Fraser Centre

State College, Pennsylvania

Technical Report I

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Structural Option

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Executive Summary

A thorough analysis was performed on the Fraser Centre that will be erected in State College, PA to develop an understanding of the structural system. This analysis included a study of the structural system as shown in the structural plans, the design codes used for the building, as well as wind and seismic loads on the structure. Calculated loads were compared to those used by the design where appropriate.

The load analysis revealed that seismic loads will be the controlling lateral condition on the structure, resulting in a base shear of 518 kips and an overturning moment of 56208 ft-kips. The wind loads were determined to be noticeably smaller in comparison to the seismic loads; base shear was 26% smaller than seismic and the overturning moment was 34% smaller than seismic.

Technical Assignment 1

Introduction

Figure 1: Site view of Fraser Centre (blue) bounded by Fraser St., Calder Way, Miller Alley, and Beaver Ave. Photo courtesy of Bing Maps.

The Fraser Centre is a mixed-use, high-rise development located in downtown State College, Pennsylvania (See Fig. 1). The site will encompass an entire block on the corner of Beaver Avenue and Fraser Street, at an approximate elevation of 1100 feet above sea level. The structural system of Fraser Centre is almost exclusively cast in place concrete. The gravity load resisting system consists of concrete columns and slabs, there are also beams located at the garage on level 2, theater on level 3, mechanical floor on level 4, and the roof.

Fraser Centre contains the following: 53 residential condominium units on 7 floors, 94 parking spaces on surface level and a supported level for residential tenants, and 50+ storage units for residential tenants. There is also a 10-auditorium movie theater, 3-4 individual retail shell spaces, Mechanical and Electrical support spaces, as well as a vegetated "green" roof. The ground floor is exclusively parking, the majority of the second floor is for parking but there are 3 retail areas as well as the theater lobby on that level. The auditoriums for the movie theater take up the entire third floor. The fourth floor is entirely for mechanical equipment, this is also where the building goes from roughly 270 ft x 165 ft to 190 ft x 76 ft. Floors 5 through 10 are all residential levels; level 5 has 9 units and levels 6-10 have 8 units each. Figure 4 in Appendix A shows a typical framing plan for the residential floors. The 11 floor consist of the penthouse suites.

Structural Systems

Gravity System

Columns are designed with 5000 psi concrete for the columns below the sixth level and 4000 psi concrete will be used for columns above the sixth level. Figure 2 in the Appendix shows the column locations and the column size and reinforcement can be found in Figure 3a through 3g. Column sizes vary from 18”x24” and 16”x32” to 24”x72” and 36”x60” and there are also 24” diameter columns.

Beams on level 2 garage vary in width from 10” to 36” with 18” being the most common and a depth between 24” and 111”, 30” is the most common depth. The theater level beams vary from 12” to 72” and 20” to 48” in width and depth respectively. Beams vary in depth from 24” to 40” and 16” to 48” on the mechanical floor. 12”x 78” and 48”x30” is the range of beams on the roof. All beams are made with 4000 psi concrete.

The parking garage has 9” slabs on grade reinforced with 13#5 bars on top and a bottom grid of #4 bars at 12” each way. 4000psi concrete will be used for the slab on grade. 18#5 top bars and a grid of #5 bottom bars at 12” reinforce the 14” concrete slab of the theatre level. In addition to #7 bottom bars at 9” East-West and #5 bottom bars North-South in the 16” slab, the mechanical floor also has a 12’-6”x7’ transfer girder with 40 #11 bottom bars and 20 #11 top bars. The residential levels and penthouse (5 through 11) as well as the roof have 12” slabs reinforced with a grid of #5 bars at 14” east-west and 12” north-south. All of the structural slabs will have 5000 psi concrete and a typical span of 40 feet. Steel beams are used for the projection of the mezzanine floor, and they vary from W8x10 to W12x22.

Lateral System

Concrete shear walls will be used in Fraser Centre to resist lateral loads. Shear walls are composed of 5000 psi concrete and reinforced with #5 horizontal bars and #6 vertical bars. Shear walls are located along column lines 3, 4, 5, 6, and 7 as shown in Fig. 2. The theatre level has 14” shear walls and 16” walls are typical of the parking levels and the residential levels.

Design Criteria

The following data is provided to illustrate the general design criteria for Fraser Centre.

Codes & Design Standards

Applied to Original Design
International Building Code IBC 2006
American Concrete Institute Building Code ACI 318-05
American Institute of Steel Connection AISC, 9th Edition
Steel Deck Institute SDI Specification
Building Code Requirements for Masonry Structures ACI 530-05

Substituted for Analysis
International Building Code IBC 2006
American Concrete Institute Building Code ACI 318-08
American Institute of Steel Connection AISC, 13th Edition
American Society for Civil Engineers ASCE 7-10

Table 1: Codes and Standards used for Original Design and Analysis.

Material Strength Requirements

Material	Strength Requirement
Cast –In-Place Concrete:	
Footings	4 ksi NWC
Basement and Bearing Walls	4 ksi NWC
Shear Walls and Columns	5 ksi NWC
Grade Beams and Slab on Grade	4 ksi NWC
Structural Slab	5 ksi NWC
Reinforcement	ASTM A615, Grade 60
Structural Steel:	
Steel Shapes	ASTM A992
Structural Tubes	ASTM A500
Plates	ASTM A36

Table 2: Material Strength Requirements per drawing S001

Dead and Live Loads

Area	Design Live Load (psf)	Live Load per ASCE 7-10
Roof/Ground Snow	Min 40	
Mechanical	125	
Rooms	40	
Stairs/Public Rooms/Corridors/ Balconies	100	
Theater	60	
Retail Sales	100	
Light Storage	125	

	Design Super-Imposed Dead Load (psf)
Roofing	10
Partitions	20
4” Hollow Non-Bearing Block	30
8” Hollow Non-Bearing Block	55
Brick Veneer	40

Table 3: Design Live and Super-Imposed Dead Loads

Design Analysis

Wind Load Summary

Wind loads were calculated as prescribed by ASCE7-10 Chapter 26 and 27. Microsoft Excel was used for a majority of the analysis and determination of net wind pressures, story forces, and overturning moments. The net wind pressures incorporated the windward, leeward, and internal pressures of the building. A detailed summary of the analysis can be found in Appendix B. After the net pressures were found, the net wind loads were determined. The North-South wind direction caused the largest wind load, resulting in a base shear of 382.9 kips and an overturning moment of 37,319 ft-kips (see Figure 5).

Wind Loads – North South Direction						
Floor	Height Above Ground	Story Height	Wind Pressure	Internal Pressure (psf)	Net Pressure (psf)	
				$+/-GC_{pi}$	$+GC_{pi}$	$-GC_{pi}$
1	-17	11	-	-	-	-
2	-6	21	18.369	+/-6.149	24.518	12.220
3	15	25	18.369	+/-6.149	24.518	12.220
Low Roof	40	8	22.322	+/-6.149	28.471	16.173
MEP/Transfer	48	11	23.187	+/-6.149	29.336	17.038
5	59	11	24.221	+/-6.149	30.370	18.072
6	70	11	25.126	+/-6.149	31.275	18.977
7	81	11	25.934	+/-6.149	32.083	19.785
8	92	11	26.667	+/-6.149	32.816	20.518
9	103	11	27.340	+/-6.149	33.489	21.191
10	114	11.5	27.964	+/-6.149	34.113	21.815
Penthouse	125.5	15.5	28.571	+/-6.149	34.720	22.422
Roof	141	14	29.329	+/-6.149	35.478	23.180
Parapet	155	-	52.644	+/-6.149	58.793	46.495
Leeward	All	-	-14.488	+/-6.149	-8.339	-20.637
Roof	0-70.5’	-	-37.669	+/-6.149	31.52	43.818

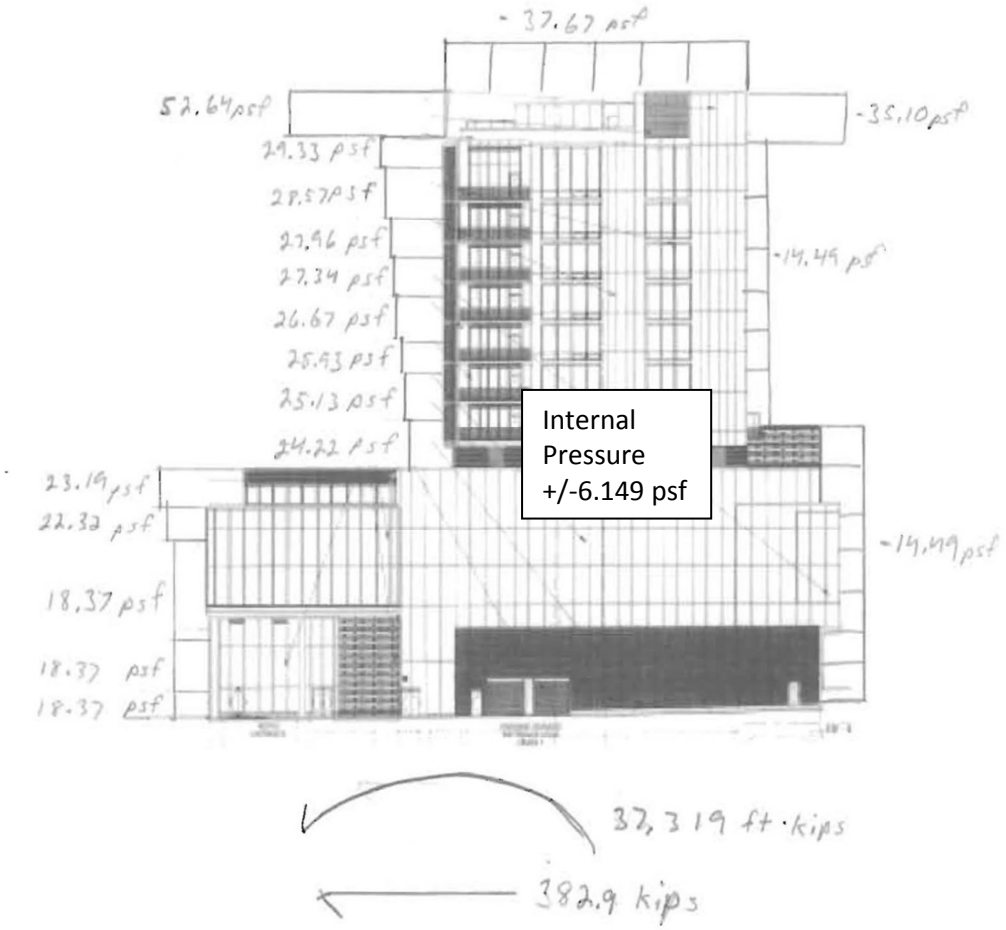


Figure 5: North South Wind Load Diagram

Wind Loads – North South Direction					
Floor Level	Elevation (ft)	Floor Height (ft)	Story Force (kips)	Total Story Shear (kips)	Overturning Moment (ft-k)
2	-6	21	21.3	382.9	96.0
3	15	25	25.4	361.6	698.8
Low Roof	40	8	16.4	336.2	722.3
MEP/Transfer	48	11	25.1	319.8	1340.9
5	59	11	21.7	294.7	1401.6
6	70	11	23.8	273.0	1793.1
7	81	11	25.6	249.2	2210.5
8	92	11	27.2	223.7	2651.2
9	103	11	28.7	196.5	3113.3
10	114	11.5	31.5	167.8	3766.6
Penthouse	125.5	15.5	44.3	136.3	5903.7
Roof	141	14	42.2	92.0	6241.7
Parapet	155	-	49.9	49.9	7379.4
			Total Overturning Moment (ft-k)		37319.2
				Total Shear (kips)	382.9

Wind Loads – East West Direction						
Floor	Height Above Ground	Story Height	Wind Pressure	Internal Pressure (psf)	Net Pressure (psf)	
				$+/-GC_{pi}$	$+GC_{pi}$	$-GC_{pi}$
1	-17	11	-	-	-	-
2	-6	21	18.796	+/-6.149	24.945	12.647
3	15	25	18.796	+/-6.149	24.945	12.647
Low Roof	40	8	22.886	+/-6.149	29.035	16.737
MEP/Transfer	48	11	23.781	+/-6.149	29.930	17.632
5	59	11	24.852	+/-6.149	31.001	18.703
6	70	11	25.788	+/-6.149	31.937	19.639
7	81	11	26.625	+/-6.149	32.774	20.476
8	92	11	27.383	+/-6.149	33.532	21.234
9	103	11	28.080	+/-6.149	34.229	21.931
10	114	11.5	28.725	+/-6.149	34.874	22.576
Penthouse	125.5	15.5	29.353	+/-6.149	35.502	23.204
Roof	141	14	30.138	+/-6.149	36.287	23.989
Parapet	155	-	52.644	+/-6.149	58.793	46.495
Leeward	0 -48	-	-11.455	+/-6.149	-5.306	-17.604
	48-141	-	-8.007	+/-6.149	-1.858	-14.156
Roof	0-70.5’	-	-33.885	+/-6.149	-27.736	-40.034
	70.5-141	-	-23.540	+/-6.149	-17.391	-29.689
	141-203	-	-18.442	+/-6.149	-12.293	-24.591

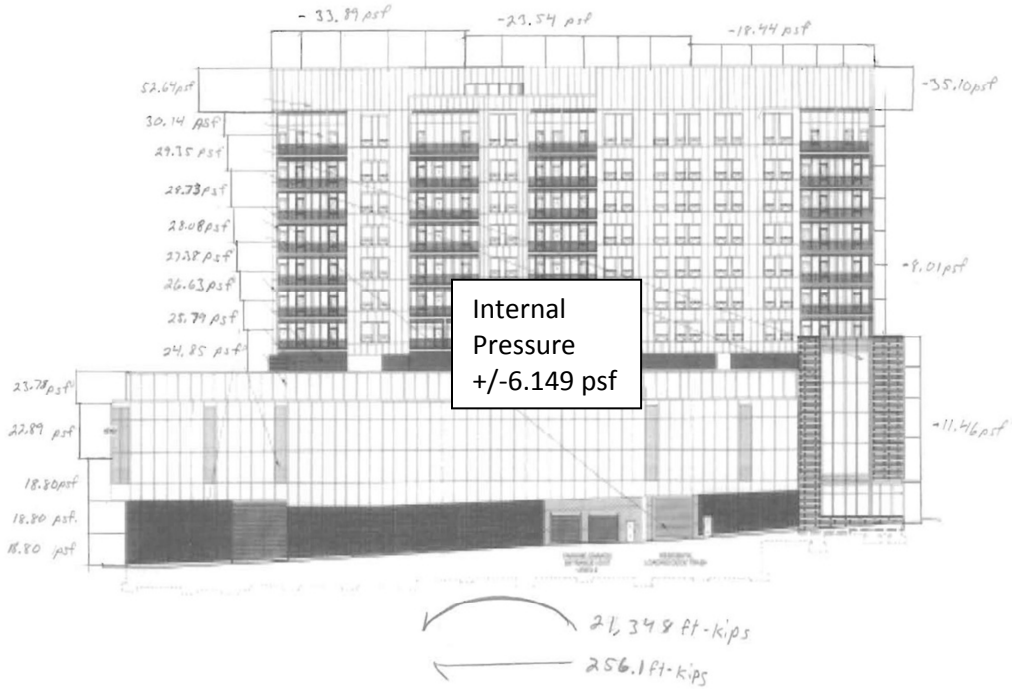


Figure 6: East West Wind Load Diagram

Wind Loads – East West Direction					
Floor Level	Elevation (ft)	Floor Height (ft)	Story Force (kips)	Total Story Shear (kips)	Overturning Moment (ft-k)
2	-6	21	25.4	256.1	114.4
3	15	25	30.3	230.6	832.1
Low Roof	40	8	15.1	200.4	663.6
MEP/Transfer	48	11	22.4	185.3	1196.4
5	59	11	14.1	162.9	908.2
6	70	11	14.9	148.9	1122.1
7	81	11	15.6	134.0	1346.1
8	92	11	16.2	118.4	1579.1
9	103	11	16.8	102.2	1820.4
10	114	11.5	18.1	85.5	2168.0
Penthouse	125.5	15.5	25.1	67.4	3350.2
Roof	141	14	23.5	42.2	3484.6
Parapet	155	-	18.7	18.7	2762.7
			Total Overturning Moment (ft-k)		21348.1
				Total Shear (kips)	256.1

Seismic Load Summary

Seismic loads were determined using the Equivalent Lateral Force Method as described in ASCE7-10. The USGS Earthquake Ground Motion Parameter Application was used in addition to ASCE7-10 to determine the seismic response coefficients for State College (40.79°N and -77.86°W). Microsoft Excel was also used extensively for determining the seismic loads. A detailed description of the process used can be found in Appendix C.

Building weight was determined by summing the weight of the concrete walls and slabs on each floor, then adding the dead load weights, 25% of storage area live loads, and a 10 psf partition load. The results of the analysis can be found in the table below and in Figure 7.

Seismic Loads								
Level	Story Weight	Story Height	h_x^k	$w_x h_x^k$	Cvx	Fx=CvxV	Vx=∑Fi	Mx
Roof	2521.8	172	481.5	1214352.5	0.091	47.1	0	8106.7
Penthouse	3720.5	158	434.9	1618042.1	0.121	62.8	47.1	9922.4
10	3404.3	142.5	384.2	1307993.7	0.098	50.8	109.9	7234.2
9	3364.8	131	347.3	1168650.9	0.088	45.4	160.7	5941.9
8	3364.8	120	312.6	1051905.6	0.079	40.8	206.1	4899.2
7	3364.8	109	278.6	937283.7	0.070	36.4	246.9	3965.2
6	3364.8	98	245.2	824955.5	0.062	32.0	283.3	3137.8
5	3481.3	87	212.5	739885.6	0.055	28.7	315.3	2498.4
MEP/ Transfer	7915.1	76	180.7	1430318.4	0.107	55.5	344.0	4219.1
3	20370.3	57	128.0	2606437.1	0.195	101.2	399.5	5766.2
2	6315.5	32	64	404192.0	0.030	15.7	500.7	502.0
1	1941.6	11	17.8	34500.9	0.003	1.3	516.4	14.7
Ground	0	0	0	0.0	0.000	0.0	517.7	0
				Effective Seismic Weight W (kips)				**63129.6**
				Base Shear V=CsW (kips)				**517.7**
				Overturning Moment M=ΣMx (ft-Kips)				**56207.9**

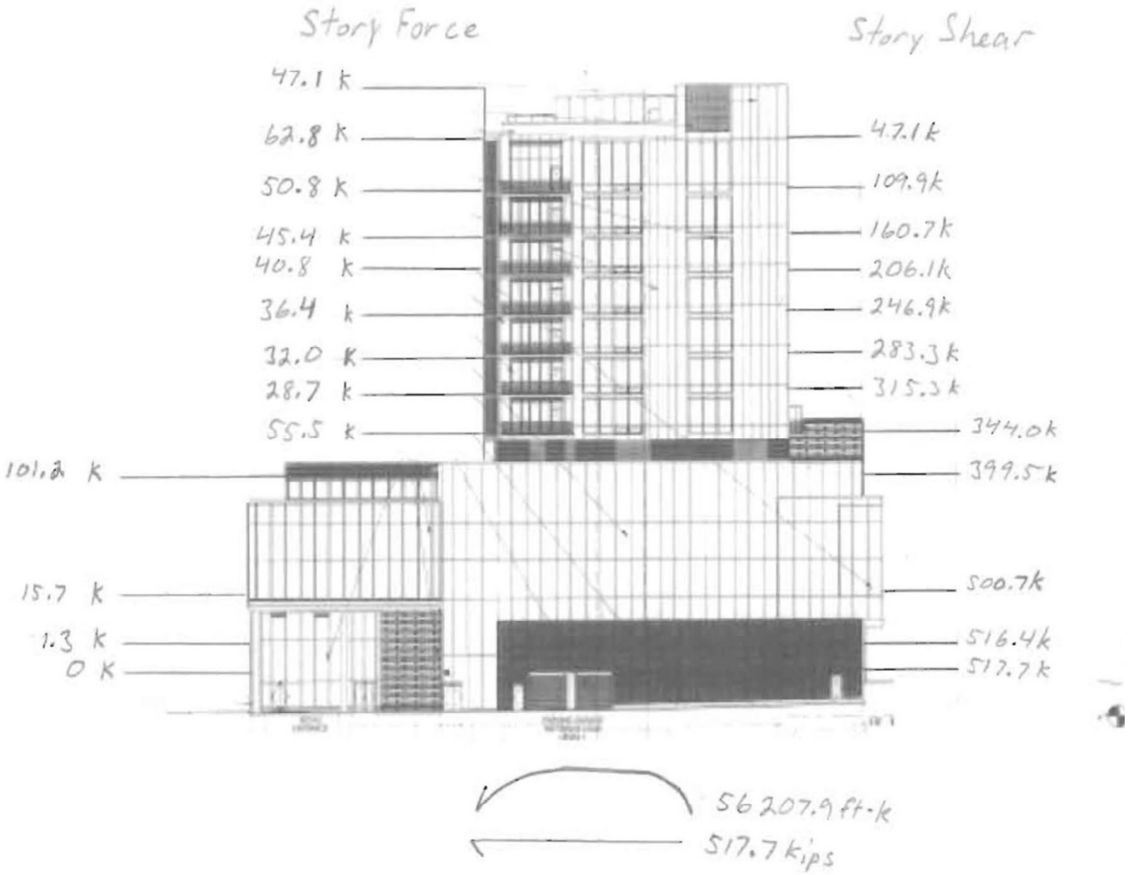


Figure 7: Seismic Load Diagram

Appendix A: Floor Plans

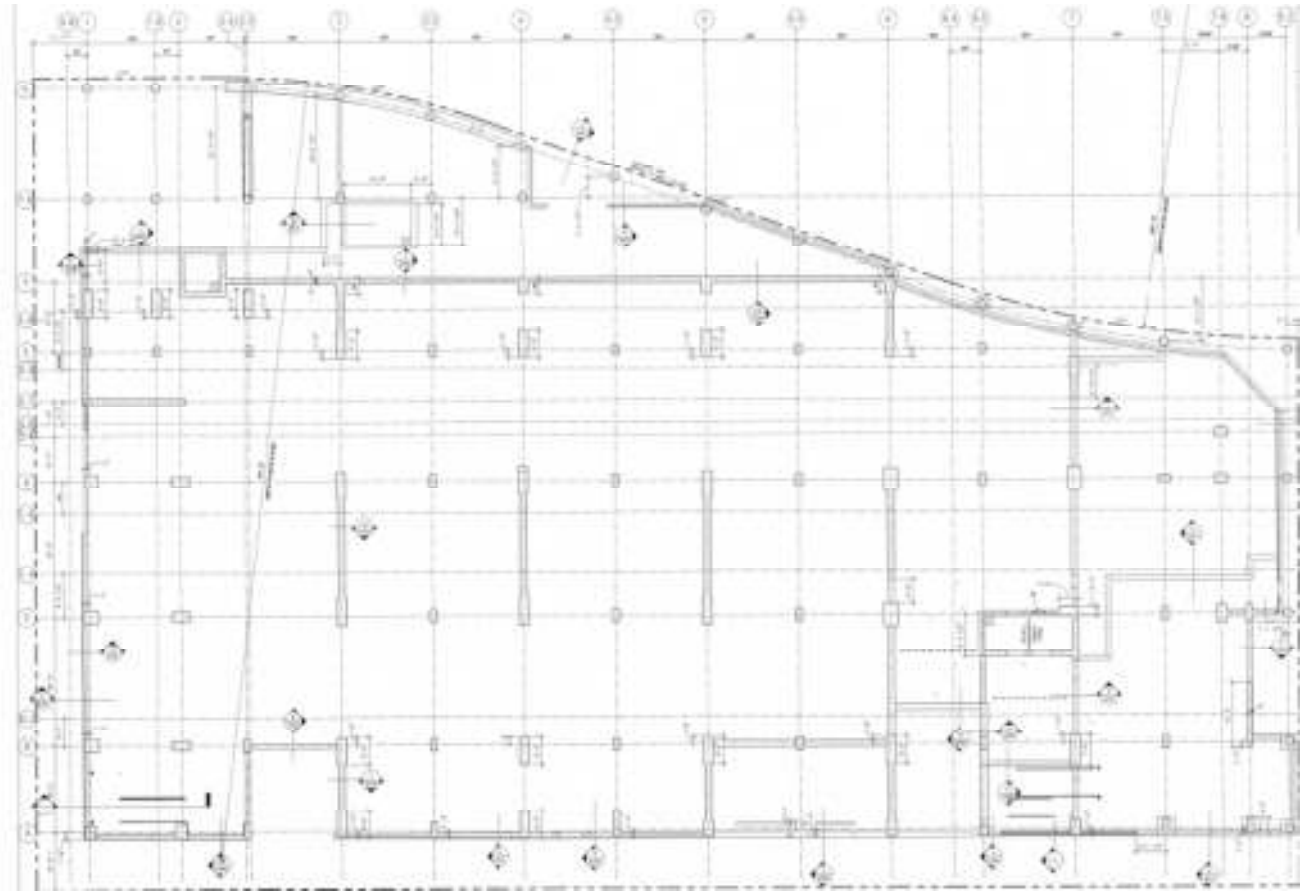


Figure 2: Column Location Plan

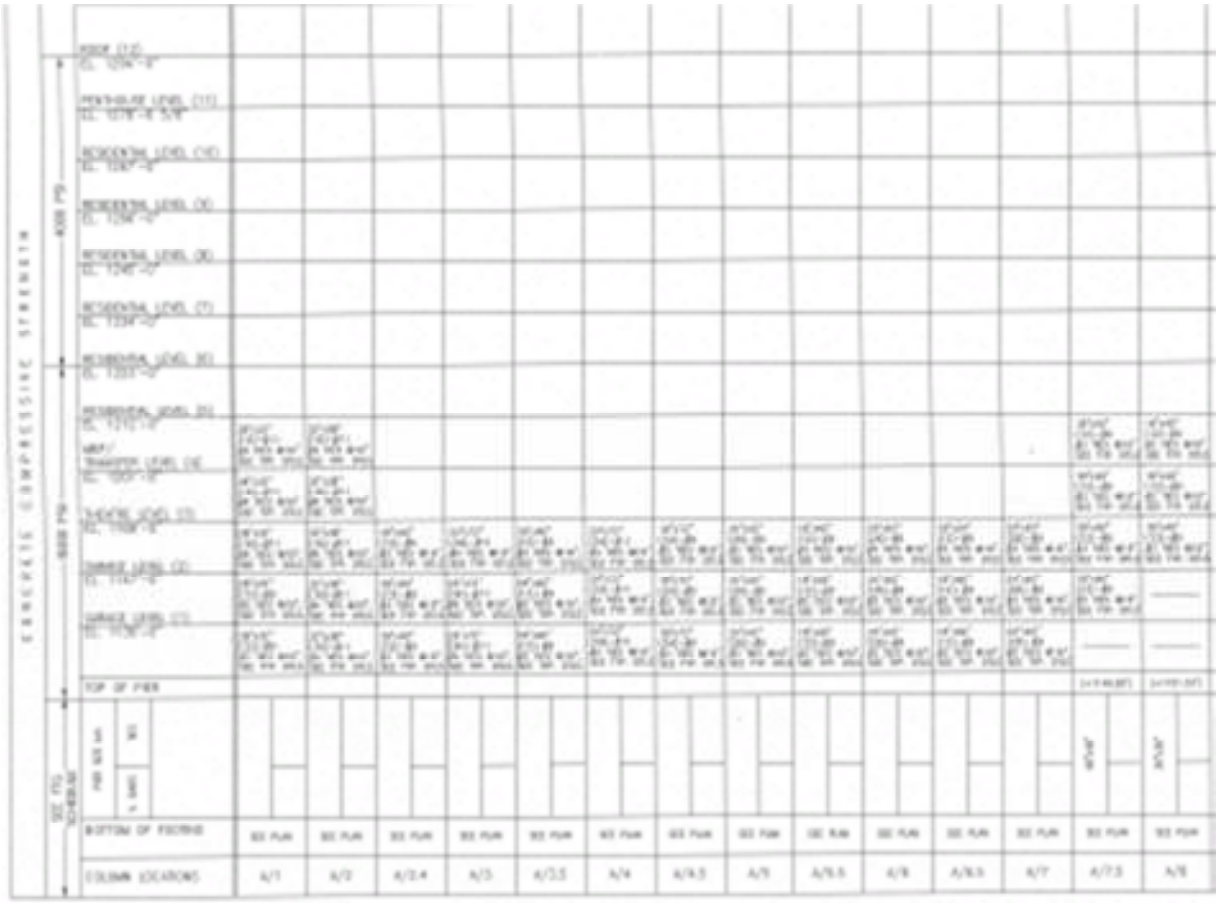


Figure 3a: Column Schedule

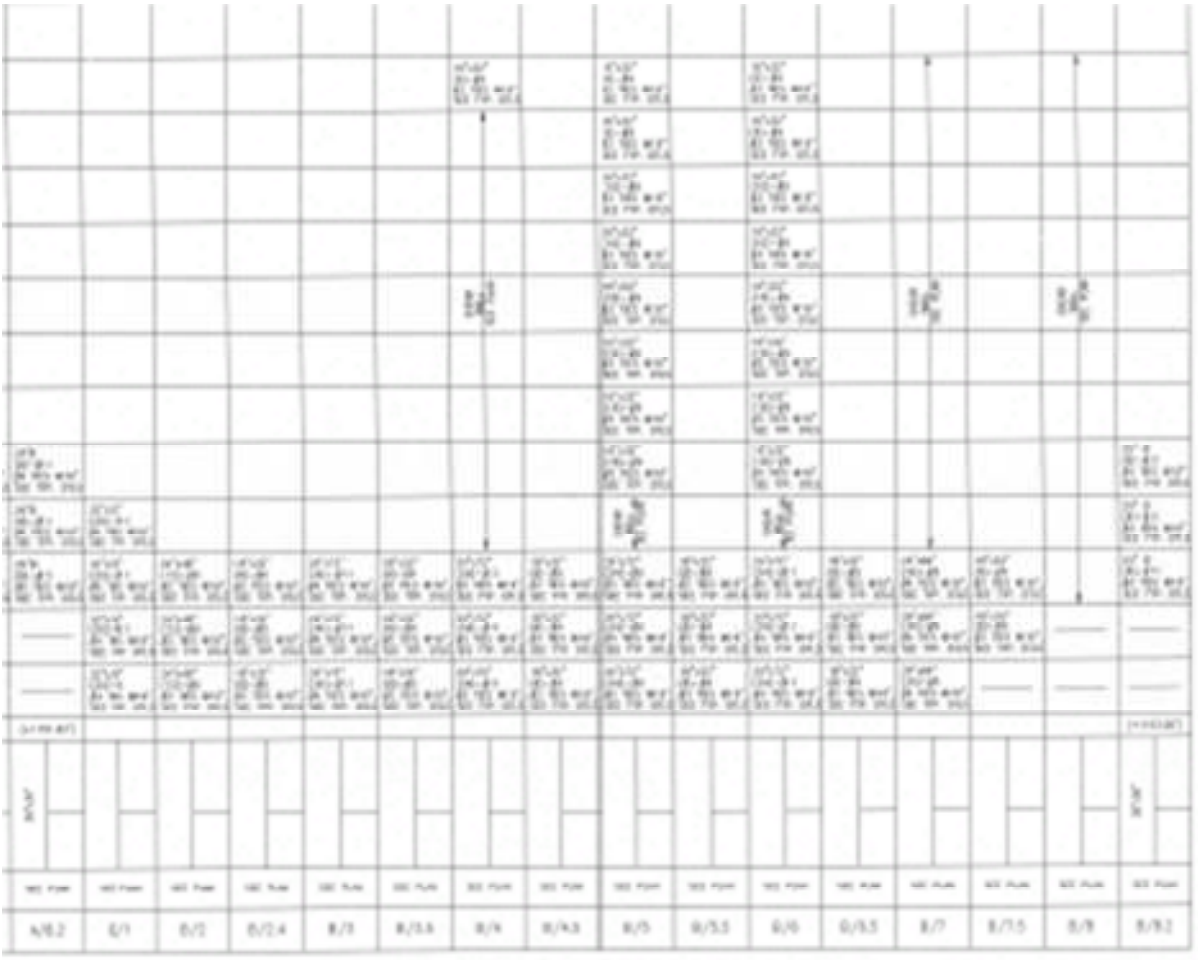


Figure 3b: Column Schedule

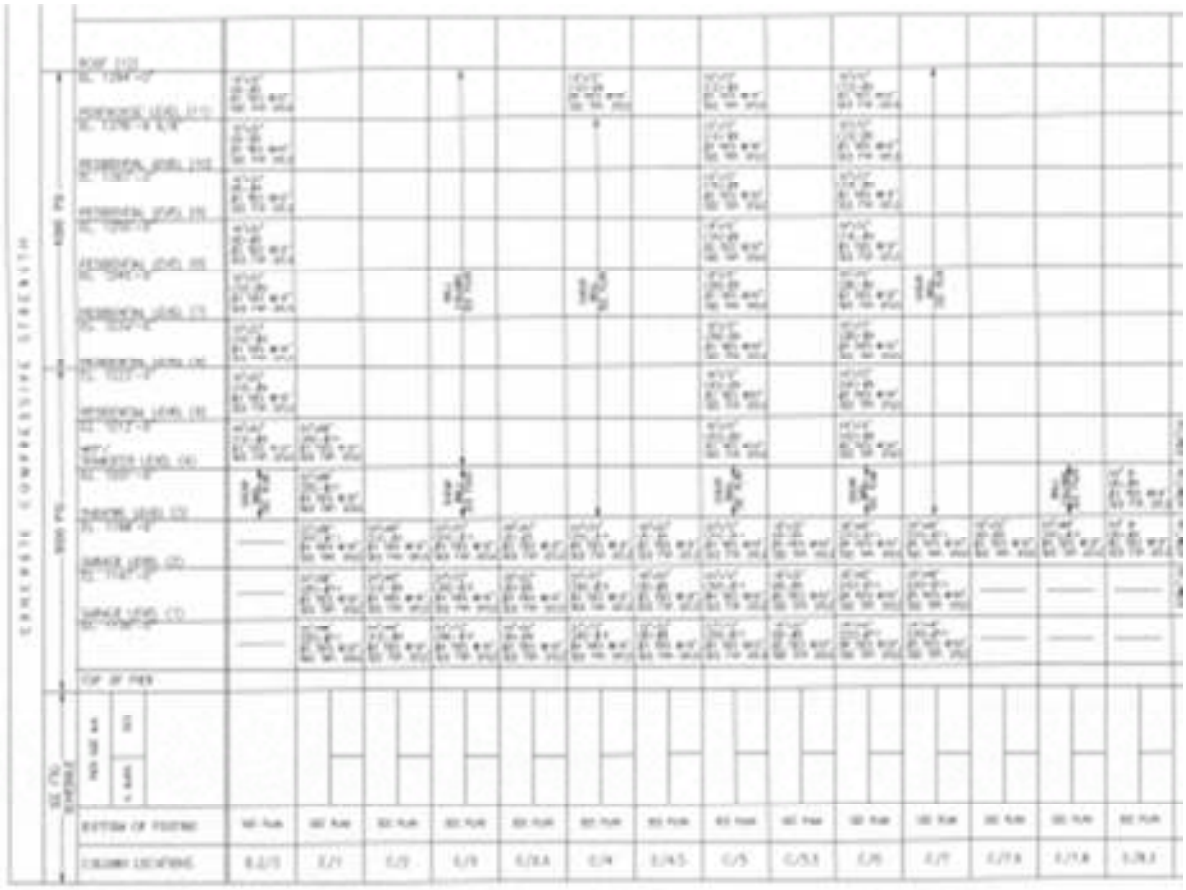


Figure 3c: Column Schedule

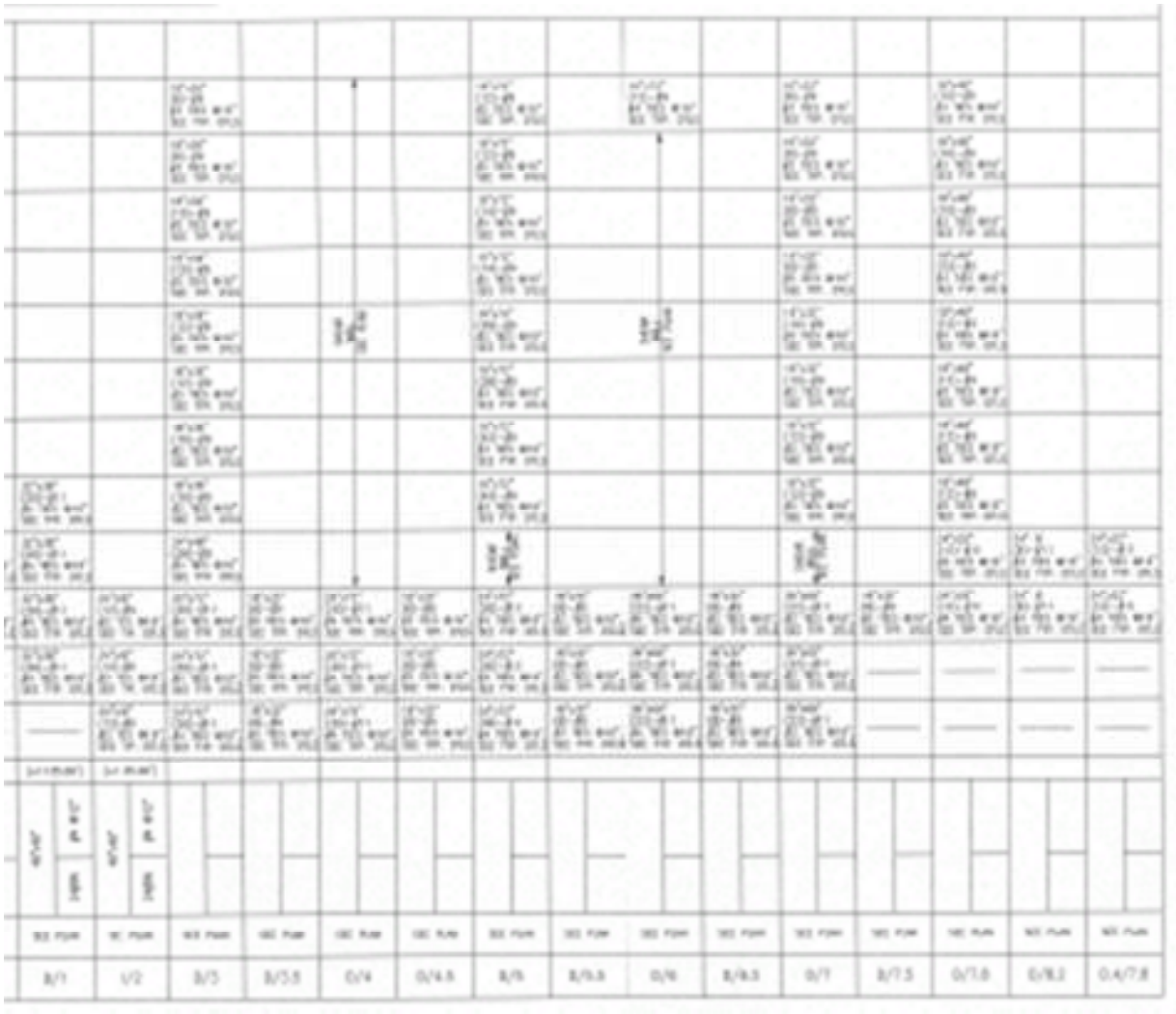


Figure 3d: Column Schedule

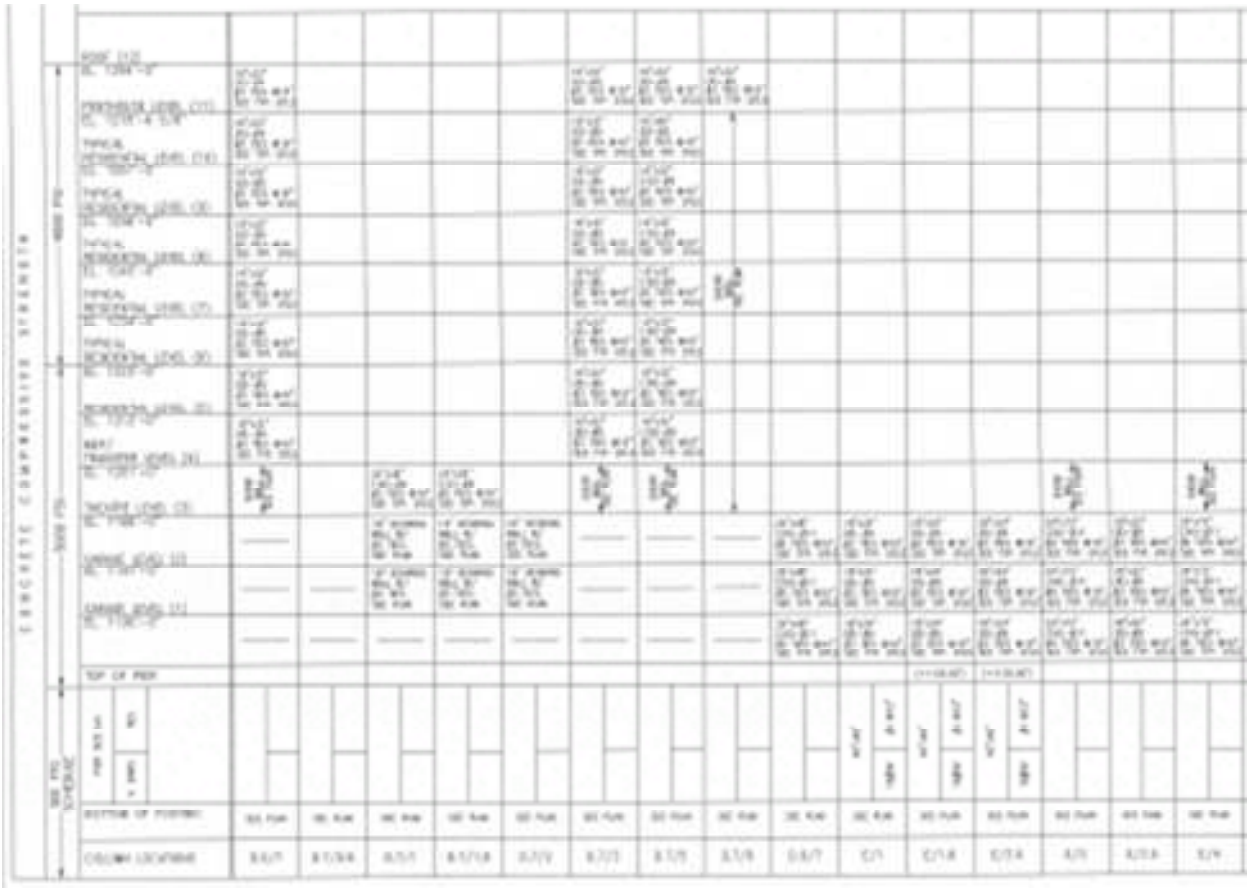


Figure 3e: Column Schedule

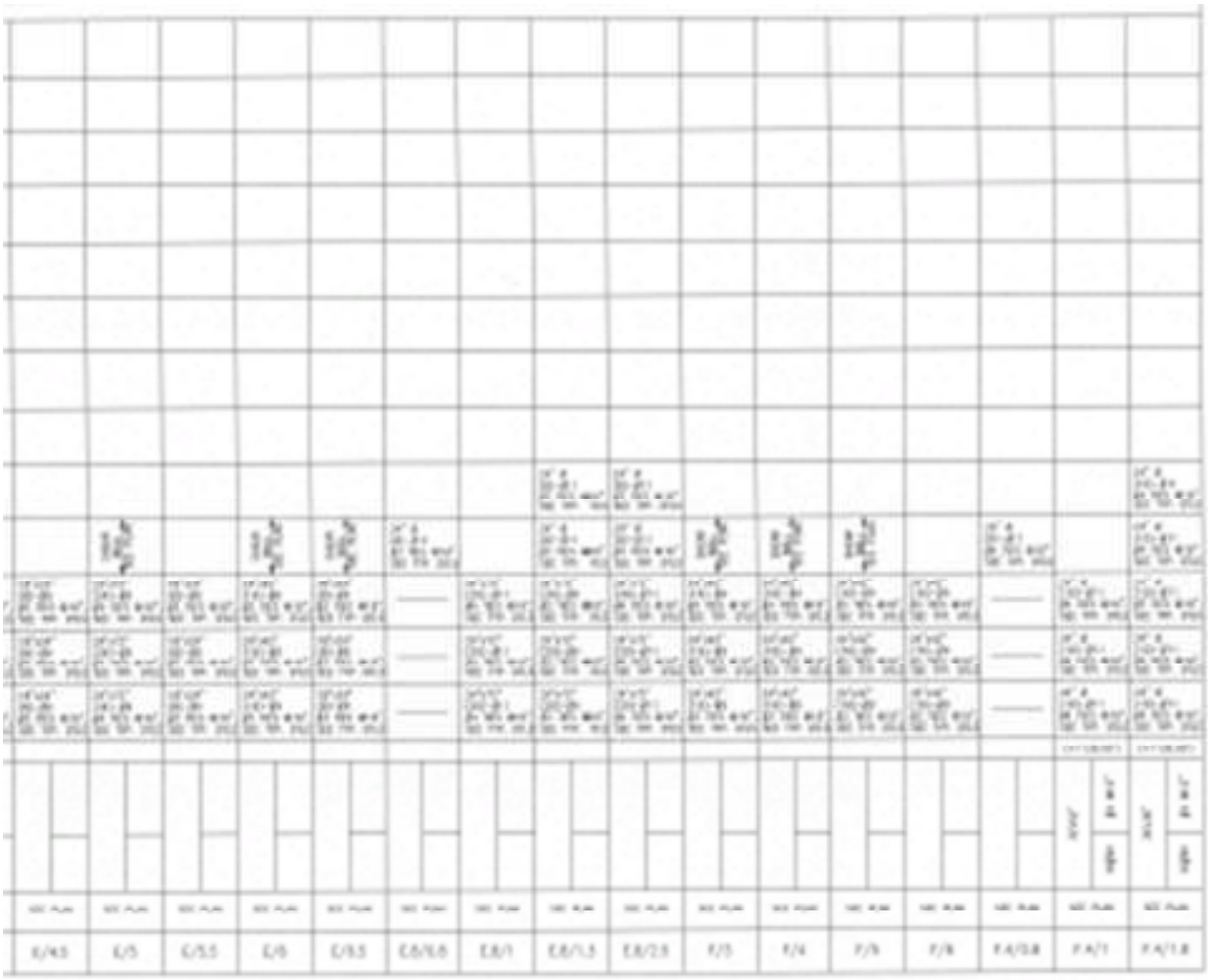


Figure 3f: Column Schedule

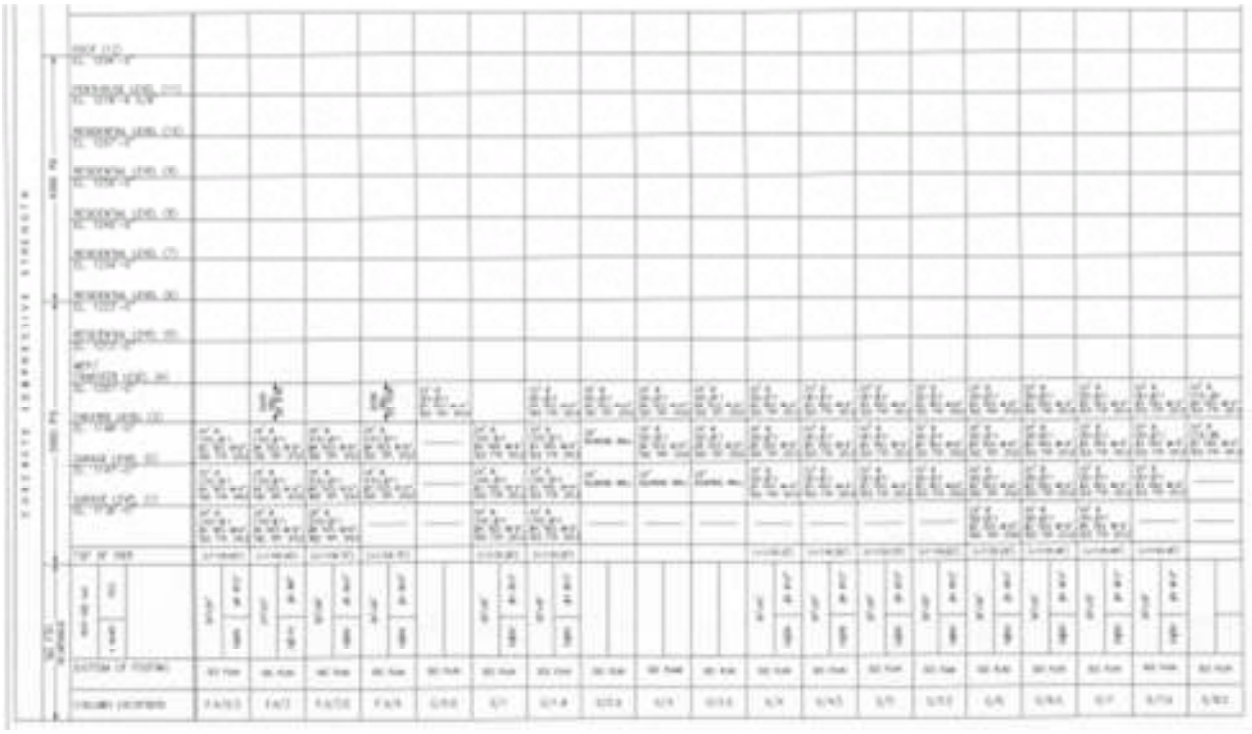


Figure 3g: Column Schedule

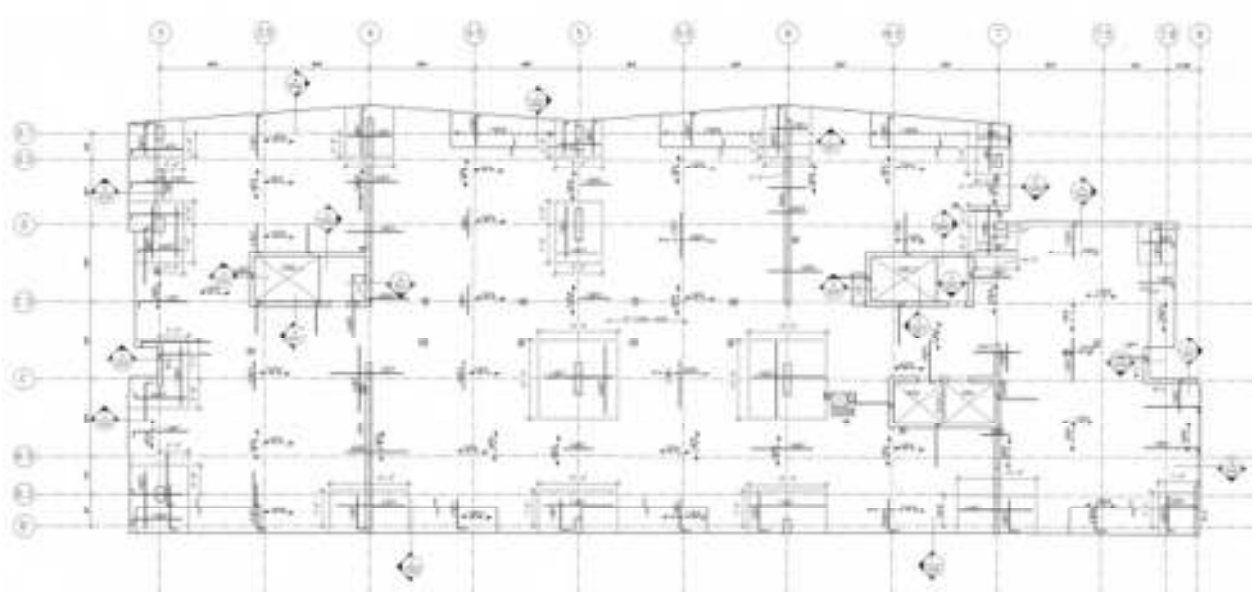
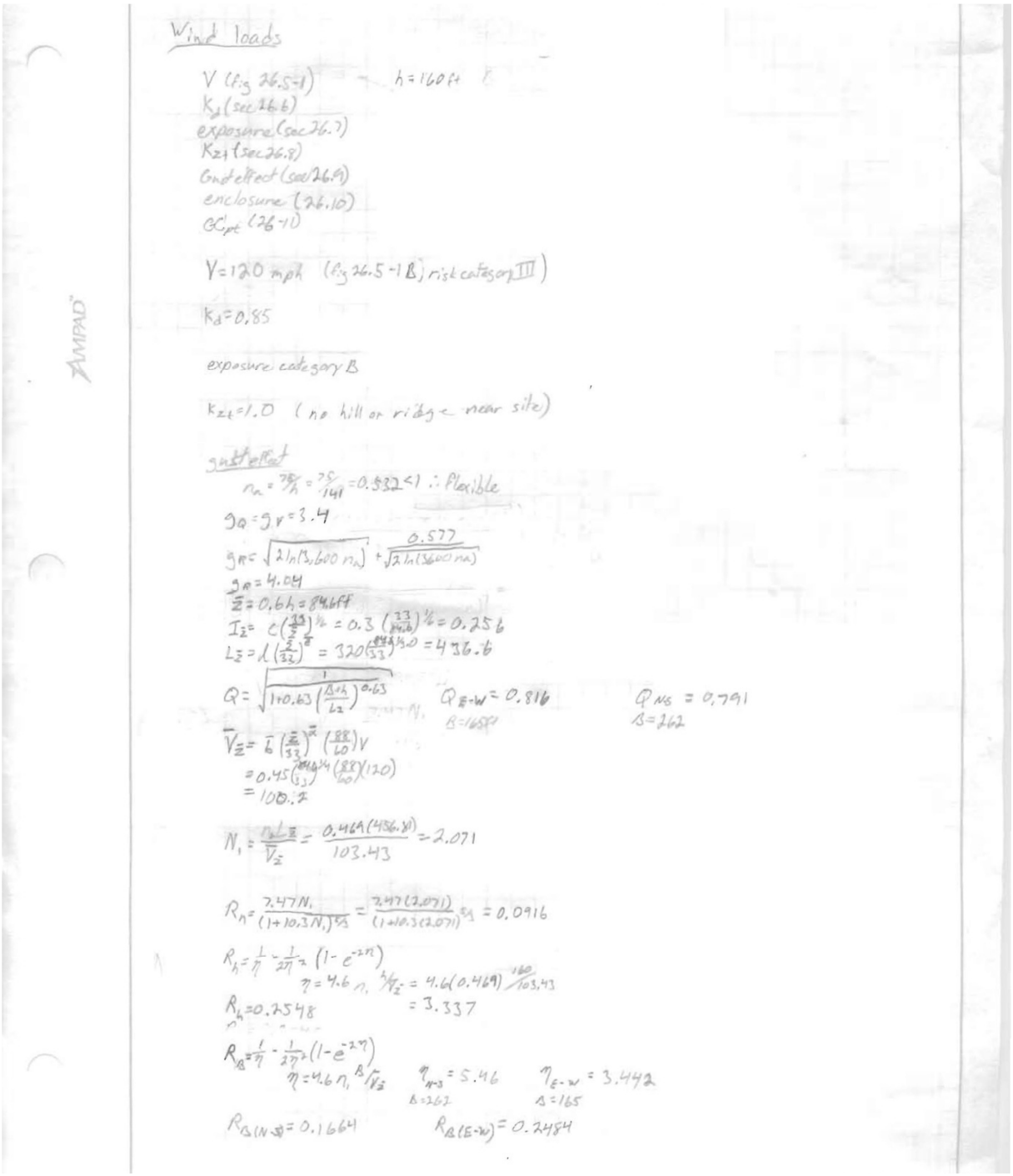


Figure 4: Typical Residential Floor Plan

Appendix B: Wind Analysis



Wind loads

V (Fig 26.5-1) — h = 160 ft
K_d (sec 26.6)
exposure (sec 26.7)
K_{zt} (sec 26.8)
Gust effect (sec 26.9)
enclosure (26.10)
GC_{pi} (26-11)

V = 120 mph (Fig 26.5-1B) risk category III

$k_d = 0.85$

exposure category B

$k_{zt} = 1.0$ (no hill or ridge near site)

gust effect

$n_a = \frac{75}{h} = \frac{75}{141} = 0.532 < 1$ ∴ Flexible

$g_Q = g_v = 3.4$

$g_R = \sqrt{2\ln(3,600\, n_a)} + \frac{0.577}{\sqrt{2\ln(3600\, n_a)}}$

$g_R = 4.04$

$\bar{z} = 0.6h = 84.6$ ft

$I_{\bar{z}} = c\left(\frac{33}{\bar{z}}\right)^{1/6} = 0.3\left(\frac{33}{84.6}\right)^{1/6} = 0.256$

$L_{\bar{z}} = l\left(\frac{\bar{z}}{33}\right)^{\varepsilon} = 320\left(\frac{84.6}{33}\right)^{1/3.0} = 436.6$

$Q = \sqrt{\frac{1}{1+0.63\left(\frac{B+h}{L_{\bar{z}}}\right)^{0.63}}}$ $Q_{E-W} = 0.816$ B = 165' $Q_{NS} = 0.791$ B = 262

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

$= 0.45\left(\frac{84.6}{33}\right)^{0.24}\left(\frac{88}{60}\right)(120)$

$= 100.2$

$N_1 = \frac{n_a L_{\bar{z}}}{\bar{V}_{\bar{z}}} = \frac{0.469(436.6)}{103.43} = 2.071$

$R_n = \frac{7.47 N_1}{(1+10.3N_1)^{5/3}} = \frac{7.47(2.071)}{(1+10.3(2.071))^{5/3}} = 0.0916$

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

$\eta = 4.6\, n_1 \frac{h}{\bar{V}_{\bar{z}}} = 4.6(0.469)\frac{160}{103.43} = 3.337$

$R_h = 0.2548$

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

$\eta = 4.6\, n_1 \frac{B}{\bar{V}_{\bar{z}}}$ $\eta_{N-S} = 5.46$ B = 262' $\eta_{E-W} = 3.442$ B = 165'

$R_{B(N-S)} = 0.1664$ $R_{B(E-W)} = 0.2484$

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

$\eta = 15.4\, n_1 L/V_z$ $\quad \eta_{N-S} = 11.522$ $\quad L = 165ft$ $\quad \eta_{E-W} = 18.296$ $\quad L = 267ft$

$R_{L(N-S)} = 0.0830$ $\quad R_{L(E-W)} = 0.0532$

$R = \sqrt{\frac{1}{\beta} R_n R_h R_B (0.53 + 0.47 R_L)}$ $\quad \beta = 0.02$

$R_{N-S} = 0.3324$ $\quad R_{E-W} = 0.4011$

$G_f = 0.925\left[\frac{1 + 1.71 I_z \sqrt{g_Q^2 Q^2 + g_R^2 R^2}}{1 + 1.7 g_v I_z}\right]$

$G_{f(N-S)} = 0.8604$ $\quad G_{f(E-W)} = 0.8926$

Building is fully enclosed

Internal pressure coefficient $GC_{pi} = \pm 0.18$ $\Rightarrow$ $p_{int} = 34.16(0.18) = \pm 6.15$ psf

$K_z = 2.01(z/z_g)^{2/\alpha}$ for $15ft \le z \le z_g$ $\quad K_z = 2.01(15/z_g)^{2/\alpha}$ for $z < 15ft$ $\quad$ & z_g from table 26.9.1

$\alpha = 7.0$

$z_g = 1200$

for values of K_z see excel spread sheet

$q_z = 0.00256\, K_z K_{zt} K_d V^2$ (lb/ft^2)

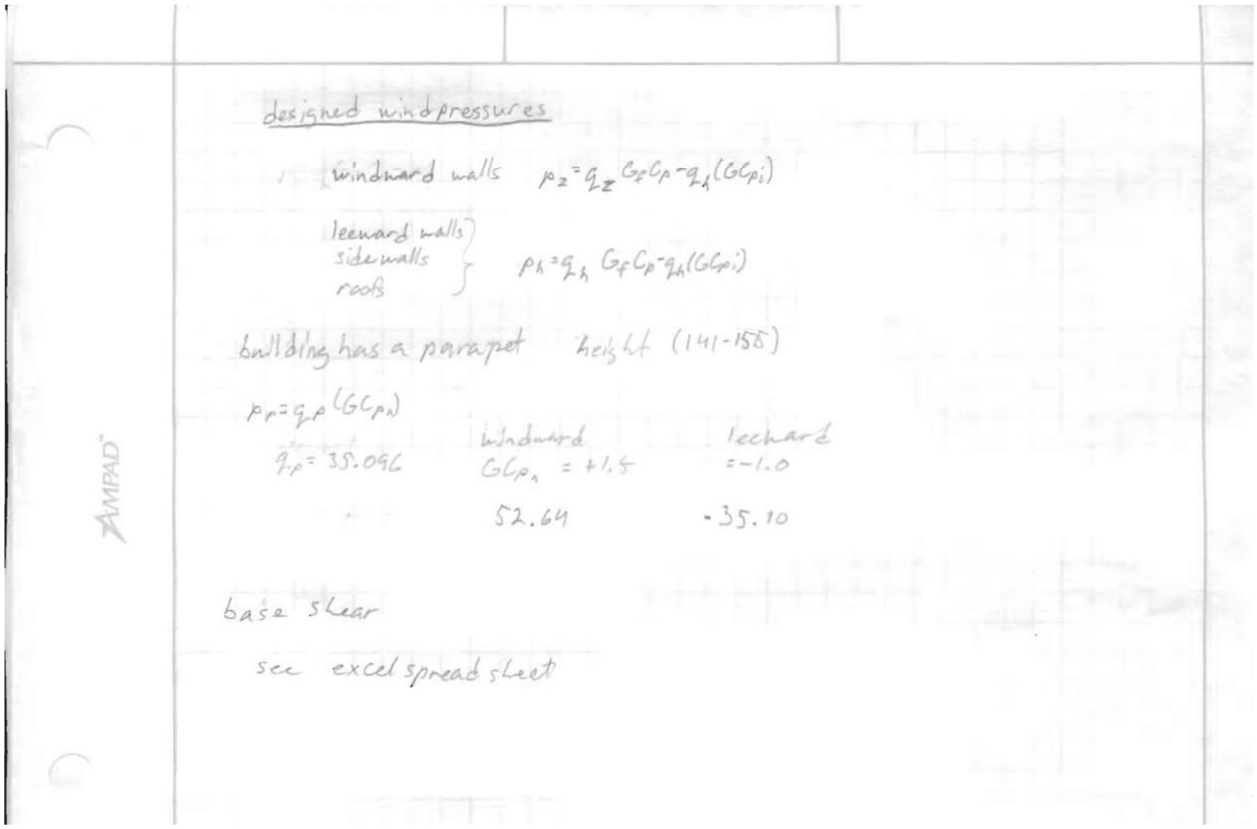
for values of q_z see excel spread sheet

external pressure coefficient

C_p (Fig. 27.4-1)

	North-south wind	East-west wind
ground-MEP	$L/B = 165/262 = 0.630$	G-MEP $L/B = 267/165 = 1.59$
MEP-roof	$L/B = 76/203 = 0.374$	MEP-roof $L/B = 203/76 = 2.67$
Windward	$C_p = 0.8$ (q_z)	$C_p = 0.8$
Leeward	$C_p = -0.5$ (q_h)	G-MEP $C_p = -0.382$
		MEP-roof $C_p = -0.267$
sidewall	$C_p = -0.7$ (q_h)	$C_p = -0.7$
roof pressure	$h/L = 2.11$	$h/L = 0.788$
	$0 - h/2$ $C_p = -1.3, -0.18$ area reduction factor 0.8 (area = 15428 > 1,000)	$0 - h/2$ $C_p = -1.13, -0.18$ $\}$ area = 6000 reduction 0.8
		$h/2 - h$ $C_p = -0.785, -0.18$ $\}$
		$h - 2h$ $C_p = -0.615, -0.18$ area = 7757 reduction 0.8

$q_h G C_p$



Wind Load Design Criteria	
Design Wind Speed	120 mph
Directionality Factor (K_d)	0.85
Exposure	B
Topographic Factor (k_{zt})	1.0
Mean Roof Height (h)	141 ft
K_h	1.090
q_h	34.16

Building Dimensions		
	N-S Wind	E-W Wind
B	262	165
L	165	262
h	141	141

Velocity Pressure Coefficients K_z and Velocity Pressure q_z			
Floor Level	Height	K_z	q_z
1	-17	0.575	18.008
2	-6	0.575	18.008
3	15	0.575	18.008
Low Roof	40	0.761	23.833
MEP/Transfer	48	0.801	25.108
5	59	0.850	26.632
6	70	0.892	27.965
7	81	0.930	29.156
8	92	0.965	30.237
9	103	0.997	31.228
10	114	1.026	32.147
Penthouse	125.5	1.054	33.042
Roof	141	1.090	34.160
Parapet	155	1.120	35.096

Gust Effect Factors G and G_f		
Term	NS Wind	EW Wind
n_1	0.532	
g_Q	3.4	
g_v	3.4	
g_R	4.04	
z_{MEAN}	84.6 ft	
I_{zMEAN}	0.256	
L_{zMEAN}	437.96	
Q	0.791	0.816
V_{zMEAN}	100.22	
N_1	2.325	
R_n	0.0815	
η_h	3.442	
R_h	0.2483	
η_B	6.397	4.029
R_B	0.1441	0.2174
η_L	13.487	21.415
R_L	0.0714	0.0456
β	0.02	
R	0.2868	0.3484
G_f	0.8483	0.8779

External Pressure Coefficents		
	N-S Wind	E-W Wind
L/B		
0 ft-65 ft	0.63	1.59
65 ft-158 ft	0.37	2.67
C_p windward walls	0.8	0.8
C_p leeward walls		
0 ft-65 ft	-0.5	-0.382
65 ft-158 ft	-0.5	-0.267
C_p side walls	-0.7	-0.7
h/L	2.11	0.788
C_p roof		
0-h/2	-1.30	-1.13
h/2-h	-	-0.785
h-2h	-	-0.615
Reduction Factor	0.8	0.8

Appendix C: Seismic Analysis

Design Seismic Base Shear

building is located on site class B land is 160 Ft tall

latitude: 40.793°
longitude: -77.862°

$S_s = 0.147g$
$S_1 = 0.049g$ > using software from USGS website ASCE 7-05 option

$F_a = 1.0$ (table 11.4-1, site class B)
$F_v = 1.0$ (table 11.4-2, site class B)

$S_{MS} = F_a S_s = 0.147g$
$S_{M1} = F_v S_1 = 0.049g$

$S_{DS} = \frac{2}{3} S_{MS} = 0.098g$
$S_{D1} = \frac{2}{3} S_{M1} = 0.033$

Bearing wall system A.2 ordinary reinforced concrete shear walls

$R = 4$ (Table 12.2-1)

risk category: III
$I = 1.25$
SDC = A

Design Base Shear $T_L = 6$ sec ASCE 7-05 Fig. 22-15

$V_b = C_s \cdot W$

$T_a = C_t h_n^x = 0.02 (160)^{0.75} = 0.900$ sec

$T = C_u T_a = 1.4 (0.900) = 1.26$ sec

$$C_s = \min \begin{cases} S_{DS}/(R/I) = 0.098/(4/1.25) = 0.0306 \\ S_{D1}/[T(R/I)] = 0.033/[1.26(4/1.25)] = 0.0082 \\ \frac{S_{D1} T_L}{T^2 (R/I)} = \frac{0.033(6)}{1.26^2 (4/1.25)} = 0.0390 \end{cases}$$

$C_s = 0.0082$

$W = 63130$ kips

$V_b = 0.0082 (63130)$

$V_b = 518$ kips

Level 1		Story Height	11 ft
Wall Thickness (in)	Length (ft)	Volume (ft^3)	Weight (kips)
12	60	660	99
14	160	2053.33	308
16	306	4488	673.2
		Total	**1080.2**
Col. Size	# of Col.	Volume (ft^3)	Weight (kips)
28x32	3	205.33	30.8
32x38	3	278.67	41.8
18x40	3	165.00	24.75
24x72	18	2376.00	356.4
18x72	1	99.00	14.85
24x42	8	616.00	92.4
28x24	1	51.33	7.7
24x48	5	440.00	66
18x32	11	484.00	72.6
24x84	1	154.00	23.1
36x60	2	330.00	49.5
18x24	6	198.00	29.7
24 dia	10	345.58	51.84
		Total	**861.44**
		Total for Level 1	**1941.6**

Level 2		Story Height	21 ft
Wall Thickness (in)	Length (ft)	Volume (ft^3)	Weight (kips)
14	148	3626	543.9
16	170	4760	714
		Total	**1257.9**
Col. Size	# of Col.	Volume (ft^3)	Weight (kips)
28x32	3	392.00	58.8
32x38	4	709.33	106.4
18x40	4	420.00	63
24x72	18	4536.00	680.4
18x72	1	189.00	28.35
24x42	8	1176.00	176.4
28x24	1	98.00	14.7
24x48	5	840.00	126
18x32	12	1008.00	151.2
24x84	1	294.00	44.1
36x60	2	630.00	94.5
18x24	6	378.00	56.7
24 dia	16	1055.58	158.34
		Total	**1758.8**
Slab Thickness (in)	Area (ft^2)	Volume (ft^3)	Weight (kips)
6	4982	2491	373.65
9	26001	19500.75	2925.11
		Total	**3298.8**
		Total for Level 2	**6315.5**

Level 3		Story Height	25 ft
Wall Thickness (in)	Length (ft)	Volume (ft^3)	Weight (kips)
14	702	20475	3071.3
		Total	**3071.3**
Col. Size	# of Col.	Volume (ft^3)	Weight (kips)
28x32	3	466.7	70
32x38	4	844.4	126.7
18x40	5	625.0	93.8
24x72	18	5400.0	810
18x72	1	225.0	33.8
24x42	8	1400.0	210
28x24	1	116.7	17.5
24x48	6	1200.0	180
18x32	14	1400.0	210
24x84	1	350.0	52.5
36x60	2	750.0	112.5
18x24	6	450.0	67.5
24x32	2	266.7	40
24 dia	23	1806.4	271
		Total	**2295.1**
Slab Thickness (in)	Area (ft^2)	Volume (ft^3)	Weight (kips)
14	81222.5	94759.6	14213.9
		Total	**3298.8**
	Perimeter (ft)	Sq. Footage (ft^2)	Weight (kips)
Façade	790	19750	**790**
		Total for Level 3	**20370.3**

Level 4		Story Height	33 ft
Wall Thickness (in)	Length (ft)	Volume (ft^3)	Weight (kips)
16	115.5	5082	762.3
		Total	**762.3**
Col. Size	# of Col.	Volume (ft^3)	Weight (kips)
28x32	1	205.3	30.8
32x38	5	1393.3	209.0
18x40	2	330.0	49.5
24x48	1	264.0	39.6
24 dia	23	2384.5	357.7
24x32	2	352.0	52.8
24x36	1	198.0	29.7
		Total	**769.1**
Slab Thickness (in)	Area (ft^2)	Volume (ft^3)	Weight (kips)
16	12586	16781.3	2517.2
12	10307.5	10307.5	1546.1
Mechanical Load	12586 sf	125 psf	1573.3
		Total	**5636.6**
	Perimeter (ft)	Sq. Footage (ft^2)	Weight (kips)
Façade	566	18678	**747.1**
		Total for Level 4	**7915.1**

Level 5		Story Height	11 ft
Wall Thickness (in)	Length (ft)	Volume (ft^3)	Weight (kips)
16	237.5	3483.3	522.5
		Total	**522.5**
Col. Size	# of Col.	Volume (ft^3)	Weight (kips)
28x32	1	68.4	10.3
32x38	3	278.7	41.8
18x40	2	110.0	16.5
24 dia	6	207.3	31.1
24x32	1	58.7	8.8
24x36	2	132.0	19.8
16x32	5	195.6	29.3
16x72	3	264.0	39.6
18x36	1	49.5	7.4
18x48	1	66.0	9.9
		Total	**214.5**
Slab Thickness (in)	Area (ft^2)	Volume (ft^3)	Weight (kips)
12	14678.1	14678.1	2201.7
Partition Load	14678.1 sf	20 psf	293.6
		Total	**2495.3**
	Perimeter (ft)	Sq. Footage (ft^2)	Weight (kips)
Façade	566	6226	**249**
		Total for Level 5	**3481.3**

Level 6-9		Story Height	11 ft
Wall Thickness (in)	Length (ft)	Volume (ft^3)	Weight (kips)
16	237.5	3483.3	522.5
		Total	**522.5**
Col. Size	# of Col.	Volume (ft^3)	Weight (kips)
16x32	7	273.8	41.1
16x72	3	264.0	39.6
18x36	1	49.5	7.4
18x48	1	66.0	9.9
		Total	**98.0**
Slab Thickness (in)	Area (ft^2)	Volume (ft^3)	Weight (kips)
12	14678.1	14678.1	2201.7
Partition Load	14678.1 sf	20 psf	293.6
		Total	**2495.3**
	Perimeter (ft)	Sq. Footage (ft^2)	Weight (kips)
Façade	566	6226	**249**
		Total for Level 6-9	**3364.8**

Level 10		Story Height	11.5 ft
Wall Thickness (in)	Length (ft)	Volume (ft^3)	Weight (kips)
16	237.5	3641.7	546.3
		Total	**546.3**
Col. Size	# of Col.	Volume (ft^3)	Weight (kips)
16x32	7	286.2	42.9
16x72	3	276.0	41.4
18x36	1	51.8	7.8
18x48	1	69.0	10.4
		Total	**102.5**
Slab Thickness (in)	Area (ft^2)	Volume (ft^3)	Weight (kips)
12	14678.1	14678.1	2201.7
Partition Load	14678.1 sf	20 psf	293.6
		Total	**2495.3**
	Perimeter (ft)	Sq. Footage (ft^2)	Weight (kips)
Façade	566	6509	**260.4**
		Total for Level 10	**3404.3**

Level 11		Story Height	15.5 ft
Wall Thickness (in)	Length (ft)	Volume (ft^3)	Weight (kips)
16	237.5	4908.3	736.3
		Total	**736.3**
Col. Size	# of Col.	Volume (ft^3)	Weight (kips)
16x32	7	385.78	57.9
16x72	3	372.00	55.8
18x36	1	69.75	10.5
18x48	1	93.00	14.0
		Total	**138.1**
Slab Thickness (in)	Area (ft^2)	Volume (ft^3)	Weight (kips)
12	14678.1	14678.1	2201.7
Partition Load	14678.1 sf	20 psf	293.6
		Total	**2495.3**
	Perimeter (ft)	Sq. Footage (ft^2)	Weight (kips)
Façade	566	8773	**350.9**
		Total for Level 11	**3720.5**

Roof Level		Story Height	14 ft
Col. Size	# of Col.	Volume (ft^3)	Weight (kips)
16x32	9	448	67.2
16x72	5	620	84
18x36	1	63	9.5
18x48	1	84	12.6
		Total	**173.3**
Slab Thickness (in)	Area (ft^2)	Volume (ft^3)	Weight (kips)
12	14678.1	14678.1	2201.7
Roof Load	14678.1 sf	10 psf	146.8
		Total	**2348.5**
		Total for Roof Level	**2521.8**