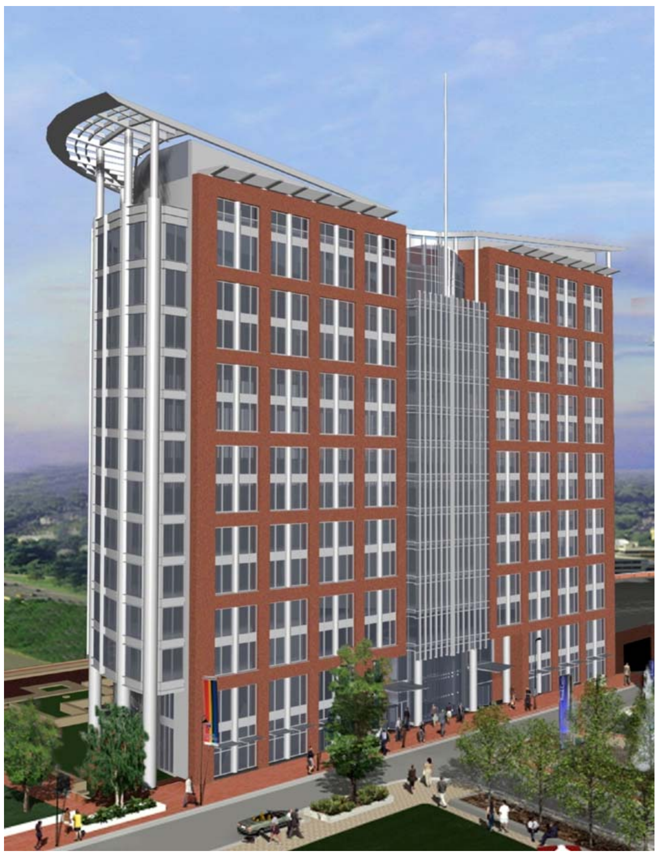
Benjamin M. Douglass
AE 482 Structural Option Thesis under Dr. T. Boothby
April 13, 2007

TOWERS CRESCENT BUILDING F



CHANTILLY, VA

FLOOR, LATERAL SYSTEM, AND FOUNDATION OPTIMIZATION

TOWERS CRESCENT F

CHANTILLY, VA

BENJAMIN DOUGLASS
STRUCTURAL OPTION

PROJECT OVERVIEW

- Towers Crescent Building F
- Chantilly, VA
- Office tower and parking
- 13 stories above grade
- 339,063 sq. ft.
- Under construction January 2007 to June 2009

PROJECT TEAM

Owner: Quadrangle Development Corp.

Architect: SmithGroup

Structural Engineer: SK&A

MEP Engineer: GHT Ltd.

Civil Engineer: VIKA

Landscape: Sasaki

Specifications: Heller and Metzger

Construction Management: Hensel Phelps

ARCHITECTURAL FEATURES

Semicircular tower on top of subterranean parking

Open plan except for core and structural columns

Mixture of glass, aluminum, and brick veneer

Large glass face above front entrance

Steel architectural ornament and spire at roof

STRUCTURAL SYSTEMS

30” to 60” diameter caissons

30' x 30' grid of concrete columns

Radial series of concrete columns along semicircular face

8” flat structural concrete slab

Concrete shear walls to resist lateral load

LIGHTING/ELECTRICAL SYSTEMS

(2) 4000A busways, 460 V, 3-phase, 4-wire

(2) 400A fusible taps per floor

120V and 265V emergency lights

120V and 277V architectural lights, fluorescent and HID

MECHANICAL SYSTEMS

Two rooftop mechanical units, 26,300 CFM each

Air supplied through ducts and 150-900 CFM VAV boxes

Separate air handling unit for elevators

Table of Contents

Executive Summary

Towers Crescent Building F is a 199' speculative office building containing 6 levels of parking and 13 floors of offices. The foundation is composed of caissons. The gravity system is a reinforced concrete flat slab with drop panels framing into reinforced concrete columns. The lateral system is a combination of reinforced concrete shear walls, and the moment resisting frames created by the monolithically cast columns and slab. The slab acts as a rigid diaphragm and distributes lateral load to the lateral load resisting elements according to stiffness.

In this thesis, the floor system has been redesigned as a one way post-tensioned slab with supporting edge beams. This was done in hopes of reducing material costs and contributing to lateral stiffness. Next, since the calculations in technical report 3 showed the lateral system to be inadequate to carry the design loads, seismic loads have been reduced through more rigorous analysis procedures and the stiffness of the lateral system has been more accurately determined. These analyses required construction of a 3-dimensional model. I have added tie beams to improve the performance of the shear walls, and investigated the possibility of making reductions in shear wall thickness. Next, since the addition of post-tensioning to the floor slab significantly reduced the building's weight, I have investigated the possibility of reducing the size of columns and foundation elements.

Results are mixed. By the addition of post-tensioning to the slab, I was able to reduce its thickness from 8" to 6", and thus achieve savings on materials. However, these savings would be offset by additional costs in time and labor. Furthermore, I was not able to reduce the floor to floor height, which is the greatest potential benefit of post-tensioning. Also, the changes which I made to the floor system required small changes which would make the mechanical system slightly more costly. All things considered, I would not recommend my slab design over the current one.

On the other hand, I would recommend the addition of shear tie beams. This should make possible significant reductions in the thicknesses of the shear walls. Though I was unfortunately unable to prove this, a wind tunnel test and a more rigorous determination of building lateral stiffness would provide the requisite proof. Next, I would also recommend downsizing many column and caisson sections, even if the current 8" slab is retained.

Lastly, I have produced an architectural rendering of the elevator lobby and an architectural floor plan for a typical office floor.

Background

Towers Crescent Building F is a 199' high speculative office building with 304,880 square feet of office space on 13 floors and 368,770 square feet of parking on 6 floors. The bottom 3 levels are exclusively parking; these floors comprise the base of the structure. Three additional levels of parking rise from the base in one location and the semicircular office tower sits on top of it in another. Table 1 presents the square footage of the building at each floor, broken down by parking area, and area relevant to floor area ratio (FAR) calculations.

Description of Existing Structural System

Foundation and Slab on Grade

The building utilizes a foundation system of 50' deep, 30"-54"φ caissons. These caissons sit below each column (in one case, two caissons support one column) and below the shear walls. The slab-on-grade is 5" thick concrete at $f'_c = 3$ ksi reinforced with 6 x 6 W2.0xW2.0 W.W.F. placed 2" below the top of the slab. It is placed over a vapor barrier on top of 4" of gravel fill.

Columns

Columns are reinforced concrete, with material strengths as follows:

- Base to 4th floor - 8 ksi
- 4th floor to 8th floor - 6 ksi
- 8th floor to penthouse roof - 5 ksi

Table 1. Floor Area

Floor	Gross SF (FAR)	Gross SF (Parking)
13	23486	
12	24232	
11	24232	
10	24232	
9	24232	
8	24232	
7	24232	
6	24232	
5	24232	
4	24232	
3	24232	
2/P6	19614	23759
Mezz/P5		23759
1/P4	19460	23759
P3		99235
P2		99235
P1		99023

The parking areas are held up by a mostly regular grid of concrete columns (typically 24" x 24" with 8 #8 reinforcing bars) extending usually from the pile caps to the P-4 or P-6 level. The tower is held up by a partially radial and partially orthogonal grid of columns. A typical internal tower column on the rectangular grid runs as follows:

- Base – P4: 24"x36", 16 #10
- P4 - 4^{th} floor: 24"x30", 10 #10
- 4^{th} floor - 5^{th} floor: 24"x24", 16 #10
- 5^{th} floor - 6^{th} floor: 24"x24", 12 #11
- 6^{th} floor - roof: 24"x24", 12 #9

A typical column along the semicircular edge of the building runs as follows:

- Base – 3^{rd} floor: 30"x30", 12 #10
- 4^{th} floor - main roof: 24"x30", 10 #8

The reinforcement is spliced by overlapping bars.

Floors

The floors are 8" minimum flat structural concrete slab (f'_c = 5 ksi) reinforced by a bottom mat of #5 rebar at 12" O.C. in each direction. Where the slab is 12" or 14" thick, it is reinforced by #6 rebar at 12" O.C. in each direction. Additional reinforcement is provided as needed, almost always top reinforcement (#5 or #6) to resist the tensile stresses resulting from the negative moments, especially around the columns. Around most every column there is a 10'x10' or similarly sized drop panel extruding 8" below the lowest adjacent slab soffit.

Lateral System

There is a structural core area in the center of the tower with 4 large concrete shear walls. Table 2 describes these walls at level P5:

Table 2. Description of Shear Walls at Level P5

Along Gridline	Length	Width	Vertical Reinforcement	Horizontal Reinforcement	Addl. End Reinforcement
FG.5	29'5-1/2"	16"	#6 @ 8" O.C.	#4 @ 12" O.C.	(4) #6
FJ.2	33'8"	12"	#5 @ 8" O.C.	#4 @ 12" O.C.	(8) #8
FK.7	33'8"	12"	#5 @ 8" O.C.	#4 @ 12" O.C.	(8) #8
FL.8	30'	16"	#6 @ 8" O.C.	#4 @ 12" O.C.	(3) #6

Wall reinforcement varies throughout the height of the building. The length and width of the shear walls, by contrast, are constant over the full height. These four walls run from north to south through the building's narrow section and resist lateral loads in that direction. Six shorter shear walls, 9'-11-5/8" in length, run perpendicular to them. Three intersect wall FJ.2, and three intersect wall FK.7, therefore these walls will act together as web and flange to one beam section. In addition, since the flat floor slab is cast monolithically with the building's concrete columns, the resulting frames will have an inherent moment resisting capacity and hence contribute somewhat to the lateral stiffness of the tower. Some will brace against the shear walls.

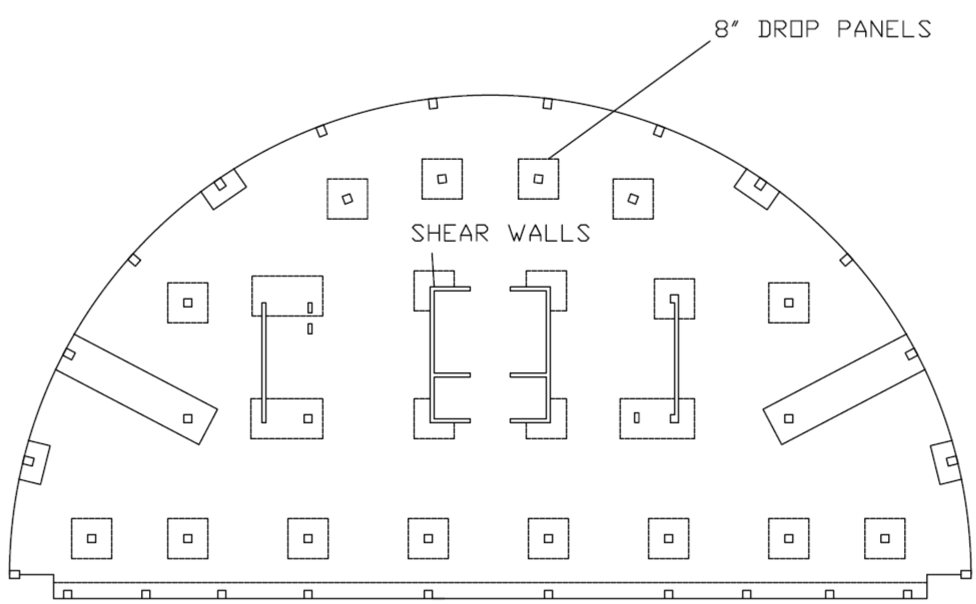
The load path for lateral loads is as follows. In the case of wind loading, the curtain wall will receive the load and distribute it to the minimum 8" thick floor slabs above and below. The slabs will then act as rigid diaphragms and thus distribute lateral load to the lateral load resisting elements according to stiffness. In the case of seismic loading, load will be distributed from all massive elements, through their structural connections with the slab, which again, will act as a rigid diaphragm.

At the base, the floor area of Towers Crescent Building F increases dramatically. At these levels the central tower area is surrounded by an additional parking structure. These areas contain additional moment resisting frames produced by the monolithic casting of the slab-beams and columns, some of which provide a small but significant resistance.

One large section of the parking structure is separated by an expansion joint. This section will rely entirely on moment resisting frames for its lateral resistance. Since it is far shorter than the tower, it is anticipated to deflect less than the central slab area under wind or seismic loads. Therefore I have assumed that, whatever structural contact would occur between them during a wind or seismic event, this section would act as a restraint against the motion of the central section. Assuming linear behavior, it could properly be modeled as a series of springs which resisted compressive but not tensile forces.

Figure 1 displays a typical floor plan for the tower, including lateral load resisting elements.

Fig. 1. Typical Tower Floor Plan



Building Codes and Design Standards

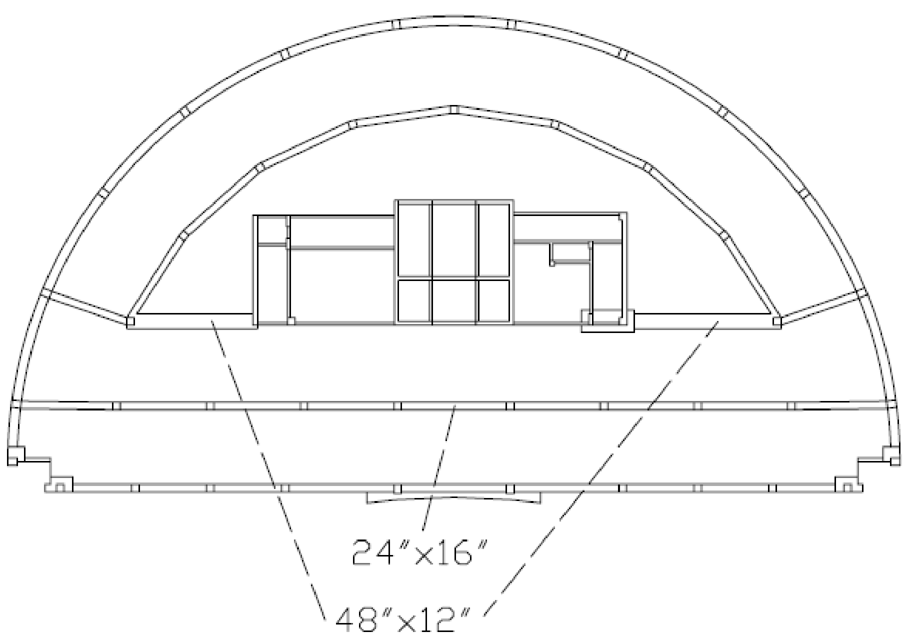
Towers Crescent Building F was designed by the 2000 USBC Virginia statewide building code, which is a variation of the IBC 2000 model code. This references the ASCE 7-98 design standard. Nevertheless, I have chosen to design by ASCE 7-02, due to my greater familiarity with it. ASCE 7 sections 6.0 and 9.0, on wind and seismic loads, respectively, are especially relevant to this assignment. Concrete structural elements would have been designed originally by the standards of ACI 318-99, but again, I will be designing based on the updated code ACI 318-05. Steel structures would have been designed either with the ASD manual of steel construction, 9th edition, or the LRFD manual of steel construction, 1st edition. I will use the LRFD 3rd edition.

Floor Slab: Post-Tensioning

Post-tensioning has been investigated as a means to reducing the thickness of the slab (from 8" to 6"), thus saving material costs and reducing the total weight of the structure. Loads on a typical office floor have been taken to be 70 psf live load and 25 psf superimposed dead load (5 for MEP, 10 for partitions, and 10 for other finishes). This is reduced from the 100 psf live load for which the slab was designed originally (this live load included partition loads, thus presumably leaving a 15 psf superimposed dead load). 100 psf live load is more conservative than necessary, especially in modern offices where computers are rendering it no longer necessary to store large quantities of heavy paper files.

Columns have been rearranged into a more regular pattern in order to facilitate the design process. This included adding one new column in the inner ring inside the North face of the building. Next, drop panels have been eliminated in favor of 24"x12" supporting edge beams. These will allow the slab to act in one-way bending, as well as having the added benefit of increasing the stiffness of the lateral frames. Finally, six columns are fitted with large capitals in areas where punching shear is critical. The new typical floor plan is pictured in figure 2. Beams which had to be increased in size over 24"x12" are noted.

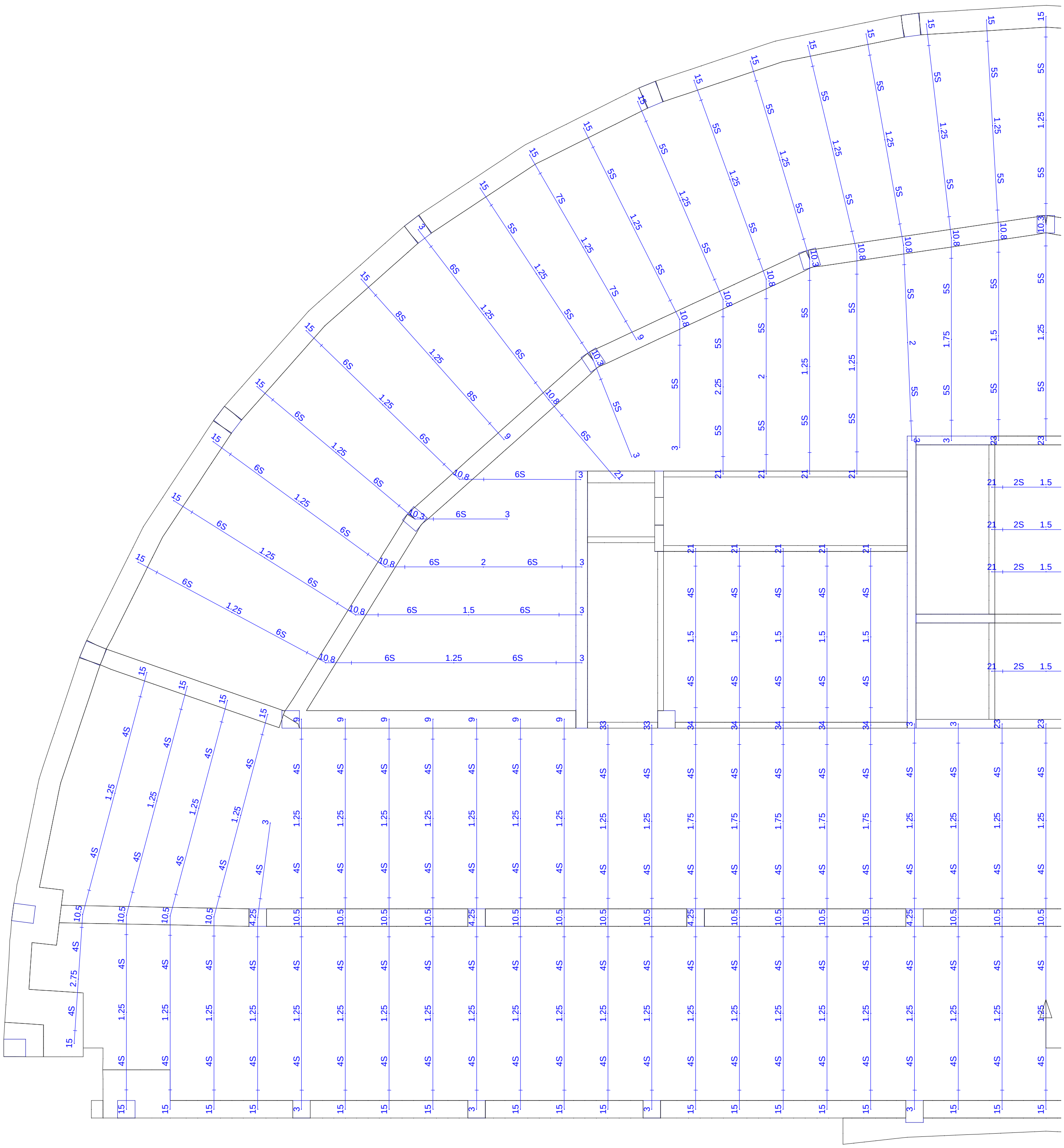
Figure 2. New Typical Tower Floor Plan.



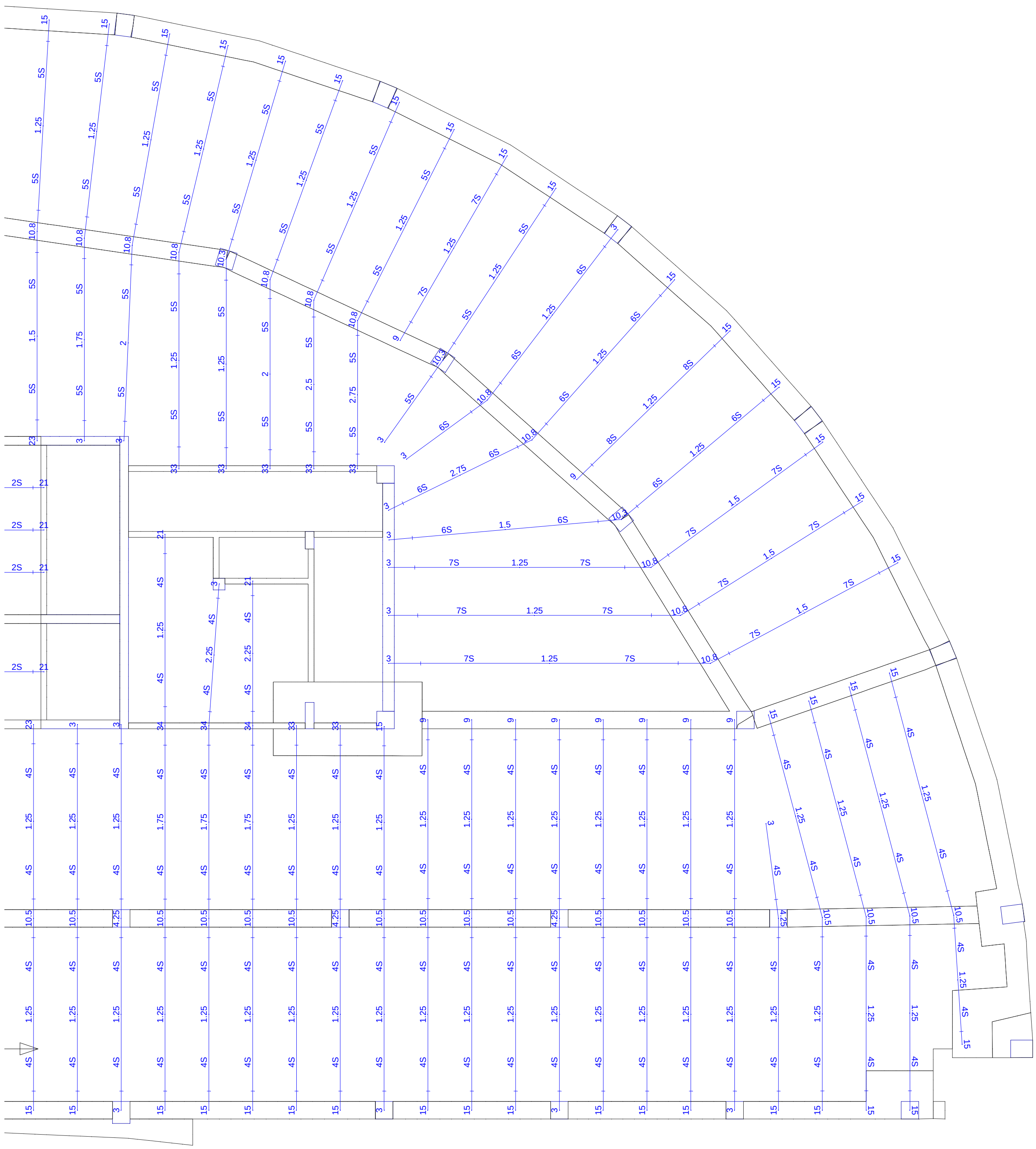
Analysis and design were performed using RAM Concept 2.0. The following pages, taken from the RAM Concept model, display the layout of longitudinal tendons in the typical slab. These balance nearly the entire self dead load of the slab. All tendons end in the center of the slab so as to avoid inducing bending stresses through eccentric loading.

Longitude Tendon: Standard Plan

Longitude Tendon: User Notes; User Lines; User Dimensions; Tendons; Num Strands; Jacks; Profile Points; Profile Values;
Drawing Import: User Notes; User Lines; User Dimensions;
Element: Wall Elements Above; Wall Elements Below; Column Elements Above; Column Elements Below; Slab Elements; Slab Element Edges;
Scale = 1:210



Longitude Tendon: Standard Plan (2)



On the following pages, I have included the design summary, which shows that the slab meets the provisions of ACI 318 at all locations, and that only two columns (at the corners) are said to fail because of punching shear. Furthermore, something is clearly wrong with RAM's conclusion that these columns will fail in punching shear. According to RAM, they fail even with a 24" deep column capital and an 18" deep drop panel. However, with only a 12" column capitol, punching shear capacity is:

$\Phi V_c = \Phi 4f'_c{}^{1/2}b_o d = 0.75*4*5000^{1/2}*(24+10.75/2+30+10.75/2)*10.75 = 148^k$

This column takes less than 100^k of factored design load at a typical floor.

Also erroneous is RAM concept's determination that the large majority of the beams employed in this structure fail. To take one beam as representative, I will examine one of the 25' long, 12"x24" beams connecting the inner ring of columns. The most heavily loaded of these members are subjected to a self dead load of:

24.33*0.075+0.15 = 1.975 klf

1.6 klf of this load is balanced by seven strands of post tensioning cable, draped at a profile of 4.75" in height at the ends and 1.75" in height at the center (both quantities measured from the bottom of the 6" slab). This will leave remaining an unbalanced design load of:

1.2(1.975+.025*24.33)+1.6(24.33*.07) – 1.6= 4.23 klf

Therefore, the maximum bending moment will be $M_u = wl^2/11 = 240.3$ ft-k. This is achievable when the member is considered as a T-beam with a 75"x6" flange and a 24"x12" web. Bottom reinforcement is (10) #7.

a = 6.0132(60)/[0.85(5)(75)] = 1.132"
ΦM_n = 0.9(6.0132)(60)(9.56 – 1.132/2)(1/12) = 243.4 ft-k > 240.3 (OK)

On the other hand, the 28' beam in the center of the horizontal row of columns 20' inside the south face of the building does indeed fail in flexural stress. Its depth must be increased to 16". Fortunately, this has no impact on the mechanical systems. Less fortunately, the 31.5' and 39' long beams which connect the shear walls to the adjacent columns also have to be upsized, and since making them deeper would adversely impact the mechanical system, I have made them wider: 48" wide.

The pages following the design summary display the rebar reinforcement layout calculated by RAM Concept.

Design Summary: Status Plan

Design Summary: User Lines; User Notes; User Dimensions; Latitude SSS Designs; Longitude SSS Designs; SSS Design Numbers; SSS Design Status; Latitude DS Designs; Longitude DS Designs; DS Design Numbers; DS Design Status; PC Designs; PC Design Numbers; PC Design Status
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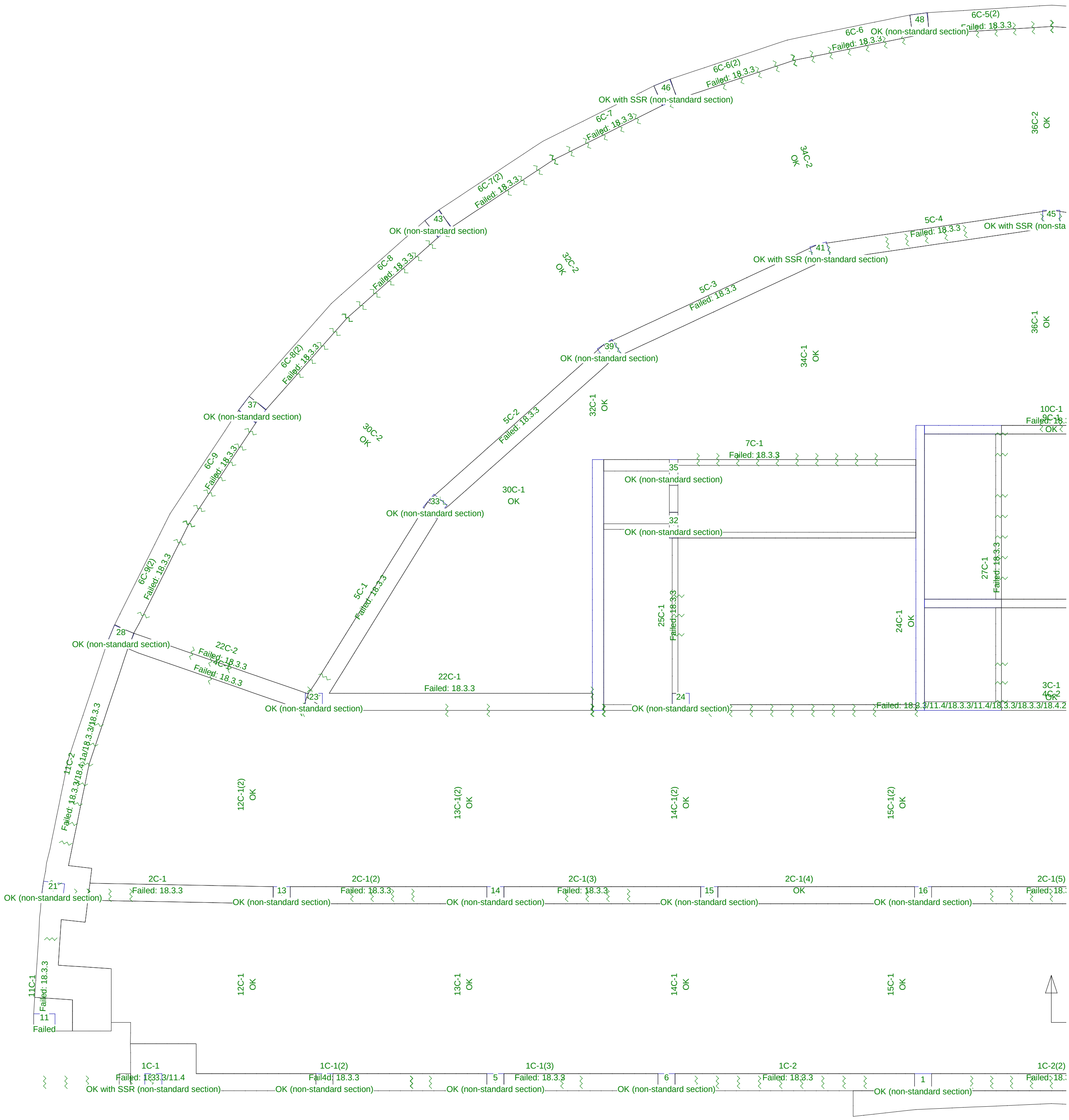
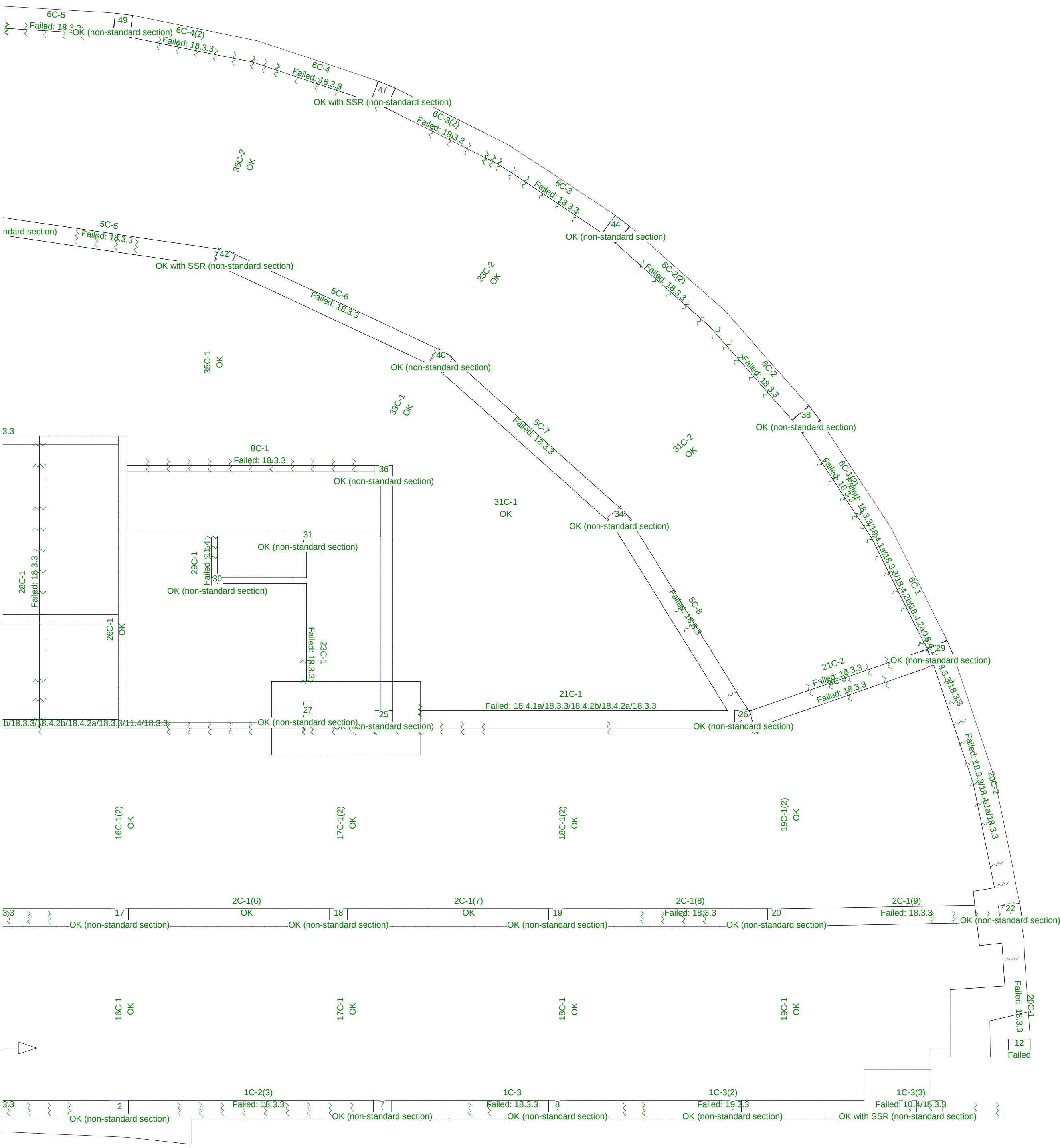
Element: Wall Elements Below; Wall Elements Above; Column Elements Below; Column Elements Above; Slab Elements; Slab Element Edges;
Scale = 1:210



Design Summary: Status Plan (2)



Design Summary: Reinforcement Plan

Design Summary: User Lines; User Notes; User Dimensions; Latitude SSS Designs; Longitude SSS Designs; SSS Design Top Bars
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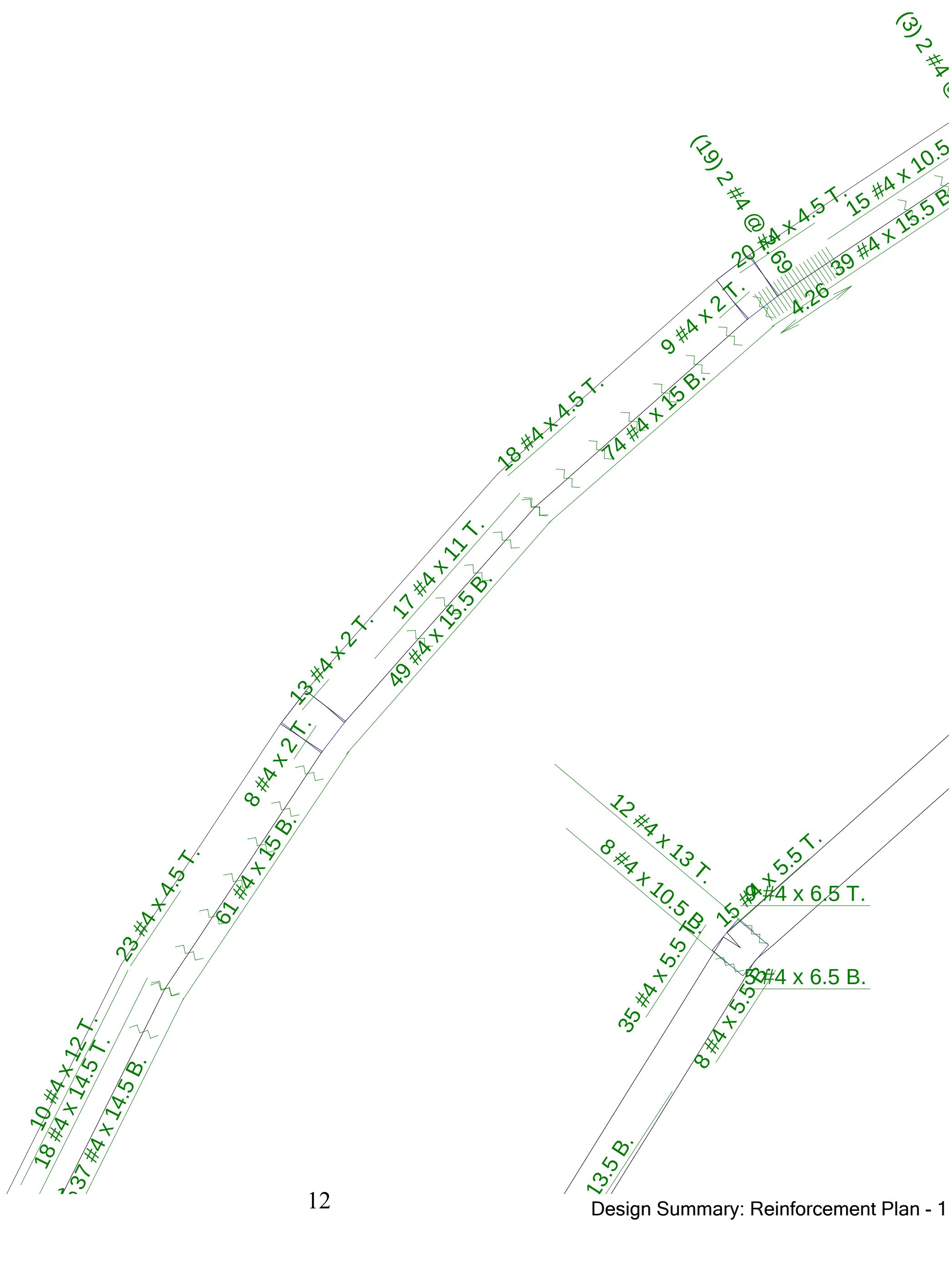
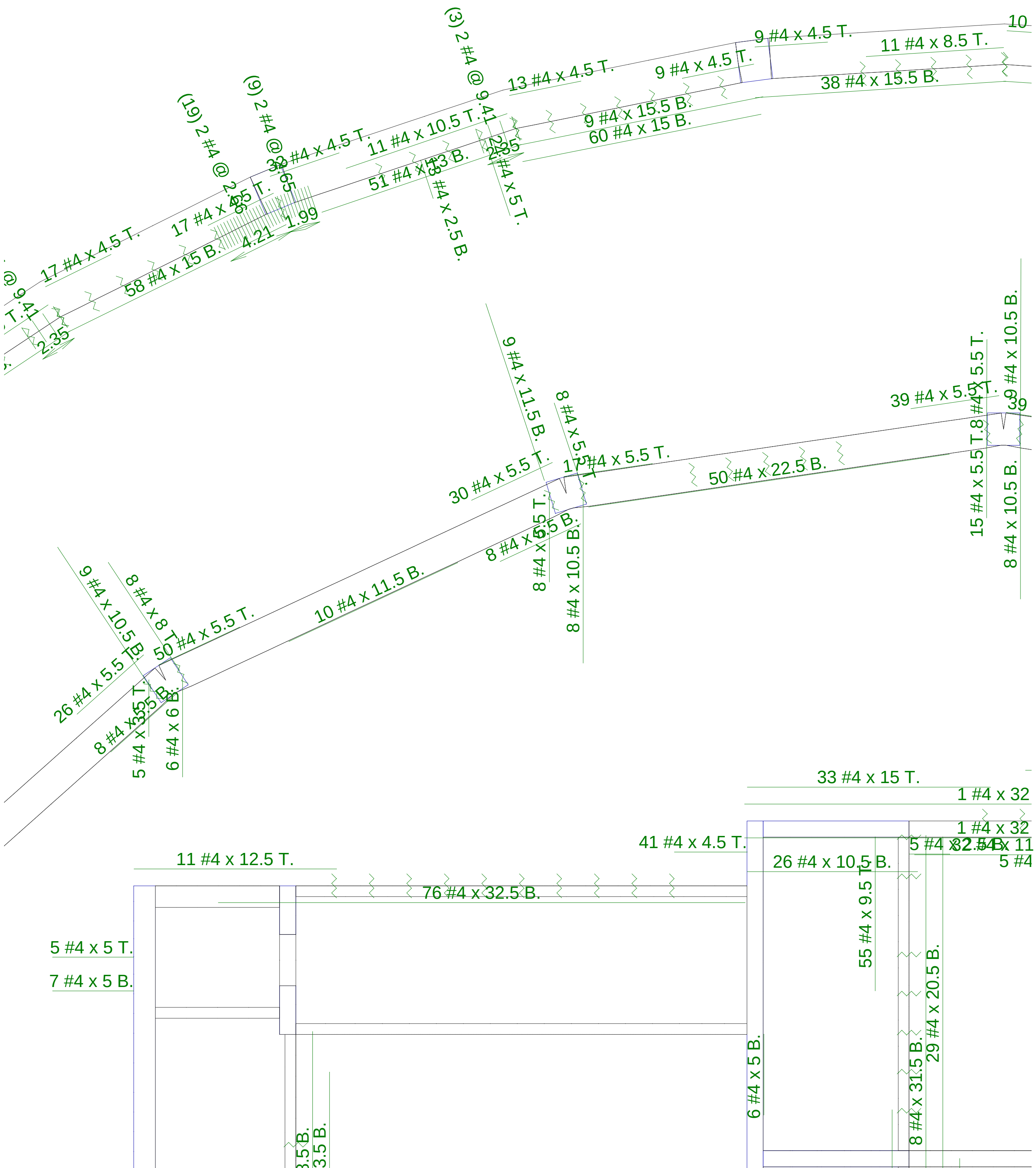
Element: Wall Elements Below; Wall Elements Above; Column Elements Below; Column Elements Above; Slab Elements; Slab Ele
Scale = 1:105



Design Summary: Reinforcement Plan (2)

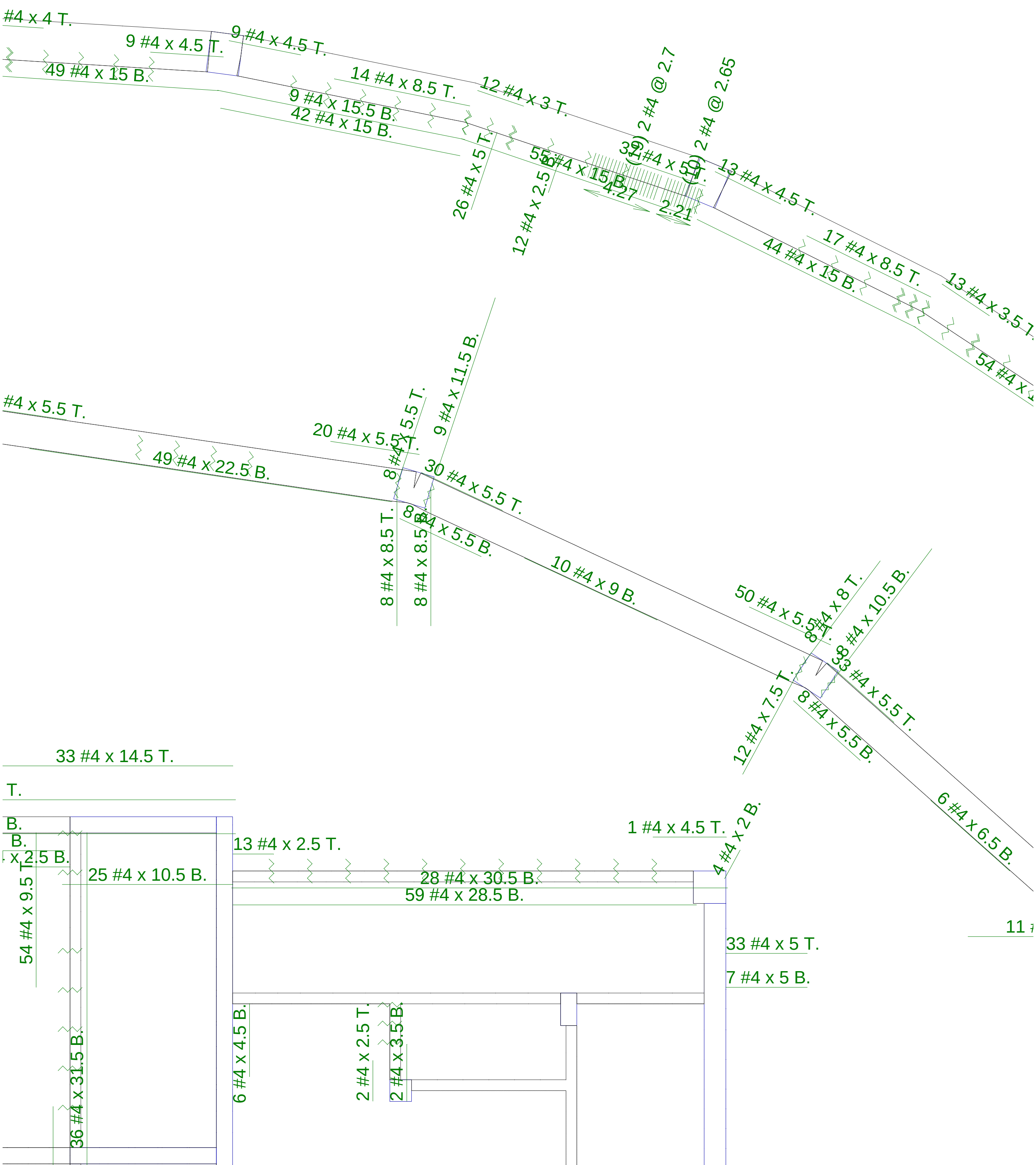
s; SSS Design Bottom Bars; SSS Design Shear Bars; SSS Design Bar Descriptions; Latitude DS Designs; Longitude DS Designs; D

ment Edges;

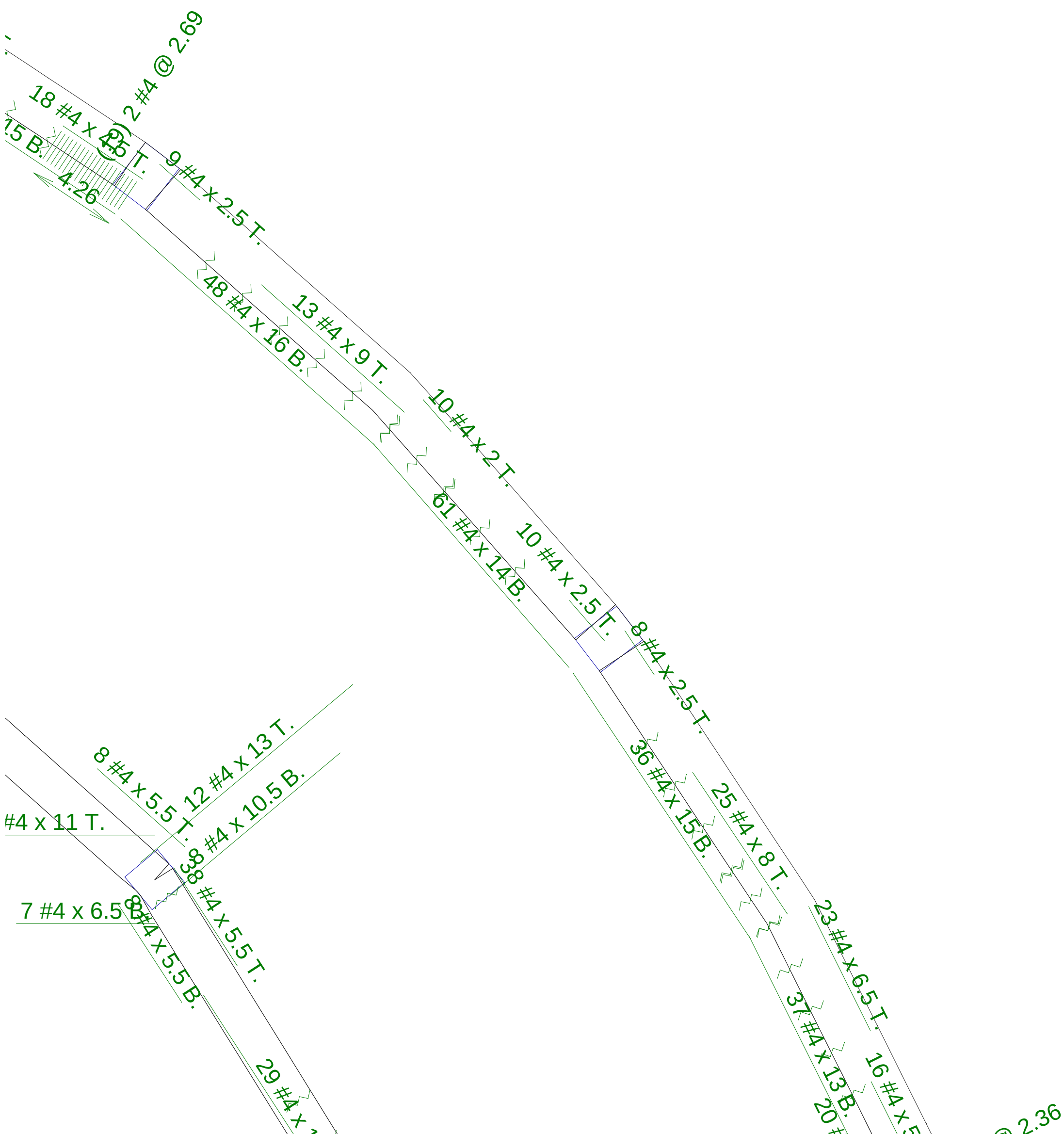


Design Summary: Reinforcement Plan (3)

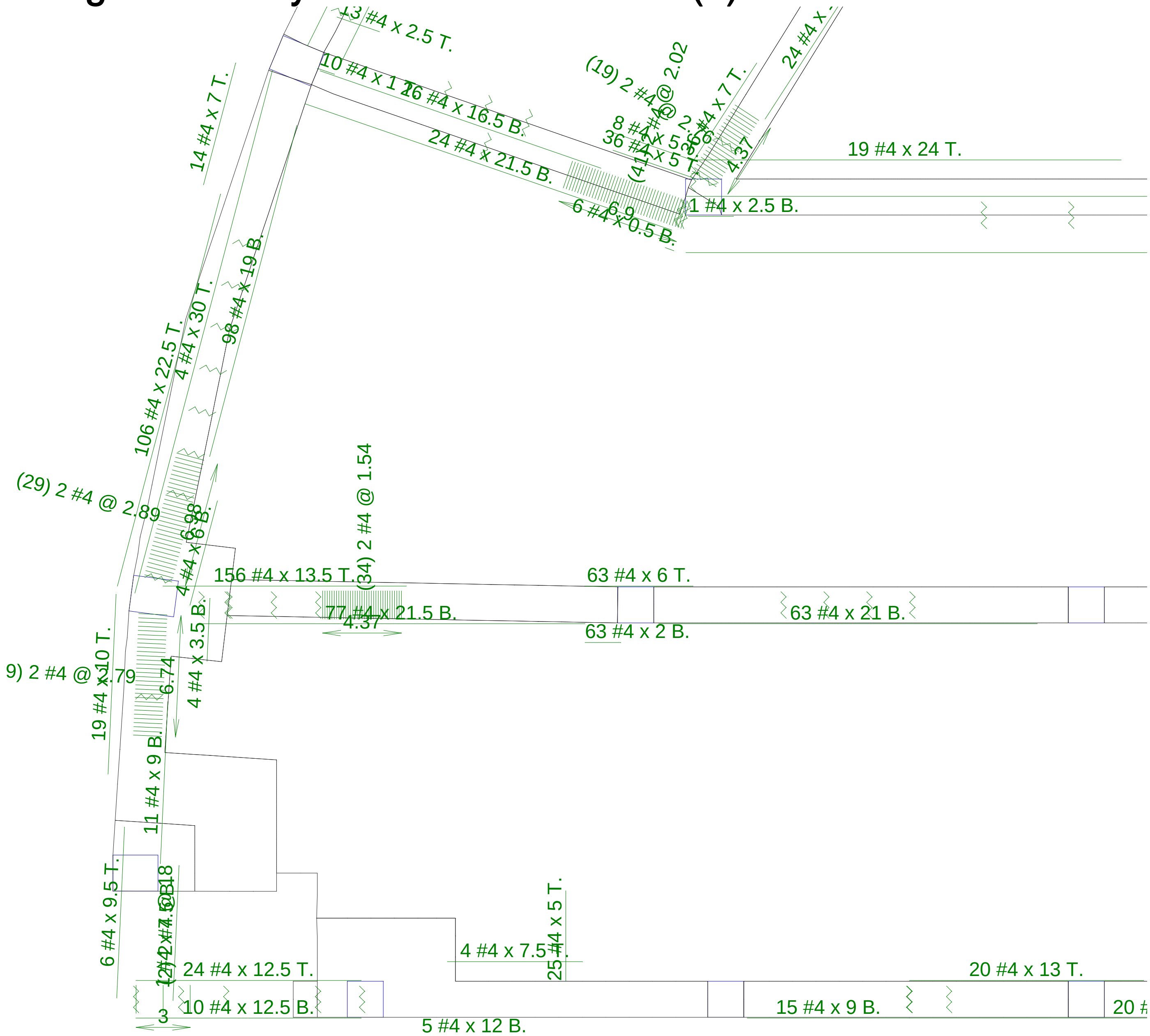
DS Design Top Bars; DS Design Bottom Bars; DS Design Shear Bars;



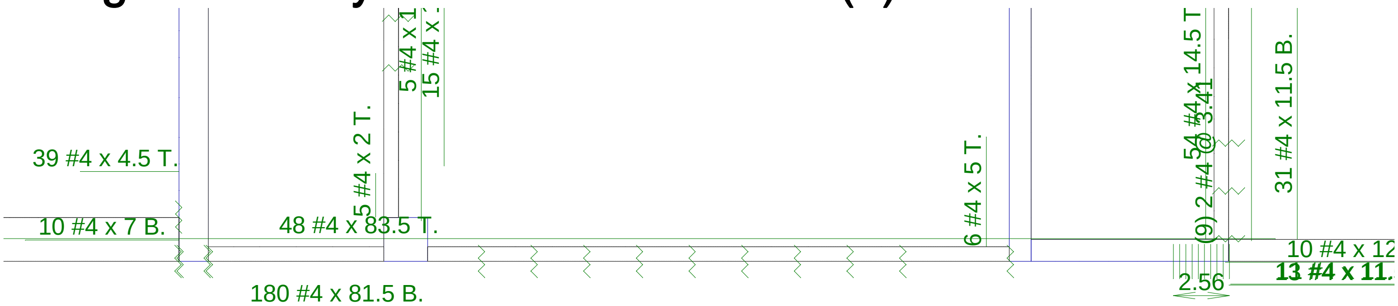
Design Summary: Reinforcement Plan (4)

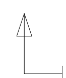


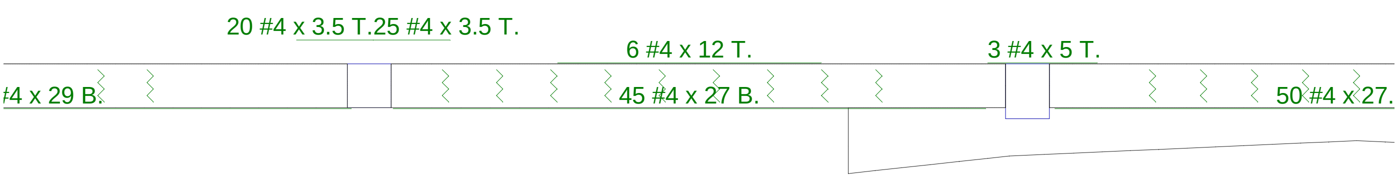
Design Summary: Reinforcement Plan (5)



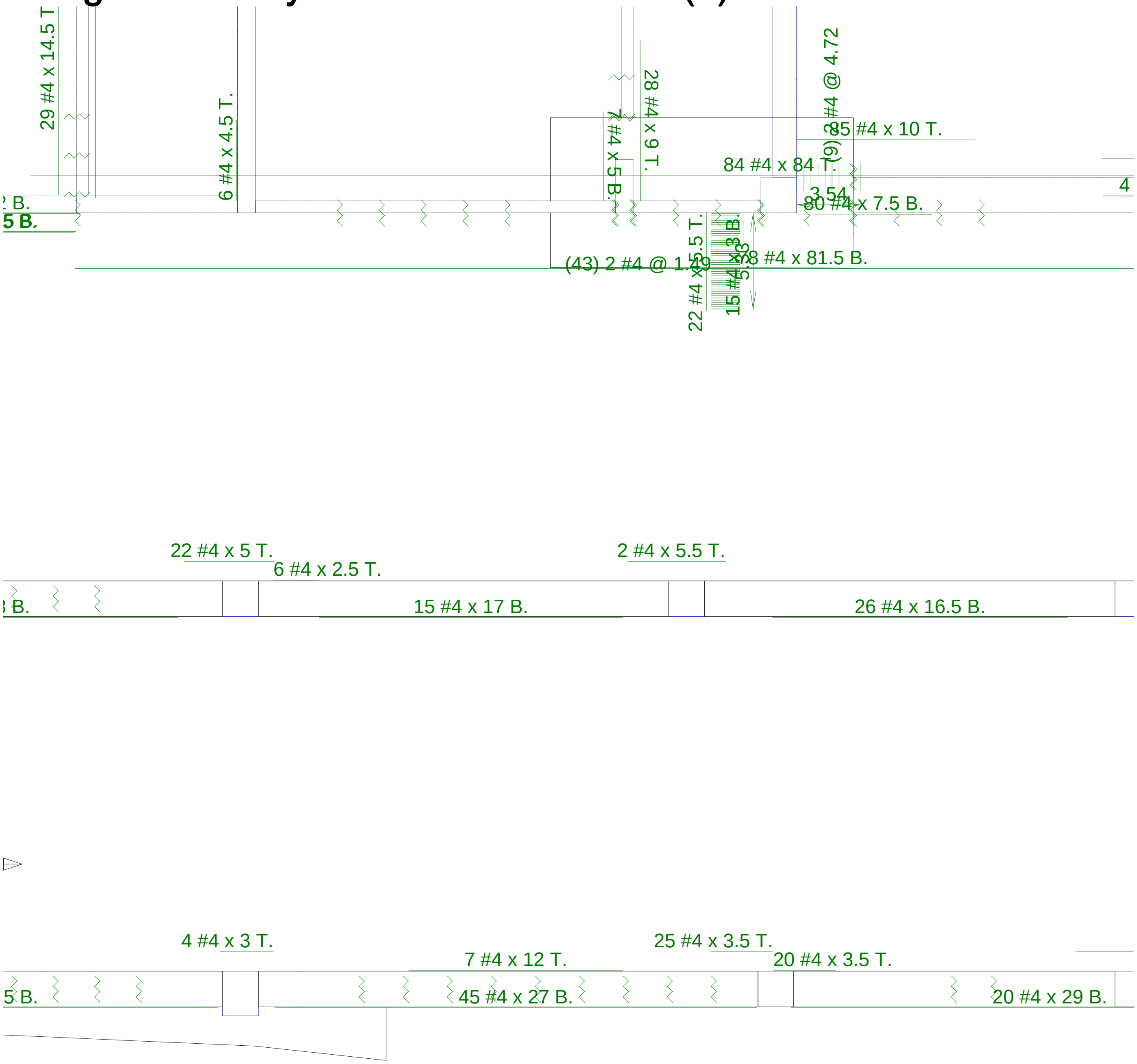
Design Summary: Reinforcement Plan (6)



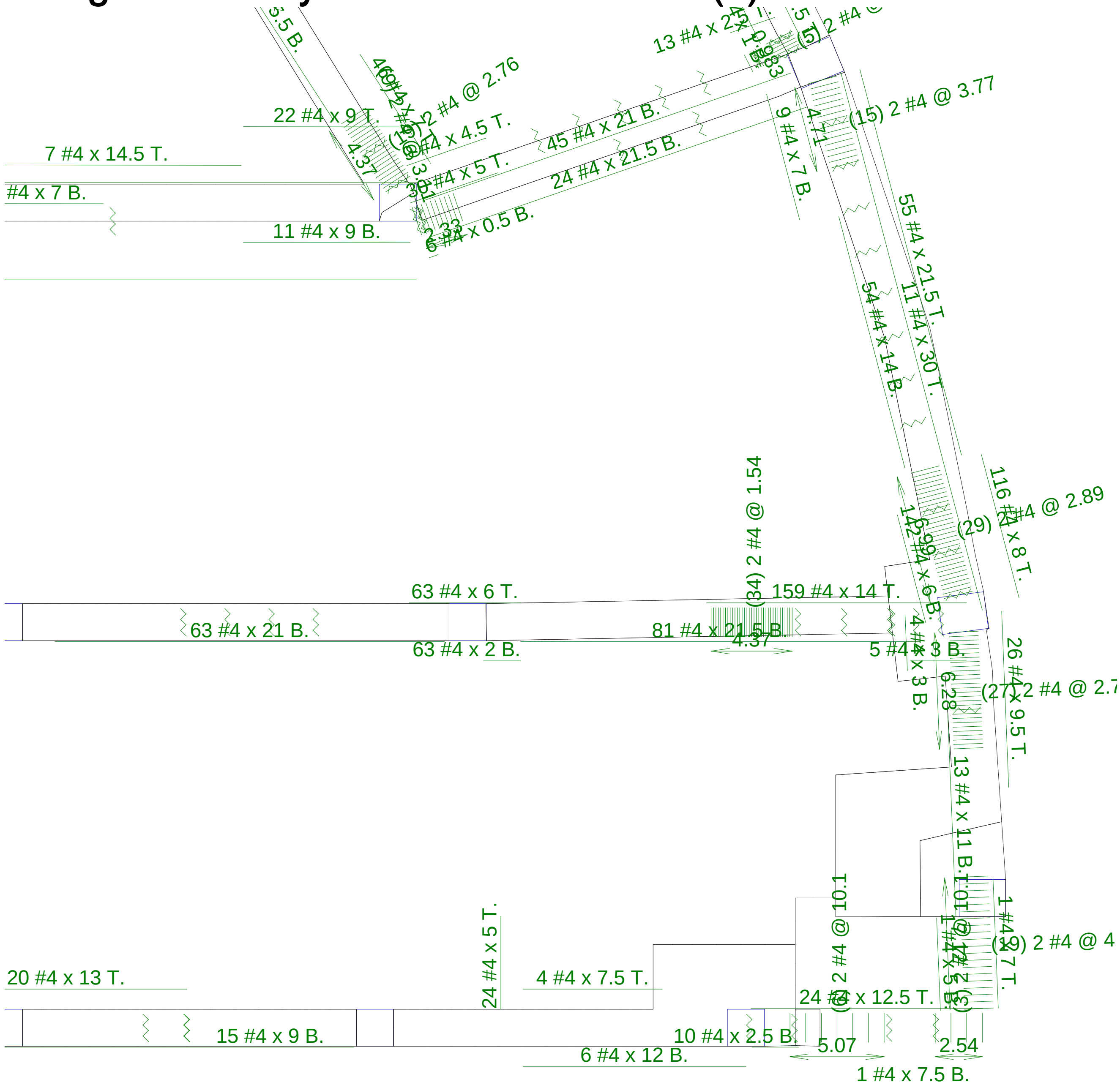




Design Summary: Reinforcement Plan (7)



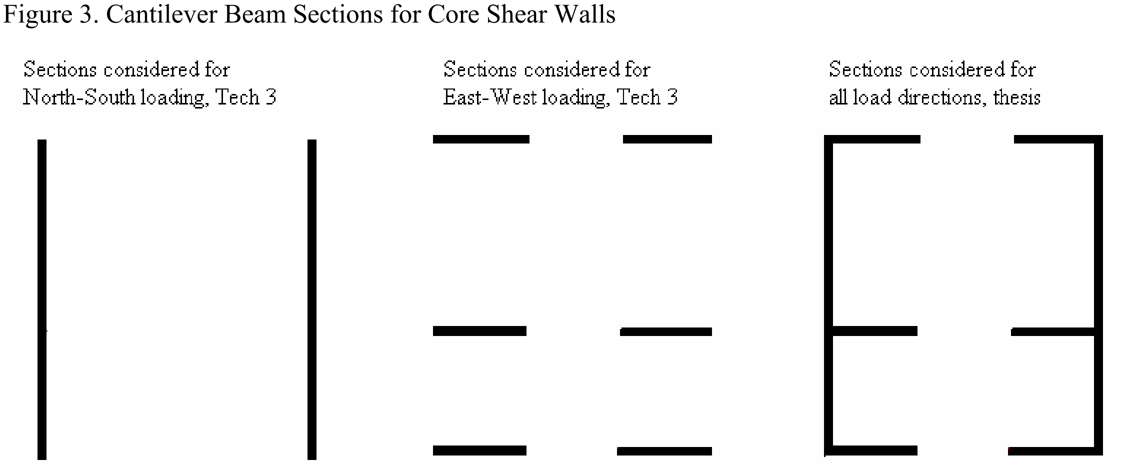
Design Summary: Reinforcement Plan (8)



Lateral Design: 3-Dimensional Modeling and Dynamic Analysis

To the end of accurately determining the lateral loads and resistances of Towers Crescent building F I performed a 3-dimensional dynamic analysis. This involved building a 3-dimensional model in ETABS which represents the spatial distribution of the mass and stiffness of the structure. A 2-dimensional model would not suffice since the lateral force resisting systems in orthogonal directions are not independent. In the analysis for previous technical reports they were considered as such, however, this is over-conservative, since when orthogonal shear walls intersect, they serve as web and flange for one beam section. Figure 3 below pictures the beam sections which were employed in the lateral stiffness analysis of technical report 3, compared to the beam sections which have employed in the present thesis.

Figure 3. Cantilever Beam Sections for Core Shear Walls



There are additional benefits to the 3-dimensional model. First, it enables the design to make use of heretofore neglected lateral resisting elements, such as curved and irregular frames. Specifically, there is a large curved frame around the entire North face of the building which contributes significantly more than it was calculated to contribute using 2-dimensional procedures. Second, the 3-dimensional model distributes loads more accurately than 2-dimensional procedures, since it satisfies all compatibility requirements simultaneously, instead of merely one floor at a time. Finally, by means of the 3-dimensional model it is possible to accurately determine the fundamental period of the building, which is much higher than the estimate T_a permitted by code, thus allowing one to reduce the seismic response coefficient and hence the seismic loads.

All lateral frames have been stiffened over those employed in technical report 3 through the introduction of edge beams. Furthermore, this has the added benefit of greatly simplifying analysis, since it is no longer necessary to employ the equivalent frame method, and determine stiffnesses for equivalent torsional members connecting the slab beams to the columns.

To determine the mass and center of mass of the structure from floor 2 and above, I created detailed spreadsheets containing the weight of each element in the structure and the distance in the x and y directions between its individual center of mass and a reference datum. I created an AutoCAD drawing of each floor to facilitate the determination of these quantities. The spreadsheet converts the weight of each element into mass, multiplies the mass by the element's x and y coordinates, and sums the total weight, total mass, and the quantities m*x and m*y. Total m*x divided by total mass yields the x-coordinate of the center of mass, and total m*y divided by total mass yields the y-coordinate. For floors P2, P3, and P4, I made an approximate determination by calculating the average weight per square foot of representative areas, and treating these areas as individual elements with center of mass at the center of area. I neglected the mass of the portion of the parking deck which is separated by an expansion joint. Spreadsheets for all mass and center of mass calculations are contained in Appendix I.

The model is pictured below in figure 4. All columns are modeled as rectangular concrete sections with the appropriate modulus of elasticity, while beams are modeled as T-sections to take into account the contribution of the slab to the stiffness of the beams. All beams have 12" rigid offsets from their supporting columns. The shear walls are modeled as walls with the dimensions listed above. I have neglected the contribution of steel reinforcement to the stiffness of all concrete sections. The effects of cracking have been taken into account by reducing the flexural stiffness of beams by 50% and reducing the flexural stiffness of walls by 30%. All lateral load resisting elements are connected at each floor by a rigid diaphragm, except for a number of columns which are located outside of the slab on the second floor. Lastly, I have neglected the stiffness of those frames on levels P2, P3, and P4 which are located outside the footprint of the main office tower.

The only change made to the lateral system prior to analysis was the addition of 26" deep shear ties to connect the shear walls surrounding the elevators in the central core of the building. This has the effect of dramatically increasing structural stiffness in the East-West direction and in torsion. Without the shear ties, the two E-shaped walls act independently, with shear flow approximately as pictured below in figure 5. With the addition of the shear ties, the combined section (figure 6) is about three times deeper in the East-West direction, and therefore exponentially stiffer, than the two individual sections. Moreover, the enclosed section provides a logical path for torsional shear flow, thus improving the torsional resistance of the entire building.

The addition of these beams required me to reduce the ceiling height in the elevator lobby from 10' to 9'.

Fig. 4. ETABS model of Towers Crescent Building F

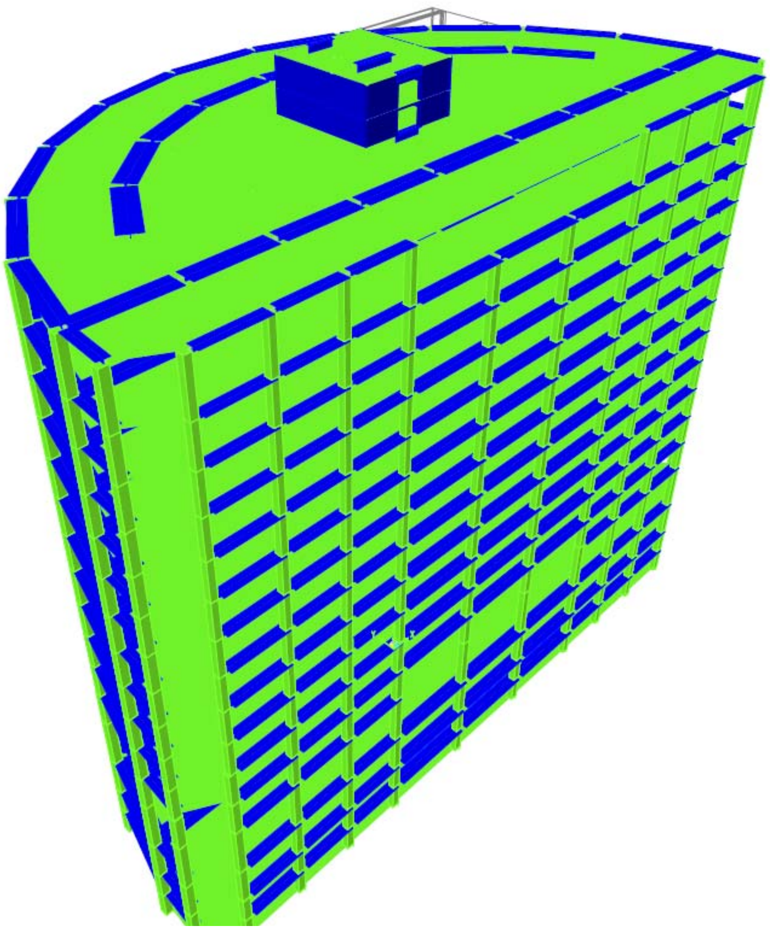


Fig. 5. Shear wall without tie beams.

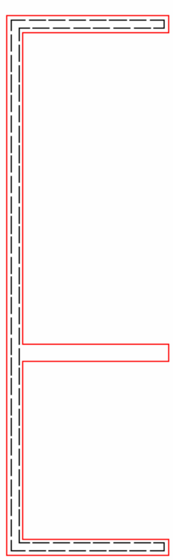
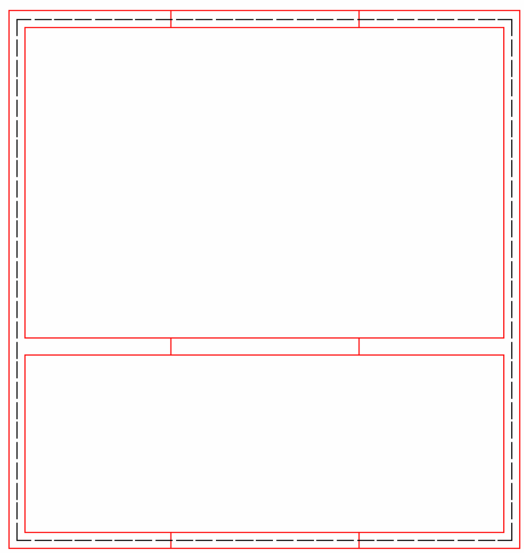


Fig. 6. Shear wall core connected with tie beams.



Seismic Analysis

Seismic loads were calculated using the equivalent lateral force method described in Section 9.5.5. of ACSE 7-02. Modal analysis of the 3-dimensional model yielded the fundamental period of the building T = 2.99 seconds in the East-West direction and T = 1.99 seconds in the North-South direction. Therefore, in determining the seismic response coefficient for equivalent lateral force analysis, it was possible to increase the period from $T_a = 0.02h^{0.75}$ = 1.12 seconds, by a factor of C_u = 1.676. Hence, T = 1.88 seconds was used for both directions. This reduced the seismic response coefficient, and therefore seismic loads, by the factor C_u. This reduction having been made, it was determined that wind loads would control the lateral design of the structure. Hence, it was not necessary to perform a modal response spectrum analysis to further reduce seismic loads. Total seismic loads are as shown below in table 3.

The loads listed in table 3 were applied to the building in the North-South direction and in the East-West direction at an eccentricity equal to the offset between the center of mass and the center of stiffness at each floor plus 5% of the width of the building in the direction under consideration. After running the analysis and obtaining the lateral deflections at each floor, story drifts were determined, multiplied by the drift amplification factor C_d = 4.5, and compared to the allowable story drift of 1.5% of the height of the story below. Happily, all deflections were found to be within tolerances. Results are displayed below in table 4. The deformed shape of the structure under North-South loading is pictured in Figure 7.

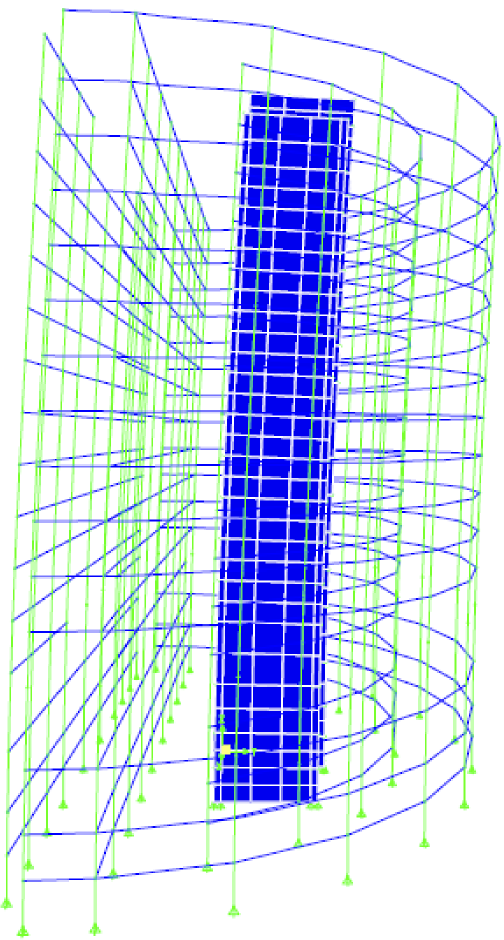
Table 3. Seismic Loads

Level	Height (ft)	Seismic Loads
Ornament	229	4.88
Pent Rf	215	10.99
Pent Bm	209	9.01
Elv/Mach	206.25	12.89
Roof	199	162.69
13	184	150.03
12	172	128.13
11	160	113.39
10	148	99.39
9	136	86.16
8	124	73.70
7	112	62.06
6	100	51.24
5	88	41.28
4	76	32.22
3	64	24.10
P6/2	52	13.81
P4	34	53.15
P3	20	10.59
P2	10	3.28

Table 4. Seismic Story Drifts.

Story Drift			
Level	NS	EW	Allowable
Roof	1.16	1.12	2.70
13	0.95	0.95	2.16
12	0.95	1.01	2.16
11	0.96	1.07	2.16
10	0.95	1.12	2.16
9	0.94	1.16	2.16
8	0.91	1.19	2.16
7	0.88	1.20	2.16
6	0.83	1.21	2.16
5	0.77	1.19	2.16
4	0.70	1.13	2.16
3	0.62	1.09	2.16
P6/2	0.80	1.49	2.16
P4	0.46	0.95	3.24
P3	0.22	0.49	2.52
P2	0.12	0.26	1.80

Fig. 7. Deformed Structure under NS Seismic Loading



All calculations involved in the analyses described above are available in Appendix II, Seismic Analysis.

Wind Analysis

Wind loads were calculated in accordance with the provisions of ASCE 7-02 Section 6.5 for dynamic structures. Design pressures were calculated, factored by 1.6 per ASCE 7-02 Section 2.3.2, and applied to the surface areas of the building in the North-South and East-West directions to yield the loads listed in table 5. For details, see Appendix III, Wind Analysis.

Table 5. Wind Loads.

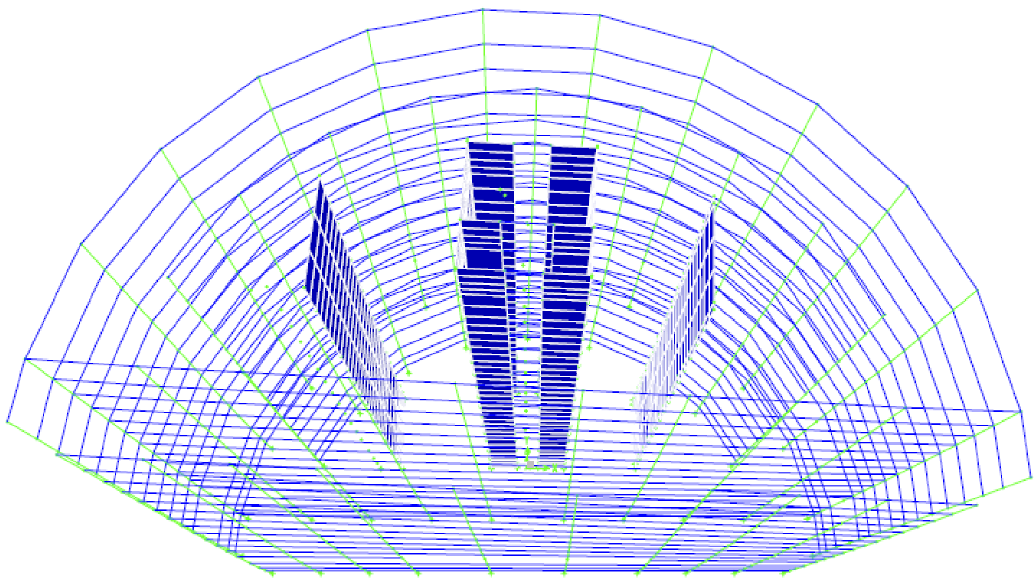
Fact. Wind Ld. (k)	N-S	E-W
Roof	355.5	182
13	145	80
12	127	70
11	125	69
10	124	68
9	122	67
8	121	67
7	118	65
6	117	64
5	114	63
4	112	62
3	108	59
P6/2	131	69
P4	104	57
P3	42	23
P2	31	17

I applied these loads at 100% strength at the center of area of each face of the building, and at 75% strength at an eccentricity determined by equation 6-21 of ASCE 7-02. This yielded the following maximum deflections:

(1) North-South, non-eccentric loading: δ_{max} = 2.69"
(2) North-South, eccentric loading: δ_{max} = 8.09"
(3) East-West, non-eccentric loading: δ_{max} = 3.24"
(4) East-West, eccentric loading: δ_{max} = 3.98"

All of these deflections are with the industry standard tolerance of l/400 except for the North-South eccentric loading. This deflection is equal to l/295. However, the load applied in this analysis is much larger than the load which would be applied in an actual windstorm, due to the 16' perforated panel wall at the top of the structure. Code requires (ASCE 7-02, Sec. 6.5.2.2) that one treat air permeable cladding as solid wall, unless "approved test data or recognized literature demonstrate lower loads for the type of air-permeable cladding being considered." Since I had no such data or literature, I treated the cladding as solid wall, which is conservative. Furthermore, since Towers Crescent Building F is a dynamic structure, the eccentricity of applied loading had to be amplified by Equation 6-21. This resulted in an eccentricity of 62.1', which is higher than actual. It would have been very helpful if a wind tunnel test had been performed on this structure, as I believe this would prove that wind loads are much lower than computed by ASCE 07. This is especially the case given that the designer was forced to treat the semicircular face of the building as the projected rectangle, which is very conservative. The curved face would allow wind to flow around it far more easily than the assumed flat face. Finally, my ETABS model neglected steel reinforcing and many elements which would contribute additional lateral stiffness to the building. Considering these three factors together, it is probable that Towers Crescent would not deflect more than l/400 in reality. The deflected shape of the building under this loading condition is pictured in figure 8.

Fig. 8. Deformed shape under eccentric North-South wind loading,



Strength Check and Overturning Moment

The reactions at the base of the left shear wall under eccentric North-South wind loading reveal that it is carrying a shear force of $2(632.4^k) = 1264.8^k$ and an overturning moment of 67275 ft-k, which is resisted by a couple of 2293.5^k compression at one end and 2293.5^k uplift at the other.

The shear force must be checked against the design strength of the wall by the provisions of ACI 318:

$$\Phi V_n = \Phi A_{cv}(\alpha_c f'_c{}^{1/2} + \rho_t f_y)$$

$h_w/l_w > 2 \Rightarrow \alpha_c = 2.0$
$A_{cv} = 16(359) = 5744\ in^2$; $\rho_t = 2(0.196)/(16(12)) = 0.002045$

$$\Phi V_n = 0.6(5744)(2(8000^{1/2}) + 0.002045(60000)) = 1039.4^k < 1264.8^k \text{ (no good)}$$

Thus, according to my calculations, this shear wall is not adequate to carry the maximum design loads. However, these loads are unrealistically large, for the reasons enumerated above.

The caissons beneath the ends of this shear wall are 48" in diameter. They are designed, according to the drawings, "for an allowable bearing pressure of 100,000 psf plus skin friction of 1,000 psf between elevation 440.00' and 420.00', and 2,000 psf for elevation below 420.00." Therefore, their bearing capacity is:

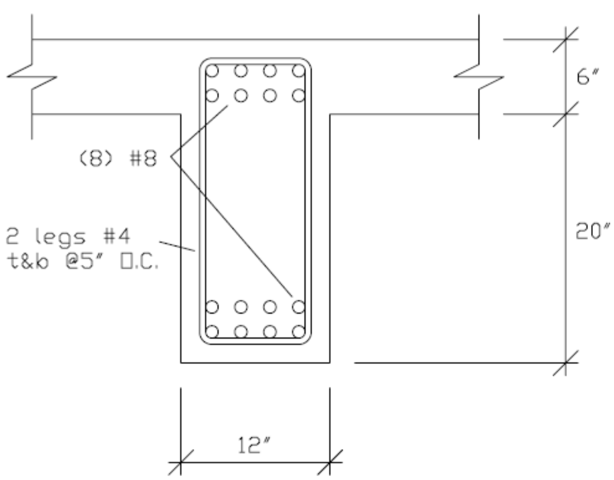
$100(4\pi) + 20(1)(4\pi) + 15(2)(4\pi) = 1885^k < 2293.5^k$ (no good)

The caissons too, then, my calculations show to be inadequate. Perhaps through a more rigorous analysis of the bearing capacity of the caisson, it could be proved to be adequate. However, I was not able to obtain a copy of the geotechnical report, which would be necessary to such analysis.

Tie Beam Design

Out of all the lateral load cases considered, the critical tie beam load is that applied to the bottom tie beam of the second floor under East-West eccentric wind loading. The maximum moment is 521 ft-k and the maximum shear is 120 k. It is not possible to design a 12"x26" 5 ksi concrete beam capable of resisting such loads which meets all the requirements of ACI 318. However, it is possible to design a beam (figure 9) which resists 512 ft-k of moment and the full 120 k shear. It may be safely assumed that, if the critical tie beam yields, load will redistribute to adjacent elements. Therefore the design of figure 9 will suffice for tie beams. Diagonal reinforcement was not pursued because cyclical earthquake loading does not control the design of this section.

Fig. 9. Tie Beam



Columns and Foundations

Since the weight of Towers Crescent Building F has been significantly reduced, it will be possible to downsize a number of columns and foundation elements. I will take column 34 and the foundation element beneath it as a representative example. Table 6 displays the column load take down for this column, which tallies the load at each floor. The two load combinations considered are 1.2D+1.6L+0.5S and 1.2D+1.0L+1.6W+0.5S. The bending moment in the column at each floor due to wind loading is taken from the ETABS model for eccentric wind loading in the East-West direction, which produces the greatest bending moments in this particular column. Vertical loads are in kips and bending moments are in foot kips.

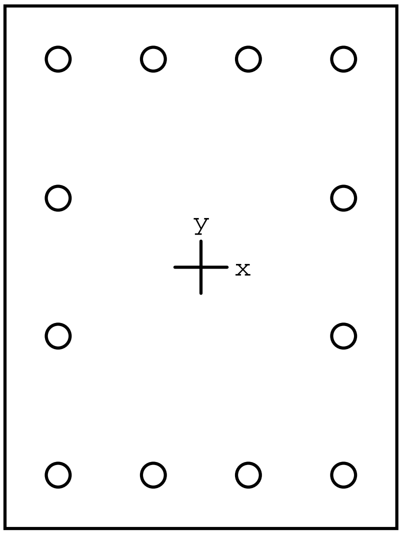
Col. Abv.	Self	Slab	Sup. D.	Beams	Live	Snow	1.2D+1.6L+0.5S	1.2D+1.0L+0.5S	Wind M
13	9.00	41.42	5.52	3.45	0.00	20.03	81	81	28.5
12	7.20	41.42	13.81	3.45	38.66	0.00	222	199	16.6
11	7.20	41.42	13.81	3.45	38.66	0.00	363	317	19.9
10	7.20	41.42	13.81	3.45	38.66	0.00	504	434	20.3
9	7.20	41.42	13.81	3.45	38.66	0.00	645	552	21.1
8	7.20	41.42	13.81	3.45	38.66	0.00	786	670	21.3
7	7.20	41.42	13.81	3.45	38.66	0.00	927	788	21.9
6	7.20	41.42	13.81	3.45	38.66	0.00	1068	905	22
5	7.20	41.42	13.81	3.45	38.66	0.00	1208	1023	24.5
4	7.20	41.42	13.81	3.45	38.66	0.00	1349	1141	23.8
3	9.00	41.34	13.78	3.45	38.59	0.00	1492	1260	30.3
P6/2	9.00	41.34	13.78	3.45	38.59	0.00	1635	1380	34.2
P4	13.50	41.34	13.78	3.45	38.59	0.00	1783	1505	48.2
P3	12.60	41.27	13.76	3.45	38.52	0.00	1930	1629	91.1
P2	9.00	41.27	2.75	3.45	22.01	0.00	2033	1719	142.8
P1	9.00	41.27	2.75	3.45	22.01	0.00	2136	1808	111.5
Caisson	0.00	33.24	0.00	0.00	0.00	0.00	2176	1848	0

As the following page prints from pcaColumn demonstrate, an 18"x24" section with (12) #9 vertical reinforcing rods suffices down to the 4th floor, and a 24"x24" section with (12) #10 suffices all the way down to the base. The compressive and bending loads are well within the envelope of acceptable values in both cases. This represents a significant downsize from the current column schedule, which calls for a 24"x24" section from the roof to the 4th floor, a 24"x30" section from the 4th floor to level P4, and a 24"x36" section from P4 to the base of the structure.

The caisson which supports column 34 is 54" in diameter. Therefore its bearing capacity is:

$$100\pi(2.25^2) + 20(1)(4.5\pi) + 15(2)(4.5\pi) = 2297.3^k > 2176^k \text{ (OK)}$$

This caisson is close to exceeding its allowable stresses, and therefore cannot be downsized without a more rigorous determination of its bearing capacity.



18 x 24 in

Code: ACI 318-02

Units: English

Run axis: About Y-axis

Run option: Investigation

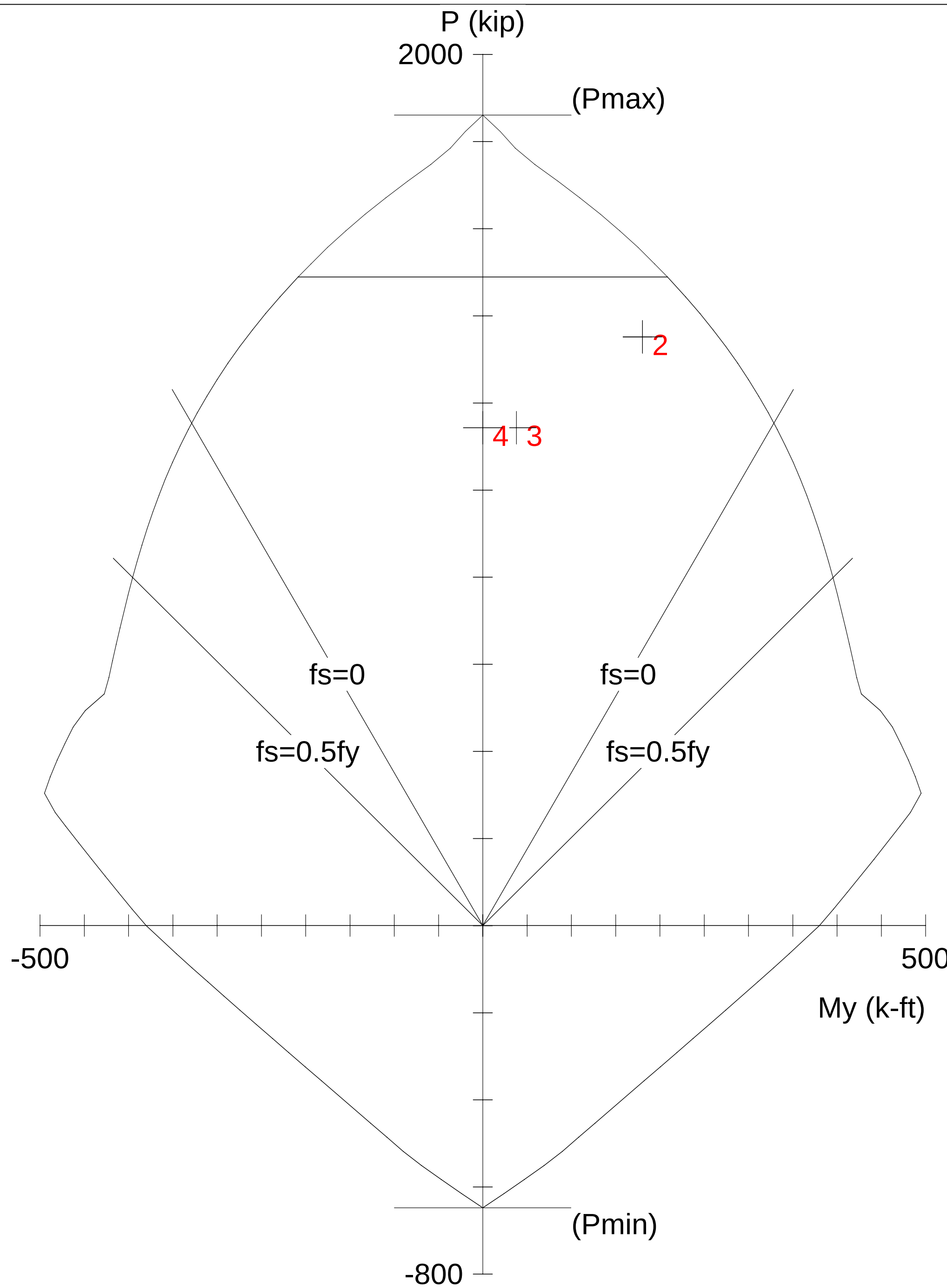
Slenderness: Considered

Column type: Structural

Bars: ASTM A615

Date: 04/12/07

Time: 14:27:00



pcaColumn v3.64. Licensed to: Penn State University. License ID: 52411-1010265-4-22545-2B5EC

File: untitled.col

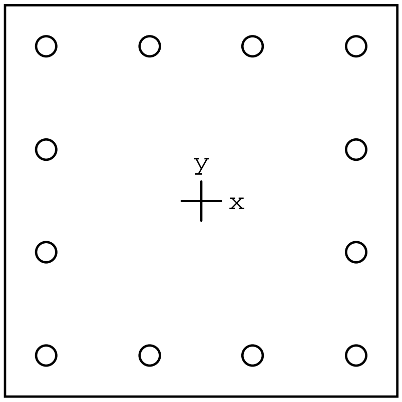
Project:

Column: Engineer:

f'c = 6 ksi	fy = 60 ksi	Ag = 432 in^2	12 #9 bars
Ec = 4415 ksi	Es = 29000 ksi	As = 12.00 in^2	Rho = 2.78%
fc = 5.1 ksi	fc = 5.1 ksi	Xo = 0.00 in	Ix = 20736 in^4
e_u = 0.003 in/in		Yo = 0.00 in	Iy = 11664 in^4
Beta1 = 0.75		Clear spacing = 3.25 in	Clear cover = 1.88 in

Confinement: Tied phi(a) = 0.8, phi(b) = 0.9, phi(c) = 0.65

ky(braced) = 1, ky(sway) = N/A



24 x 24 in

Code: ACI 318-02

Units: English

Run axis: About Y-axis

Run option: Investigation

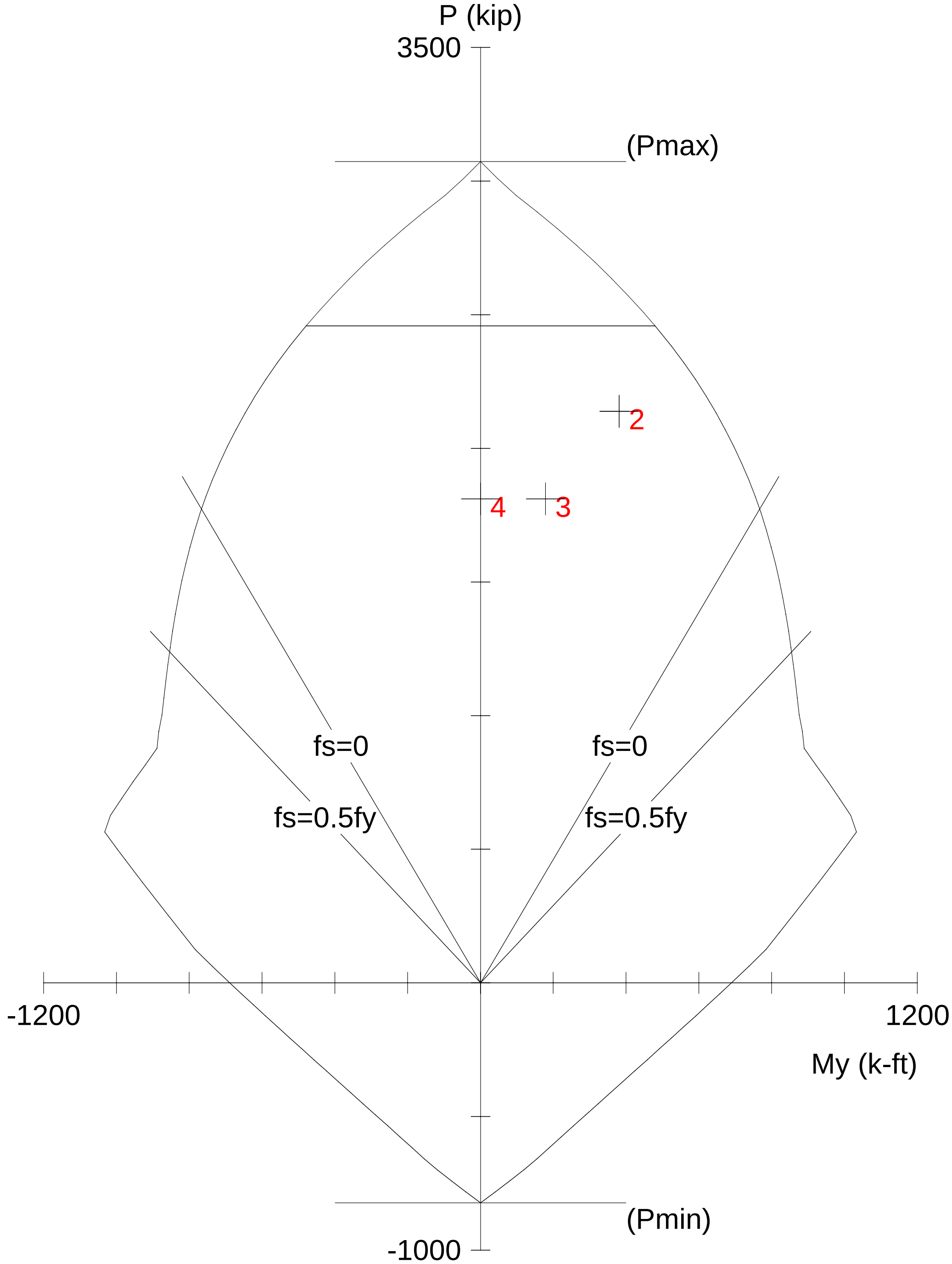
Slenderness: Considered

Column type: Structural

Bars: ASTM A615

Date: 04/12/07

Time: 14:42:38



pcaColumn v3.64. Licensed to: Penn State University. License ID: 52411-1010265-4-22545-2B5EC

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Project:

Column: Engineer:

f'c = 8 ksi	fy = 60 ksi	Ag = 576 in^2	12 #10 bars
Ec = 5098 ksi	Es = 29000 ksi	As = 15.24 in^2	Rho = 2.65%
fc = 6.8 ksi	fc = 6.8 ksi	Xo = 0.00 in	Ix = 27648 in^4
e_u = 0.003 in/in		Yo = 0.00 in	Iy = 27648 in^4
Beta1 = 0.65		Clear spacing = 5.06 in	Clear cover = 1.88 in

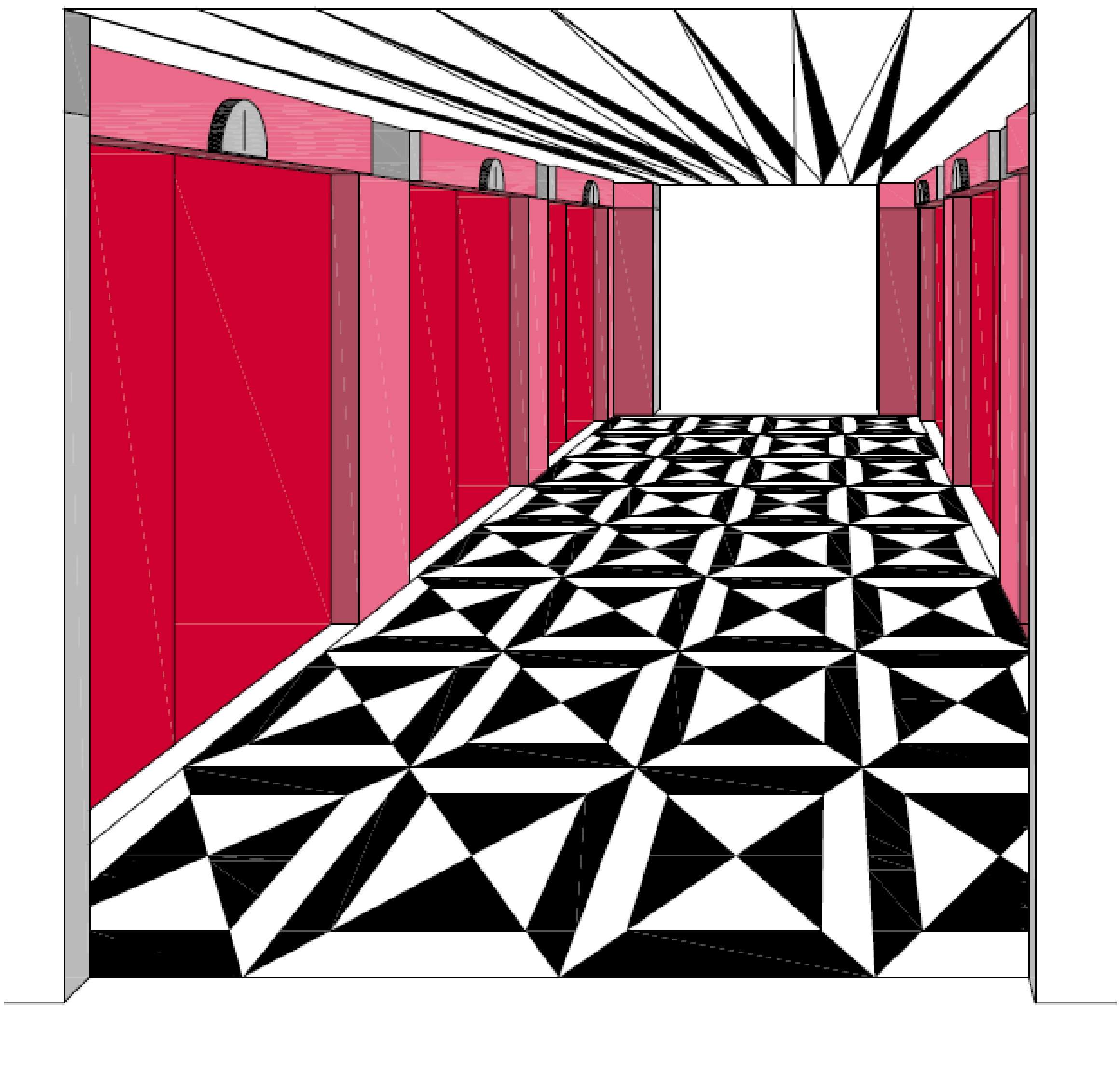
Confinement: Tied phi(a) = 0.8, phi(b) = 0.9, phi(c) = 0.65

ky(braced) = 1, ky(sway) = N/A

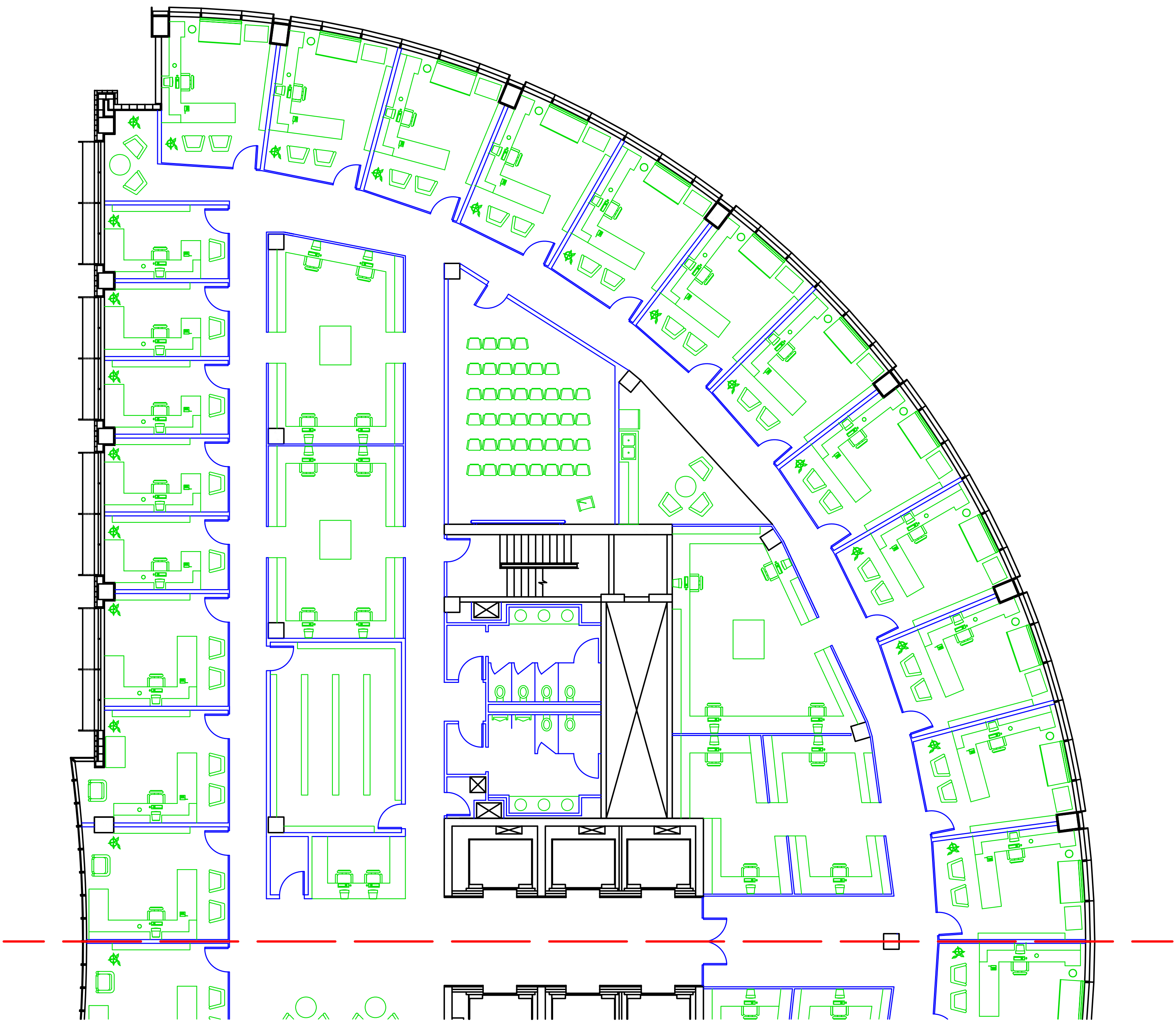
Architectural Design

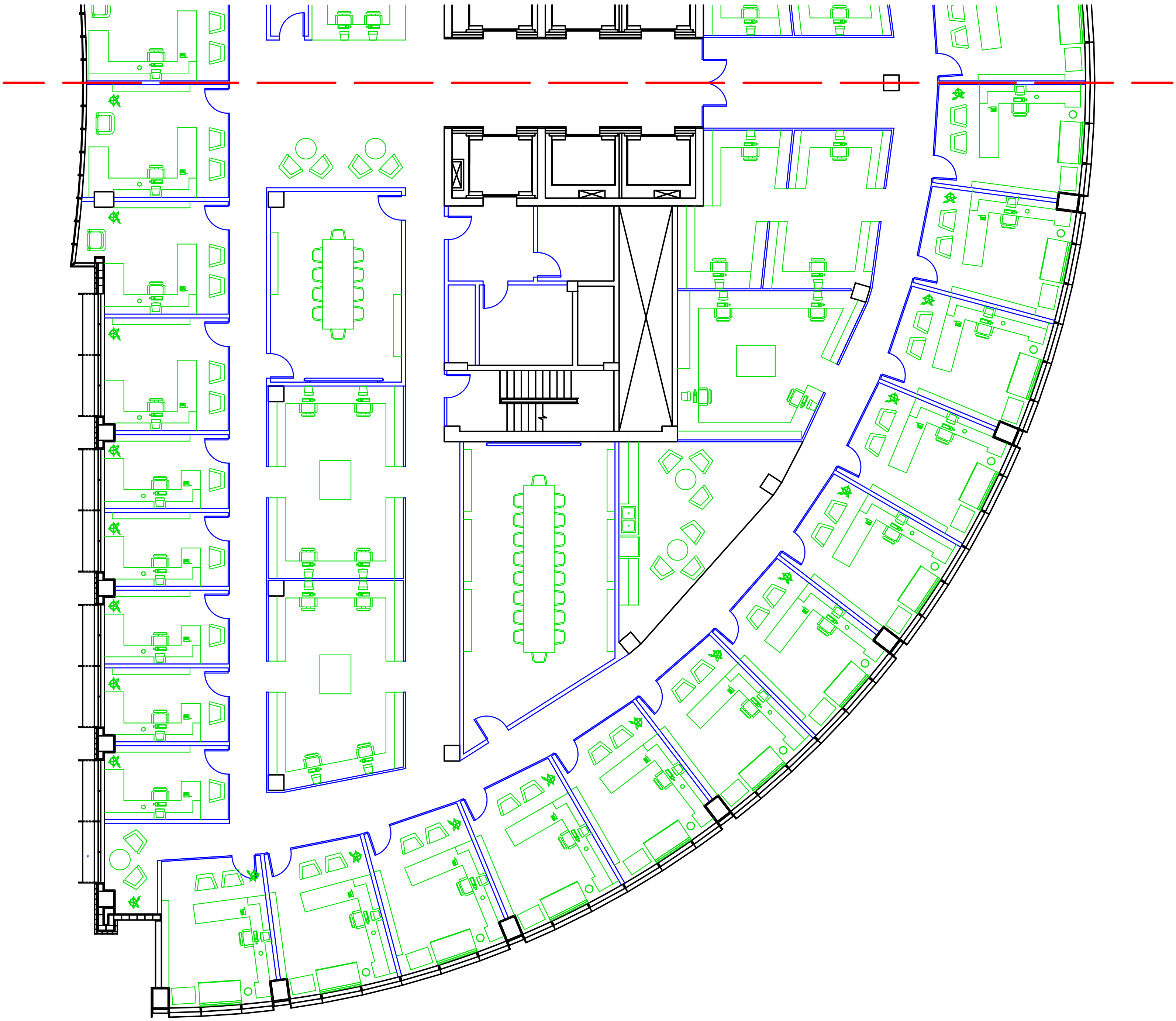
I have produced a perspective rendering of a concept for the interior design of the elevator lobby (figure 10). The color scheme is designed to match the exterior of the building. The patterns would be constructed out of panels of various shades of white, black, and rose granite.

Fig 10. Elevator Lobby.



Next, I have produced a floor plan for a typical office floor. It is reproduced on the following pages. Outside the elevator lobby a space is provided for a waiting room and a receptionist. Through this area, one reaches a hall which leads around the building and provides access to the offices which comprise the perimeter. The walls between these offices and the hallway shall be made of glass in order to allow light through the offices and into the interior of the building. The same hall leads to two small, secluded meeting areas at the building's corners. In the interior of the building, space is provided for a lecture room, two conference rooms, a small library, several cubicles, bathrooms, utility rooms, and two social areas with a refrigerator and sink.





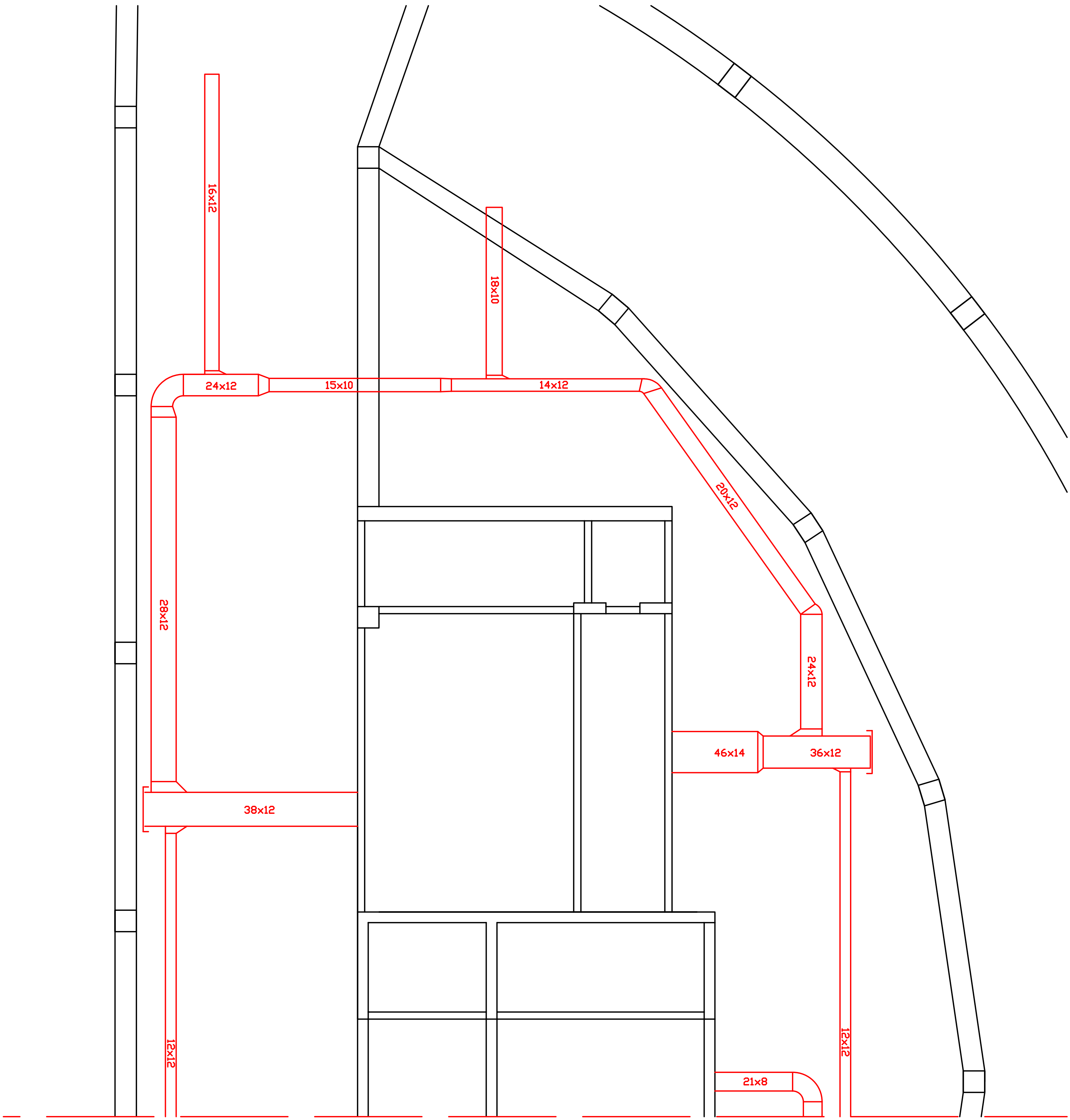
Impact on Mechanical Systems

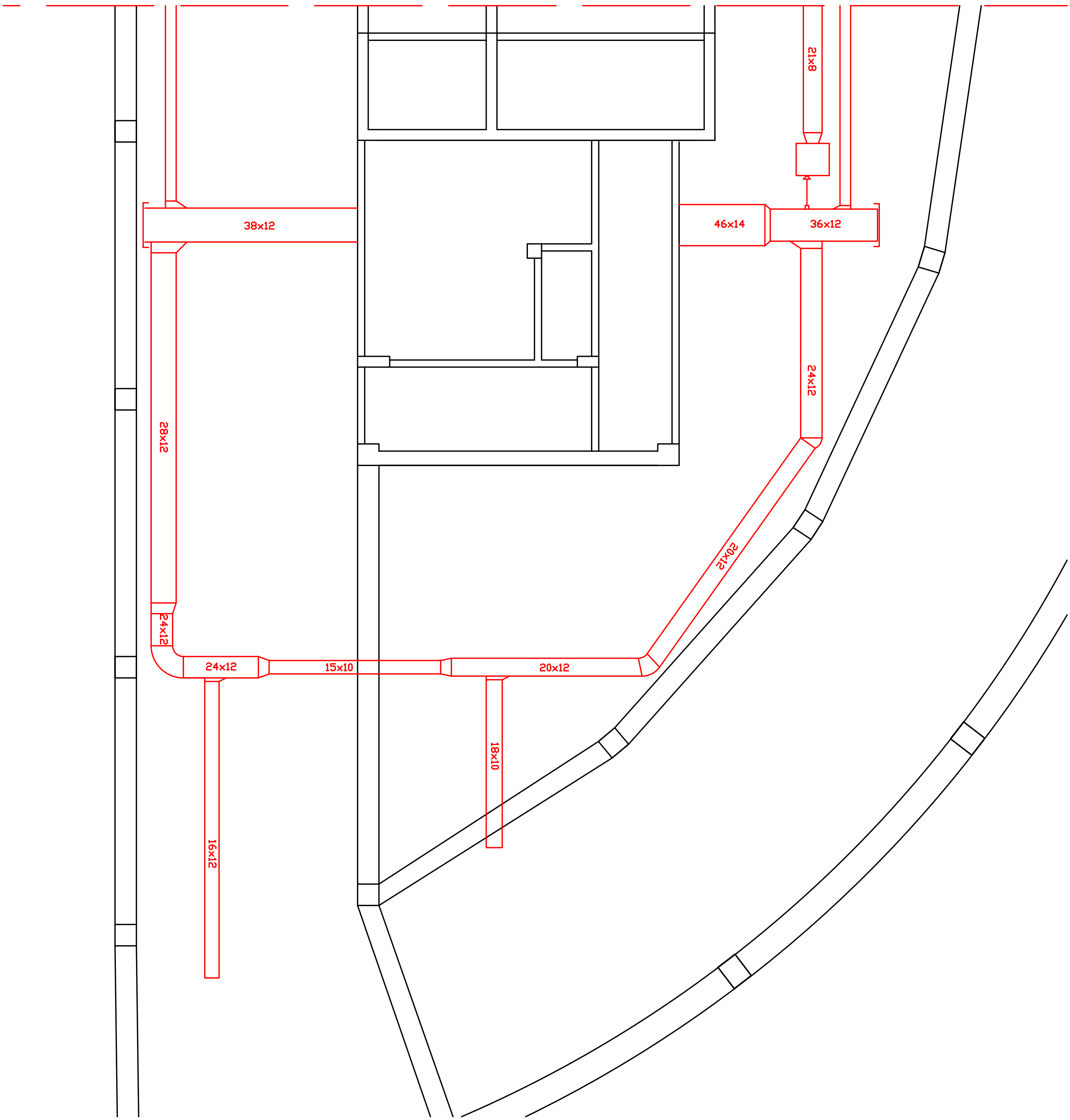
In the process of redesigning the floor slab, I placed beams in certain places where they interfere with the existing mechanical systems. So, I have moved certain ducts a few feet and also flattened five ducts by 2”. The calculations which determined the amount by which I needed to widen the ducts in order to compensate for this flattening are reproduced below. The plans of the modified mechanical system are on the following pages.

$D_e = 1.3(ab)^{5/8}/(a + b)^{1/4} = 1.3(12*12)^{5/8}/(12 + 12)^{1/4} = 13.12 = 1.3(10 * b)^{5/8}/(10 + b)^{1/4}$
b = 15”

$D_e = 1.3(16*10)^{5/8}/(16 + 10)^{1/4} = 13.73 = 1.3(8 * b)^{5/8}/(8 + b)^{1/4}$
b = 21”

$D_e = 1.3(14*12)^{5/8}/(14 + 12)^{1/4} = 14.16 = 1.3(10 * b)^{5/8}/(10 + b)^{1/4}$
b = 18”


16x12
18x10
24x12
15x10
14x12
20x12
28x12
24x12
46x14
36x12
38x12
12x12
12x12
21x8


21x8
38x12
46x14
36x12
24x12
28x12
20x12
24x12
24x12
15x10
20x12
18x10
16x12

Discussion and Recommendations

Laying out the post-tensioning was very difficult given the irregular shape of the structure. Results are only moderately successful. I was in fact able to reduce the width of the slab from 8” to 6”, thus saving money in terms of the cost of materials. However, this benefit would be offset by the additional labor and time of construction required to build the post-tensioned slab. The greatest potential benefit of a post-tensioned slab, the reduction in floor to floor height, I was not able to achieve. On the contrary, in some places I have had to make the floor system deeper, thus requiring changes to the mechanical system which would render it slightly more expensive. Weighing the advantages and disadvantages of my post-tensioned slab against the current conventional reinforced slab, on the whole I would choose the current system.

On the other hand, I would certainly recommend the addition of shear tie beams to connect the shear walls in the East-West direction. This is the first and most obvious change which presents itself to the engineer studying these plans. Shear ties will dramatically increase the stiffness of this building in the East-West direction. Hence, adding these small members should render it possible to make large reductions in the size of the lateral system elsewhere. For example, it should be possible to thin a number of shear walls.

Unfortunately, I was not able to prove this. It appears that SK&A, the structural engineers who created the original design, were able to determine the stiffness of the structure more rigorously, and hence less conservatively, than I. According to my calculations, the structure fails a deflection criterion (maximum building deflection under eccentric wind loading in the North-South direction) even with the addition of the shear ties. Presumably, the structure does not fail this criterion in the calculations of SK&A. For that matter, in my calculations, one wall, with the caissons underneath it, fails strength criteria.

It would be immensely helpful if this building were subject to wind tunnel testing, for the reasons which have been enumerated in the body of this report. This would most likely drastically decrease the one particular load (eccentric North-South wind load) which I believe to be especially conservative, and which is the greatest impediment to downsizing the lateral system (deflections under this loading condition are over twice as large as deflections under the second most critical condition). I believe the performance of this test, combined with the addition of shear ties and a more rigorous determination of building stiffness, would make it possible to reduce the thickness of the shear walls and thus achieve significant materials savings.

Next, even though I would not recommend replacing the current flat slab with a lighter post-tensioned slab, I would still recommend decreasing the live load on the office floor from 100 psf to 70 psf, which would make it possible to downsize many of the columns. The current columns are designed more conservatively than necessary. Furthermore, I would recommend a more rigorous analysis of the bearing capacity of the caissons. The current stipulation of the plans, that caissons are designed “for an allowable bearing pressure of 100,000 psf plus skin friction of 1,000 psf between elevation 440.00' and 420.00', and 2,000 psf for elevation below 420.00," reveals by the very roundness of its numbers that it is only a rough, conservative estimate of actual capacity. Allowable stresses could be determined more accurately by a number of accepted theoretical and empirical methods, such as those listed in chapter 12 of *Principles of Foundation Engineering*, by Braja M. Das. This, I believe, would make it possible to downsize many of the caissons.

Acknowledgments

Thanks are due to Dr. Boothby, my advisor, and to Dr. Lepage, both of whom provided valuable assistance during the course of this thesis. Thanks are also due to Cynthia Milinichik, my peer, who obtained the first set of plans and gave them to me when I hadn't obtained a building of my own, to John Logue of Hensel-Phelps Construction, the construction manager of the Towers Crescent Building F project, who provided me with updated plans and with useful information about the project, and to Joe Uchno of SK&A Consulting Structural Engineers, the structural engineer who answered a large number of my questions about the design.

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American Society of Civil Engineers, *ASCE 7-02, Minimum design loads for buildings and other structures* (AISC, 2003)

Appendix I, Mass and Center of Mass Tabulation

Mass and Center of Mass
P2, P3

Type	Sub-type	Num.	Weight (k)	Mass (k-s^2/in)	X Centroid	Y Centroid	Mx	Yx
Everything		E1	10297.15	26.65	-62.40	54.60	-1662.89	1455.03
Sum			10297.15	26.65			-1662.89	1455.03

Center of Mass	
X Coord:	-62.40
Y Coord:	54.60

Mass and Center of Mass
P4

Type	Sub-type	Num.	Weight (k)	Mass (k-s^2/in)	X Centroid	Y Centroid	Mx	Yx
Everything		E1	3695.10	9.56	-174.00	-32.00	-1663.94	-306.01
		E2	435.22	1.13	-210.60	8.77	-237.21	9.88
		E3	1341.25	3.47	-209.00	52.60	-725.47	182.58
		E4	1743.39	4.51	-157.50	108.70	-710.62	490.44
		E5	717.55	1.86	-65.90	147.30	-122.38	273.54
		E6	7978.57	20.65	-36.30	100.00	-749.54	2064.85
		E7	722.75	1.87	66.17	147.30	123.77	275.52
		E8	1721.41	4.46	131.10	94.98	584.05	423.14
		E9	2721.40	7.04	0.00	41.40	0.00	291.58
Sum			21076.65	54.55			-3501.34	3705.51

Center of Mass	
X Coord:	-64.19
Y Coord:	67.93

Mass and Center of Mass
2-P6

Type	Sub-type	Num.	Weight (k)	Mass (k-s^2/in)	X Centroid	Y Centroid	Mx	Yx
Columns	24x30 Columns	C1	9.00	0.0233	-117.75	0.00	-2.74	0.00
		C2	9.00	0.0233	-116.74	15.37	-2.72	0.36
		C3	9.00	0.0233	-108.79	45.06	-2.53	1.05
		C4	9.00	0.0233	-93.42	71.67	-2.18	1.67
		C5	9.00	0.0233	-71.69	93.41	-1.67	2.18
		C6	9.00	0.0233	-45.07	108.78	-1.05	2.53
		C7	9.00	0.0233	-15.39	116.74	-0.36	2.72
		C8	9.00	0.0233	15.39	116.74	0.36	2.72
		C9	9.00	0.0233	45.07	108.78	1.05	2.53
		C10	9.00	0.0233	71.69	93.41	1.67	2.18
		C11	9.00	0.0233	93.42	71.67	2.18	1.67
		C12	9.00	0.0233	108.79	45.06	2.53	1.05
		C13	9.00	0.0233	116.74	15.37	2.72	0.36
		C14	9.00	0.0233	117.75	0.00	2.74	0.00
		C14.5	9.00	0.0233	105	-6.75	2.45	-0.16
		C15	9.00	0.0233	85.00	-6.75	1.98	-0.16
		C16	9.00	0.0233	65.00	-6.75	1.51	-0.16
		C17	9.00	0.0233	45.00	-6.75	1.05	-0.16
		C18	9.00	0.0233	15.00	-6.75	0.35	-0.16
		C19	9.00	0.0233	-15.00	-6.75	-0.35	-0.16
		C20	9.00	0.0233	-45.00	-6.75	-1.05	-0.16
		C21	9.00	0.0233	-65.00	-6.75	-1.51	-0.16
		C22	9.00	0.0233	-85.00	-6.75	-1.98	-0.16
		C22.5	9.00	0.0233	-105.00	-6.75	-2.45	-0.16
		C23	9.00	0.0233	-92.83	14.63	-2.16	0.34
		C24	9.00	0.0233	-86.23	37.75	-2.01	0.88
		C25	9.00	0.0233	-72.06	60.37	-1.68	1.41
		C26	9.00	0.0233	-51.69	78.52	-1.20	1.83
		C27	9.00	0.0233	-26.98	90.05	-0.63	2.10
		C28	9.00	0.0233	0.00	93.76	0.00	2.18
		C29	9.00	0.0233	26.98	90.05	0.63	2.10
		C30	9.00	0.0233	51.69	78.52	1.20	1.83
		C31	9.00	0.0233	72.06	60.37	1.68	1.41
		C32	9.00	0.0233	86.23	37.75	2.01	0.88
		C33	9.00	0.0233	92.83	14.63	2.16	0.34
		C34	9.00	0.0233	67.50	14.63	1.57	0.34
		C35	9.00	0.0233	42.17	14.63	0.98	0.34
		C36	9.00	0.0233	16.83	14.63	0.39	0.34
		C37	9.00	0.0233	-16.83	14.63	-0.39	0.34
		C38	9.00	0.0233	-42.17	14.63	-0.98	0.34
		C39	9.00	0.0233	-67.50	14.63	-1.57	0.34
		C40	9.00	0.0233	-43.33	37.75	-1.01	0.88
	16x16 Columns	C91	4.00	0.0104	-26.17	-7.33	-0.27	-0.08
		C92	4.00	0.0104	26.17	-7.33	0.27	-0.08
		C93	4.00	0.0104	-106.00	14.00	-1.10	0.14
		C94	4.00	0.0104	-99.00	41.00	-1.02	0.42
		C95	4.00	0.0104	-85.00	65.13	-0.88	0.67
		C96	4.00	0.0104	-65.00	85.88	-0.67	0.89
		C97	4.00	0.0104	-41.00	98.83	-0.42	1.02
		C98	4.00	0.0104	-14.00	106.00	-0.14	1.10

		C99	4.00	0.0104	14.00	106.00	0.14	1.10
		C100	4.00	0.0104	41.00	98.83	0.42	1.02
		C101	4.00	0.0104	65.00	85.88	0.67	0.89
		C102	4.00	0.0104	85.00	65.13	0.88	0.67
		C103	4.00	0.0104	99.00	41.00	1.02	0.42
		C104	4.00	0.0104	106.00	14.00	1.10	0.14
	Misc. Columns	C41	5.40	0.0140	-44.17	58.17	-0.62	0.81
		C42	5.40	0.0140	-44.17	64.33	-0.62	0.90
		C43	3.60	0.0093	36.50	58.00	0.34	0.54
		C44	5.40	0.0140	36.50	38.00	0.51	0.53
		C45	3.20	0.0083	26.17	53.00	0.22	0.44
Shear Walls		S1	70.40	0.1822	-53.00	51.17	-9.66	9.32
		S2	60.00	0.1553	-15.33	53.17	-2.38	8.26
		S3	60.00	0.1553	15.33	53.17	2.38	8.26
		S4	76.80	0.1988	45.50	51.50	9.04	10.24
		S5	16.20	0.0419	-10.33	69.33	-0.43	2.91
		S6	16.20	0.0419	-10.33	49.00	-0.43	2.05
		S7	16.20	0.0419	-10.33	37.00	-0.43	1.55
		S8	16.20	0.0419	10.33	69.33	0.43	2.91
		S9	16.20	0.0419	10.33	49.00	0.43	2.05
		S10	16.20	0.0419	10.33	37.00	0.43	1.55
Curtain Walls		W1	58.86	0.1523	0.00	74.25	0.00	11.31
		W3	6.84	0.0177	107.67	-1.67	1.91	-0.03
		W4	4.320216	0.0112	106.33	-8.00	1.19	-0.09
		W5	2.4	0.0062	95.00	-8.00	0.59	-0.05
		W6	3.6	0.0093	85.00	-8.00	0.79	-0.07
		W7	2.4	0.0062	75.00	-8.00	0.47	-0.05
		W8	3.6	0.0093	65.00	-8.00	0.61	-0.07
		W9	2.4	0.0062	55.00	-8.00	0.34	-0.05
		W10	3.6	0.0093	45.00	-8.00	0.42	-0.07
		W11	2.4	0.0062	35.00	-8.00	0.22	-0.05
		W12	1.44	0.0037	25.50	-4.00	0.10	-0.01
		W13	9.18	0.0238	0.00	0.00	0.00	0.00
		W14	1.44	0.0037	-25.50	-4.00	-0.10	-0.01
		W20	2.4	0.0062	-35.00	-8.00	-0.22	-0.05
		W21	3.6	0.0093	-45.00	-8.00	-0.42	-0.07
		W22	2.4	0.0062	-55.00	-8.00	-0.34	-0.05
		W23	3.6	0.0093	-65.00	-8.00	-0.61	-0.07
		W24	2.4	0.0062	-75.00	-8.00	-0.47	-0.05
		W25	3.6	0.0093	-85.00	-8.00	-0.79	-0.07
		W26	2.4	0.0062	-95.00	-8.00	-0.59	-0.05
		W27	4.320216	0.0112	-106.33	-8.00	-1.19	-0.09
		W28	6.84	0.0177	-107.67	-1.67	-1.91	-0.03
Slab		A1	275.88	0.7140	0.00	79.70	0.00	56.90
		A2	348.69	0.9024	2.62	66.73	2.36	60.22
		A3	9.89	0.0256	-48.40	61.74	-1.24	1.58
		A4	15.55	0.0402	-48.34	47.40	-1.95	1.91
		A5	73.81	0.1910	-29.71	51.21	-5.67	9.78
		A6	21.43	0.0555	0.00	59.17	0.00	3.28
		A7	12.19	0.0315	0.00	43.00	0.00	1.36
		A8	18.71	0.0484	30.25	62.40	1.46	3.02
		A9	8.70	0.0225	31.20	56.00	0.70	1.26
		A10	35.57	0.0921	25.32	46.54	2.33	4.28
		A11	15.64	0.0405	40.90	47.82	1.66	1.94

		A12	413.10	1.0691	0.00	26.18	0.00	27.99
		A13	374.75	0.9699	0.00	4.40	0.00	4.27
Beams		B1	0.63	0.0016	-44.00	61.25	-0.07	0.10
		B2	3.53	0.0091	-44.00	47.83	-0.40	0.44
		B14	8.10	0.0210	95.50	-7.00	2.00	-0.15
		B15	8.10	0.0210	75.00	-7.00	1.57	-0.15
		B16	8.10	0.0210	55.00	-7.00	1.15	-0.15
		B17	7.73	0.0200	-35.42	-7.00	-0.71	-0.14
		B19	7.73	0.0200	35.42	-7.00	0.71	-0.14
		B20	8.10	0.0210	-55.00	-7.00	-1.15	-0.15
		B21	8.10	0.0210	-75.00	-7.00	-1.57	-0.15
		B22	8.10	0.0210	-95.50	-7.00	-2.00	-0.15
		B23	5.18	0.0134	-92.75	31.00	-1.24	0.42
		B24	5.18	0.0134	92.75	31.00	1.24	0.42
	24x12 Beams	B25	9.45	0.0245	-69.45	37.50	-1.70	0.92
		B26	9.45	0.0245	69.45	37.50	1.70	0.92
		B44	2.18	0.0056	-98.21	14.38	-0.55	0.08
		B45	3.45	0.0089	-77.50	15.00	-0.69	0.13
		B46	3.45	0.0089	-52.50	15.00	-0.47	0.13
		B47	3.45	0.0089	-27.50	15.00	-0.25	0.13
		B48	4.20	0.0109	0.00	15.00	0.00	0.16
		B49	3.45	0.0089	27.50	15.00	0.25	0.13
		B50	3.45	0.0089	52.50	15.00	0.47	0.13
		B51	3.45	0.0089	77.50	15.00	0.69	0.13
		B52	2.18	0.0056	98.21	14.38	0.55	0.08
		B53	3.75	0.0097	-79.50	49.00	-0.77	0.48
		B54	3.79	0.0098	-62.00	69.50	-0.61	0.68
		B55	3.79	0.0098	-39.40	84.40	-0.39	0.83
		B56	3.79	0.0098	-13.50	92.17	-0.13	0.90
		B57	3.79	0.0098	13.50	92.17	0.13	0.90
		B58	3.79	0.0098	39.40	84.40	0.39	0.83
		B59	3.79	0.0098	62.00	69.50	0.61	0.68
		B60	3.75	0.0098	79.50	49.00	0.78	0.48
	8x36 Beams	B27	2.40	0.0062	-48.33	36.83	-0.30	0.23
		B30	8.35	0.0216	-29.75	65.50	-0.64	1.42
		B32	7.95	0.0206	-29.08	36.83	-0.60	0.76
		B36	2.40	0.0062	30.00	66.17	0.19	0.41
		B42	6.05	0.0157	25.92	36.83	0.41	0.58
		B43	2.15	0.0056	40.58	36.83	0.23	0.20
	8x24 Beams	B28	1.53	0.0040	-48.50	58.00	-0.19	0.23
		B37	4.03	0.0104	25.92	58.67	0.27	0.61
		B38	1.57	0.0041	40.92	58.67	0.17	0.24
		B39	0.93	0.0024	25.83	56.00	0.06	0.14
		B40	1.90	0.0049	31.58	53.33	0.16	0.26
		B41	3.50	0.0091	36.67	48.25	0.33	0.44
		B61	3.87	0.0100	-6.17	59.17	-0.06	0.59
		B62	3.87	0.0100	6.17	59.17	0.06	0.59
		B63	2.20	0.0057	-6.17	43.00	-0.04	0.24
		B64	2.20	0.0057	6.17	43.00	0.04	0.24
	16x24 Beams	B29	3.07	0.0079	-48.50	65.00	-0.38	0.52
	12x26 Beams	B33	3.79	0.0098	0.00	69.33	0.00	0.68
		B34	3.79	0.0098	0.00	49.00	0.00	0.48
		B35	3.79	0.0098	0.00	37.00	0.00	0.36
Sum			2670.62	6.9116			-5.36	283.63

Center of Mass	
X Coord:	-0.775
Y Coord:	41.036

Mass and Center of Mass
Typical Odd Floor

Type	Sub-type	Num.	Weight (k)	Mass (k-s^2/in)	X Centroid	Y Centroid	Mx	Yx
Columns	24x24 Columns	C14.5	7.20	0.0186	105	-7	1.96	-0.13
		C15	7.20	0.0186	85.00	-7.00	1.58	-0.13
		C16	7.20	0.0186	65.00	-7.00	1.21	-0.13
		C17	7.20	0.0186	45.00	-7.00	0.84	-0.13
		C20	7.20	0.0186	-45.00	-7.00	-0.84	-0.13
		C21	7.20	0.0186	-65.00	-7.00	-1.21	-0.13
		C22	7.20	0.0186	-85.00	-7.00	-1.58	-0.13
		C22.5	7.20	0.0186	-105.00	-7.00	-1.96	-0.13
		C23	7.20	0.0186	-92.83	14.88	-1.73	0.28
		C24	7.20	0.0186	-86.23	37.50	-1.61	0.70
		C25	7.20	0.0186	-72.06	60.37	-1.34	1.12
		C26	7.20	0.0186	-51.69	78.52	-0.96	1.46
		C27	7.20	0.0186	-26.98	90.05	-0.50	1.68
		C28	7.20	0.0186	0.00	94.01	0.00	1.75
		C29	7.20	0.0186	26.98	90.05	0.50	1.68
		C30	7.20	0.0186	51.69	78.52	0.96	1.46
		C31	7.20	0.0186	72.06	60.37	1.34	1.12
		C32	7.20	0.0186	86.23	37.50	1.61	0.70
		C33	7.20	0.0186	92.83	14.88	1.73	0.28
		C34	7.20	0.0186	67.50	14.88	1.26	0.28
		C35	7.20	0.0186	42.17	14.88	0.79	0.28
		C36	7.20	0.0186	16.83	14.88	0.31	0.28
		C37	7.20	0.0186	-16.83	14.88	-0.31	0.28
		C38	7.20	0.0186	-42.17	14.88	-0.79	0.28
		C39	7.20	0.0186	-67.50	14.88	-1.26	0.28
		C40	7.20	0.0186	-43.33	37.50	-0.81	0.70
	24x30 Columns	C1	9.00	0.0233	-117.75	0.00	-2.74	0.00
		C2	9.00	0.0233	-116.74	15.37	-2.72	0.36
		C3	9.00	0.0233	-108.79	45.06	-2.53	1.05
		C4	9.00	0.0233	-93.42	71.67	-2.18	1.67
		C5	9.00	0.0233	-71.69	93.41	-1.67	2.18
		C6	9.00	0.0233	-45.07	108.78	-1.05	2.53
		C7	9.00	0.0233	-15.39	116.74	-0.36	2.72
		C8	9.00	0.0233	15.39	116.74	0.36	2.72
		C9	9.00	0.0233	45.07	108.78	1.05	2.53
		C10	9.00	0.0233	71.69	93.41	1.67	2.18
		C11	9.00	0.0233	93.42	71.67	2.18	1.67
		C12	9.00	0.0233	108.79	45.06	2.53	1.05
		C13	9.00	0.0233	116.74	15.37	2.72	0.36
		C14	9.00	0.0233	117.75	0.00	2.74	0.00
		C18	9.00	0.0233	15.00	-6.75	0.35	-0.16
		C19	9.00	0.0233	-15.00	-6.75	-0.35	-0.16
	Misc. Columns	C41	5.40	0.0140	-44.17	58.17	-0.62	0.81
		C42	5.40	0.0140	-44.17	64.33	-0.62	0.90
		C43	3.60	0.0093	36.50	58.00	0.34	0.54
		C44	5.40	0.0140	36.50	38.00	0.51	0.53
		C45	3.20	0.0083	26.17	53.00	0.22	0.44
Shear Walls		S1	70.40	0.1822	-53.00	51.17	-9.66	9.32
		S2	60.00	0.1553	-15.33	53.17	-2.38	8.26
		S3	60.00	0.1553	15.33	53.17	2.38	8.26

		S4	76.80	0.1988	45.50	51.50	9.04	10.24
		S5	16.20	0.0419	-10.33	69.33	-0.43	2.91
		S6	16.20	0.0419	-10.33	49.00	-0.43	2.05
		S7	16.20	0.0419	-10.33	37.00	-0.43	1.55
		S8	16.20	0.0419	10.33	69.33	0.43	2.91
		S9	16.20	0.0419	10.33	49.00	0.43	2.05
		S10	16.20	0.0419	10.33	37.00	0.43	1.55
Curtain Walls		W1	67.29	0.1742	0.00	75.81	0.00	13.20
		W2	2.0394	0.0053	113.25	0.00	0.60	0.00
		W3	4.32	0.0112	109.67	-4.00	1.23	-0.04
		W4	3.60018	0.0093	106.33	-8.00	0.99	-0.07
		W5	3.84	0.0099	95.00	-8.00	0.94	-0.08
		W6	2.16	0.0056	85.00	-8.00	0.48	-0.04
		W7	3.84	0.0099	75.00	-8.00	0.75	-0.08
		W8	2.16	0.0056	65.00	-8.00	0.36	-0.04
		W9	3.84	0.0099	55.00	-8.00	0.55	-0.08
		W10	2.16	0.0056	45.00	-8.00	0.25	-0.04
		W11	3.84	0.0099	35.00	-8.00	0.35	-0.08
		W12	2.06982	0.0054	25.08	-8.00	0.13	-0.04
		W13	0.54	0.0014	23.17	-9.50	0.03	-0.01
		W14	1.3194	0.0034	19.50	-10.60	0.07	-0.04
		W15	2.8494	0.0074	7.92	-9.85	0.06	-0.07
		W16	2.8494	0.0074	-7.92	-9.85	-0.06	-0.07
		W17	1.3194	0.0034	-19.50	-10.60	-0.07	-0.04
		W18	0.54	0.0014	-23.17	-9.50	-0.03	-0.01
		W19	2.06982	0.0054	-25.08	-8.00	-0.13	-0.04
		W20	3.84	0.0099	-35.00	-8.00	-0.35	-0.08
		W21	2.16	0.0056	-45.00	-8.00	-0.25	-0.04
		W22	3.84	0.0099	-55.00	-8.00	-0.55	-0.08
		W23	2.16	0.0056	-65.00	-8.00	-0.36	-0.04
		W24	3.84	0.0099	-75.00	-8.00	-0.75	-0.08
		W25	2.16	0.0056	-85.00	-8.00	-0.48	-0.04
		W26	3.84	0.0099	-95.00	-8.00	-0.94	-0.08
		W27	3.60018	0.0093	-106.33	-8.00	-0.99	-0.07
		W28	4.32	0.0112	-109.67	-4.00	-1.23	-0.04
		W29	2.0394	0.0053	-113.25	0.00	-0.60	0.00
Slab	Flat Portions	A1	894.14	2.3140	1.00	76.67	2.31	177.42
		A2	9.89	0.0256	-48.42	61.74	-1.24	1.58
		A3	15.55	0.0402	-48.34	47.40	-1.95	1.91
		A4	51.39	0.1330	-29.71	46.95	-3.95	6.24
		A5	21.43	0.0555	0.00	59.17	0.00	3.28
		A6	12.19	0.0316	0.00	43.00	0.00	1.36
		A7	8.70	0.0225	31.20	55.98	0.70	1.26
		A8	35.57	0.0921	25.32	46.54	2.33	4.28
		A9	15.67	0.0405	40.90	47.80	1.66	1.94
		A10	939.05	2.4302	0.00	15.67	0.00	38.08
		A11	9.00	0.0233	0.00	-9.10	0.00	-0.21
Beams	24x18 Beams	B1	6.08	0.0157	-117.30	7.70	-1.84	0.12
		B2	13.05	0.0338	-113.74	30.47	-3.84	1.03
		B3	13.05	0.0338	-101.98	58.87	-3.44	1.99
		B4	13.05	0.0338	-83.27	83.26	-2.81	2.81
		B5	13.05	0.0338	-58.89	101.97	-1.99	3.44
		B6	13.05	0.0338	-30.49	113.73	-1.03	3.84
		B7	13.05	0.0338	0.00	117.75	0.00	3.98

		B8	13.05	0.0338	30.49	113.73	1.03	3.84
		B9	13.05	0.0338	58.89	101.97	1.99	3.44
		B10	13.05	0.0338	83.27	83.26	2.81	2.81
		B11	13.05	0.0338	101.98	58.87	3.44	1.99
		B12	13.05	0.0338	113.74	30.47	3.84	1.03
		B13	6.08	0.0157	117.30	7.70	1.84	0.12
		B14	8.10	0.0210	95.50	-7.00	2.00	-0.15
		B15	8.10	0.0210	75.00	-7.00	1.57	-0.15
		B16	8.10	0.0210	55.00	-7.00	1.15	-0.15
		B17	12.60	0.0326	30.00	-7.00	0.98	-0.23
		B18	12.60	0.0326	0.00	-7.00	0.00	-0.23
		B19	12.60	0.0326	-30.00	-7.00	-0.98	-0.23
		B20	8.10	0.0210	-55.00	-7.00	-1.15	-0.15
		B21	8.10	0.0210	-75.00	-7.00	-1.57	-0.15
		B22	8.10	0.0210	-95.50	-7.00	-2.00	-0.15
		B23	9.75	0.0252	-97.43	41.04	-2.46	1.04
		B24	9.75	0.0252	97.43	41.04	2.46	1.04
	24x12 Beams	B25	9.45	0.0245	-69.45	37.50	-1.70	0.92
		B26	9.45	0.0245	69.45	37.50	1.70	0.92
		B44	3.68	0.0095	-103.25	15.00	-0.98	0.14
		B45	3.45	0.0089	-77.50	15.00	-0.69	0.13
		B46	3.45	0.0089	-52.50	15.00	-0.47	0.13
		B47	3.45	0.0089	-27.50	15.00	-0.25	0.13
		B48	4.20	0.0109	0.00	15.00	0.00	0.16
		B49	3.45	0.0089	27.50	15.00	0.25	0.13
		B50	3.45	0.0089	52.50	15.00	0.47	0.13
		B51	3.45	0.0089	77.50	15.00	0.69	0.13
		B52	3.68	0.0095	103.25	15.00	0.98	0.14
		B53	3.75	0.0097	-79.50	49.00	-0.77	0.48
		B54	3.79	0.0098	-62.00	69.50	-0.61	0.68
		B55	3.79	0.0098	-39.40	84.40	-0.39	0.83
		B56	3.79	0.0098	-13.50	92.17	-0.13	0.90
		B57	3.79	0.0098	13.50	92.17	0.13	0.90
		B58	3.79	0.0098	39.40	84.40	0.39	0.83
		B59	3.79	0.0098	62.00	69.50	0.61	0.68
		B60	3.75	0.0098	79.50	49.00	0.78	0.48
	8x36 Beams	B27	2.40	0.0062	-48.33	36.83	-0.30	0.23
		B30	8.35	0.0216	-29.75	65.50	-0.64	1.42
		B32	7.95	0.0206	-29.08	36.83	-0.60	0.76
		B36	2.40	0.0062	30.00	66.17	0.19	0.41
		B42	6.05	0.0157	25.92	36.83	0.41	0.58
		B43	2.15	0.0056	40.58	36.83	0.23	0.20
	8x24 Beams	B28	1.53	0.0040	-48.50	58.00	-0.19	0.23
		B31	1.53	0.0040	-29.75	57.00	-0.12	0.23
		B37	4.03	0.0104	25.92	58.67	0.27	0.61
		B38	1.57	0.0041	40.92	58.67	0.17	0.24
		B39	0.93	0.0024	25.83	56.00	0.06	0.14
		B40	1.90	0.0049	31.58	53.33	0.16	0.26
		B41	3.50	0.0091	36.67	48.25	0.33	0.44
		B61	3.87	0.0100	-6.17	59.17	-0.06	0.59
		B62	3.87	0.0100	6.17	59.17	0.06	0.59
		B63	2.20	0.0057	-6.17	43.00	-0.04	0.24
		B64	2.20	0.0057	6.17	43.00	0.04	0.24
	16x24 Beams	B29	3.07	0.0079	-48.50	65.00	-0.38	0.52

	12x26 Beams	B33	3.79	0.0098	0.00	69.33	0.00	0.68
		B34	3.79	0.0098	0.00	49.00	0.00	0.48
		B35	3.79	0.0098	0.00	37.00	0.00	0.36
Sum			3282.27	8.4946			-4.10	384.83

Center of Mass	
X Coord:	-0.483
Y Coord:	45.304

Mass and Center of Mass
Typical Even Floor

Type	Sub-type	Num.	Weight (k)	Mass (k-s^2/in)	X Centroid	Y Centroid	Mx	Yx
Columns	24x24 Columns	C14.5	7.20	0.0186	105	-7	1.96	-0.13
		C15	7.20	0.0186	85.00	-7.00	1.58	-0.13
		C16	7.20	0.0186	65.00	-7.00	1.21	-0.13
		C17	7.20	0.0186	45.00	-7.00	0.84	-0.13
		C20	7.20	0.0186	-45.00	-7.00	-0.84	-0.13
		C21	7.20	0.0186	-65.00	-7.00	-1.21	-0.13
		C22	7.20	0.0186	-85.00	-7.00	-1.58	-0.13
		C22.5	7.20	0.0186	-105.00	-7.00	-1.96	-0.13
		C23	7.20	0.0186	-92.83	14.88	-1.73	0.28
		C24	7.20	0.0186	-86.23	37.50	-1.61	0.70
		C25	7.20	0.0186	-72.06	60.37	-1.34	1.12
		C26	7.20	0.0186	-51.69	78.52	-0.96	1.46
		C27	7.20	0.0186	-26.98	90.05	-0.50	1.68
		C28	7.20	0.0186	0.00	94.01	0.00	1.75
		C29	7.20	0.0186	26.98	90.05	0.50	1.68
		C30	7.20	0.0186	51.69	78.52	0.96	1.46
		C31	7.20	0.0186	72.06	60.37	1.34	1.12
		C32	7.20	0.0186	86.23	37.50	1.61	0.70
		C33	7.20	0.0186	92.83	14.88	1.73	0.28
		C34	7.20	0.0186	67.50	14.88	1.26	0.28
		C35	7.20	0.0186	42.17	14.88	0.79	0.28
		C36	7.20	0.0186	16.83	14.88	0.31	0.28
		C37	7.20	0.0186	-16.83	14.88	-0.31	0.28
		C38	7.20	0.0186	-42.17	14.88	-0.79	0.28
		C39	7.20	0.0186	-67.50	14.88	-1.26	0.28
		C40	7.20	0.0186	-43.33	37.50	-0.81	0.70
	24x30 Columns	C1	9.00	0.0233	-117.75	0.00	-2.74	0.00
		C2	9.00	0.0233	-116.74	15.37	-2.72	0.36
		C3	9.00	0.0233	-108.79	45.06	-2.53	1.05
		C4	9.00	0.0233	-93.42	71.67	-2.18	1.67
		C5	9.00	0.0233	-71.69	93.41	-1.67	2.18
		C6	9.00	0.0233	-45.07	108.78	-1.05	2.53
		C7	9.00	0.0233	-15.39	116.74	-0.36	2.72
		C8	9.00	0.0233	15.39	116.74	0.36	2.72
		C9	9.00	0.0233	45.07	108.78	1.05	2.53
		C10	9.00	0.0233	71.69	93.41	1.67	2.18
		C11	9.00	0.0233	93.42	71.67	2.18	1.67
		C12	9.00	0.0233	108.79	45.06	2.53	1.05
		C13	9.00	0.0233	116.74	15.37	2.72	0.36
		C14	9.00	0.0233	117.75	0.00	2.74	0.00
		C18	9.00	0.0233	15.00	-6.75	0.35	-0.16
		C19	9.00	0.0233	-15.00	-6.75	-0.35	-0.16
	Misc. Columns	C41	5.40	0.0140	-44.17	58.17	-0.62	0.81
		C42	5.40	0.0140	-44.17	64.33	-0.62	0.90
		C43	3.60	0.0093	36.50	58.00	0.34	0.54
		C44	5.40	0.0140	36.50	38.00	0.51	0.53
		C45	3.20	0.0083	26.17	53.00	0.22	0.44
Shear Walls		S1	70.40	0.1822	-53.00	51.17	-9.66	9.32
		S2	60.00	0.1553	-15.33	53.17	-2.38	8.26
		S3	60.00	0.1553	15.33	53.17	2.38	8.26

		S4	76.80	0.1988	45.50	51.50	9.04	10.24
		S5	16.20	0.0419	-10.33	69.33	-0.43	2.91
		S6	16.20	0.0419	-10.33	49.00	-0.43	2.05
		S7	16.20	0.0419	-10.33	37.00	-0.43	1.55
		S8	16.20	0.0419	10.33	69.33	0.43	2.91
		S9	16.20	0.0419	10.33	49.00	0.43	2.05
		S10	16.20	0.0419	10.33	37.00	0.43	1.55
Curtain Walls		W1	67.29	0.1742	0.00	75.81	0.00	13.20
		W2	2.0394	0.0053	113.25	0.00	0.60	0.00
		W3	4.32	0.0112	109.67	-4.00	1.23	-0.04
		W4	4.320216	0.0112	106.33	-8.00	1.19	-0.09
		W5	2.4	0.0062	95.00	-8.00	0.59	-0.05
		W6	3.6	0.0093	85.00	-8.00	0.79	-0.07
		W7	2.4	0.0062	75.00	-8.00	0.47	-0.05
		W8	3.6	0.0093	65.00	-8.00	0.61	-0.07
		W9	2.4	0.0062	55.00	-8.00	0.34	-0.05
		W10	3.6	0.0093	45.00	-8.00	0.42	-0.07
		W11	2.4	0.0062	35.00	-8.00	0.22	-0.05
		W12	2.75976	0.0071	25.08	-8.00	0.18	-0.06
		W13	0.54	0.0014	23.17	-9.50	0.03	-0.01
		W14	1.3194	0.0034	19.50	-10.60	0.07	-0.04
		W15	2.8494	0.0074	7.92	-9.85	0.06	-0.07
		W16	2.8494	0.0074	-7.92	-9.85	-0.06	-0.07
		W17	1.3194	0.0034	-19.50	-10.60	-0.07	-0.04
		W18	0.54	0.0014	-23.17	-9.50	-0.03	-0.01
		W19	2.75976	0.0071	-25.08	-8.00	-0.18	-0.06
		W20	2.4	0.0062	-35.00	-8.00	-0.22	-0.05
		W21	3.6	0.0093	-45.00	-8.00	-0.42	-0.07
		W22	2.4	0.0062	-55.00	-8.00	-0.34	-0.05
		W23	3.6	0.0093	-65.00	-8.00	-0.61	-0.07
		W24	2.4	0.0062	-75.00	-8.00	-0.47	-0.05
		W25	3.6	0.0093	-85.00	-8.00	-0.79	-0.07
		W26	2.4	0.0062	-95.00	-8.00	-0.59	-0.05
		W27	4.320216	0.0112	-106.33	-8.00	-1.19	-0.09
		W28	4.32	0.0112	-109.67	-4.00	-1.23	-0.04
		W29	2.0394	0.0053	-113.25	0.00	-0.60	0.00
Slab	Flat Portions	A1	894.14	2.3140	1.00	76.67	2.31	177.42
		A2	9.89	0.0256	-48.42	61.74	-1.24	1.58
		A3	15.55	0.0402	-48.34	47.40	-1.95	1.91
		A4	51.39	0.1330	-29.71	46.95	-3.95	6.24
		A5	21.43	0.0555	0.00	59.17	0.00	3.28
		A6	12.19	0.0316	0.00	43.00	0.00	1.36
		A7	8.70	0.0225	31.20	55.98	0.70	1.26
		A8	35.57	0.0921	25.32	46.54	2.33	4.28
		A9	15.67	0.0405	40.90	47.80	1.66	1.94
		A10	939.05	2.4302	0.00	15.67	0.00	38.08
		A11	9.00	0.0233	0.00	-9.10	0.00	-0.21
Beams	24x18 Beams	B1	6.08	0.0157	-117.30	7.70	-1.84	0.12
		B2	13.05	0.0338	-113.74	30.47	-3.84	1.03
		B3	13.05	0.0338	-101.98	58.87	-3.44	1.99
		B4	13.05	0.0338	-83.27	83.26	-2.81	2.81
		B5	13.05	0.0338	-58.89	101.97	-1.99	3.44
		B6	13.05	0.0338	-30.49	113.73	-1.03	3.84
		B7	13.05	0.0338	0.00	117.75	0.00	3.98

		B8	13.05	0.0338	30.49	113.73	1.03	3.84
		B9	13.05	0.0338	58.89	101.97	1.99	3.44
		B10	13.05	0.0338	83.27	83.26	2.81	2.81
		B11	13.05	0.0338	101.98	58.87	3.44	1.99
		B12	13.05	0.0338	113.74	30.47	3.84	1.03
		B13	6.08	0.0157	117.30	7.70	1.84	0.12
		B14	8.10	0.0210	95.50	-7.00	2.00	-0.15
		B15	8.10	0.0210	75.00	-7.00	1.57	-0.15
		B16	8.10	0.0210	55.00	-7.00	1.15	-0.15
		B17	12.60	0.0326	30.00	-7.00	0.98	-0.23
		B18	12.60	0.0326	0.00	-7.00	0.00	-0.23
		B19	12.60	0.0326	-30.00	-7.00	-0.98	-0.23
		B20	8.10	0.0210	-55.00	-7.00	-1.15	-0.15
		B21	8.10	0.0210	-75.00	-7.00	-1.57	-0.15
		B22	8.10	0.0210	-95.50	-7.00	-2.00	-0.15
		B23	9.75	0.0252	-97.43	41.04	-2.46	1.04
		B24	9.75	0.0252	97.43	41.04	2.46	1.04
	24x12 Beams	B25	9.45	0.0245	-69.45	37.50	-1.70	0.92
		B26	9.45	0.0245	69.45	37.50	1.70	0.92
		B44	3.68	0.0095	-103.25	15.00	-0.98	0.14
		B45	3.45	0.0089	-77.50	15.00	-0.69	0.13
		B46	3.45	0.0089	-52.50	15.00	-0.47	0.13
		B47	3.45	0.0089	-27.50	15.00	-0.25	0.13
		B48	4.20	0.0109	0.00	15.00	0.00	0.16
		B49	3.45	0.0089	27.50	15.00	0.25	0.13
		B50	3.45	0.0089	52.50	15.00	0.47	0.13
		B51	3.45	0.0089	77.50	15.00	0.69	0.13
		B52	3.68	0.0095	103.25	15.00	0.98	0.14
		B53	3.75	0.0097	-79.50	49.00	-0.77	0.48
		B54	3.79	0.0098	-62.00	69.50	-0.61	0.68
		B55	3.79	0.0098	-39.40	84.40	-0.39	0.83
		B56	3.79	0.0098	-13.50	92.17	-0.13	0.90
		B57	3.79	0.0098	13.50	92.17	0.13	0.90
		B58	3.79	0.0098	39.40	84.40	0.39	0.83
		B59	3.79	0.0098	62.00	69.50	0.61	0.68
		B60	3.75	0.0098	79.50	49.00	0.78	0.48
	8x36 Beams	B27	2.40	0.0062	-48.33	36.83	-0.30	0.23
		B30	8.35	0.0216	-29.75	65.50	-0.64	1.42
		B32	7.95	0.0206	-29.08	36.83	-0.60	0.76
		B36	2.40	0.0062	30.00	66.17	0.19	0.41
		B42	6.05	0.0157	25.92	36.83	0.41	0.58
		B43	2.15	0.0056	40.58	36.83	0.23	0.20
	8x24 Beams	B28	1.53	0.0040	-48.50	58.00	-0.19	0.23
		B31	1.53	0.0040	-29.75	57.00	-0.12	0.23
		B37	4.03	0.0104	25.92	58.67	0.27	0.61
		B38	1.57	0.0041	40.92	58.67	0.17	0.24
		B39	0.93	0.0024	25.83	56.00	0.06	0.14
		B40	1.90	0.0049	31.58	53.33	0.16	0.26
		B41	3.50	0.0091	36.67	48.25	0.33	0.44
		B61	3.87	0.0100	-6.17	59.17	-0.06	0.59
		B62	3.87	0.0100	6.17	59.17	0.06	0.59
		B63	2.20	0.0057	-6.17	43.00	-0.04	0.24
		B64	2.20	0.0057	6.17	43.00	0.04	0.24
	16x24 Beams	B29	3.07	0.0079	-48.50	65.00	-0.38	0.52

	12x26 Beams	B33	3.79	0.0098	0.00	69.33	0.00	0.68
		B34	3.79	0.0098	0.00	49.00	0.00	0.48
		B35	3.79	0.0098	0.00	37.00	0.00	0.36
Sum			3282.21	8.4944			-4.10	384.84

Center of Mass	
X Coord:	-0.483
Y Coord:	45.305

Mass and Center of Mass
Thirteenth Floor

Type	Sub-type	Num.	Weight (k)	Mass (k-s^2/in)	X Centroid	Y Centroid	Mx	Yx
Columns	24x24 Columns	C14.5	9.30	0.0241	105	-7	2.53	-0.17
		C15	9.30	0.0241	85.00	-7.00	2.05	-0.17
		C16	9.30	0.0241	65.00	-7.00	1.56	-0.17
		C17	9.30	0.0241	45.00	-7.00	1.08	-0.17
		C20	9.30	0.0241	-45.00	-7.00	-1.08	-0.17
		C21	9.30	0.0241	-65.00	-7.00	-1.56	-0.17
		C22	9.30	0.0241	-85.00	-7.00	-2.05	-0.17
		C22.5	9.30	0.0241	-105.00	-7.00	-2.53	-0.17
		C23	9.30	0.0241	-92.83	14.88	-2.23	0.36
		C24	9.30	0.0241	-86.23	37.50	-2.08	0.90
		C25	8.10	0.0210	-72.06	60.37	-1.51	1.27
		C26	8.10	0.0210	-51.69	78.52	-1.08	1.65
		C27	8.10	0.0210	-26.98	90.05	-0.57	1.89
		C28	8.10	0.0210	0.00	94.01	0.00	1.97
		C29	8.10	0.0210	26.98	90.05	0.57	1.89
		C30	8.10	0.0210	51.69	78.52	1.08	1.65
		C31	8.10	0.0210	72.06	60.37	1.51	1.27
		C32	9.30	0.0241	86.23	37.50	2.08	0.90
		C33	9.30	0.0241	92.83	14.88	2.23	0.36
		C34	9.30	0.0241	67.50	14.88	1.62	0.36
		C35	9.30	0.0241	42.17	14.88	1.01	0.36
		C36	9.30	0.0241	16.83	14.88	0.41	0.36
		C37	9.30	0.0241	-16.83	14.88	-0.41	0.36
		C38	9.30	0.0241	-42.17	14.88	-1.01	0.36
		C39	9.30	0.0241	-67.50	14.88	-1.62	0.36
		C40	8.10	0.0210	-43.33	37.50	-0.91	0.79
	24x30 Columns	C1	10.13	0.0262	-117.75	0.00	-3.09	0.00
		C2	10.13	0.0262	-116.74	15.37	-3.06	0.40
		C3	10.13	0.0262	-108.79	45.06	-2.85	1.18
		C4	10.13	0.0262	-93.42	71.67	-2.45	1.88
		C5	10.13	0.0262	-71.69	93.41	-1.88	2.45
		C6	10.13	0.0262	-45.07	108.78	-1.18	2.85
		C7	10.13	0.0262	-15.39	116.74	-0.40	3.06
		C8	10.13	0.0262	15.39	116.74	0.40	3.06
		C9	10.13	0.0262	45.07	108.78	1.18	2.85
		C10	10.13	0.0262	71.69	93.41	1.88	2.45
		C11	10.13	0.0262	93.42	71.67	2.45	1.88
		C12	10.13	0.0262	108.79	45.06	2.85	1.18
		C13	10.13	0.0262	116.74	15.37	3.06	0.40
		C14	10.13	0.0262	117.75	0.00	3.09	0.00
		C18	4.50	0.0116	15.00	-6.75	0.17	-0.08
		C19	4.50	0.0116	-15.00	-6.75	-0.17	-0.08
	Misc. Columns	C41	6.08	0.0157	-44.17	58.17	-0.69	0.91
		C42	6.08	0.0157	-44.17	64.33	-0.69	1.01
		C43	4.05	0.0105	36.50	58.00	0.38	0.61
		C44	6.08	0.0157	36.50	38.00	0.57	0.60
		C45	3.60	0.0093	26.17	53.00	0.24	0.49
	12x12 Posts	C46	1.13	0.0029	-26.00	-6.00	-0.08	-0.02
		C47	1.13	0.0029	26.00	-6.00	0.08	-0.02
		C48	1.13	0.0029	-15.17	6.17	-0.04	0.02

		C49	1.13	0.0029	15.17	6.17	0.04	0.02
Shear Walls		S1	79.20	0.2050	-53.00	51.17	-10.86	10.49
		S2	67.50	0.1747	-15.33	53.17	-2.68	9.29
		S3	67.50	0.1747	15.33	53.17	2.68	9.29
		S4	86.40	0.2236	45.50	51.50	10.17	11.52
		S5	18.23	0.0472	-10.33	69.33	-0.49	3.27
		S6	18.23	0.0472	-10.33	49.00	-0.49	2.31
		S7	18.23	0.0472	-10.33	37.00	-0.49	1.75
		S8	18.23	0.0472	10.33	69.33	0.49	3.27
		S9	18.23	0.0472	10.33	49.00	0.49	2.31
		S10	18.23	0.0472	10.33	37.00	0.49	1.75
Curtain Walls		W1	84.12	0.2177	0.00	75.81	0.00	16.50
		W2	2.54925	0.0066	113.25	0.00	0.75	0.00
		W3	5.4	0.0140	109.67	-4.00	1.53	-0.06
		W4	4.500225	0.0116	106.33	-8.00	1.24	-0.09
		W5	4.56	0.0118	95.00	-8.00	1.12	-0.09
		W6	2.7	0.0070	85.00	-8.00	0.59	-0.06
		W7	4.56	0.0118	75.00	-8.00	0.89	-0.09
		W8	2.7	0.0070	65.00	-8.00	0.45	-0.06
		W9	4.56	0.0118	55.00	-8.00	0.65	-0.09
		W10	2.7	0.0070	45.00	-8.00	0.31	-0.06
		W11	4.56	0.0118	35.00	-8.00	0.41	-0.09
		W12	2.587275	0.0067	25.08	-8.00	0.17	-0.05
		W2.1	3.07485	0.0080	-25.67	-1.17	-0.20	-0.01
		W2.2	2.475	0.0064	-20.17	5.67	-0.13	0.04
		W2.3	3.6	0.0093	-7.33	2.50	-0.07	0.02
		W2.4	3.6	0.0093	7.33	2.50	0.07	0.02
		W2.5	2.475	0.0064	20.17	5.67	0.13	0.04
		W2.6	3.07485	0.0080	25.67	-1.17	0.20	-0.01
		W2.7	3.1274775	0.0081	0.00	-8.00	0.00	-0.06
		W19	2.587275	0.0067	-25.08	-8.00	-0.17	-0.05
		W20	4.56	0.0118	-35.00	-8.00	-0.41	-0.09
		W21	2.7	0.0070	-45.00	-8.00	-0.31	-0.06
		W22	4.56	0.0118	-55.00	-8.00	-0.65	-0.09
		W23	2.7	0.0070	-65.00	-8.00	-0.45	-0.06
		W24	4.56	0.0118	-75.00	-8.00	-0.89	-0.09
		W25	2.7	0.0070	-85.00	-8.00	-0.59	-0.06
		W26	4.56	0.0118	-95.00	-8.00	-1.12	-0.09
		W27	4.500225	0.0116	-106.33	-8.00	-1.24	-0.09
		W28	5.4	0.0140	-109.67	-4.00	-1.53	-0.06
		W29	2.54925	0.0066	-113.25	0.00	-0.75	0.00
Slab	Flat Portions	A1	894.14	2.3140	1.00	76.67	2.31	177.42
		A2	9.89	0.0256	-48.42	61.74	-1.24	1.58
		A3	15.55	0.0402	-48.34	47.40	-1.95	1.91
		A4	51.39	0.1330	-29.71	46.95	-3.95	6.24
		A5	21.43	0.0555	0.00	59.17	0.00	3.28
		A6	12.19	0.0316	0.00	43.00	0.00	1.36
		A7	8.70	0.0225	31.20	55.98	0.70	1.26
		A8	35.57	0.0921	25.32	46.54	2.33	4.28
		A9	15.67	0.0405	40.90	47.80	1.66	1.94
		A10	939.05	2.4302	0.00	15.67	0.00	38.08
		A11	9.00	0.0233	0.00	-9.10	0.00	-0.21
Beams	24x18 Beams	B1	6.08	0.0157	-117.30	7.70	-1.84	0.12
		B2	13.05	0.0338	-113.74	30.47	-3.84	1.03

		B3	13.05	0.0338	-101.98	58.87	-3.44	1.99
		B4	13.05	0.0338	-83.27	83.26	-2.81	2.81
		B5	13.05	0.0338	-58.89	101.97	-1.99	3.44
		B6	13.05	0.0338	-30.49	113.73	-1.03	3.84
		B7	13.05	0.0338	0.00	117.75	0.00	3.98
		B8	13.05	0.0338	30.49	113.73	1.03	3.84
		B9	13.05	0.0338	58.89	101.97	1.99	3.44
		B10	13.05	0.0338	83.27	83.26	2.81	2.81
		B11	13.05	0.0338	101.98	58.87	3.44	1.99
		B12	13.05	0.0338	113.74	30.47	3.84	1.03
		B13	6.08	0.0157	117.30	7.70	1.84	0.12
		B14	8.10	0.0210	95.50	-7.00	2.00	-0.15
		B15	8.10	0.0210	75.00	-7.00	1.57	-0.15
		B16	8.10	0.0210	55.00	-7.00	1.15	-0.15
		B17	12.60	0.0326	30.00	-7.00	0.98	-0.23
		B18	12.60	0.0326	0.00	-7.00	0.00	-0.23
		B19	12.60	0.0326	-30.00	-7.00	-0.98	-0.23
		B20	8.10	0.0210	-55.00	-7.00	-1.15	-0.15
		B21	8.10	0.0210	-75.00	-7.00	-1.57	-0.15
		B22	8.10	0.0210	-95.50	-7.00	-2.00	-0.15
		B23	9.75	0.0252	-97.43	41.04	-2.46	1.04
		B24	9.75	0.0252	97.43	41.04	2.46	1.04
	24x12 Beams	B25	9.45	0.0245	-69.45	37.50	-1.70	0.92
		B26	9.45	0.0245	69.45	37.50	1.70	0.92
		B44	3.68	0.0095	-103.25	15.00	-0.98	0.14
		B45	3.45	0.0089	-77.50	15.00	-0.69	0.13
		B46	3.45	0.0089	-52.50	15.00	-0.47	0.13
		B47	3.45	0.0089	-27.50	15.00	-0.25	0.13
		B48	4.20	0.0109	0.00	15.00	0.00	0.16
		B49	3.45	0.0089	27.50	15.00	0.25	0.13
		B50	3.45	0.0089	52.50	15.00	0.47	0.13
		B51	3.45	0.0089	77.50	15.00	0.69	0.13
		B52	3.68	0.0095	103.25	15.00	0.98	0.14
		B53	3.75	0.0097	-79.50	49.00	-0.77	0.48
		B54	3.79	0.0098	-62.00	69.50	-0.61	0.68
		B55	3.79	0.0098	-39.40	84.40	-0.39	0.83
		B56	3.79	0.0098	-13.50	92.17	-0.13	0.90
		B57	3.79	0.0098	13.50	92.17	0.13	0.90
		B58	3.79	0.0098	39.40	84.40	0.39	0.83
		B59	3.79	0.0098	62.00	69.50	0.61	0.68
		B60	3.75	0.0098	79.50	49.00	0.78	0.48
	8x36 Beams	B27	2.40	0.0062	-48.33	36.83	-0.30	0.23
		B30	8.35	0.0216	-29.75	65.50	-0.64	1.42
		B32	7.95	0.0206	-29.08	36.83	-0.60	0.76
		B36	2.40	0.0062	30.00	66.17	0.19	0.41
		B42	6.05	0.0157	25.92	36.83	0.41	0.58
		B43	2.15	0.0056	40.58	36.83	0.23	0.20
	8x24 Beams	B28	1.53	0.0040	-48.50	58.00	-0.19	0.23
		B31	1.53	0.0040	-29.75	57.00	-0.12	0.23
		B37	4.03	0.0104	25.92	58.67	0.27	0.61
		B38	1.57	0.0041	40.92	58.67	0.17	0.24
		B39	0.93	0.0024	25.83	56.00	0.06	0.14
		B40	1.90	0.0049	31.58	53.33	0.16	0.26
		B41	3.50	0.0091	36.67	48.25	0.33	0.44

		B61	3.87	0.0100	-6.17	59.17	-0.06	0.59
		B62	3.87	0.0100	6.17	59.17	0.06	0.59
		B63	2.20	0.0057	-6.17	43.00	-0.04	0.24
		B64	2.20	0.0057	6.17	43.00	0.04	0.24
	16x24 Beams	B29	3.07	0.0079	-48.50	65.00	-0.38	0.52
	12x26 Beams	B33	3.79	0.0098	0.00	69.33	0.00	0.68
		B34	3.79	0.0098	0.00	49.00	0.00	0.48
		B35	3.79	0.0098	0.00	37.00	0.00	0.36
Sum			3428.69	8.8735			-4.87	399.63

Center of Mass	
X Coord:	-0.549
Y Coord:	45.037

Mass and Center of Mass
Roof

Type	Sub-type	Num.	Weight (k)	Mass (k-s^2/in)	X Centroid	Y Centroid	Mx	Yx
Columns	24x24 Columns	C14.5	5.70	0.0148	105	-7	1.55	-0.10
		C15	5.70	0.0148	85.00	-7.00	1.25	-0.10
		C16	5.70	0.0148	65.00	-7.00	0.96	-0.10
		C17	5.70	0.0148	45.00	-7.00	0.66	-0.10
		C20	5.70	0.0148	-45.00	-7.00	-0.66	-0.10
		C21	5.70	0.0148	-65.00	-7.00	-0.96	-0.10
		C22	5.70	0.0148	-85.00	-7.00	-1.25	-0.10
		C22.5	5.70	0.0148	-105.00	-7.00	-1.55	-0.10
		C23	5.70	0.0148	-92.83	14.88	-1.37	0.22
		C24	5.70	0.0148	-86.23	37.50	-1.27	0.55
		C25	4.50	0.0116	-72.06	60.37	-0.84	0.70
		C26	4.50	0.0116	-51.69	78.52	-0.60	0.91
		C27	4.50	0.0116	-26.98	90.05	-0.31	1.05
		C28	4.50	0.0116	0.00	94.01	0.00	1.09
		C29	4.50	0.0116	26.98	90.05	0.31	1.05
		C30	4.50	0.0116	51.69	78.52	0.60	0.91
		C31	4.50	0.0116	72.06	60.37	0.84	0.70
		C32	5.70	0.0148	86.23	37.50	1.27	0.55
		C33	5.70	0.0148	92.83	14.88	1.37	0.22
		C34	5.70	0.0148	67.50	14.88	1.00	0.22
		C35	5.70	0.0148	42.17	14.88	0.62	0.22
		C36	5.70	0.0148	16.83	14.88	0.25	0.22
		C37	5.70	0.0148	-16.83	14.88	-0.25	0.22
		C38	5.70	0.0148	-42.17	14.88	-0.62	0.22
		C39	5.70	0.0148	-67.50	14.88	-1.00	0.22
		C40	7.50	0.0194	-43.33	37.50	-0.84	0.73
	24x30 Columns	C1	5.63	0.0146	-117.75	0.00	-1.71	0.00
		C2	5.63	0.0146	-116.74	15.37	-1.70	0.22
		C3	5.63	0.0146	-108.79	45.06	-1.58	0.66
		C4	5.63	0.0146	-93.42	71.67	-1.36	1.04
		C5	5.63	0.0146	-71.69	93.41	-1.04	1.36
		C6	5.63	0.0146	-45.07	108.78	-0.66	1.58
		C7	5.63	0.0146	-15.39	116.74	-0.22	1.70
		C8	5.63	0.0146	15.39	116.74	0.22	1.70
		C9	5.63	0.0146	45.07	108.78	0.66	1.58
		C10	5.63	0.0146	71.69	93.41	1.04	1.36
		C11	5.63	0.0146	93.42	71.67	1.36	1.04
		C12	5.63	0.0146	108.79	45.06	1.58	0.66
		C13	5.63	0.0146	116.74	15.37	1.70	0.22
		C14	5.63	0.0146	117.75	0.00	1.71	0.00
	Misc. Columns	C41	5.63	0.0146	-44.17	58.17	-0.64	0.85
		C42	5.63	0.0146	-44.17	64.33	-0.64	0.94
		C43	2.25	0.0058	36.50	58.00	0.21	0.34
		C44	3.38	0.0087	36.50	38.00	0.32	0.33
		C45	2.00	0.0052	26.17	53.00	0.14	0.27
	12x12 Posts	C46	1.13	0.0029	-26.00	-6.00	-0.08	-0.02
		C47	1.13	0.0029	26.00	-6.00	0.08	-0.02
		C48	1.13	0.0029	-15.17	6.17	-0.04	0.02
		C49	1.13	0.0029	15.17	6.17	0.04	0.02
		C50	0.75	0.0019	-52.83	75.67	-0.10	0.15

		C51	0.75	0.0019	-44.33	75.67	-0.09	0.15
		C52	0.75	0.0019	-38.33	75.67	-0.07	0.15
		C53	0.75	0.0019	-30.83	75.67	-0.06	0.15
		C54	0.75	0.0019	-23.33	75.67	-0.05	0.15
		C55	0.75	0.0019	-38.33	65.67	-0.07	0.13
		C56	0.75	0.0019	-30.83	65.67	-0.06	0.13
		C57	0.75	0.0019	-23.33	65.67	-0.05	0.13
		C58	0.75	0.0019	-38.33	55.67	-0.07	0.11
		C59	0.75	0.0019	-30.83	55.67	-0.06	0.11
		C60	0.75	0.0019	-23.33	55.67	-0.05	0.11
		C61	0.75	0.0019	-38.33	46.67	-0.07	0.09
		C62	0.75	0.0019	-30.83	46.67	-0.06	0.09
		C63	0.75	0.0019	-23.33	46.67	-0.05	0.09
		C64	0.75	0.0019	-38.33	38.67	-0.07	0.08
		C65	0.75	0.0019	-30.83	38.67	-0.06	0.08
		C66	0.75	0.0019	-23.33	38.67	-0.05	0.08
		C67	0.75	0.0019	-15.33	85.33	-0.03	0.17
		C68	0.75	0.0019	15.33	85.33	0.03	0.17
		C69	0.75	0.0019	23.33	75.67	0.05	0.15
		C70	0.75	0.0019	30.83	75.67	0.06	0.15
		C71	0.75	0.0019	38.33	75.67	0.07	0.15
		C72	0.75	0.0019	44.33	75.67	0.09	0.15
		C73	0.75	0.0019	52.83	75.67	0.10	0.15
		C74	0.75	0.0019	23.33	65.67	0.05	0.13
		C75	0.75	0.0019	30.83	65.67	0.06	0.13
		C76	0.75	0.0019	38.33	65.67	0.07	0.13
		C77	0.75	0.0019	52.83	65.67	0.10	0.13
		C78	0.75	0.0019	23.33	55.67	0.05	0.11
		C79	0.75	0.0019	38.33	55.67	0.07	0.11
		C80	0.75	0.0019	44.33	55.67	0.09	0.11
		C81	0.75	0.0019	52.83	55.67	0.10	0.11
		C82	0.75	0.0019	23.33	46.67	0.05	0.09
		C83	0.75	0.0019	30.83	46.67	0.06	0.09
		C84	0.75	0.0019	38.33	46.67	0.07	0.09
		C85	0.75	0.0019	44.33	46.67	0.09	0.09
		C86	0.75	0.0019	52.83	46.67	0.10	0.09
		C87	0.75	0.0019	23.33	38.67	0.05	0.08
		C88	0.75	0.0019	30.83	38.67	0.06	0.08
		C89	0.75	0.0019	38.33	38.67	0.07	0.08
		C90	0.75	0.0019	52.83	38.67	0.10	0.08
Shear Walls		S1B	44.00	0.1139	-53.00	51.17	-6.04	5.83
		S1A	26.00	0.0673	-53.00	52.50	-3.57	3.53
		S2	55.63	0.1440	-15.33	53.17	-2.21	7.65
		S3	55.63	0.1440	15.33	53.17	2.21	7.65
		S4B	48.00	0.1242	45.50	51.50	5.65	6.40
		S4A	6.00	0.0155	45.50	51.50	0.71	0.80
		S5	15.02	0.0389	-10.33	69.33	-0.40	2.69
		S6	15.02	0.0389	-10.33	49.00	-0.40	1.90
		S7	15.02	0.0389	-10.33	37.00	-0.40	1.44
		S8	15.02	0.0389	10.33	69.33	0.40	2.69
		S9	15.02	0.0389	10.33	49.00	0.40	1.90
		S10	15.02	0.0389	10.33	37.00	0.40	1.44
Curtain Walls		W1	22.43	0.0581	0.00	75.81	0.00	4.40
		W2	0.6798	0.0018	113.25	0.00	0.20	0.00

		W3	4.32	0.0112	109.67	-4.00	1.23	-0.04
		W4	6.120306	0.0158	106.33	-8.00	1.68	-0.13
		W5	1.68	0.0043	95.00	-8.00	0.41	-0.03
		W6	7.2	0.0186	85.00	-8.00	1.58	-0.15
		W7	1.68	0.0043	75.00	-8.00	0.33	-0.03
		W8	7.2	0.0186	65.00	-8.00	1.21	-0.15
		W9	1.68	0.0043	55.00	-8.00	0.24	-0.03
		W10	7.2	0.0186	45.00	-8.00	0.84	-0.15
		W11	1.68	0.0043	35.00	-8.00	0.15	-0.03
		W12	3.518694	0.0091	25.08	-8.00	0.23	-0.07
		W2.1	1.22994	0.0032	-25.67	-1.17	-0.08	0.00
		W2.2	0.99	0.0026	-20.17	5.67	-0.05	0.01
		W2.3	1.44	0.0037	-7.33	2.50	-0.03	0.01
		W2.4	1.44	0.0037	7.33	2.50	0.03	0.01
		W2.5	0.99	0.0026	20.17	5.67	0.05	0.01
		W2.6	1.22994	0.0032	25.67	-1.17	0.08	0.00
		W2.7	3.1274775	0.0081	0.00	-8.00	0.00	-0.06
		W19	3.518694	0.0091	-25.08	-8.00	-0.23	-0.07
		W20	1.68	0.0043	-35.00	-8.00	-0.15	-0.03
		W21	7.2	0.0186	-45.00	-8.00	-0.84	-0.15
		W22	1.68	0.0043	-55.00	-8.00	-0.24	-0.03
		W23	7.2	0.0186	-65.00	-8.00	-1.21	-0.15
		W24	1.68	0.0043	-75.00	-8.00	-0.33	-0.03
		W25	7.2	0.0186	-85.00	-8.00	-1.58	-0.15
		W26	1.68	0.0043	-95.00	-8.00	-0.41	-0.03
		W27	6.120306	0.0158	-106.33	-8.00	-1.68	-0.13
		W28	4.32	0.0112	-109.67	-4.00	-1.23	-0.04
		W29	0.6798	0.0018	-113.25	0.00	-0.20	0.00
Slab	Flat Portions	A1	894.14	2.3140	1.00	76.67	2.31	177.42
		A2	9.89	0.0256	-48.42	61.74	-1.24	1.58
		A3	15.55	0.0402	-48.34	47.40	-1.95	1.91
		A4	51.39	0.1330	-29.71	46.95	-3.95	6.24
		A5	21.43	0.0555	0.00	59.17	0.00	3.28
		A6	12.19	0.0316	0.00	43.00	0.00	1.36
		A7	8.70	0.0225	31.20	55.98	0.70	1.26
		A8	35.57	0.0921	25.32	46.54	2.33	4.28
		A9	15.67	0.0405	40.90	47.80	1.66	1.94
		A10	883.50	2.2865	0.00	16.56	0.00	37.86
		A11	9.00	0.0233	0.00	-9.10	0.00	-0.21
Beams	24x18 Beams	B1	6.08	0.0157	-117.30	7.70	-1.84	0.12
		B2	13.05	0.0338	-113.74	30.47	-3.84	1.03
		B3	13.05	0.0338	-101.98	58.87	-3.44	1.99
		B4	13.05	0.0338	-83.27	83.26	-2.81	2.81
		B5	13.05	0.0338	-58.89	101.97	-1.99	3.44
		B6	13.05	0.0338	-30.49	113.73	-1.03	3.84
		B7	13.05	0.0338	0.00	117.75	0.00	3.98
		B8	13.05	0.0338	30.49	113.73	1.03	3.84
		B9	13.05	0.0338	58.89	101.97	1.99	3.44
		B10	13.05	0.0338	83.27	83.26	2.81	2.81
		B11	13.05	0.0338	101.98	58.87	3.44	1.99
		B12	13.05	0.0338	113.74	30.47	3.84	1.03
		B13	6.08	0.0157	117.30	7.70	1.84	0.12
		B14	8.10	0.0210	95.50	-7.00	2.00	-0.15
		B15	8.10	0.0210	75.00	-7.00	1.57	-0.15

		B16	8.10	0.0210	55.00	-7.00	1.15	-0.15
		B17	12.60	0.0326	30.00	-7.00	0.98	-0.23
		B18	12.60	0.0326	0.00	-7.00	0.00	-0.23
		B19	12.60	0.0326	-30.00	-7.00	-0.98	-0.23
		B20	8.10	0.0210	-55.00	-7.00	-1.15	-0.15
		B21	8.10	0.0210	-75.00	-7.00	-1.57	-0.15
		B22	8.10	0.0210	-95.50	-7.00	-2.00	-0.15
		B23	9.75	0.0252	-97.43	41.04	-2.46	1.04
		B24	9.75	0.0252	97.43	41.04	2.46	1.04
	24x12 Beams	B25	9.45	0.0245	-69.45	37.50	-1.70	0.92
		B26	9.45	0.0245	69.45	37.50	1.70	0.92
		B44	3.68	0.0095	-103.25	15.00	-0.98	0.14
		B45	3.45	0.0089	-77.50	15.00	-0.69	0.13
		B46	3.45	0.0089	-52.50	15.00	-0.47	0.13
		B47	3.45	0.0089	-27.50	15.00	-0.25	0.13
		B48	4.20	0.0109	0.00	15.00	0.00	0.16
		B49	3.45	0.0089	27.50	15.00	0.25	0.13
		B50	3.45	0.0089	52.50	15.00	0.47	0.13
		B51	3.45	0.0089	77.50	15.00	0.69	0.13
		B52	3.68	0.0095	103.25	15.00	0.98	0.14
		B53	3.75	0.0097	-79.50	49.00	-0.77	0.48
		B54	3.79	0.0098	-62.00	69.50	-0.61	0.68
		B55	3.79	0.0098	-39.40	84.40	-0.39	0.83
		B56	3.79	0.0098	-13.50	92.17	-0.13	0.90
		B57	3.79	0.0098	13.50	92.17	0.13	0.90
		B58	3.79	0.0098	39.40	84.40	0.39	0.83
		B59	3.79	0.0098	62.00	69.50	0.61	0.68
		B60	3.75	0.0098	79.50	49.00	0.78	0.48
	8x36 Beams	B27	2.40	0.0062	-48.33	36.83	-0.30	0.23
		B30	8.35	0.0216	-29.75	65.50	-0.64	1.42
		B32	7.95	0.0206	-29.08	36.83	-0.60	0.76
		B36	2.40	0.0062	30.00	66.17	0.19	0.41
		B42	6.05	0.0157	25.92	36.83	0.41	0.58
		B43	2.15	0.0056	40.58	36.83	0.23	0.20
	8x24 Beams	B28	1.53	0.0040	-48.50	58.00	-0.19	0.23
		B31	1.53	0.0040	-29.75	57.00	-0.12	0.23
		B37	4.03	0.0104	25.92	58.67	0.27	0.61
		B38	1.57	0.0041	40.92	58.67	0.17	0.24
		B39	0.93	0.0024	25.83	56.00	0.06	0.14
		B40	1.90	0.0049	31.58	53.33	0.16	0.26
		B41	3.50	0.0091	36.67	48.25	0.33	0.44
		B61	3.87	0.0100	-6.17	59.17	-0.06	0.59
		B62	3.87	0.0100	6.17	59.17	0.06	0.59
		B63	2.20	0.0057	-6.17	43.00	-0.04	0.24
		B64	2.20	0.0057	6.17	43.00	0.04	0.24
	16x24 Beams	B29	3.07	0.0079	-48.50	65.00	-0.38	0.52
	12x26 Beams	B33	3.79	0.0098	0.00	69.33	0.00	0.68
		B34	3.79	0.0098	0.00	49.00	0.00	0.48
		B35	3.79	0.0098	0.00	37.00	0.00	0.36
Sum			3083.80	7.9810			-6.28	362.70

Center of Mass	
X Coord:	-0.787
Y Coord:	45.445

Mass and Center of Mass
Elevator Machine Room

Type	Sub-type	Num.	Weight (k)	Mass (k-s^2/in)	X Centroid	Y Centroid	Mx	Yx
Shear Walls		S2	40.00	0.1035	-15.33	53.17	-1.59	5.50
		S3	40.00	0.1035	15.33	53.17	1.59	5.50
		S5	10.80	0.0280	-10.33	69.33	-0.29	1.94
		S6	10.80	0.0280	-10.33	49.00	-0.29	1.37
		S7	10.80	0.0280	-10.33	37.00	-0.29	1.03
		S8	10.80	0.0280	10.33	69.33	0.29	1.94
		S9	10.80	0.0280	10.33	49.00	0.29	1.37
		S10	10.80	0.0280	10.33	37.00	0.29	1.03
Slab	Flat Portions	A1	88.83	0.2299	0.00	53.25	0.00	12.24
Beams	8x24 Beams	B61	2.90	0.0075	-6.17	59.17	-0.05	0.44
		B62	2.90	0.0075	6.17	59.17	0.05	0.44
		B63	1.65	0.0043	-6.17	43.00	-0.03	0.18
		B64	1.65	0.0043	6.17	43.00	0.03	0.18
Sum			242.72	0.6282			0.00	33.19

Center of Mass	
X Coord:	-2E-16
Y Coord:	52.832

Mass and Center of Mass
Penthouse Roof 664

Type	Sub-type	Num.	Weight (k)	Mass (k-s^2/in)	X Centroid	Y Centroid	Mx	Yx
Columns		C40	3.00	0.0078	-43.33	37.50	-0.34	0.29
		C91	3.00	0.0078	45.17	65.50	0.35	0.51
		C92	3.00	0.0078	45.17	37.50	0.35	0.29
		C41	2.25	0.0058	-44.17	58.17	-0.26	0.34
		C42	2.25	0.0058	-44.17	64.33	-0.26	0.37
		C50	0.60	0.0016	-52.83	75.67	-0.08	0.12
		C51	0.60	0.0016	-44.33	75.67	-0.07	0.12
		C52	0.60	0.0016	-38.33	75.67	-0.06	0.12
		C53	0.60	0.0016	-30.83	75.67	-0.05	0.12
		C54	0.60	0.0016	-23.33	75.67	-0.04	0.12
		C55	0.60	0.0016	-38.33	65.67	-0.06	0.10
		C56	0.60	0.0016	-30.83	65.67	-0.05	0.10
		C57	0.60	0.0016	-23.33	65.67	-0.04	0.10
		C58	0.60	0.0016	-38.33	55.67	-0.06	0.09
		C59	0.60	0.0016	-30.83	55.67	-0.05	0.09
		C60	0.60	0.0016	-23.33	55.67	-0.04	0.09
		C61	0.60	0.0016	-38.33	46.67	-0.06	0.07
		C62	0.60	0.0016	-30.83	46.67	-0.05	0.07
		C63	0.60	0.0016	-23.33	46.67	-0.04	0.07
		C64	0.60	0.0016	-38.33	38.67	-0.06	0.06
		C65	0.60	0.0016	-30.83	38.67	-0.05	0.06
		C66	0.60	0.0016	-23.33	38.67	-0.04	0.06
		C69	0.60	0.0016	23.33	75.67	0.04	0.12
		C70	0.60	0.0016	30.83	75.67	0.05	0.12
		C71	0.60	0.0016	38.33	75.67	0.06	0.12
		C72	0.60	0.0016	44.33	75.67	0.07	0.12
		C73	0.60	0.0016	52.83	75.67	0.08	0.12
		C74	0.60	0.0016	23.33	65.67	0.04	0.10
		C75	0.60	0.0016	30.83	65.67	0.05	0.10
		C76	0.60	0.0016	38.33	65.67	0.06	0.10
		C77	0.60	0.0016	52.83	65.67	0.08	0.10
		C78	0.60	0.0016	23.33	55.67	0.04	0.09
		C79	0.60	0.0016	38.33	55.67	0.06	0.09
		C80	0.60	0.0016	44.33	55.67	0.07	0.09
		C81	0.60	0.0016	52.83	55.67	0.08	0.09
		C82	0.60	0.0016	23.33	46.67	0.04	0.07
		C83	0.60	0.0016	30.83	46.67	0.05	0.07
		C84	0.60	0.0016	38.33	46.67	0.06	0.07
		C85	0.60	0.0016	44.33	46.67	0.07	0.07
		C86	0.60	0.0016	52.83	46.67	0.08	0.07
		C87	0.60	0.0016	23.33	38.67	0.04	0.06
		C88	0.60	0.0016	30.83	38.67	0.05	0.06
		C89	0.60	0.0016	38.33	38.67	0.06	0.06
		C90	0.60	0.0016	52.83	38.67	0.08	0.06
Shear Walls		S1	26.00	0.0673	-53.00	52.50	-3.57	3.53
Curtain Walls		W1	10.70	0.0277	0.00	36.50	0.00	1.01
		W2	3.8	0.0098	53.33	57.67	0.52	0.57
		W3	3.75	0.0097	34.60	76.17	0.34	0.74
		W4	0.966	0.0025	15.83	81.00	0.04	0.20
		W5	3.166	0.0082	0.00	85.83	0.00	0.70

		W6	0.966	0.0025	-15.83	81.00	-0.04	0.20
		W7	3.75	0.0097	-34.60	76.17	-0.34	0.74
		W8	3.8	0.0098	-53.33	57.67	-0.52	0.57
Roof		A1	9.29	0.0240	-34.60	67.92	-0.83	1.63
		A2	8.55	0.0221	-29.08	48.92	-0.64	1.08
		A3	21.38	0.0553	34.60	57.17	1.91	3.16
Slab		A1	27.51	0.0712	-48.00	48.00	-3.42	3.42
Beams		B1	5.55	0.0144	-34.33	75.67	-0.49	1.09
		B2	1.47	0.0038	-52.83	70.75	-0.20	0.27
		B3	1.35	0.0035	-38.33	70.67	-0.13	0.25
		B4	5.48	0.0142	-34.08	65.67	-0.48	0.93
		B5	1.15	0.0030	-48.50	59.17	-0.14	0.18
		B6	4.95	0.0128	-17.50	57.17	-0.22	0.73
		B7	5.48	0.0142	-34.08	55.67	-0.48	0.79
		B8	5.48	0.0142	-34.08	46.67	-0.48	0.66
		B9	2.40	0.0062	-44.17	47.67	-0.27	0.30
		B10	4.25	0.0110	-30.00	38.67	-0.33	0.43
		B11	1.20	0.0031	-48.33	37.67	-0.15	0.12
		B16	5.55	0.0144	34.33	75.67	0.49	1.09
		B17	1.35	0.0035	38.33	70.67	0.13	0.25
		B18	5.48	0.0142	34.08	65.67	0.48	0.93
		B19	4.95	0.0128	17.50	57.17	0.22	0.73
		B20	5.48	0.0142	34.08	55.67	0.48	0.79
		B21	4.95	0.0128	52.83	57.17	0.68	0.73
		B22	5.48	0.0142	34.08	46.67	0.48	0.66
		B23	5.48	0.0142	34.33	38.67	0.49	0.55
Sum			166.07	0.4298			-6.21	23.94

Center of Mass	
X Coord:	-14.46
Y Coord:	55.71

Mass and Center of Mass
Penthouse Roof 670

Type	Sub-type	Num.	Weight (k)	Mass (k-s^2/in)	X Centroid	Y Centroid	Mx	Yx
Columns		C67	0.60	0.0016	-15.33	85.33	-0.02	0.13
		C68	0.60	0.0016	15.33	85.33	0.02	0.13
Shear Walls		S2	18.55	0.0480	-15.33	53.17	-0.74	2.55
		S3	18.55	0.0480	15.33	53.17	0.74	2.55
		S5	5.01	0.0130	-10.33	69.33	-0.13	0.90
		S6	5.01	0.0130	-10.33	49.00	-0.13	0.64
		S7	5.01	0.0130	-10.33	37.00	-0.13	0.48
		S8	5.01	0.0130	10.33	69.33	0.13	0.90
		S9	5.01	0.0130	10.33	49.00	0.13	0.64
		S10	5.01	0.0130	10.33	37.00	0.13	0.48
Slab		A2	124.96	0.3234	0.00	61.17	0.00	19.78
		B12	5.93	0.0154	0.00	85.33	0.00	1.31
		B13	2.33	0.0060	0.00	69.33	0.00	0.42
		B14	2.33	0.0060	0.00	49.00	0.00	0.30
		B15	2.33	0.0060	0.00	37.00	0.00	0.22
Sum			193.31	0.5003			0.00	29.18

Center of Mass	
X Coord:	-1E-16
Y Coord:	58.322

Appendix II, Seismic Analysis

General
Occupancy Category III - Seismic Use Group II
I = 1.25
Seismic Site Classification D
Seismic design category B; $\rho = 1.0$
Seismic Force Resisting System: Shear wall-frame interactive system with ordinary reinforced concrete moment frames and ordinary reinforced concrete shear walls.
$R = 5.5$; $\Omega = 5.5$; $C_d = 4.5$

Spectral Response Acceleration
$S_s = 0.195$; $S_1 = 0.07$
$S_{ms} = 1.6(0.195) = 0.312$; $S_{m1} = 2.4(0.07) = 0.168$
$S_{ds} = 2/3(S_{ms}) = 0.208$; $S_{d1} = 2/3(S_{m1}) = 0.112$

Snow Load
$p_s = 25$ psf, Exposure B
$C_e = 1.3$; $C_t = 1.0$; $I_s = 1.1$
$p_s = 25(1.3)(1.0)(1.1) = 36$ psf
$36(1/2 * \pi * 120^2 + 2 * 8 * 86) = 864^k$

Equivalent Lateral Force Analysis
From ETABS model: T = 2.986 sec in the East-West direction and 1.990 seconds in the North-South direction.
$T_a = 0.02(670 - 455)^{0.75}) = 1.12$ sec
$C_u = (0.112 – 0.15)/(0.1 – 0.15) * (1.7 – 1.6) +1.6 = 1.676$
$T = 1.676 * 1.12 = 1.88$ sec

$W = 2(10297) + 21077 + 2671 + 10(3282) + 3429 + 3084 + 243 + 166 + 193 + 77 + (0.2)(864) = 84{,}527^k$

$C_s = 0.208 / (5.5 / 1.25) = 0.047$
$C_s = 0.112 / (1.88 (5.5 / 1.25)) = 0.0135$ <= controls
$C_s = 0.044(0.208)(1.25) = 0.01144$

$V = 0.0135(84{,}527) = 1143^k$
$k = (1.88 – 0.5) / (2.5 – 0.5) * (2 – 1) + 1 = 1.69$

Level	Height (ft)	Wt (k)	$w_i h_i^k$	Seismic Loads
Ornament	229	77	749226	4.88
Pent Rf	215	193	1688023	10.99
Pent Bm	209	166	1384061	9.01
Elv/Mach	206.25	243	1981217	12.89
Roof	199	3257	24996515	162.69
13	184	3429	23052053	150.03
12	172	3282	19687096	128.13
11	160	3282	17422134	113.39
10	148	3282	15271471	99.39
9	136	3282	13237907	86.16
8	124	3282	11324557	73.70
7	112	3282	9534920	62.06
6	100	3282	7872970	51.24
5	88	3282	6343286	41.28
4	76	3282	4951235	32.22
3	64	3282	3703247	24.10
P6/2	52	2671	2121874	13.81
P4	34	21077	8165977	53.15
P3	20	10297	1627239	10.59
P2	10	10297	504325	3.28

$\Sigma w_i h_i^k$	1.76E+08
V	1143

Application in North-South Direction

Accidental eccentricity:	P2, P3, P4:	0.05 * 413 = 20.65’
	2:	0.05 * 214 = 10.7’
	3-Roof:	0.05 * 240 = 12’
	Mech Room:	0.05 * 32 = 1.6’
	Pent Roof:	0.05 * 32 = 1.6’
Total Eccentricity:	P2, P3:	-62.4 – 20.65 = -83’ = -966”
	P4:	-64.2 – 20.65 = -84.9’ = -1019”
	2:	0 - 10.7 = -10.7’ = -128”
	3 – 12:	-0.48 – 12 = -12.5’ = -150”
	13:	-0.55 – 12 = -12.6’ = -151”
	Roof:	-0.79 – 12 = -12.8’ = -154”
	Mech Room:	0 – 1.6 = 1.6’ = -19”
	Pent Roof:	-5.5 – 1.6 = -7.1’ = -85”

Displacement			Story Drift				
Level	x	y	x	y	Combined	Delta*Cd	Allowable
Roof	-0.49	2.67	-0.04	0.26	0.26	1.16	2.70
13	-0.45	2.41	-0.03	0.21	0.21	0.95	2.16
12	-0.42	2.21	-0.03	0.21	0.21	0.95	2.16
11	-0.38	2.00	-0.03	0.21	0.21	0.96	2.16
10	-0.35	1.79	-0.04	0.21	0.21	0.95	2.16
9	-0.31	1.58	-0.04	0.21	0.21	0.94	2.16
8	-0.28	1.37	-0.04	0.20	0.20	0.91	2.16
7	-0.24	1.17	-0.04	0.19	0.20	0.88	2.16
6	-0.20	0.98	-0.03	0.18	0.18	0.83	2.16
5	-0.17	0.80	-0.03	0.17	0.17	0.77	2.16
4	-0.14	0.63	-0.03	0.15	0.16	0.70	2.16
3	-0.11	0.48	-0.03	0.14	0.14	0.62	2.16
P6/2	-0.08	0.35	-0.04	0.17	0.18	0.80	2.16
P4	-0.04	0.17	-0.02	0.10	0.10	0.46	3.24
P3	-0.02	0.07	-0.01	0.05	0.05	0.22	2.52
P2	-0.01	0.03	-0.01	0.03	0.03	0.12	1.80

Application in East-West Direction

Accidental eccentricity:	P2, P3, P4:	0.05 * 262 = 13.1’ = 157”
	2:	0.05 * 115 = 5.75’ = 69”
	3-Roof:	0.05 * 127 = 6.35’ = 76”
	Mech Room:	0.05 * 33.333 = 1.667’ = 20”
	Pent Roof:	0.05 * 33.333 = 1.667’ = 20”
Total Eccentricity:	P2, P3:	655 – 523 + 157 = 289”
	P4:	815 – 523 + 157 = 449”
	2:	492 – 492 + 69 = 69”
	3 – 12:	544 – 540 + 76 = 80”
	13:	540 – 540 + 76 = 80”
	Roof:	545 – 544 + 76 = 77”
	Mech Room:	634 – 633 + 20 = 21”
	Pent Roof:	684 – 633 + 20 = 71”

Displacement			Story Drift				
Level	x	y	x	y	Combined	Delta*Cd	Allowable
Roof	3.69	-0.03	0.25	0.00	0.25	1.12	2.70
13	3.44	-0.03	0.21	0.00	0.21	0.95	2.16
12	3.23	-0.03	0.22	0.00	0.22	1.01	2.16
11	3.01	-0.03	0.24	0.00	0.24	1.07	2.16
10	2.77	-0.03	0.25	0.00	0.25	1.12	2.16
9	2.52	-0.02	0.26	0.00	0.26	1.16	2.16
8	2.26	-0.02	0.26	0.00	0.26	1.19	2.16
7	2.00	-0.02	0.27	0.00	0.27	1.20	2.16
6	1.73	-0.02	0.27	0.00	0.27	1.21	2.16
5	1.46	-0.01	0.26	0.00	0.26	1.19	2.16
4	1.20	-0.01	0.25	0.00	0.25	1.13	2.16
3	0.95	-0.01	0.24	0.00	0.24	1.09	2.16
P6/2	0.71	-0.01	0.33	0.00	0.33	1.49	2.16
P4	0.38	0.00	0.21	0.00	0.21	0.95	3.24
P3	0.17	0.00	0.11	0.00	0.11	0.49	2.52
P2	0.06	0.00	0.06	0.00	0.06	0.26	1.80

Appendix III, Wind Analysis

General
I_w = 1.15 (occupancy > 5000); Surface roughness B; Exposure B
V = 90 mph; K_d = 0.85; K_{zt} = 1.0

h = 223'
T = 1.88 sec; f = 1/T = 0.532 Hz < 1 Hz => dynamic structure
z = 0.6(217) = 133.8' > z_{min} (ok)

Gust Effect Factor
Dynamic structure
$V_z = 0.45(133.8/33)^{1/4}(90)(88/60) = 84.3$ ft./s
$\beta = 0.05$
$\eta_{Rh} = 4.6(0.532)(223)/84.3 = 6.345$
$R_h = 0.1425$
$\eta_{Rb} = 4.6(0.532)/84.3 = 0.029$
$R_b = 0.981$
$\eta_{RL} = 15.4(0.532)(132)/84.3 = 12.83$
$R_L = 0.0749$
$L_z = 320(133.8/33)^{1/3} = 510.27$; $N_1 = 0.532(510.27)/84.3 = 3.22$
$R_n = 7.47(3.22)/(1 + 10.3(3.22))^{5/3} = 0.0669$
$Q = (1/(1 + 0.63((240+223)/510.27)^{0.63}))^{1/2} = 0.7924$
$R = ((1/0.05)(0.0669)(0.1425)(0.981)(0.53 + 0.47(0.0749)))^{1/2} = 0.325$
$g_r = (2\ln(3600(0.532)))^{1/2} + 0.577/(2\ln(3600(0.532)))^{1/2} = 4.04$
$I_z = 0.3(33/133.8)^{1/6} = 0.2376$

$G_f = 0.925(1 + 1.7(0.2376)(3.4^2(0.7924^2) + 4.04^2(0.325^2))^{1/2})/(1 + 1.7(3.4)(0.2376)) =$
0.862

Velocity Pressures and Design Pressures
Enclosure Classification: Closed
$q_z = 0.00256(1.0)(0.85)(90^2)(1.15)K_z = 20.27K_z$
GC_{pi} = +- 0.18
$C_{p,\ windward}$ = 0.8; $C_{p,\ leeward}$ = -0.5
$C_{p,\ roof}$ = -1.3(0.8), -0.18 between 0 and h/2
= -0.7, -0.18 between h/2 and h

Height (ft.)	Kz	qz (psf)	p (psf)	factored p (psf)	Fact. Wind Ld. (k) N-S		E-W
223	1.28	25.9	29.1	46.5	Roof	355.5	182
200	1.2	24.3	27.9	44.7	13	145	80
180	1.17	23.7	27.5	44.0	12	127	70
160	1.13	22.9	27.0	43.1	11	125	69
140	1.09	22.1	26.4	42.2	10	124	68
120	1.04	21.1	25.7	41.1	9	122	67
100	0.99	20.1	25.0	40.0	8	121	67
90	0.96	19.5	24.6	39.3	7	118	65
80	0.93	18.9	24.2	38.7	6	117	64
70	0.89	18.0	23.6	37.8	5	114	63
60	0.85	17.2	23.0	36.9	4	112	62
50	0.81	16.4	22.5	36.0	3	108	59
40	0.76	15.4	21.8	34.9	P6/2	131	69
34	0.76	15.4	10.6	17.0	P4	104	57
30	0.7	14.2	9.8	15.7	P3	42	23
25	0.66	13.4	9.2	14.8	P2	31	17
20	0.62	12.6	8.7	13.9			
0-15	0.57	11.6	8.0	12.7			

<u>Application in North-South Direction</u>

$e_Q = 0.15 * 240 = 36$

$e = [36 + 1.7(0.2376)(3.4)(0.7924)(36)]/(1.7(0.2376)((3.4(0.7924))^2 + (4.04(0.325))^2)^{1/2}]$
$= 62.1'$

Apply 100% of wind load at center of area:

$\delta_{max} = 2.69"$

$l/\delta_{max} = 887 > 400$ (OK)

Apply 75% of wind load at 62.1 ft eccentricity:

$\delta_{max} = (2.545^2 + 7.683^2)^{1/2} = 8.09"$

$l/\delta_{max} = 295 < 400$ (No Good)

<u>Application in East-West Direction</u>

$e_Q = 0.15 * 133 = 19.8$

$e = [19.8 + 1.7(0.2376)(3.4)(0.7924)(19.8)]/(1.7(0.2376)((3.4(0.7924))^2 + (4.04(0.325))^2)^{1/2})$
$= 34.15$

Apply 100% of wind load at center of area:

$\delta_{max} = (3.01^2 + 1.20^2)^{1/2} = 3.24"$

$l/\delta_{max} = 738 > 400$ (OK)

Apply 75% of wind load at 34.15 ft eccentricity:

$\delta_{max} = (2.920^2 + 2.705^2)^{1/2} = 3.98"$

$l/\delta_{max} = 600 > 400$ (OK)