31	5122.27	5976.45
W12X58	2	52.7	3047	1.52	4760.94	601.78	219.38	5582.10	6512.96
W10X60	2	52.7	3155	1.58	4929.69	623.11	227.16	5779.96	6743.81
W14X61	7	184.4	11231	5.62	17548.44	2218.12	808.63	20575.19	24006.26
W12X65	3	79	5136	2.57	8025.00	1014.36	369.79	9409.15	10978.20
W10X68	2	52.7	3585	1.79	5601.56	708.04	258.12	6567.72	7662.94
W14X68	3	79	5378	2.69	8403.13	1062.16	387.22	9852.50	11495.48
W12X72	4	105.4	7565	3.78	11820.31	1494.09	544.68	13859.08	16170.19
W12X79	3	79	6238	3.12	9746.88	1232.01	449.14	11428.02	13333.73
W14X82	1	26.3	2151	1.08	3360.94	424.82	154.87	3940.63	4597.76
W10X88	2	56.3	4965	2.48	7757.81	980.59	357.48	9095.88	10612.69
W14X90	12	316.1	28502	14.25	44534.38	5629.15	2052.14	52215.66	60923.03
W12X96	5	133.5	12813	6.41	20020.31	2530.57	922.54	23473.42	27387.79
W12X106	2	54.5	5787	2.89	9042.19	1142.93	416.66	10601.78	12369.71
W14X109	6	158	17209	8.60	26889.06	3398.78	1239.05	31526.89	36784.24
W12X120	4	107.2	12875	6.44	20117.19	2542.81	927.00	23587.00	27520.31
W14X120	2	52.7	6328	3.16	9887.50	1249.78	455.62	11592.90	13526.10
W14X132	4	107.2	14152	7.08	22112.50	2795.02	1018.94	25926.46	30249.90
W12X136	3	84.5	11474	5.74	17928.13	2266.12	826.13	21020.37	24525.68
W14X145	4	109	15840	7.92	24750.00	3128.40	1140.48	29018.88	33858.00
W12X152	1	26.3	4006	2.00	6259.38	791.19	288.43	7338.99	8562.83
W14X159	3	79	12557	6.28	19620.31	2480.01	904.10	23004.42	26840.59
W14X176	4	112.7	19861	9.93	31032.81	3922.55	1429.99	36385.35	42452.89
W12X190	1	26.3	5001	2.50	7814.06	987.70	360.07	9161.83	10689.64
W14X193	2	56.3	10889	5.44	17014.06	2150.58	784.01	19948.65	23275.24
W12X230	1	26.3	6068	3.03	9481.25	1198.43	436.90	11116.58	12970.35
W12X279	1	28.2	7851	3.93	12267.19	1550.57	565.27	14383.03	16781.51
Total				145	$ 453,792.19	$ 57,359.33	$ 20,910.74	$ 532,062.26	$ 620,787.71

Structural Steel - Beams and Girders 05 12 23.77 (0900 - Offices 7-15 Stories)

Member	#	Length	Lbs	Tons	Material	Labor	Equipment	Total	Total Including O&P
					3125	395	144	3664	4275
W8X10	160	182.36	1837	0.92	2870.31	362.81	132.26	3365.38	3926.59
W12X14	331	6330.74	89615	44.81	140023.44	17698.96	6452.28	164174.68	191552.06
W12X16	12	330.46	5296	2.65	8275.00	1045.96	381.31	9702.27	11320.20
W12X19	10	241.33	4574	2.29	7146.88	903.37	329.33	8379.57	9776.93
W14X22	21	619.67	13685	6.84	21382.81	2702.79	985.32	25070.92	29251.69
W16X26	263	7034.51	183835	91.92	287242.19	36307.41	13236.12	336785.72	392947.31
W16X31	55	1703.5	52923	26.46	82692.19	10452.29	3810.46	96954.94	113122.91
W18X35	131	3749.15	131403	65.70	205317.19	25952.09	9461.02	240730.30	280873.91
W18X46	2	82.33	3782	1.89	5909.38	746.95	272.30	6928.62	8084.03
W21X44	824	33862.55	1497948	748.97	2340543.75	295844.73	107852.26	2744240.74	3201863.85
W21X50	95	2850	142559	71.28	222748.44	28155.40	10264.25	261168.09	304719.86
W24X55	19	568.25	31325	15.66	48945.31	6186.69	2255.40	57387.40	66957.19
W24X62	60	1772.6	109778	54.89	171528.13	21681.16	7904.02	201113.30	234650.48
W24X68	34	663.5	45381	22.69	70907.81	8962.75	3267.43	83137.99	97001.89
W24X76	14	450	34300	17.15	53593.75	6774.25	2469.60	62837.60	73316.25
W27X84	56	2040.33	172181	86.09	269032.81	34005.75	12397.03	315435.59	368036.89
Total				1260	$ 3,938,159.38	$ 497,783.35	$ 181,470.38	$ 4,617,413.10	$ 5,387,402.03

SPECIAL MOMENT FRAME COST

Structural Steel Columns 05 12 23.77 (0900 - Offices 7-15 Stories)

Member Size	Tons	Material	Labor	Equipment	Total	Total Including O&P
		3125	395	144	3664	4275
W14X233	10.14	31685.94	4005.10	1460.09	37151.13	43346.36
W14X283	4.11	12843.75	1623.45	591.84	15059.04	17570.25
W14X311	16.38	51200.00	6471.68	2359.30	60030.98	70041.60
W14X342	36.21	113154.69	14302.75	5214.17	132671.61	154795.61
W14X370	190.68	595868.75	75317.81	27457.63	698644.19	815148.45
W14X398	23.59	73732.81	9319.83	3397.61	86450.25	100866.49
W14X455	6.42	20070.31	2536.89	924.84	23532.04	27456.19
W14X500	79.97	249896.88	31586.97	11515.25	292999.09	341858.93
W14X550	59.09	184648.44	23339.56	8508.60	216496.60	252599.06
Total	426.59	$ 1,333,101.56	$ 168,504.04	$ 61,429.32	$ 1,563,034.92	$ 1,823,682.94

Structural Steel - Beams and Girders 05 12 23.77 (0900 - Offices 7-15 Stories)

Member	Tons	Material	Labor	Equipment	Total	Total Including O&P
		3125.00	395.00	144.00	3664.00	4275.00
W14X145	60.81	190020.31	24018.57	8756.14	222795.02	259947.79
W16X77	6.92	21628.13	2733.80	996.62	25358.54	29587.28
W24X131	5.90	18421.88	2328.53	848.88	21599.28	25201.13
W24X146	15.36	48010.94	6068.58	2212.34	56291.86	65678.96
W24X162	4.87	15217.19	1923.45	701.21	17841.85	20817.11
W24X176	13.19	41231.25	5211.63	1899.94	48342.82	56404.35
W24X192	20.12	62859.38	7945.43	2896.56	73701.36	85991.63
W24X207	34.08	106500.00	13461.60	4907.52	124869.12	145692.00
W24X229	75.46	235807.81	29806.11	10866.02	276479.94	322585.09
W24X250	48.77	152404.69	19263.95	7022.81	178691.45	208489.61
Total	285.47	$ 892,101.56	$ 112,761.64	$ 41,108.04	$ 1,045,971.24	$ 1,220,394.94

TOTAL STEEL FRAMING COST

$9,052,267.61

Shear Wall Estimate

Formwork - Concrete Shear Walls 03 11 13.85 (2400 - Job built plywood, over 8 to 16 feet high)									
Level	Wall Height	Length	Average Level	S.F.C.A	Material	Labor	Equipment	Total	Total Including O&P
					9.4	6.65	0	16.05	20.5
PH Roof	24.33	30.00	1.50	1533	14408.2	10193.1	0.0	24601.3	31422.2
PH	14.50	297.00	1.50	8657	81371.1	57565.73	0.00	138936.83	177458.25
13	13.17	297.00	2.17	7880	74073.3	52402.92	0.00	126476.21	161542.82
12	13.17	297.00	2.17	7880	74073.3	52402.92	0.00	126476.21	161542.82
11	13.17	297.00	2.17	7880	74073.3	52402.92	0.00	126476.21	161542.82
10	13.17	297.00	2.17	7880	74073.3	52402.92	0.00	126476.21	161542.82
9	13.17	297.00	2.17	7880	74073.3	52402.92	0.00	126476.21	161542.82
8	13.17	297.00	2.17	7880	74073.3	52402.92	0.00	126476.21	161542.82
7	13.17	297.00	2.17	7880	74073.3	52402.92	0.00	126476.21	161542.82
6	13.17	297.00	2.17	7880	74073.3	52402.92	0.00	126476.21	161542.82
5	13.17	297.00	2.17	7880	74073.3	52402.92	0.00	126476.21	161542.82
4	13.17	297.00	2.17	7880	74073.3	52402.92	0.00	126476.21	161542.82
3	13.17	297.00	2.17	7880	74073.3	52402.92	0.00	126476.21	161542.82
2	15.00	297.00	2.33	8980	84411.1	59716.34	0.00	144127.40	184087.95
Total				105851	$ 994,996.63	$ 703,907.19	$ -	$ 1,698,903.83	$ 2,386,933.42

Placing Structural Concrete Shear Walls - 03 31 05.70 (5300)									
Level	Wall Height	Length	Average Level	C.Y.	Material	Labor	Equipment	Total	Total Including O&P
					0	18.1	6.6	24.7	35
PH Roof	24.33	30.00	1.50	38	0.0	683.3	249.2	932.5	1321.4
PH	14.50	297.00	1.50	223	0.0	4031.78	1470.15	5501.93	7796.25
13	13.17	297.00	2.17	293	0.0	5297.64	1931.74	7229.38	10244.06
12	13.17	297.00	2.17	293	0.0	5297.64	1931.74	7229.38	10244.06
11	13.17	297.00	2.17	293	0.0	5297.64	1931.74	7229.38	10244.06
10	13.17	297.00	2.17	293	0.0	5297.64	1931.74	7229.38	10244.06
9	13.17	297.00	2.17	293	0.0	5297.64	1931.74	7229.38	10244.06
8	13.17	297.00	2.17	293	0.0	5297.64	1931.74	7229.38	10244.06
7	13.17	297.00	2.17	293	0.0	5297.64	1931.74	7229.38	10244.06
6	13.17	297.00	2.17	293	0.0	5297.64	1931.74	7229.38	10244.06
5	13.17	297.00	2.17	293	0.0	5297.64	1931.74	7229.38	10244.06
4	13.17	297.00	2.17	293	0.0	5297.64	1931.74	7229.38	10244.06
3	13.17	297.00	2.17	293	0.0	5297.64	1931.74	7229.38	10244.06
2	15.00	297.00	2.33	358	0.0	6478.65	2362.38	8841.02	12527.77
Ground	15.00	297.00	2.33	358	0.0	6478.65	2362.38	8841.02	12527.77
LL1	15.00	297.00	2.33	358	0.0	6478.65	2362.38	8841.02	12527.77
Total				4554	$ -	$ 82,425.10	$ 30,055.56	$ 112,480.66	$ 159,385.55

Structural Concrete - Shear Walls -03 31 05.35 Normal Weight Concrete										
Level	Wall Height	Length	Average Level Thickness	C.Y.	Concrete	Material	Labor	Equipment	Total	Total Including O&P
					6000	127	0	0	127	139
					7000	166.5	0	0	166.5	183
PH Roof	24.33	30.00	1.50	38	6000	4794.7	0.0	0.0	4794.7	5247.7
PH	14.50	297.00	1.50	223	6000	28289.3	0.0	0.0	28289.3	30962.25
13	13.17	297.00	2.17	293	6000	37171.3	0.0	0.0	37171.3	40683.54
12	13.17	297.00	2.17	293	6000	37171.3	0.0	0.0	37171.3	40683.54
11	13.17	297.00	2.17	293	6000	37171.3	0.0	0.0	37171.3	40683.54
10	13.17	297.00	2.17	293	6000	37171.3	0.0	0.0	37171.3	40683.54
9	13.17	297.00	2.17	293	6000	37171.3	0.0	0.0	37171.3	40683.54
8	13.17	297.00	2.17	293	6000	37171.3	0.0	0.0	37171.3	40683.54
7	13.17	297.00	2.17	293	6000	37171.3	0.0	0.0	37171.3	40683.54
6	13.17	297.00	2.17	293	6000	37171.3	0.0	0.0	37171.3	40683.54
5	13.17	297.00	2.17	293	7000	48732.4	0.0	0.0	48732.4	53561.79
4	13.17	297.00	2.17	293	7000	48732.4	0.0	0.0	48732.4	53561.79
3	13.17	297.00	2.17	293	7000	48732.4	0.0	0.0	48732.4	53561.79
2	15.00	297.00	2.33	358	7000	59596.4	0.0	0.0	59596.4	65502.33
Ground	15.00	297.00	2.33	358	7000	59596.4	0.0	0.0	59596.4	65502.33
LL1	15.00	297.00	2.33	358	7000	59596.4	0.0	0.0	59596.4	65502.33
Total				4554	-	$ 655,440.76	$ -	$ -	$ 655,440.76	$ 754,814.19

Finishing Concrete Shear Walls 03 35 29.60 (0020)									
Level	Wall Height	Length	Average Level Thickness	S.F.	Material	Labor	Equipment	Total	Total Including O&P
					0.03	0.57	0.00	0.60	0.86
PH Roof	24.33	30.00	1.50	1460	43.8	832.1	0.0	875.9	1255.4
PH	14.50	297.00	1.50	8613	258.4	4909.41	0.00	5167.80	7407.18
13	13.17	297.00	2.17	7823	234.7	4459.10	0.00	4693.79	6727.76
12	13.17	297.00	2.17	7823	234.7	4459.10	0.00	4693.79	6727.76
11	13.17	297.00	2.17	7823	234.7	4459.10	0.00	4693.79	6727.76
10	13.17	297.00	2.17	7823	234.7	4459.10	0.00	4693.79	6727.76
9	13.17	297.00	2.17	7823	234.7	4459.10	0.00	4693.79	6727.76
8	13.17	297.00	2.17	7823	234.7	4459.10	0.00	4693.79	6727.76
7	13.17	297.00	2.17	7823	234.7	4459.10	0.00	4693.79	6727.76
6	13.17	297.00	2.17	7823	234.7	4459.10	0.00	4693.79	6727.76
5	13.17	297.00	2.17	7823	234.7	4459.10	0.00	4693.79	6727.76
4	13.17	297.00	2.17	7823	234.7	4459.10	0.00	4693.79	6727.76
3	13.17	297.00	2.17	7823	234.7	4459.10	0.00	4693.79	6727.76
2	15.00	297.00	2.33	8910	267.3	5078.70	0.00	5346.00	7662.60
Ground	15.00	297.00	2.33	8910	267.3	5078.70	0.00	5346.00	7662.60
LL1	15.00	297.00	2.33	8910	267.3	5078.70	0.00	5346.00	7662.60
Total				122856	$ 3,685.67	$ 70,027.68	$ -	$ 73,713.35	$ 105,655.80

Reinforcing Bars - Shear Walls 03 21 10.60 (0750)						
Rebar	Tons	Material	Labor	Equipment	Total	Total Including O&P
		1475.00	355.00	0.00	1830.00	2200.00
Vertical End Bars	267	393258.8	94648.7	0.0	487907.5	586555.5
Vertical Wall	88	129790.4	31237.7	0.0	161028.0	193585.6
Horizontal Wall	36	53493.2	12874.6	0.0	66367.9	79786.5
Total	391	$ 576,542.39	$ 138,761.05	$ -	$ 715,303.44	$ 902,924.02

Foundation Wall Estimate

Formwork - Concrete Foundation Walls 03 11 13.85 (4200 - Job built plywood, below grade)						
Level	S.F.C.A	Material	Labor	Equipment	Total	Total Including O&P
		4.25	8.30	0	12.82	17.85
LL 1	12420	52785.0	103086.0	0.0	159224.4	221697.00
LL 1	750	3187.5	6225.00	0.00	9615.00	13387.50
LL 2	12420	52785.0	103086.00	0.00	159224.40	221697.00
LL 2	750	3187.5	6225.00	0.00	9615.00	13387.50
Total	26340	$ 111,945.00	$ 218,622.00	$ -	$ 337,678.80	$ 517,185.90

Placing Structural Concrete Foundation Walls - 03 31 05.70 (5300)						
Level	C.Y.	Material	Labor	Equipment	Total	Total Including O&P
		0	18.1	6.6	24.7	35
LL 1	14490	0.0	262269.0	95634.0	357903.0	507150.0
LL 1	1000	0.0	18100.00	6600.00	24700.00	35000.00
LL 2	14490	0.0	262269.00	95634.00	357903.00	507150.00
LL 2	1000	0.0	18100.00	6600.00	24700.00	35000.00
Total	30980	$ -	$ 560,738.00	$ 204,468.00	$ 765,206.00	$ 1,084,300.00

Structural Concrete - Foundation -03 31 05.35 Normal Weight Concrete							
Level	C.Y.	Concrete Strength	Material	Labor	Equipment	Total	Total Including O&P
		5000	111	0	0	111	122
LL 1	537	5000	59570.0	0.00	0.00	59570.00	65473.3
LL 1	37	5000	4111.1	0.00	0.00	4111.11	4518.52
LL 2	537	5000	59570.0	0.00	0.00	59570.00	65473.33
LL 2	37	5000	4111.1	0.00	0.00	4111.11	4518.52
Total	1147	-	$ 127,362.22	$ -	$ -	$ 127,362.22	$ 146,982.89

Finishing Concrete Foundation Walls - 03 35 29.60 (0020)						
Level	S.F.	Material	Labor	Equipment	Total	Total Including O&P
		0.03	0.57	0.00	0.60	0.86
LL 1	12420	372.60	7079.40	0.00	7452.0	10681.2
LL 1	750	22.50	427.50	0.00	450.00	645.00
LL 2	12420	372.60	7079.40	0.00	7452.00	10681.20
LL 2	750	22.50	427.50	0.00	450.00	645.00
Total	26340	$ 790.20	$ 15,013.80	$ -	$ 15,804.00	$ 22,652.40

Reinforcing Bars - Foundation Walls - 03 21 10.60 (1160)						
Level	Tons	Material	Labor	Equipment	Total	Total Including O&P
		1550.00	445.00	0.00	1995.00	2425.00
Horizontal	20	30661.1	8802.7	0.00	39463.77	47969.75
Vertical	42	65475.6	18797.84	0.00	84273.47	102437.67
Total	62	$ 96,136.70	$ 27,600.54	$ -	$ 123,737.24	$ 157,927.80

Lower Level Concrete Slab Estimate

Formwork - Concrete Slabs Below Grade 03 11 13.35 (1000 - Job built plywood)						
Level	S.F.C.A	Material	Labor	Equipment	Total	Total Including O&P
		4.53	3.97	0	8.5	11.15
LL1	39060	176941.80	155068.20	0.00	332010.00	435519.00
LL2	39060	176941.80	155068.20	0.00	332010.00	435519.00
Total	78120	$353,883.60	$310,136.40	$ -	$ 664,020.00	$ 958,141.80

Placing Structural Concrete Slabs Below Grade - 03 31 05.70 (1600)						
Level	CY	Material	Labor	Equipment	Total	Total Including O&P
		0	12.05	4.39	16.44	23.5
LL1	1688	0.00	20337.72	7409.34	27747.07	39662.78
LL2	1929	0.00	23243.11	8467.82	31710.93	45328.89
Total	3617	$ -	$ 43,580.83	$ 15,877.17	$ 59,458.00	$ 84,991.67

Structural Concrete - Slabs Below Grade -03 31 05.35 Normal Weight Concrete (0400)						
Level	C.Y.	Material	Labor	Equipment	Total	Total Including O&P
		111	0	0	111	122
LL1	1688	187343.3	0.00	0.00	187343.33	205908.9
LL2	1929	214106.7	0.00	0.00	214106.67	235324.44
Total	3617	$401,450.00	$ -	$ -	$ 401,450.00	$ 463,295.00

Finishing Concrete Slabs Below Grade - 03 35 29.30 (0250)						
Level	S.F.	Material	Labor	Equipment	Total	Total Including O&P
		0.00	0.50	0.02	0.52	0.78
LL1	39060	0.00	19530.00	781.20	20311.20	30466.80
LL2	39060	0.00	19530.00	781.20	20311.20	30466.80
Total	78120	$ -	$ 39,060.00	$ 1,562.40	$ 40,622.40	$ 60,933.60

Reinforcing Bars - Slabs - 03 21 10.60 (0400)						
Location	Tons	Material	Labor	Equipment	Total	Total Including O&P
		1650.00	490.00	0.00	2140.00	2600.00
Top E - W	87.65	144618.1	42947.2	0.0	187565.3	227883.1
Top N - S	87.65	144618.1	42947.19	0.00	187565.29	227883.06
Bot N-S	81.15	133898.5	39763.80	0.00	173662.32	210991.60
Bot E - W	121.73	200847.8	59645.70	0.00	260493.47	316487.40
Total	378.17	$ 623,982.48	$ 185,303.89	$ -	$809,286.37	$ 1,229,056.41

Lower Level Concrete Columns Estimate

Formwork - Columns - 03 11 13.25 (700)									
Level	Column Size	Level Height	# of Columns	S.F.C.A	Material	Labor	Equipment	Total	Total Including O&P
					1.81	6.05	0	7.86	11.4
Lower Level 1	24x24	15.00	1.00	120	217.20	726.00	0.00	943.20	1368.00
	24x48	15.00	1.00	180	325.80	1089.00	0.00	1414.80	2052.00
	24x40	15.00	2.00	320	579.20	1936.00	0.00	2515.20	3648.00
	24x30	15.00	1.00	135	244.35	816.75	0.00	1061.10	1539.00
	24x24	15.00	2.00	240	434.40	1452.00	0.00	1886.40	2736.00
	24x36	15.00	4.00	600	1086.00	3630.00	0.00	4716.00	6840.00
	24x24	15.00	3.00	360	651.60	2178.00	0.00	2829.60	4104.00
	42x42	15.00	2.00	420	760.20	2541.00	0.00	3301.20	4788.00
	30x48	15.00	4.00	780	1411.80	4719.00	0.00	6130.80	8892.00
	30x48	15.00	2.00	390	705.90	2359.50	0.00	3065.40	4446.00
	30x30	15.00	12.00	1800	3258.00	10890.00	0.00	14148.00	20520.00
	24x30	15.00	1.00	135	244.35	816.75	0.00	1061.10	1539.00
	24x24	15.00	6.00	720	1303.20	4356.00	0.00	5659.20	8208.00
Lower Level 2	24x24	15.00	1.00	120	217.20	726.00	0.00	943.20	1368.00
	24x48	15.00	1.00	180	325.80	1089.00	0.00	1414.80	2052.00
	24x40	15.00	2.00	320	579.20	1936.00	0.00	2515.20	3648.00
	24x30	15.00	1.00	135	244.35	816.75	0.00	1061.10	1539.00
	18x18	15.00	2.00	90	162.90	544.50	0.00	707.40	1026.00
	24x36	15.00	4.00	600	1086.00	3630.00	0.00	4716.00	6840.00
	18x18	15.00	3.00	90	162.90	544.50	0.00	707.40	1026.00
	36x42	15.00	2.00	195	352.95	1179.75	0.00	1532.70	2223.00
	30x42	15.00	4.00	195	352.95	1179.75	0.00	1532.70	2223.00
	30x48	15.00	2.00	390	705.90	2359.50	0.00	3065.40	4446.00
	30x30	15.00	12.00	1800	3258.00	10890.00	0.00	14148.00	20520.00
	24x30	15.00	1.00	135	244.35	816.75	0.00	1061.10	1539.00
Total				10450	$ 18,914.50	$ 63,222.50	$ -	$ 82,137.00	$ 131,043.00

Placement - Columns - 03 31 05.70 (1000)										
Level	b	h	Level Height	# of Columns	CY	Material	Labor	Equipment	Total	Total Including O&P
						0	15.50	5.65	21.15	29.5
Lower Level 1	24	24	15.00	1.00	2	0.00	34.44	12.56	47.00	65.56
	24	48	15.00	1.00	4	0.00	68.89	25.11	94.00	131.11
	24	40	15.00	2.00	7	0.00	114.81	41.85	156.67	218.52
	40	30	15.00	1.00	5	0.00	71.76	26.16	97.92	136.57
	24	24	15.00	2.00	4	0.00	68.89	25.11	94.00	131.11
	24	36	15.00	4.00	13	0.00	206.67	75.33	282.00	393.33
	24	24	15.00	3.00	7	0.00	103.33	37.67	141.00	196.67
	42	42	15.00	2.00	14	0.00	210.97	76.90	287.88	401.53
	30	48	15.00	4.00	22	0.00	344.44	125.56	470.00	655.56
	30	48	15.00	2.00	11	0.00	172.22	62.78	235.00	327.78
	30	48	15.00	12.00	67	0.00	1033.33	376.67	1410.00	1966.67
	24	48	15.00	1.00	4	0.00	68.89	25.11	94.00	131.11
	24	48	15.00	6.00	27	0.00	413.33	150.67	564.00	786.67
Lower Level 2	24	24	15.00	1.00	2	0.00	34.44	12.56	47.00	65.56
	24	48	15.00	1.00	4	0.00	68.89	25.11	94.00	131.11
	24	40	15.00	2.00	7	0.00	114.81	41.85	156.67	218.52
	40	30	15.00	1.00	5	0.00	71.76	26.16	97.92	136.57
	24	24	15.00	2.00	4	0.00	68.89	25.11	94.00	131.11
	24	36	15.00	4.00	13	0.00	206.67	75.33	282.00	393.33
	24	24	15.00	3.00	7	0.00	103.33	37.67	141.00	196.67
	42	42	15.00	2.00	14	0.00	210.97	76.90	287.88	401.53
	30	48	15.00	4.00	22	0.00	344.44	125.56	470.00	655.56
	30	48	15.00	2.00	11	0.00	172.22	62.78	235.00	327.78
	30	30	15.00	12.00	42	0.00	645.83	235.42	881.25	1229.17
	24	30	15.00	1.00	3	0.00	43.06	15.69	58.75	81.94
Total					322	$ -	$ 4,997.31	$ 1,821.60	$ 6,818.92	$ 9,511.02

Structural Concrete - Columns - 03 31 05.35 (0411)										
Level	b	h	Level Height	# of Columns	CY	Material	Labor	Equipment	Total	Total Including O&P
						111	0.00	0	111	122
Lower Level 1	24	24	15.00	1.00	2	246.67	0.00	0.00	246.67	271.11
	24	48	15.00	1.00	4	493.33	0.00	0.00	493.33	542.22
	24	40	15.00	2.00	7	822.22	0.00	0.00	822.22	903.70
	40	30	15.00	1.00	5	513.89	0.00	0.00	513.89	564.81
	24	24	15.00	2.00	4	493.33	0.00	0.00	493.33	542.22
	24	36	15.00	4.00	13	1480.00	0.00	0.00	1480.00	1626.67
	24	24	15.00	3.00	7	740.00	0.00	0.00	740.00	813.33
	42	42	15.00	2.00	14	1510.83	0.00	0.00	1510.83	1660.56
	30	48	15.00	4.00	22	2466.67	0.00	0.00	2466.67	2711.11
	30	48	15.00	2.00	11	1233.33	0.00	0.00	1233.33	1355.56
	30	48	15.00	12.00	67	7400.00	0.00	0.00	7400.00	8133.33
	24	48	15.00	1.00	4	493.33	0.00	0.00	493.33	542.22
	24	48	15.00	6.00	27	2960.00	0.00	0.00	2960.00	3253.33
Lower Level 2	24	24	15.00	1.00	2	246.67	0.00	0.00	246.67	271.11
	24	48	15.00	1.00	4	493.33	0.00	0.00	493.33	542.22
	24	40	15.00	2.00	7	822.22	0.00	0.00	822.22	903.70
	40	30	15.00	1.00	5	513.89	0.00	0.00	513.89	564.81
	24	24	15.00	2.00	4	493.33	0.00	0.00	493.33	542.22
	24	36	15.00	4.00	13	1480.00	0.00	0.00	1480.00	1626.67
	24	24	15.00	3.00	7	740.00	0.00	0.00	740.00	813.33
	42	42	15.00	2.00	14	1510.83	0.00	0.00	1510.83	1660.56
	30	48	15.00	4.00	22	2466.67	0.00	0.00	2466.67	2711.11
	30	48	15.00	2.00	11	1233.33	0.00	0.00	1233.33	1355.56
	30	30	15.00	12.00	42	4625.00	0.00	0.00	4625.00	5083.33
	24	30	15.00	1.00	3	308.33	0.00	0.00	308.33	338.89
Total					322	$ 35,787.22	$ -	$ -	$ 35,787.22	$ 41,300.39

Finishing Concrete - Columns - 03 35 29.60 (0020)										
Level	b	h	Level Height	# of Columns	S.F.C.A	Material	Labor	Equipment	Total	Total Including O&P
						0.03	0.57	0	0.6	0.86
Lower Level 1	24	24	15.00	1.00	120	3.60	68.40	0.00	72.00	103.20
	24	48	15.00	1.00	180	5.40	102.60	0.00	108.00	154.80
	24	40	15.00	2.00	320	9.60	182.40	0.00	192.00	275.20
	40	30	15.00	1.00	135	4.05	76.95	0.00	81.00	116.10
	24	24	15.00	2.00	240	7.20	136.80	0.00	144.00	206.40
	24	36	15.00	4.00	600	18.00	342.00	0.00	360.00	516.00
	24	24	15.00	3.00	360	10.80	205.20	0.00	216.00	309.60
	42	42	15.00	2.00	420	12.60	239.40	0.00	252.00	361.20
	30	48	15.00	4.00	780	23.40	444.60	0.00	468.00	670.80
	30	48	15.00	2.00	390	11.70	222.30	0.00	234.00	335.40
	30	48	15.00	12.00	1800	54.00	1026.00	0.00	1080.00	1548.00
	24	48	15.00	1.00	135	4.05	76.95	0.00	81.00	116.10
	24	48	15.00	6.00	720	21.60	410.40	0.00	432.00	619.20
Lower Level 2	24	24	15.00	1.00	120	3.60	68.40	0.00	72.00	103.20
	24	48	15.00	1.00	180	5.40	102.60	0.00	108.00	154.80
	24	40	15.00	2.00	320	9.60	182.40	0.00	192.00	275.20
	40	30	15.00	1.00	135	4.05	76.95	0.00	81.00	116.10
	24	24	15.00	2.00	90	2.70	51.30	0.00	54.00	77.40
	24	36	15.00	4.00	600	18.00	342.00	0.00	360.00	516.00
	24	24	15.00	3.00	90	2.70	51.30	0.00	54.00	77.40
	42	42	15.00	2.00	195	5.85	111.15	0.00	117.00	167.70
	30	48	15.00	4.00	195	5.85	111.15	0.00	117.00	167.70
	30	48	15.00	2.00	390	11.70	222.30	0.00	234.00	335.40
	30	30	15.00	12.00	1800	54.00	1026.00	0.00	1080.00	1548.00
	24	30	15.00	1.00	135	4.05	76.95	0.00	81.00	116.10
Total					10450	$ 313.50	$ 5,956.50	$ -	$ 6,270.00	$ 8,987.00

Reinforcement Bars - Columns - 03 21 10.60 (0250)										
Level	b	h	Level Height	# of Columns	Tons	Material	Labor	Equipment	Total	Total Including O&P
						1550	620.00	0	2170	2725
Lower Level 1	24	24	15.00	1.00	0.063	97.00	38.80	0.00	135.80	170.53
	24	48	15.00	1.00	0.141	218.25	87.30	0.00	305.55	383.69
	24	40	15.00	2.00	0.100	155.20	62.08	0.00	217.28	272.85
	40	30	15.00	1.00	0.091	141.46	56.58	0.00	198.04	248.69
	24	24	15.00	2.00	0.053	82.83	33.13	0.00	115.96	145.62
	24	36	15.00	4.00	0.078	121.25	48.50	0.00	169.75	213.16
	24	24	15.00	3.00	0.053	82.83	33.13	0.00	115.96	145.62
	42	42	15.00	2.00	0.110	169.75	67.90	0.00	237.65	298.43
	30	48	15.00	4.00	0.102	157.62	63.05	0.00	220.67	277.11
	30	48	15.00	2.00	0.102	157.62	63.05	0.00	220.67	277.11
	30	48	15.00	12.00	0.102	157.62	63.05	0.00	220.67	277.11
	24	48	15.00	1.00	0.094	145.50	58.20	0.00	203.70	255.80
	24	48	15.00	6.00	0.094	145.50	58.20	0.00	203.70	255.80
Lower Level 2	24	24	15.00	1.00	0.063	97.00	38.80	0.00	135.80	170.53
	24	48	15.00	1.00	0.141	218.25	87.30	0.00	305.55	383.69
	24	40	15.00	2.00	0.100	155.20	62.08	0.00	217.28	272.85
	40	30	15.00	1.00	0.091	141.46	56.58	0.00	198.04	248.69
	24	24	15.00	2.00	0.053	82.83	33.13	0.00	115.96	145.62
	24	36	15.00	4.00	0.078	121.25	48.50	0.00	169.75	213.16
	24	24	15.00	3.00	0.053	82.83	33.13	0.00	115.96	145.62
	42	42	15.00	2.00	0.110	169.75	67.90	0.00	237.65	298.43
	30	48	15.00	4.00	0.102	157.62	63.05	0.00	220.67	277.11
	30	48	15.00	2.00	0.102	157.62	63.05	0.00	220.67	277.11
	30	30	15.00	12.00	0.078	121.25	48.50	0.00	169.75	213.16
	24	30	15.00	1.00	0.070	109.12	43.65	0.00	152.77	191.85
Total					2	$ 3,446.61	$ 1,378.65	$ -	$ 4,825.26	$ 7,574.21

Mat Foundation Estimate

Cast in Place Mat Foundation - 03 30 53.40 (4050)							
Mat Thickness (ft)	Area (ft^2)	C.Y.	Material	Labor	Equipment	Total	Total Including O&P
			218	76	0.46	294.46	360
4.50	16120.00	2687	585693.3	204186.7	1235.9	791115.9	967200.0
5.50	3720.00	758	165195.6	57591.1	348.58	223135.24	272800.00
6.50	4960.00	1194	260308.1	90749.6	549.27	351607.05	429866.67
4.75	2480.00	436	95112.6	33158.5	200.70	128471.81	157066.67
3.00	6200.00	689	150177.8	52355.6	316.89	202850.22	248000.00
Total		5764	$ 1,256,487.41	$ 438,041.48	$ 2,651.30	$ 1,697,180.19	$ 2,178,680.00

Finishing Mat Top - 03 35 29.30 (0250)							
Mat Thickness (ft)	Area (ft^2)	S.F.	Material	Labor	Equipment	Total	Total Including O&P
			0.03	0.50	0.02	0.52	0.78
4.50	16120.00	16120.00	483.60	8060.00	322.40	8382.4	12573.6
5.50	3720.00	3720.00	111.60	1860.00	74.40	1934.40	2901.60
6.50	4960.00	4960.00	148.80	2480.00	99.20	2579.20	3868.80
4.75	2480.00	2480.00	74.40	1240.00	49.60	1289.60	1934.40
3.00	6200.00	6200.00	186.00	3100.00	124.00	3224.00	4836.00
Total		33480	$ 1,004.40	$ 16,740.00	$ 669.60	$ 17,409.60	$ 26,114.40

Reinforcing Bars - Mat - 03 21 10.60 (0400)						
Location	Tons	Material	Labor	Equipment	Total	Total Including O&P
		1650.00	490.00	0.00	2140.00	2600.00
Top E - W	66.13	109121.5	32405.8	0.0	141527.3	171949.1
Top N - S	158.72	261891.6	77773.88	0.00	339665.51	412677.72
Bot N-S	200.88	331447.0	98429.71	0.00	429876.67	522280.07
Bot E - W	143.48	236747.8	70306.93	0.00	307054.76	373057.19
Total	569.22	$ 939,207.94	$ 278,916.30	$ -	$ 1,218,124.24	$ 1,849,955.04

Total Steel Structure Cost

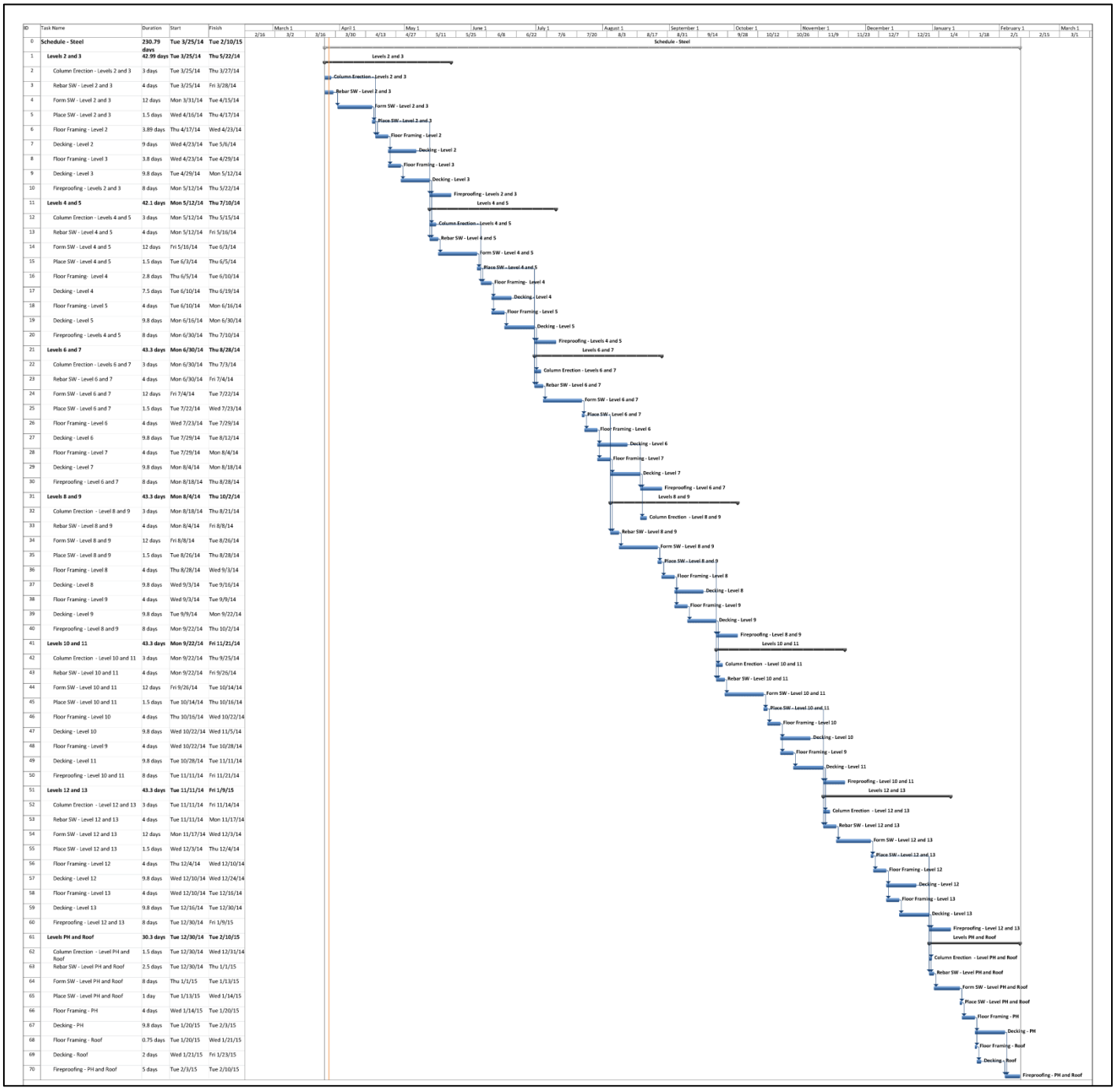
Total Steel Structure Cost (Based on 2009 RS Means)		
Item	Cost	% Total Cost
Concrete on Metal Deck	$ 3,049,983.64	12.01%
Structural Steel Framing	$ 9,052,267.61	35.65%
Shear Walls	$ 4,309,712.97	16.97%
Foundation Walls	$ 1,929,048.98	7.60%
Lower Level Concrete Slabs	$ 2,796,418.47	11.01%
Lower Level Concrete Columns	$ 198,415.62	0.78%
Mat Foundation	$ 4,054,749.44	15.97%
Total Cost	$ 25,390,596.74	100.00%

Location Modifier	105.1	1.051
Time Multiplier		1.13

Final Modified Total Cost	$ 30,072,276.51
Per SF	$ 65.05

Time Multiplier Calculation	
BCI 2009 =	4757.40
FEB BCI 2014 =	5321.27
BCI 2014/BCI 2009 =	1.12
3% Inflation to April 2014 =	1.0075
Time Multiplier =	1.13

Appendix M – Schedule Analysis Information



ID	Task Name	Duration	Start	Finish
0	**Schedule - Steel**	**230.79 days**	**Tue 3/25/14**	**Tue 2/10/15**
1	**Levels 2 and 3**	**42.99 days**	**Tue 3/25/14**	**Thu 5/22/14**
2	Column Erection - Levels 2 and 3	3 days	Tue 3/25/14	Thu 3/27/14
3	Rebar SW - Level 2 and 3	4 days	Tue 3/25/14	Fri 3/28/14
4	Form SW - Level 2 and 3	12 days	Mon 3/31/14	Tue 4/15/14
5	Place SW - Level 2 and 3	1.5 days	Wed 4/16/14	Thu 4/17/14
6	Floor Framing - Level 2	3.89 days	Thu 4/17/14	Wed 4/23/14
7	Decking - Level 2	9 days	Wed 4/23/14	Tue 5/6/14
8	Floor Framing - Level 3	3.8 days	Wed 4/23/14	Tue 4/29/14
9	Decking - Level 3	9.8 days	Tue 4/29/14	Mon 5/12/14
10	Fireproofing - Levels 2 and 3	8 days	Mon 5/12/14	Thu 5/22/14
11	**Levels 4 and 5**	**42.1 days**	**Mon 5/12/14**	**Thu 7/10/14**
12	Column Erection - Levels 4 and 5	3 days	Mon 5/12/14	Thu 5/15/14
13	Rebar SW - Level 4 and 5	4 days	Mon 5/12/14	Fri 5/16/14
14	Form SW - Level 4 and 5	12 days	Fri 5/16/14	Tue 6/3/14
15	Place SW - Level 4 and 5	1.5 days	Tue 6/3/14	Thu 6/5/14
16	Floor Framing- Level 4	2.8 days	Thu 6/5/14	Tue 6/10/14
17	Decking - Level 4	7.5 days	Tue 6/10/14	Thu 6/19/14
18	Floor Framing - Level 5	4 days	Tue 6/10/14	Mon 6/16/14
19	Decking - Level 5	9.8 days	Mon 6/16/14	Mon 6/30/14
20	Fireproofing - Levels 4 and 5	8 days	Mon 6/30/14	Thu 7/10/14
21	**Levels 6 and 7**	**43.3 days**	**Mon 6/30/14**	**Thu 8/28/14**
22	Column Erection - Levels 6 and 7	3 days	Mon 6/30/14	Thu 7/3/14
23	Rebar SW - Level 6 and 7	4 days	Mon 6/30/14	Fri 7/4/14
24	Form SW - Level 6 and 7	12 days	Fri 7/4/14	Tue 7/22/14
25	Place SW - Level 6 and 7	1.5 days	Tue 7/22/14	Wed 7/23/14
26	Floor Framing - Level 6	4 days	Wed 7/23/14	Tue 7/29/14
27	Decking - Level 6	9.8 days	Tue 7/29/14	Tue 8/12/14
28	Floor Framing - Level 7	4 days	Tue 7/29/14	Mon 8/4/14
29	Decking - Level 7	9.8 days	Mon 8/4/14	Mon 8/18/14
30	Fireproofing - Level 6 and 7	8 days	Mon 8/18/14	Thu 8/28/14
31	**Levels 8 and 9**	**43.3 days**	**Mon 8/4/14**	**Thu 10/2/14**
32	Column Erection - Level 8 and 9	3 days	Mon 8/18/14	Thu 8/21/14
33	Rebar SW - Level 8 and 9	4 days	Mon 8/4/14	Fri 8/8/14
34	Form SW - Level 8 and 9	12 days	Fri 8/8/14	Tue 8/26/14
35	Place SW - Level 8 and 9	1.5 days	Tue 8/26/14	Thu 8/28/14
36	Floor Framing - Level 8	4 days	Thu 8/28/14	Wed 9/3/14
37	Decking - Level 8	9.8 days	Wed 9/3/14	Tue 9/16/14
38	Floor Framing - Level 9	4 days	Wed 9/3/14	Tue 9/9/14
39	Decking - Level 9	9.8 days	Tue 9/9/14	Mon 9/22/14
40	Fireproofing - Level 8 and 9	8 days	Mon 9/22/14	Thu 10/2/14
41	**Levels 10 and 11**	**43.3 days**	**Mon 9/22/14**	**Fri 11/21/14**
42	Column Erection - Level 10 and 11	3 days	Mon 9/22/14	Thu 9/25/14
43	Rebar SW - Level 10 and 11	4 days	Mon 9/22/14	Fri 9/25/14
44	Form SW - Level 10 and 11	12 days	Fri 9/26/14	Tue 10/14/14
45	Place SW - Level 10 and 11	1.5 days	Tue 10/14/14	Thu 10/16/14
46	Floor Framing - Level 10	4 days	Thu 10/16/14	Wed 10/22/14
47	Decking - Level 10	9.8 days	Wed 10/22/14	Wed 11/5/14
48	Floor Framing - Level 9	4 days	Wed 10/22/14	Tue 10/28/14
49	Decking - Level 11	9.8 days	Tue 10/28/14	Tue 11/11/14
50	Fireproofing - Level 10 and 11	8 days	Tue 11/11/14	Fri 11/21/14
51	**Levels 12 and 13**	**43.3 days**	**Tue 11/11/14**	**Fri 1/9/15**
52	Column Erection - Level 12 and 13	3 days	Tue 11/11/14	Fri 11/14/14
53	Rebar SW - Level 12 and 13	4 days	Tue 11/11/14	Mon 11/17/14
54	Form SW - Level 12 and 13	12 days	Mon 11/17/14	Wed 12/3/14
55	Place SW - Level 12 and 13	1.5 days	Wed 12/3/14	Thu 12/4/14
56	Floor Framing - Level 12	4 days	Thu 12/4/14	Wed 12/10/14
57	Decking - Level 12	9.8 days	Wed 12/10/14	Wed 12/24/14
58	Floor Framing - Level 13	4 days	Wed 12/10/14	Tue 12/16/14
59	Decking - Level 13	9.8 days	Tue 12/16/14	Tue 12/30/14
60	Fireproofing - Level 12 and 13	8 days	Tue 12/30/14	Fri 1/9/15
61	**Levels PH and Roof**	**30.3 days**	**Tue 12/30/14**	**Tue 2/10/15**
62	Column Erection - Level PH and Roof	1.5 days	Tue 12/30/14	Wed 12/31/14
63	Rebar SW - Level PH and Roof	2.5 days	Tue 12/30/14	Thu 1/1/15
64	Form SW - Level PH and Roof	8 days	Thu 1/1/15	Tue 1/13/15
65	Place SW - Level PH and Roof	1 day	Tue 1/13/15	Wed 1/14/15
66	Floor Framing - PH	4 days	Wed 1/14/15	Tue 1/20/15
67	Decking - PH	9.8 days	Tue 1/20/15	Tue 2/3/15
68	Floor Framing - Roof	0.75 days	Tue 1/20/15	Wed 1/21/15
69	Decking - Roof	2 days	Wed 1/21/15	Fri 1/23/15
70	Fireproofing - PH and Roof	5 days	Tue 2/3/15	Tue 2/10/15

Crew Information – RS Means

Crew Types								
	Foreman	Steel Worker	Welder	Laborers	Cement Finisher	Equip Operator	Carpenter	Rodmen
E-4	1	3	1					
C-20	1			5	1	1		
C-10C				1	2			
C-8	1			3	2	1		
E-6	3	9	1			3		
C-2	1			1			4	
C-6	1			4	1			
1 Cefi					1			
4 Rodm								
C-1				1			3	
C-14C	1			4	1		6	2

Note: *In the duration calculations to follow, the number of crews utilized for each task has been embedded in the daily output values.*

Concrete on Metal Deck Duration Calculations

Steel Deck - 05 31 13.50 (5200)			
Level	SF	Crew	Daily Output
			15440
2nd	26494	E-4	1.72
3rd	29703	E-4	1.92
4th	29703	E-4	2
5th	29703	E-4	2
6th	29703	E-4	2
7th	29703	E-4	2
8th	29703	E-4	2
9th	29703	E-4	2
10th	29703	E-4	2
11th	29703	E-4	2
12th	29703	E-4	2
13th	29703	E-4	2
PH	29703	E-4	2
PH Roof	6704	E-4	0
Total	389634		25

Placing Concrete - 03 31 05.70 (1400)			
Level	CY	Crew	Daily Output
			560
2nd	367.97	C-20	1
3rd	412.54	C-20	1
4th	412.54	C-20	1
5th	412.54	C-20	1
6th	412.54	C-20	1
7th	412.54	C-20	1
8th	412.54	C-20	1
9th	412.54	C-20	1
10th	412.54	C-20	1
11th	412.54	C-20	1
12th	412.54	C-20	1
13th	412.54	C-20	1
PH	412.54	C-20	1
PH Roof	93.11	C-20	0
Total	5412		10

Finishing Concrete - 03 35 29.30 (0250)			
Level	SF	Crew	Daily Output
			6860
2nd	26494	C-10C	4
3rd	29703	C-10C	4
4th	29703	C-10C	4
5th	29703	C-10C	4
6th	29703	C-10C	4
7th	29703	C-10C	4
8th	29703	C-10C	4
9th	29703	C-10C	4
10th	29703	C-10C	4
11th	29703	C-10C	4
12th	29703	C-10C	4
13th	29703	C-10C	4
PH	29703	C-10C	4
PH Roof	6704	C-10C	1
Total	389634		57

Concrete Topping - 03 30 53.40 (3300)			
Level	SF	Crew	Daily Output
			10340
2nd	26494.00	C-8	3
3rd	29703.00	C-8	3
4th	29703.00	C-8	3
5th	29703.00	C-8	3
6th	29703.00	C-8	3
7th	29703.00	C-8	3
8th	29703.00	C-8	3
9th	29703.00	C-8	3
10th	29703.00	C-8	3
11th	29703.00	C-8	3
12th	29703.00	C-8	3
13th	29703.00	C-8	3
PH	29703.00	C-8	3
PH Roof	6704.00	C-8	1
Total	389634		38

Structural Steel Framing Duration Calculations

GRAVITY SYSTEM DURATIONS						
Structural Steel Columns 05 12 23.77 (0900 - Offices 7-15 Stories)						
Member Size	#	Length	Lbs	Tons	Crew	Daily Output
						28.4
W10X33	7	126.7	4186	2.09	E-6	0.07
W10X39	2	52.7	2061	1.03	E-6	0.04
W12X40	13	283.9	11302	5.65	E-6	0.20
W14X43	13	308.9	13242	6.62	E-6	0.23
W10X49	4	101.3	4966	2.48	E-6	0.09
W12X50	2	52.7	2617	1.31	E-6	0.05
W12X53	4	105.4	5593	2.80	E-6	0.10
W14X53	2	52.7	2796	1.40	E-6	0.05
W12X58	2	52.7	3047	1.52	E-6	0.05
W10X60	2	52.7	3155	1.58	E-6	0.06
W14X61	7	184.4	11231	5.62	E-6	0.20
W12X65	3	79	5136	2.57	E-6	0.09
W10X68	2	52.7	3585	1.79	E-6	0.06
W14X68	3	79	5378	2.69	E-6	0.09
W12X72	4	105.4	7565	3.78	E-6	0.13
W12X79	3	79	6238	3.12	E-6	0.11
W14X82	1	26.3	2151	1.08	E-6	0.04
W10X88	2	56.3	4965	2.48	E-6	0.09
W14X90	12	316.1	28502	14.25	E-6	0.50
W12X96	5	133.5	12813	6.41	E-6	0.23
W12X106	2	54.5	5787	2.89	E-6	0.10
W14X109	6	158	17209	8.60	E-6	0.30
W12X120	4	107.2	12875	6.44	E-6	0.23
W14X120	2	52.7	6328	3.16	E-6	0.11
W14X132	4	107.2	14152	7.08	E-6	0.25
W12X136	3	84.5	11474	5.74	E-6	0.20
W14X145	4	109	15840	7.92	E-6	0.28
W12X152	1	26.3	4006	2.00	E-6	0.07
W14X159	3	79	12557	6.28	E-6	0.22
W14X176	4	112.7	19861	9.93	E-6	0.35
W12X190	1	26.3	5001	2.50	E-6	0.09
W14X193	2	56.3	10889	5.44	E-6	0.19
W12X230	1	26.3	6068	3.03	E-6	0.11
W12X279	1	28.2	7851	3.93	E-6	0.14
Total				145		5

Structural Steel - Beams and Girders 05 12 23.77 (0900 - Offices 7-15 Stories)						
Member	#	Length	Lbs	Tons	Crew	Daily Output
						28.4
W8X10	160	182.36	1837	0.92	E-6	0.03
W12X14	331	6330.74	89615	44.81	E-6	1.58
W12X16	12	330.46	5296	2.65	E-6	0.09
W12X19	10	241.33	4574	2.29	E-6	0.08
W14X22	21	619.67	13685	6.84	E-6	0.24
W16X26	263	7034.51	183835	91.92	E-6	3.24
W16X31	55	1703.5	52923	26.46	E-6	0.93
W18X35	131	3749.15	131403	65.70	E-6	2.31
W18X46	2	82.33	3782	1.89	E-6	0.07
W21X44	824	33862.55	1497948	748.97	E-6	26.37
W21X50	95	2850	142559	71.28	E-6	2.51
W24X55	19	568.25	31325	15.66	E-6	0.55
W24X62	60	1772.6	109778	54.89	E-6	1.93
W24X68	34	663.5	45381	22.69	E-6	0.80
W24X76	14	450	34300	17.15	E-6	0.60
W27X84	56	2040.33	172181	86.09	E-6	3.03
Total				1260		44

SPECIAL MOMENT FRAME DURATIONS			
Structural Steel Columns 05 12 23.77 (0900 - Offices 7-15 Stories)			
Member Size	Tons	Crew	Daily Output
			28.4
W14X233	10.14	E-6	0.36
W14X283	4.11	E-6	0.14
W14X311	16.38	E-6	0.58
W14X342	36.21	E-6	1.27
W14X370	190.68	E-6	6.71
W14X398	23.59	E-6	0.83
W14X455	6.42	E-6	0.23
W14X500	79.97	E-6	2.82
W14X550	59.09	E-6	2.08
Total	426.59		15

Structural Steel - Beams and Girders 05 12 23.77 (0900 - Offices 7-15 Stories)			
Member	Tons	Crew	Daily Output
			28.4
W14X145	60.81	E-6	2.14
W16X77	6.92	E-6	0.24
W24X131	5.90	E-6	0.21
W24X146	15.36	E-6	0.54
W24X162	4.87	E-6	0.17
W24X176	13.19	E-6	0.46
W24X192	20.12	E-6	0.71
W24X207	34.08	E-6	1.20
W24X229	75.46	E-6	2.66
W24X250	48.77	E-6	1.72
Total	285.47		10

Shear Wall Duration Calculations

Formwork - Concrete Shear Walls 03 11 13.85 (2400 - Job built plywood, over 8 to 16 feet high)				
Level	Wall Height	S.F.C.A	Crew	Daily Output
				1120
PH Roof	24.33	1533	C-2	1.4
PH	14.50	8657	C-2	7.73
13	13.17	7880	C-2	7.04
12	13.17	7880	C-2	7.04
11	13.17	7880	C-2	7.04
10	13.17	7880	C-2	7.04
9	13.17	7880	C-2	7.04
8	13.17	7880	C-2	7.04
7	13.17	7880	C-2	7.04
6	13.17	7880	C-2	7.04
5	13.17	7880	C-2	7.04
4	13.17	7880	C-2	7.04
3	13.17	7880	C-2	7.04
2	15.00	8980	C-2	8.02
Total		105851		95

Placing Structural Concrete Shear Walls - 03 31 05.70 (5300)				
Level	Wall Height	C.Y.	Crew	Daily Output
				420
PH Roof	24.33	38	C-6	0.1
PH	14.50	223	C-6	0.53
13	13.17	293	C-6	0.70
12	13.17	293	C-6	0.70
11	13.17	293	C-6	0.70
10	13.17	293	C-6	0.70
9	13.17	293	C-6	0.70
8	13.17	293	C-6	0.70
7	13.17	293	C-6	0.70
6	13.17	293	C-6	0.70
5	13.17	293	C-6	0.70
4	13.17	293	C-6	0.70
3	13.17	293	C-6	0.70
2	15.00	358	C-6	0.85
Ground	15.00	358	C-6	0.85
LL1	15.00	358	C-6	0.85
Total		4554		11

Finishing Concrete Shear Walls 03 35 29.60 (0020)				
Level	Wall Height	S.F.	Crew	Daily Output
				3240
PH Roof	24.33	1460	1 Cefi	0.5
PH	14.50	8613	1 Cefi	2.66
13	13.17	7823	1 Cefi	2.41
12	13.17	7823	1 Cefi	2.41
11	13.17	7823	1 Cefi	2.41
10	13.17	7823	1 Cefi	2.41
9	13.17	7823	1 Cefi	2.41
8	13.17	7823	1 Cefi	2.41
7	13.17	7823	1 Cefi	2.41
6	13.17	7823	1 Cefi	2.41
5	13.17	7823	1 Cefi	2.41
4	13.17	7823	1 Cefi	2.41
3	13.17	7823	1 Cefi	2.41
2	15.00	8910	1 Cefi	2.75
Ground	15.00	8910	1 Cefi	2.75
LL1	15.00	8910	1 Cefi	2.75
Total		122856		38

Reinforcing Bars - Shear Walls 03 21 10.60 (0750)			
Rebar	Tons	Crew	Daily Output
			12
Vertical End Bars	267	4 Rodm	22.2
Vertical Wall	88	4 Rodm	7.3
Horizontal Wall	36	4 Rodm	3.0
Total	391		33