WISCONSIN PLACE RESIDENTIAL

TECHNICAL ASSIGNMENT 3

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Executive Summary

The purpose of this report is to perform a detailed analysis and confirmation design study of the lateral system of Wisconsin Place Residential. The building consists of 15 above stories and 2 below grade stories. The size is approximately 479,000 SF, stretching from 25 feet below grade to 142 feet above grade. The building consists of 432 units spread out over the 15 floors.

Wisconsin Place residential is a post-tensioned flat plate system. The building resists lateral loads using shear walls around an elevator core as well as 3- 8 ½ foot walls located at the west wing of the building. The walls use stiffness in the plane of the lateral load and act like a cantilever that is free at the top of the roof.

A three-dimensional computer model created by using ETABS was a significant tool that aided the distribution of the lateral loads. After completing the seismic and wind analysis I found the maximum base shear of the building to be controlled by the wind in the N-S direction (770 kips) and the maximum moment due to the seismic loads to control (67,171 ft-kips). The shear modulus was found by ETAB'S calculated shear at the top of each pier on the 15th story, along with the the total displacement at the top of the wall in the direction of the wind. This was then used in a stiffness formula for a wall that is fixed at the base and acts like a cantilever at the top of the building. A comparison of the shear forces due to the distribution of stiffness and a spreadsheet were very similar to the distributions ETABS calculated. This, among a spot check of a shear wall gives confidence that the distribution is reasonably accurate.

A check on the building drift under design loading was performed using ETABS. The frame was found to meet the H/400 requirements in the North-South direction, but not in the East-West direction. This can be primarily because the building is modeled, as if the entire building is uniform all the way up which it is not, as seen in the floor plans located at the beginning of the appendix. The columns are defined as having only typical reinforcement, not actual

reinforcement, the slab thickness are modeled as being typical and they are not all typical, and the weight of the pool was not incorporated. The frames will experience a maximum drift of 3.22 inches in the North-South direction and 23.1 inches in the East-West of the building. The allowable drift is 4.29 inches which makes 23.1 inches seem very wrong. Please note that there are no shear walls in the entire Eastern (North-South) wing of the building as shown in **Figure: 1** and a higher drift was expected.

Because of the shape of the building and after watching the animation of the deformed shape while using ETABS, torsion seems like it will become a significant issue. The effects of torsion will be looked at in greater depth in a future report.

The overall turning moment of 67,171 ft-kips was governed by the seismic forces. The resisting moments to overturning are much larger than the overturning moments themselves, which is expected since the building is in a U-shape. The resisting moments were found by multiplying the overall weight of the building by the distance from the outside wall to the center of mass in each direction.

Introduction

Wisconsin Place Residential consists of 15 above stories and 2 below grade stories. The building is approximately 479,000 SF, stretching from 25 feet below grade to 142 feet above grade. The building consists of 432 units spread out over the 15 floors. The 13th floor contains a 1,000 SF pool for all tenants of the building. The two levels below grade are set aside for residential parking and are integrated with the parking for the mixed use development. The code used to design Wisconsin Place Residential was the IBC 2003 with reference to ASCE-7 02' for load values. For this analysis, ASCE-7 05' was used as an update. The lateral loads that were used for the ETABS computer model were user defined loads for seismic and wind forces. The forces were calculated by a spread sheet using ASCE-7 05' and were applied to the model as a static representation of the dynamic loads.

Existing Gravity System

Foundations

The foundation shall be supported on spread footings. Column and wall footings supported by rock shall be designed for a bearing pressure of 40,000 PSF. A 4-inch gravel base shall be provided below floor slabs as a moisture barrier. Also, under-floor sub-drainage system shall be installed. All exterior footings shall be a minimum of 2'-6" below grade. All controlled compacted fill shall be compacted to not less than 95% of the maximum dry density determined in accordance with ASTM D-698.

Floor Systems

1st Floor:

Slab on grade.

<u>2nd - 12th Floor:</u>

Flat plate 7 ½" thick unbounded post-tension slabs, with a two-way bottom reinforcement mat of #4@24" continuous bars each way. Hooked bars at discontinuous ends are provided along with 2 #5 top and bottom additional bars along free slab edges. Concrete for slabs shall be normal weight concrete at 5000 psi. The post-tension cables consist of uniform tendons being pulled in the S-N direction and the banded tendons are in the pulled in the W-E direction of the building. The typical uniform cables are 15.0 klf and the banded cables range from approximately 50 - 400 kips.

<u>13th Floor:</u>

Floors are typically post-tensioned the same as the 2nd - 12th except in the pool area. The 12" and 15" slab areas require #5@24" O.C. each way continuous on top and bottom. The 23" slab area requires #6@12" O.C. each way continuous on top and bottom.

<u>Pool House Roof:</u>

7" slab with normal weight concrete and 60,000 psi reinforcing steel. A top and bottom mat of #4@12" O.C. continuous each way is required. Additional top reinforcing for column and middle strips is 6#5 top bars.

<u>14th and 15th Floors:</u>

Floors are typically post-tensioned the same as the 2nd - 12th.

<u>Main Roof:</u>

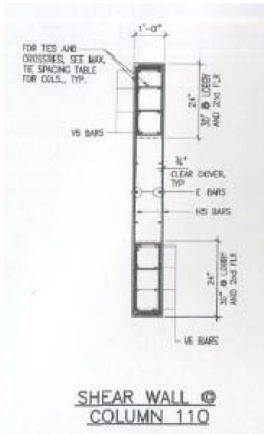
Slab is 8" thick unbounded post tensioned with a two-way bottom reinforcement of #4@24" continuous each way. For the 10" and 12" thick areas, #5@24" continuous mats are required as well as 2 #6 top and bottom additional bars along free slab edges.

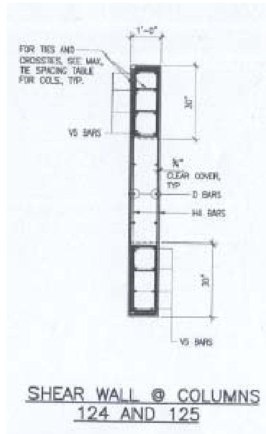
Columns

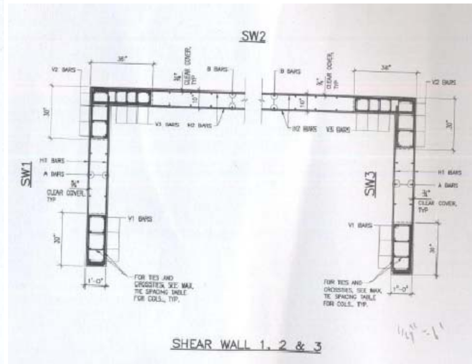
The columns in Wisconsin Place Residential are primarily standard reinforced concrete with varying sizes, shape, and reinforcement depending on their location and loads that are applied throughout the building. The most typical shapes are 16”x28” and 16”x32”. The reinforcement for the columns varies from floor to floor. The typical reinforcement is 8#7 or 8#8 bars, but varies throughout typical levels. The 12^{th} – 13^{th} floor reinforcement is typically #10 or #11 bars, due to the fact that they are supporting the pool. The loads vary greatly from column to column and are as large as 1380k and as small as 122k for dead loads and 293k to 17k for live loads at the top of the pad.

Lateral System

Concrete shear walls make up the buildings lateral load resisting system. Two elevator cores serve as the main components of these elements and are connected from the 1^{st} Floor to the roof. There are also three other shear walls spread out on the west side of the building. Typically the shear wall reinforcement is #4@12” for horizontal reinforcement and #6 or #7 bars for vertical reinforcement. The shear walls have a bearing capacity of f’c = 5000 psi from the 1^{st} – 5^{th} floor and f’c = 6000psi from the 6^{th} – Roof. The typical reinforcement for ties and crossties cooresponds to the maximum spacing for columns.







Codes and Code Requirements

Codes Used for the building

The structural design of Wisconsin Place Residential used various codes for gravity and lateral load conditions. Some of the codes used are the "ACI 318-02 Building Code Requirements for Structural Concrete", "ASCE 7-02", and the 2003 International Building Code.

Codes Used for this Report

All of the information that I computed throughout this report took in consideration the most up-to-date codes. ACI 318-05, ASCE 7-05, and the 2006 IBC. Also I referenced the "Design of Concrete Structures" 13th edition by Nilson, Darwin, and Dolan for structural designs.

Load Cases

The following load cases as obtained from ASCE-7 '05 chapter 2 were used in the analysis of Wisconsin Place Residential in ETABS.

1) 1.4(D + F)
2) 1.2(D + F + T) +1.6(L + H) + 0.5(Lr or S or R)
3) 1.2D + 1.6(Lr or S or R) + (L or 0.8W)
4) 1.2D + 1.6W + L + 0.5(Lr or S or R)
5) 1.2D + 1.0E + L + 0.2S
6) 0.9D + 1.6W + 1.6H
7) 0.9D + 1.0E + 1.6H
8.) 1.0D + 1.0L + 1.0E

Gravity and Lateral Loads

The gravity and lateral loads were determined in accordance with ASCE 7-05. Live Loads were established using section 4 of ASCE 7-05. General assumptions for dead loads were made based on unit weights from ASCE 7-05. Instead of calculating every column and wall, I assumed an addition 10 PSF load on each floor.

Dead Loads:

<u>Construction Dead Loads:</u>

Concrete	150 PCF

Superimposed Dead Loads:

Partitions	20PSF
Finishes & Miscellaneous	5 PSF
MEP	10 PSF
Columns & Walls	10 PSF
Shear Walls	(SEE APPENDIX A)

Live Loads:

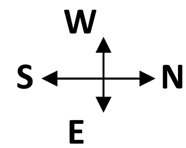
Floors Including Partition Load	60 PSF
Canopy	75 PSF
Slab-On-Grade	100 PSF
Storage	125 PSF
Public Rooms and Corridors	100 PSF
Balconies	100 PSF
Lobby, Corridors, Stairs and Pool Areas	100 PSF
Penthouse, Mechanical Room	150 PSF
Elevator Machine Room	125 PSF
Roof	30 PSF
Roof Snow Load	27 PSF

Lateral Loads

Wind

Wind loads were analyzed using section 6 of ASCE 7-05. For ease of the analysis I assumed the building to be a rectangle instead of a U-shape. I also ignored the cut-backs in different elevations of the building because they only occurred on one side of the U-shape. Therefore the wind would still be affecting either the East or West side regardless. I also did not take in consideration the Penthouse above the Main Roof or the canopy, because it would contribute minimally. The building also had many curves and undulations, so I assumed them to be straight. As you can see in the picture below of my actual building floor plan, there is a court yard formed within the U-shape. Please note that if a wind tunnel test was performed the cladding report would most likely show higher wind pressures on the South Elevation of the building because the legs of the "U" would act like a funnel, thus causing higher wind speeds which would increase pressures. Another assumption I made was that throughout my calculations I took the worst case of the K_z factor that applied to each floor because there were as many as three different K_z factors applying to each level and I was being conservative.

Typical Floor Plan



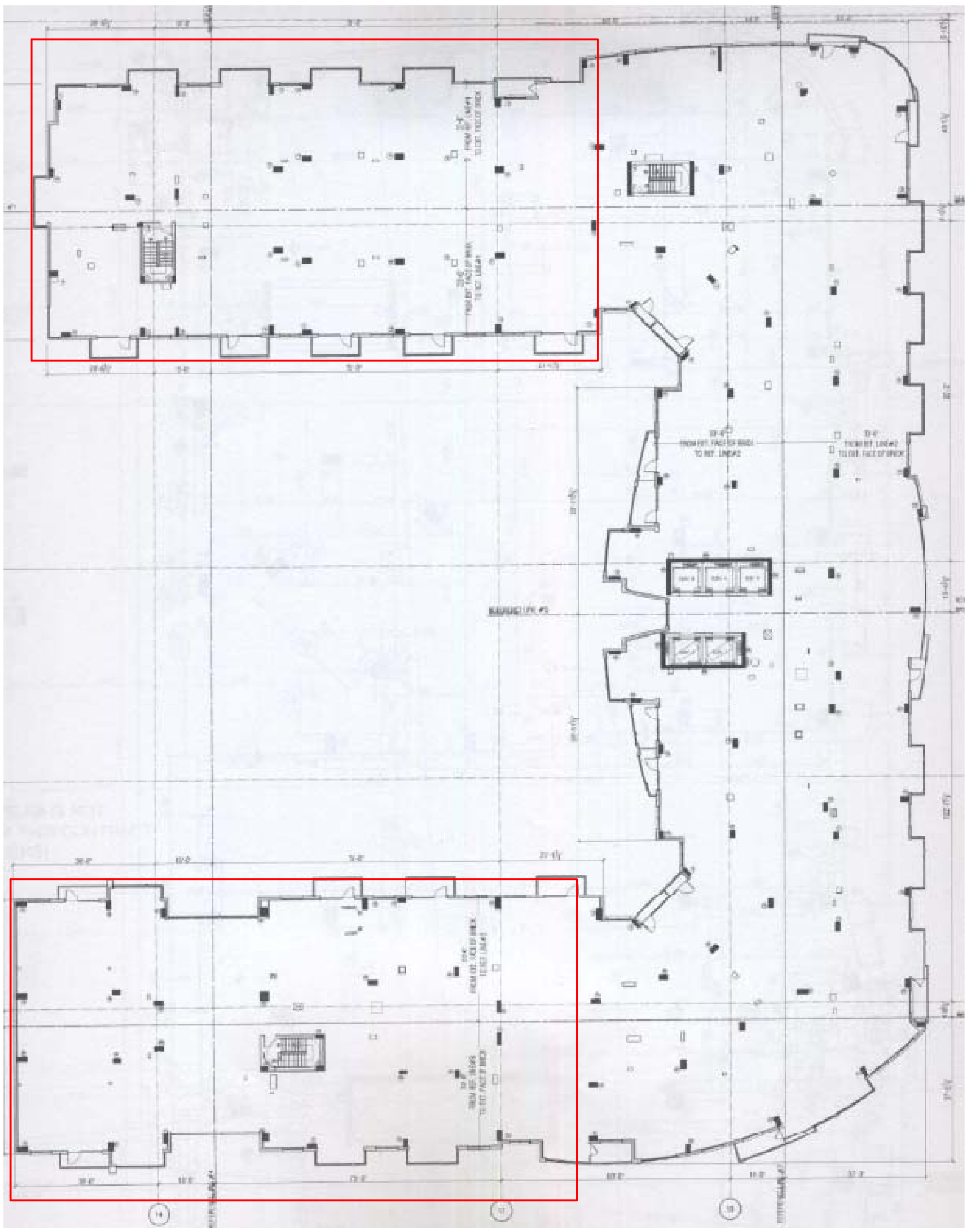


Figure: 1 (Typical Floor Plan**)**

					Pressures (PSF)						Load (kips)		Shear (kips)		Moment (ft-k)			
Level	FL-FL Height	h_x	K_z	q_z	N/S Wind			E/W Wind			N/S	E/W	N/S	E/W	N/S	E/W	Internal Pressure (PSF)	
					Windward	Leeward	Sidewall	Windward	Leeward	Sidewall							+	-
Roof	9.85	141.23	1.13	19.92	13.54	-8.46	-11.85	13.54	-7.69	11.85	32	25	0	0	4,536	3,548	25	-25
15	9.48	131.38	1.09	19.21	13.06	-8.46	-11.85	13.06	-7.69	11.85	62	48	32	25	8,096	6,327	24	-24
14	9.48	121.9	1.09	19.21	13.06	-8.46	-11.85	13.06	-7.69	11.85	60	47	94	73	7,364	5,755	22	-22
13	9.21	112.42	1.04	18.33	12.46	-8.46	-11.85	12.46	-7.69	11.85	58	45	154	120	6,512	5,083	20	-20
12	9.21	103.21	1.04	18.33	12.46	-8.46	-11.85	12.46	-7.69	11.85	56	44	212	165	5,799	4,527	19	-19
11	9.21	94	0.99	17.45	11.87	-8.46	-11.85	11.87	-7.69	11.85	55	43	268	209	5,131	4,001	17	-17
10	9.21	84.79	0.96	16.92	11.51	-8.46	-11.85	11.51	-7.69	11.85	54	42	323	252	4,546	3,542	15	-15
9	9.21	75.58	0.96	16.92	11.51	-8.46	-11.85	11.51	-7.69	11.85	54	42	376	294	4,052	3,158	14	-14
8	9.21	66.37	0.93	16.39	11.15	-8.46	-11.85	11.15	-7.69	11.85	53	41	430	335	3,494	2,721	12	-12
7	9.21	57.16	0.89	15.69	10.67	-8.46	-11.85	10.67	-7.69	11.85	51	40	483	376	2,936	2,284	10	-10
6	9.21	47.95	0.85	14.98	10.19	-8.46	-11.85	10.19	-7.69	11.85	50	39	534	416	2,401	1,866	9	-9
5	9.21	38.74	0.81	14.28	9.71	-8.46	-11.85	9.71	-7.69	11.85	49	38	584	455	1,890	1,467	7	-7
4	8.93	29.53	0.76	13.40	9.11	-8.46	-11.85	9.11	-7.69	11.85	47	37	633	493	1,393	1,080	5	-5
3	8.93	20.6	0.66	11.63	7.91	-8.46	-11.85	7.91	-7.69	11.85	43	33	680	530	892	689	4	-4
2	11.67	11.67	0.57	10.05	6.83	-8.46	-11.85	6.83	-7.69	11.85	47	36	723	563	544	419	2	-2
Totals											770	599	**770**	**599**	**59,587**	**46,464**	205	-205

Table: 1 (Wind Distribution)

Lateral Analysis

After completing the seismic and wind analysis I found the maximum base shear of the building to be controlled by the wind in the N-S direction (770 kips) and the maximum moment due to the seismic loads to control (67,171 ft-kips). **Table: 1** shows the wind forces that were implemented on each floor for the computational model of Wisconsin Place Residential in ETABS. The results from ETABS for drift were a maximum displacement of 3.22 inches in the North-South direction and 23.11 inches in the East-West direction. The assumed drift tolerance is H/400 which equals 4.29 inches. The drift in the North-South direction complies, but the East-West direction is very much passed the allowable tolerance. A summary of the results can be found in the appendix.

Approximate Fundamental Period	0.819			
Topographic Factor K_{zt}	1			
Wind Directionality Factor K_d	0.85			
Basic Wind Speed V (mph)	90			
N-S Length of Building	240			
E-W Length of Building	296			
No. of Stories	15			
Typ. Story Height (ft)	9.21			
Building Height (ft)	141.23			
L/B in N-S Direction	0.81			
L/B in E-W Direction	1.23			
h/L in N-S Direction	0.588			
h/L in E-W Direction	0.477			
	$C_{p, windward}$	$C_{p, leeward}$	$C_{p, side wall}$	Gust Factor
N-S Direction	0.8	-0.5	-0.7	0.85
E-W Direction	0.8	-0.454	-0.7	0.85

Table: 2

Seismic Analysis

After entering the mass of the building into ETABS, 12 different failure modes were evaluated in showing how Wisconsin Place Residential fundamentally behaves. Failure mode 2 calculated the period of the building to be 1.76 seconds in the East-West direction and failure mode 4, calculated the period to be .70 seconds in the North-South direction. The previous hand calculated period was 1.39 seconds. When the 1.76 and .70 seconds were substituted into the C_s equations, the same percentage was achieved as before, because the .01% is the minimum C_s and we are still below the minimum. This means that the user defined loads for earthquake lateral forces are acceptable as per the spreadsheet using ASCE -7 '05 Chapter 12. Using the shear forces per floor from **Table: 5** and inputting that data into the ETABS model acting at the center of gravity of each floor, it was found that the maximum displacements were 1.04 inches in the North-South direction and 5.31 inches in the East-West direction. The assumed drift tolerance is H/400 which equals 4.29 inches. The drift in the North-South direction complies, but the East-West direction is passed the allowable tolerance. A summary of the results can be found in the appendix.

Weight of the Building

Floor	Net Floor Area	Loads	Weight of Shear Walls (kips)	Dead Load (excluding Shear Walls) (kips)	Total Dead Load
	(SF)	(PSF)			(kips)
2	22,988	139	122	3,195	3,317
3	30,510	139	105	4,241	4,346
4	30,507	139	107	4,240	4,347
5	40,789	139	107	5,670	5,777
6	40,789	139	107	5,670	5,777
7	40,789	139	107	5,670	5,777
8	33,283	139	107	4,626	4,733
9	32,974	139	107	4,583	4,690
10	32,980	139	107	4,584	4,691
11	32,980	139	107	4,584	4,691
12	32,980	139	107	4,584	4,691
13	23,329	139	110	3,243	3,353
13	2,500	233	0	583	583
14	25,373	139	112	3,527	3,639
15	25,373	139	114	3,527	3,641
Roof	25,373	145	58	3,679	3,737
Sum	473,517		1584	66,206	67,790

Table: 3

Factors Used in Seismic Distribution Spread Sheet

Site Classification	B
$S_{s\,(g)}$	0.154
$S_{1\,(g)}$	0.05
F_a	1
F_v	1
$S_{ms\,(g)}$	0.154
$S_{m1\,(g)}$	0.05
$S_{DS\,(g)}$	0.103
$S_{D1\,(g)}$	0.033
R	4.5
Seismic Importance factor	1
Occupancy Category	II
Seismic Design Category	A
T (s)	1.39
$T_{L\,(s)}$	8
C_S	0.01
$h_{n\,(ft)}$	141.23
V (k)	678
M (ft-kips)	67,171

Table: 4

Seismic Distribution

						Load	Shear	Moment
Level	w_x	FL-FL Height	h_x	$w_x h_x^k$	C_{vx}	F_x	V_x	M_x
	(kips)	(ft)	(ft)			(kips)	(kips)	(ft-kips)
Roof	3,737	9.85	141.23	4,970,121	0.131	89	0	12,559
15	3,641	9.48	131.38	4,359,570	0.115	78	89	10,248
14	3,639	9.48	121.9	3,907,918	0.103	70	167	8,523
13	3,936	9.21	112.42	3,757,775	0.099	67	237	7,558
12	4,691	9.21	103.21	3,955,516	0.104	71	304	7,304
11	4,691	9.21	94	3,453,188	0.091	62	375	5,808
10	4,691	9.21	84.79	2,972,694	0.078	53	437	4,510
9	4,690	9.21	75.58	2,514,769	0.066	45	490	3,401
8	4,733	9.21	66.37	2,101,172	0.055	38	535	2,495
7	5,777	9.21	57.16	2,064,227	0.054	37	572	2,111
6	5,777	9.21	47.95	1,599,146	0.042	29	609	1,372
5	5,777	9.21	38.74	1,173,001	0.031	21	638	813
4	4,347	8.93	29.53	594,953	0.016	11	659	314
3	4,346	8.93	20.6	352,484	0.009	6	670	130
2	3,317	11.67	11.67	117,815	0.003	2	676	25
Totals				37,894,348	1.00	678	**678**	**67,171**

Table: 5

Load Distribution

The story shears for the seismic forces were computed by using hand calculations that followed ASCE-7 ’05. These values were then inserted into ETABS at the center of gravity of each floor in Wisconsin Place Residential. After the analysis each shear wall was investigated in order to calculate the stiffness. The relative stiffness divided by the total stiffness will give the amount of load distribution into each shear wall. The ETAB’S calculated shear at the top of each pier on the 15th story along with the the total displacement at the top of the wall in the direction of the wind was used to calculate the shear modulus. The majority of the lateral forces go into the core of the building as shown in the **Table: 6**. Instead of calculating the stiffness of the element another approximate method would be taking the relative shear force at the top of the wall and dividing that by the total shear force going into that floor. That will give you an understanding of how much load is going to each shearwall or a basic equation assuming G=.4E for concrete or masonry may be used.

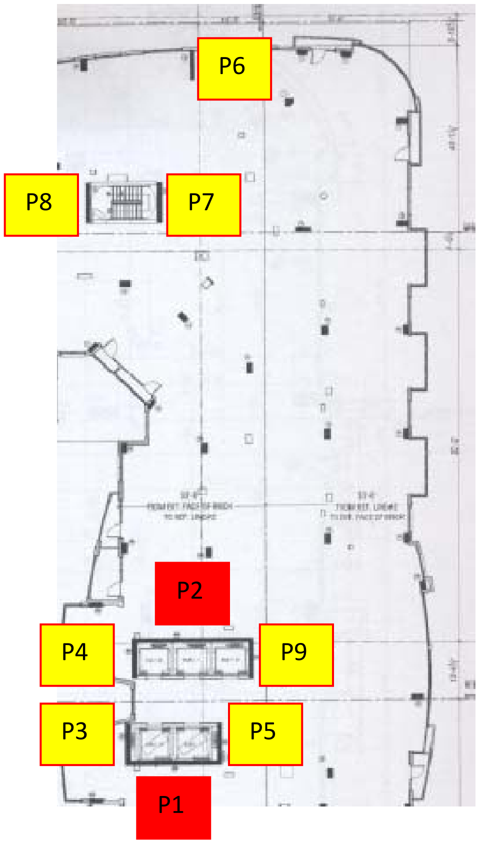
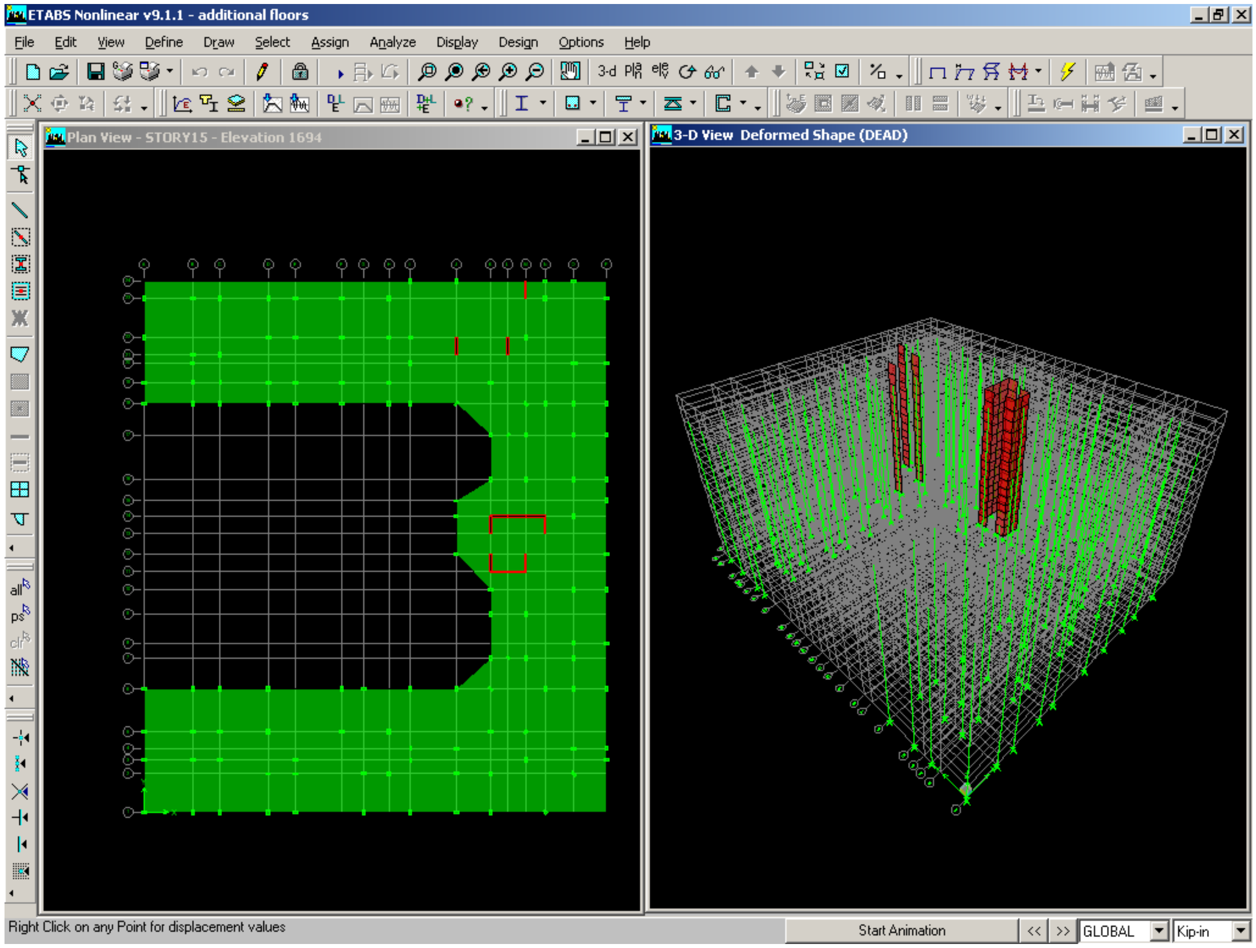


Figure: 2 (Shear Wall Locations)

Pier	Direction of Wind	Load at the Top of the Wall (kips)	Relative Displacement (inches)	Relative Stiffness	% Distributions
1	North-South	8.13	1.17	0.609	32
2	North-South	27.34	0.709	1.27	68
			Σ	1.879	100
3	East-West	10.93	5.58	0.21	22
4	East-West	10.03	5.58	0.208	22
5	East-West	0.09	3.81	0.018	2
6	East-West	1.73	3.81	0.147	15
7	East-West	1.15	4.7	0.11	12
8	East-West	0.57	7.32	0.051	5
9	East-West	5.76	2.83	0.211	22
			Σ	0.955	100

Table: 6

ETABS Analysis



When using ETABS, the model was simplified for Wisconsin Place Residential. Since the column grid was so irregular, I assumed the columns to be in straight lines rather than having an eccentricty of 2 or 3 feet in some places. As long as the sizes and reinforcement of the columns and shear walls are correct, this shouldn't jepordize the computer model. All of the columns were simplified, using only the typical floor reinforcement as specified per column grid. This was done because the whole building was simplified as a structure that has columns that start at the base of the building and are continuous to the top of the roof. This is not the case on the actual plan, a lot of columns stop at different floors and sections of the buildings do not continue all the way up as seen in the floor plans at the beginning of the appendix. To allow all the shearwalls to act as one system the members were connected to a rigid diaphram at each floor. This analysis technique permits a more direct analysis and interpretation of the results and easier application of the lateral loads. The wind and seismic loads were applied manually as user defined loads calculated from the wind and seismic analysis in **Tables: 1 &5** in accordance with ASCE-7 ’05 chapters 6 and 12.

Viewing the animated results and story displacement values show that the wind and seismic forces develop some torsion. Torsion will be looked at in more detail in later reports since it may be a significant factor. The expected levels of shear in the shear walls as calculated by ETABS are very comparable to the shear calculated by the spread sheet in **Table: 1** and the use of the distribution of forces as calculated by the relative stiffness of the shearwalls. This, in addition to the fact that the forces were user defined from hand calculations rather than calculated by ETABS helps to confirm that the ETABS model has run properly and developed justifiable results.

Load in N-S direction (kips)	**Pier**	**% Distributions**	**Load at top of 15th Floor (kips)**	**ETAB's Load at top of 15th Floor (kips)**	**% Difference**
32	1	0.29	9.28	8.13	
	2	0.71	22.72	27.33	
			Σ	35.46	9.8
Load in E-W direction (kips)					
25	3	0.26	6.5	10.93	
	4	0.25	6.25	10.03	
	5	0.01	0.25	0.09	
	6	0.12	3	1.73	
	7	0.07	1.75	1.15	
	8	0.03	0.75	0.57	
	9	0.26	6.565	5.76	
			Σ	30.26	17.4

Table: 7 (Comparison Chart)

Conclusion

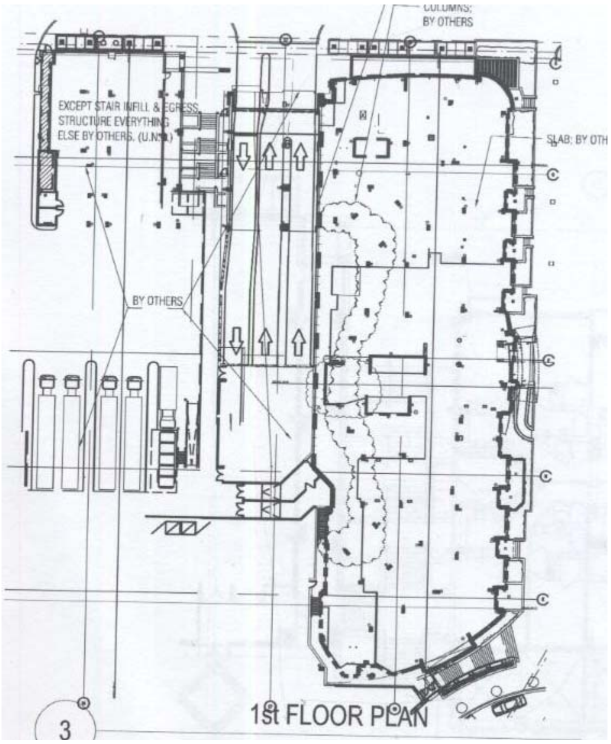
A thorough analysis utilizing the structure of Wisconsin Place Residential modeled in ETABS as well as hand calculations determined the response characteristics of the lateral force resisting system to the seismic and wind loads was successfully determined. Modeling all of the columns and shearwalls and connecting them with a rigid diaphragm on each floor made it possible to apply user defined loads for the wind and seismis forces as calculated by ASCE-7 '05.

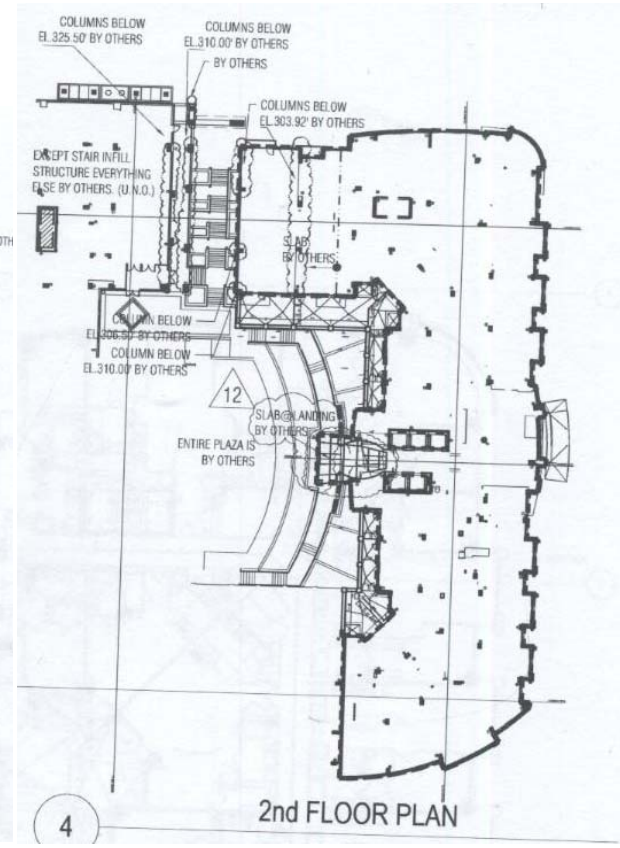
A check on the building drift under design loading was performed using ETABS. The frame was found to meet the H/400 requirements in the North-South direction, but not in the East-West direction. This can be primarily because the building is modeled, as if the entire building is uniform all the way up which it is not as seen in the floor plans located at the beginning of the appendix. The columns are defined as having only typical reinforcement, not actual reinforcement, the slab thickness are modeled as being typical and they are not all typical, and the weight of the pool was not incorporated. The frames will experience a maximum drift of 3.22 inches in the North-South direction and 23.1 inches in the East-West of the building. The allowable drift is 4.29 inches which makes 23.1 inches seem very wrong. Please note that there are no shear walls in the entire Eastern (North-South) wing of the building and a higher drift was expected.

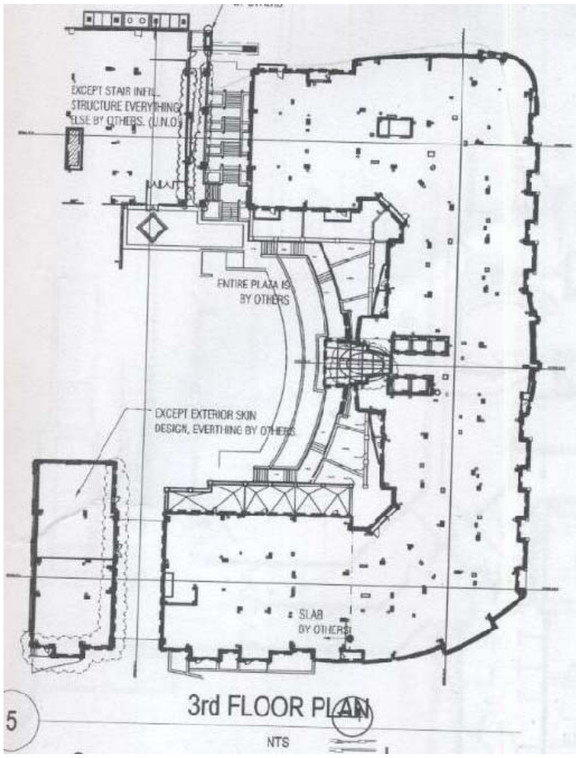
Because of the shape of the building and watching the animation of the deformed shape while using ETABS, torsion seems like it will become a significant issue. The effects of torsion will be looked at in greater depth in a future report.

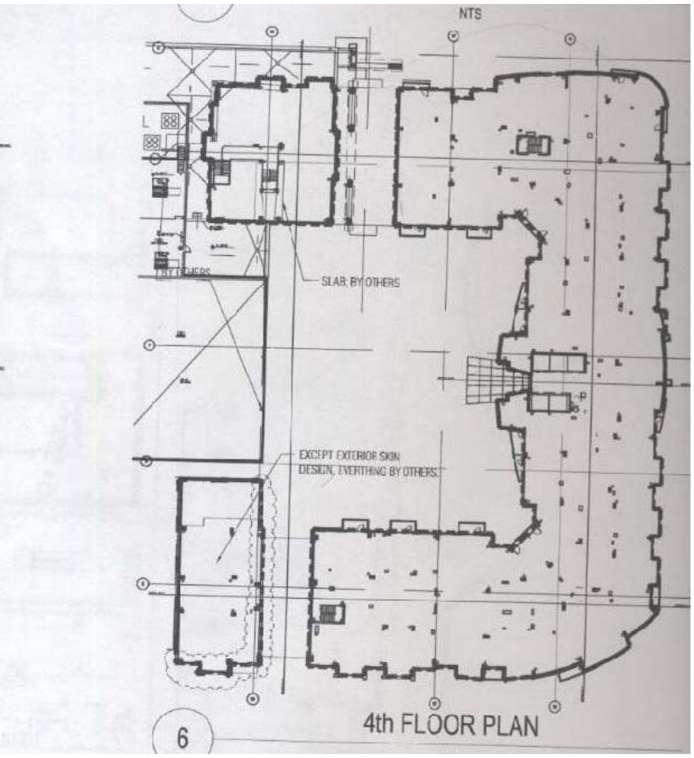
The overall turning moment of 67,171 ft-kips was governed by the seismic forces. The resisting moments to overturning are much larger than the overturning moments themselves, which is expected since the building is in a U-shape. The resisting moments were found by multiplying the overall weight of the building by the distance from the outside wall to the center of mass in each direction.

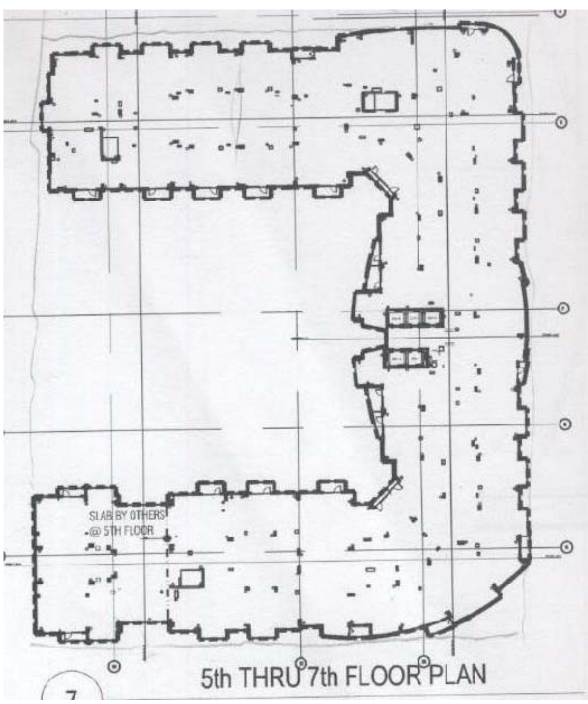
Appendix

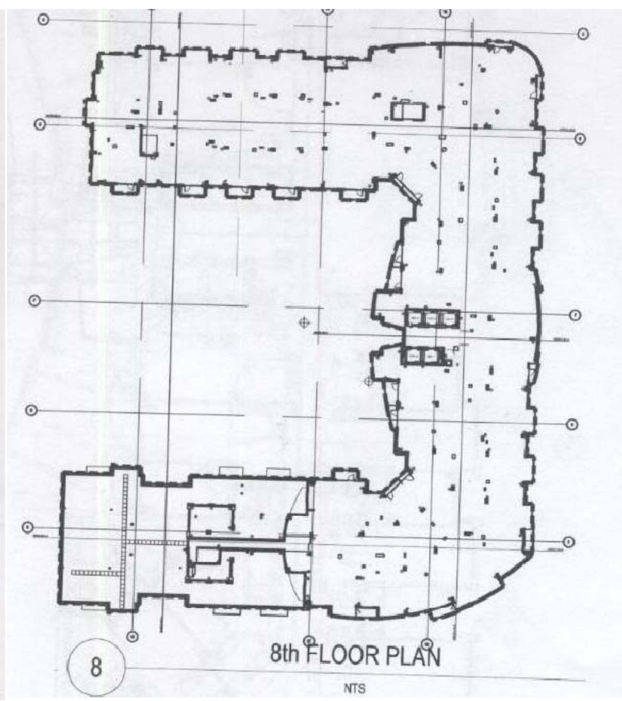

COLUMNS:
BY OTHERS
EXCEPT STAIR INFILL & EGRESS
STRUCTURE EVERYTHING
ELSE BY OTHERS. (U.N.O.)
SLAB: BY OTH
BY OTHERS
3
1st FLOOR PLAN

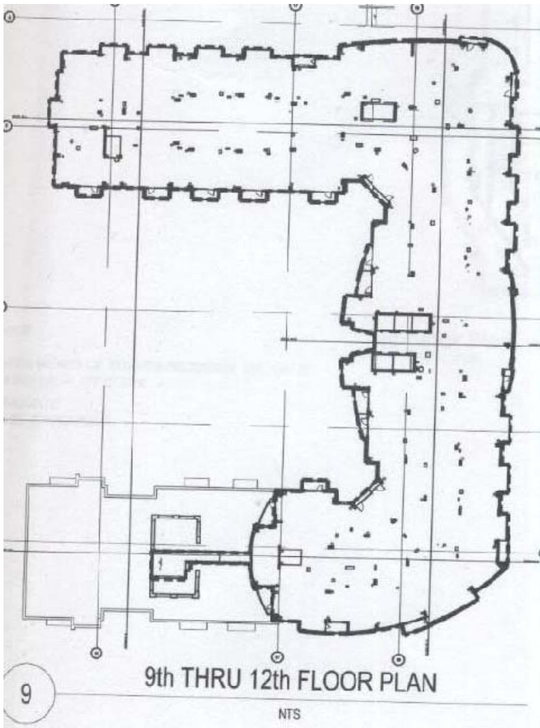

COLUMNS BELOW
EL.325.50' BY OTHERS
COLUMNS BELOW
EL.310.00' BY OTHERS
BY OTHERS
COLUMNS BELOW
EL.303.92' BY OTHERS
EXCEPT STAIR INFILL
STRUCTURE EVERYTHING
ELSE BY OTHERS. (U.N.O.)
SLAB
BY OTHERS
COLUMN BELOW
EL.306.50' BY OTHERS
COLUMN BELOW
EL.310.00' BY OTHERS
12
SLAB@LANDING
BY OTHERS
ENTIRE PLAZA IS
BY OTHERS
4
2nd FLOOR PLAN

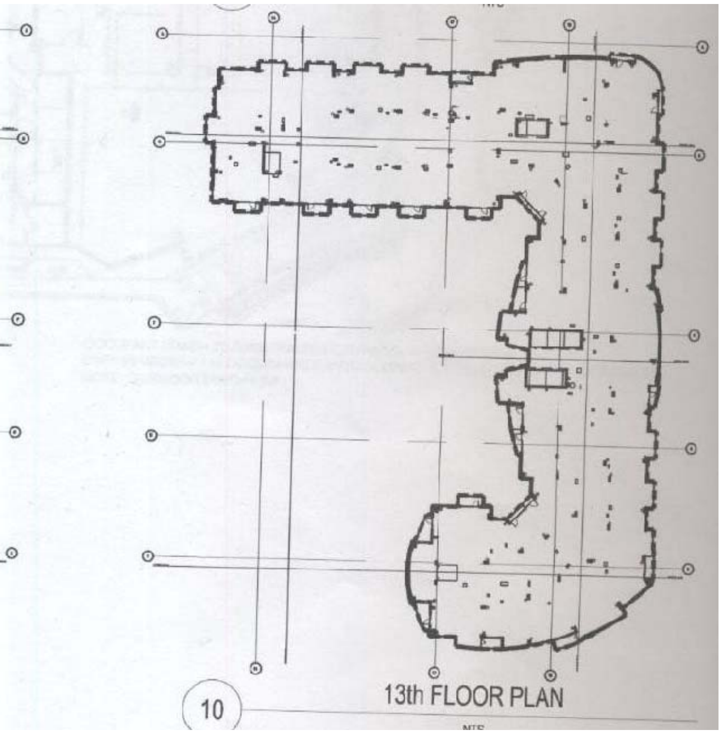

EXCEPT STAIR INFILL STRUCTURE EVERYTHING ELSE BY OTHERS. (U.N.O)
ENTIRE PLAZA IS BY OTHERS
EXCEPT EXTERIOR SKIN DESIGN, EVERTHING BY OTHERS
SLAB BY OTHERS
5
3rd FLOOR PLAN
NTS

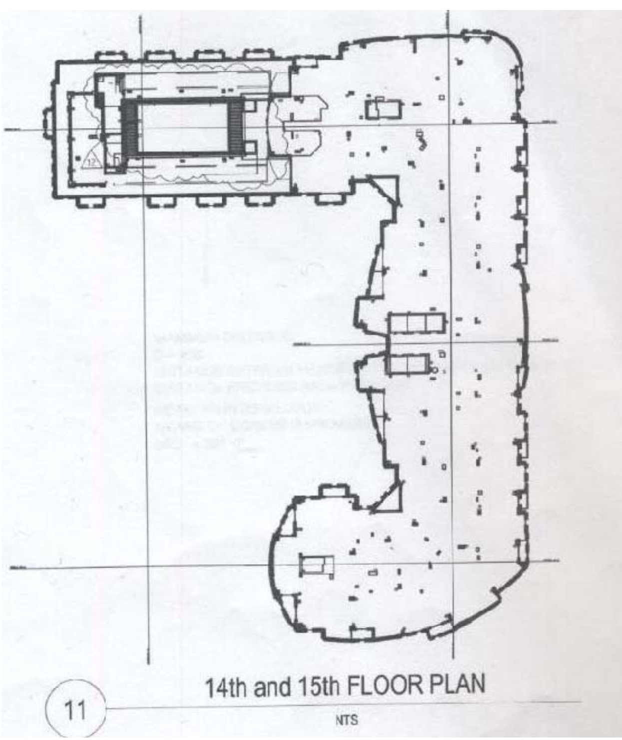

NTS
SLAB BY OTHERS
EXCEPT EXTERIOR SKIN DESIGN, EVERTHING BY OTHERS
6
4th FLOOR PLAN

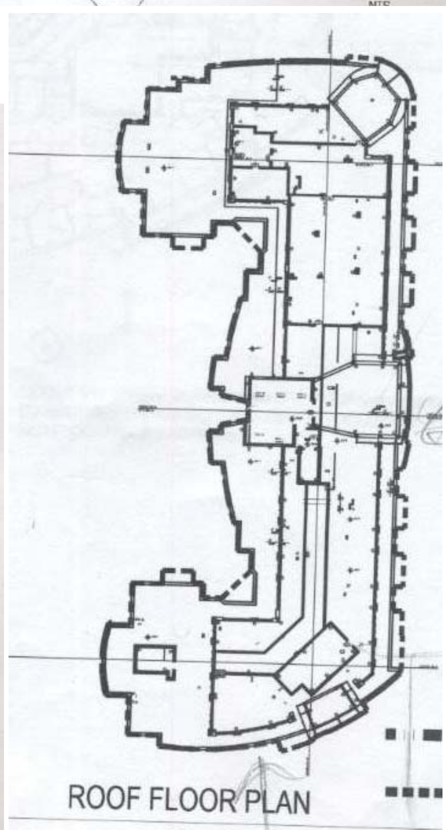

SLAB BY OTHERS @ 5TH FLOOR
5th THRU 7th FLOOR PLAN


8
8th FLOOR PLAN
NTS


9
9th THRU 12th FLOOR PLAN
NTS


10
13th FLOOR PLAN


11
14th and 15th FLOOR PLAN
NTS


ROOF FLOOR PLAN

Loads at the Top of the Wall computed by ETABS									
Story	**Pier**	**Load**	**Loc**	**P**	**V2**	**V3**	**T**	**M2**	**M3**
STORY15	P1	WIND	Top	-0.06	8.13	0	229.356	0.025	-460.19
STORY15	P1	WIND	Bottom	-0.06	8.13	0	229.356	-0.149	442.555
STORY15	P1	WINDY	Top	7.65	-27.41	0.07	-1303.39	-2.303	1171.375
STORY15	P1	WINDY	Bottom	7.65	-27.41	0.07	-1303.39	4.978	-1871.16
STORY15	P2	WIND	Top	0.05	27.33	-0.01	343.574	0.146	-1165.94
STORY15	P2	WIND	Bottom	0.05	27.33	-0.01	343.574	-0.44	1867.489
STORY15	P2	WINDY	Top	-11.96	27.46	0.13	-2018.05	-4.411	-867.675
STORY15	P2	WINDY	Bottom	-11.96	27.46	0.13	-2018.05	9.919	2180.152
STORY15	P3	WIND	Top	2.17	-2.81	0.01	114.167	0.921	116.18
STORY15	P3	WIND	Bottom	2.17	-2.81	0.01	114.167	1.798	-195.228
STORY15	P3	WINDY	Top	-9.28	10.93	0.08	-652.799	-4.505	-498.027
STORY15	P3	WINDY	Bottom	-9.28	10.93	0.08	-652.799	4.018	715.705
STORY15	P4	WIND	Top	3.46	3.96	-0.01	110.468	2.032	-185.583
STORY15	P4	WIND	Bottom	3.46	3.96	-0.01	110.468	0.61	254.402
STORY15	P4	WINDY	Top	8.58	10.03	-0.08	-652.598	4.401	-460.348
STORY15	P4	WINDY	Bottom	8.58	10.03	-0.08	-652.598	-4.094	653.266
STORY15	P5	WIND	Top	-2.11	2.7	0.01	114.158	0.907	-113.212
STORY15	P5	WIND	Bottom	-2.11	2.7	0.01	114.158	1.806	186.029
STORY15	P5	WINDY	Top	1.63	0.09	0.04	-650.596	-2.487	87.389
STORY15	P5	WINDY	Bottom	1.63	0.09	0.04	-650.596	1.638	97.446
STORY15	P6	WIND	Top	0	-0.07	0.02	112.845	0	0
STORY15	P6	WIND	Bottom	0	-0.07	0.02	112.845	2.538	-7.664
STORY15	P6	WINDY	Top	0	1.73	0.12	-647.962	0	0
STORY15	P6	WINDY	Bottom	0	1.73	0.12	-647.962	13.236	192.08
STORY15	P7	WIND	Top	0	-0.04	0.02	112.845	0	0
STORY15	P7	WIND	Bottom	0	-0.04	0.02	112.845	2.712	-4.43
STORY15	P7	WINDY	Top	0	1.15	0.09	-647.962	0	0
STORY15	P7	WINDY	Bottom	0	1.15	0.09	-647.962	10.253	127.621
STORY15	P8	WIND	Top	0	0.05	0.02	112.845	0	0
STORY15	P8	WIND	Bottom	0	0.05	0.02	112.845	2.712	5.123
STORY15	P8	WINDY	Top	0	-0.57	0.09	-647.962	0	0
STORY15	P8	WINDY	Bottom	0	-0.57	0.09	-647.962	10.253	-62.771
STORY15	P9	WIND	Top	-3.51	-4.07	-0.01	110.514	1.999	188.242
STORY15	P9	WIND	Bottom	-3.51	-4.07	-0.01	110.514	0.664	-263.447
STORY15	P9	WINDY	Top	3.39	5.76	0.01	-647.847	-0.209	-181.296
STORY15	P9	WINDY	Bottom	3.39	5.76	0.01	-647.847	0.914	457.545

DISPLACEMENTS AND DRIFTS AT PIER P1

STORY	DISP-X	DISP-Y	DRIFT-X	DRIFT-Y
STORY15	1.179477	-0.115321	0.000864	0.000078
STORY14	1.083545	-0.106663	0.000868	0.000078
STORY13	0.987176	-0.098009	0.000871	0.000078
STORY12	0.890540	-0.089364	0.000869	0.000078
STORY11	0.794038	-0.080747	0.000863	0.000077
STORY10	0.698230	-0.072184	0.000851	0.000076
STORY9	0.603824	-0.063711	0.000830	0.000075
STORY8	0.511678	-0.055375	0.000801	0.000073
STORY7	0.422796	-0.047231	0.000761	0.000071
STORY6	0.338335	-0.039341	0.000709	0.000068
STORY5	0.259600	-0.031775	0.000645	0.000065
STORY4	0.188019	-0.024606	0.000566	0.000060
STORY3	0.125139	-0.017903	0.000474	0.000056
STORY2	0.072554	-0.011721	0.000364	0.000051
STORY1	0.032134	-0.006084	0.000230	0.000043

DISPLACEMENTS AND DRIFTS AT PIER 2

STORY	DISP-X	DISP-Y	DRIFT-X	DRIFT-Y
STORY15	0.709346	-0.115321	0.000528	0.000078
STORY14	0.650741	-0.106663	0.000532	0.000078
STORY13	0.591716	-0.098009	0.000534	0.000078
STORY12	0.532403	-0.089364	0.000534	0.000078
STORY11	0.473100	-0.080747	0.000531	0.000077
STORY10	0.414195	-0.072184	0.000523	0.000076
STORY9	0.356170	-0.063711	0.000510	0.000075
STORY8	0.299595	-0.055375	0.000491	0.000073
STORY7	0.245131	-0.047231	0.000465	0.000071
STORY6	0.193537	-0.039341	0.000431	0.000068
STORY5	0.145678	-0.031775	0.000389	0.000065
STORY4	0.102511	-0.024606	0.000337	0.000060
STORY3	0.065114	-0.017903	0.000274	0.000056
STORY2	0.034682	-0.011721	0.000197	0.000051
STORY1	0.012867	-0.006084	0.000092	0.000043

D I S P L A C E M E N T S A N D D R I F T S AT P IER 3

STORY	DISP-X	DISP-Y	DRIFT-X	DRIFT-Y
STORY15	-2.136676	5.584479	0.001498	0.004284
STORY14	-1.970378	5.108957	0.001500	0.004282
STORY13	-1.803861	4.633644	0.001501	0.004270
STORY12	-1.637205	4.159633	0.001499	0.004241
STORY11	-1.470810	3.688871	0.001490	0.004187
STORY10	-1.305365	3.224084	0.001473	0.004102
STORY9	-1.141824	2.768745	0.001445	0.003979
STORY8	-0.981396	2.327054	0.001404	0.003812
STORY7	-0.825529	1.903917	0.001348	0.003594
STORY6	-0.675907	1.504942	0.001275	0.003320
STORY5	-0.534416	1.136415	0.001183	0.002983
STORY4	-0.403101	0.805260	0.001072	0.002579
STORY3	-0.284067	0.519020	0.000944	0.002103
STORY2	-0.179240	0.285620	0.000802	0.001546
STORY1	-0.090246	0.114068	0.000645	0.000815

D I S P L A C E M E N T S A N D D R I F T S AT PIER 4

STORY	DISP-X	DISP-Y	DRIFT-X	DRIFT-Y
STORY15	-0.224241	5.584479	0.000179	0.004284
STORY14	-0.204407	5.108957	0.000178	0.004282
STORY13	-0.184635	4.633644	0.000177	0.004270
STORY12	-0.164980	4.159633	0.000175	0.004241
STORY11	-0.145509	3.688871	0.000173	0.004187
STORY10	-0.126313	3.224084	0.000169	0.004102
STORY9	-0.107511	2.768745	0.000165	0.003979
STORY8	-0.089250	2.327054	0.000158	0.003812
STORY7	-0.071713	1.903917	0.000150	0.003594
STORY6	-0.055117	1.504942	0.000139	0.003320
STORY5	-0.039726	1.136415	0.000125	0.002983
STORY4	-0.025859	0.805260	0.000107	0.002579
STORY3	-0.013939	0.519020	0.000085	0.002103
STORY2	-0.004517	0.285620	0.000053	0.001546
STORY1	0.001343	0.114068	0.000010	0.000815

D I S P L A C E M E N T S   A N D   D R I F T S   AT   P IER 5

STORY	DISP-X	DISP-Y	DRIFT-X	DRIFT-Y
STORY15	-2.136676	3.811579	0.001498	0.003061
STORY14	-1.970378	3.471835	0.001500	0.003057
STORY13	-1.803861	3.132559	0.001501	0.003043
STORY12	-1.637205	2.794824	0.001499	0.003014
STORY11	-1.470810	2.460266	0.001490	0.002966
STORY10	-1.305365	2.131058	0.001473	0.002893
STORY9	-1.141824	1.809897	0.001445	0.002792
STORY8	-0.981396	1.500000	0.001404	0.002657
STORY7	-0.825529	1.205100	0.001348	0.002483
STORY6	-0.675907	0.929446	0.001275	0.002267
STORY5	-0.534416	0.677818	0.001183	0.002002
STORY4	-0.403101	0.455542	0.001072	0.001684
STORY3	-0.284067	0.268600	0.000944	0.001306
STORY2	-0.179240	0.123645	0.000802	0.000851
STORY1	-0.090246	0.029161	0.000645	0.000208

D I S P L A C E M E N T S   A N D   D R I F T S   AT   P IER 6

STORY	DISP-X	DISP-Y	DRIFT-X	DRIFT-Y
STORY15	11.652551	3.811579	0.008016	0.003061
STORY14	10.762799	3.471835	0.008032	0.003057
STORY13	9.871243	3.132559	0.008047	0.003043
STORY12	8.977975	2.794824	0.008045	0.003014
STORY11	8.085005	2.460266	0.008009	0.002966
STORY10	7.195950	2.131058	0.007929	0.002893
STORY9	6.315887	1.809897	0.007790	0.002792
STORY8	5.451243	1.500000	0.007581	0.002657
STORY7	4.609714	1.205100	0.007293	0.002483
STORY6	3.800172	0.929446	0.006916	0.002267
STORY5	3.032450	0.677818	0.006446	0.002002
STORY4	2.316924	0.455542	0.005885	0.001684
STORY3	1.663640	0.268600	0.005253	0.001306
STORY2	1.080570	0.123645	0.004598	0.000851
STORY1	0.570141	0.029161	0.004072	0.000208

D I S P L A C E M E N T S A N D D R I F T S AT P IER 7

STORY	DISP-X	DISP-Y	DRIFT-X	DRIFT-Y
STORY15	8.796211	4.698029	0.006045	0.003672
STORY14	8.125212	4.290396	0.006058	0.003669
STORY13	7.452828	3.883102	0.006069	0.003657
STORY12	6.779117	3.477228	0.006068	0.003628
STORY11	6.105586	3.074569	0.006042	0.003577
STORY10	5.434964	2.677571	0.005981	0.003498
STORY9	4.771075	2.289321	0.005877	0.003386
STORY8	4.118768	1.913527	0.005720	0.003234
STORY7	3.483842	1.554508	0.005503	0.003039
STORY6	2.872984	1.217194	0.005220	0.002793
STORY5	2.293599	0.907117	0.004866	0.002493
STORY4	1.753490	0.630401	0.004444	0.002131
STORY3	1.260186	0.393810	0.003969	0.001704
STORY2	0.819609	0.204633	0.003480	0.001198
STORY1	0.433347	0.071615	0.003095	0.000512

D I S P L A C E M E N T S A N D D R I F T S AT P IER 8

STORY	DISP-X	DISP-Y	DRIFT-X	DRIFT-Y
STORY15	8.796211	7.316340	0.006045	0.005479
STORY14	8.125212	6.708184	0.006058	0.005479
STORY13	7.452828	6.099981	0.006069	0.005470
STORY12	6.779117	5.492849	0.006068	0.005440
STORY11	6.105586	4.889036	0.006042	0.005380
STORY10	5.434964	4.291809	0.005981	0.005283
STORY9	4.771075	3.705398	0.005877	0.005139
STORY8	4.118768	3.134963	0.005720	0.004941
STORY7	3.483842	2.586557	0.005503	0.004680
STORY6	2.872984	2.067116	0.005220	0.004349
STORY5	2.293599	1.584396	0.004866	0.003942
STORY4	1.753490	1.146882	0.004444	0.003453
STORY3	1.260186	0.763642	0.003969	0.002881
STORY2	0.819609	0.443846	0.003480	0.002224
STORY1	0.433347	0.197010	0.003095	0.0014

D I S P L A C E M E N T S   A N D   D R I F T S   AT   PIER 9

STORY	DISP-X	DISP-Y	DRIFT-X	DRIFT-Y
STORY15	-0.224241	2.826634	0.000179	0.002381
STORY14	-0.204407	2.562322	0.000178	0.002376
STORY13	-0.184635	2.298623	0.000177	0.002361
STORY12	-0.164980	2.036597	0.000175	0.002332
STORY11	-0.145509	1.777708	0.000173	0.002287
STORY10	-0.126313	1.523821	0.000169	0.002222
STORY9	-0.107511	1.277203	0.000165	0.002132
STORY8	-0.089250	1.040526	0.000158	0.002015
STORY7	-0.071713	0.816868	0.000150	0.001866
STORY6	-0.055117	0.609726	0.000139	0.001682
STORY5	-0.039726	0.423042	0.000125	0.001458
STORY4	-0.025859	0.261255	0.000107	0.001187
STORY3	-0.013939	0.129478	0.000085	0.000863
STORY2	-0.004517	0.033658	0.000053	0.000465
STORY1	0.001343	-0.018009	0.000010	0.000129

D I S P L A C E M E N T S   A N D   D R I F T S   AT   P O I N T   O B J E C T   1

(Wind Force in the North-South Direction)

STORY	DISP-X	DISP-Y	DRIFT-X	DRIFT-Y
STORY15	3.215791	-3.058808	0.002321	0.002183
STORY14	2.958185	-2.816450	0.002325	0.002184
STORY13	2.700063	-2.573983	0.002327	0.002183
STORY12	2.441764	-2.331656	0.002321	0.002176
STORY11	2.184145	-2.090143	0.002303	0.002159
STORY10	1.928492	-1.850524	0.002270	0.002128
STORY9	1.676506	-1.614270	0.002218	0.002081
STORY8	1.430289	-1.383225	0.002144	0.002015
STORY7	1.192333	-1.159594	0.002043	0.001925
STORY6	0.965510	-0.945922	0.001914	0.001810
STORY5	0.753039	-0.745041	0.001754	0.001667
STORY4	0.558387	-0.559971	0.001561	0.001498
STORY3	0.385128	-0.393716	0.001338	0.001305
STORY2	0.236589	-0.248834	0.001090	0.001100
STORY1	0.115587	-0.126715	0.000826	0.000905

D I S P L A C E M E N T S   A N D   D R I F T S   AT   P O I N T   O B J E C T   1

(Wind Force in the East-West Direction)

STORY	DISP-X	DISP-Y	DRIFT-X	DRIFT-Y
STORY15	-14.259704	23.108288	0.009863	0.016375
STORY14	-13.164962	21.290703	0.009881	0.016396
STORY13	-12.068223	19.470755	0.009896	0.016405
STORY12	-10.969717	17.649757	0.009890	0.016370
STORY11	-9.871964	15.832719	0.009843	0.016260
STORY10	-8.779438	14.027839	0.009739	0.016050
STORY9	-7.698395	12.246253	0.009564	0.015715
STORY8	-6.636757	10.501866	0.009304	0.015231
STORY7	-5.604014	8.811205	0.008945	0.014576
STORY6	-4.611126	7.193291	0.008476	0.013730
STORY5	-3.670286	5.669308	0.007890	0.012679
STORY4	-2.794456	4.261958	0.007189	0.011421
STORY3	-1.996426	2.994231	0.006393	0.009978
STORY2	-1.286823	1.886629	0.005549	0.008408
STORY1	-0.670837	0.953311	0.004792	0.006809

D I S P L A C E M E N T S   A N D   D R I F T S   AT   P O I N T   O B J E C T   44

(Seismic Force in the North-South Direction)

STORY	DISP-X	DISP-Y	DRIFT-X	DRIFT-Y
STORY15	1.043680	0.139430	0.000794	0.000092
STORY14	0.955596	0.129237	0.000798	0.000092
STORY13	0.867032	0.118988	0.000800	0.000093
STORY12	0.778282	0.108666	0.000797	0.000093
STORY11	0.689835	0.098290	0.000789	0.000094
STORY10	0.602273	0.087899	0.000774	0.000093
STORY9	0.516411	0.077555	0.000750	0.000092
STORY8	0.433204	0.067335	0.000716	0.000090
STORY7	0.353703	0.057330	0.000673	0.000087
STORY6	0.279034	0.047636	0.000619	0.000084
STORY5	0.210361	0.038353	0.000553	0.000079
STORY4	0.148965	0.029588	0.000475	0.000073
STORY3	0.096189	0.021442	0.000386	0.000067
STORY2	0.053389	0.014004	0.000282	0.000060
STORY1	0.022104	0.007328	0.000158	0.000052

D I S P L A C E M E N T S   A N D   D R I F T S   AT   P O I N T   O B J E C T   76

(Seismic Force in the East-West Direction)

STORY	DISP-X	DISP-Y	DRIFT-X	DRIFT-Y
STORY15	-5.306243	2.895181	0.003797	0.002760
STORY14	-4.884827	2.588791	0.003798	0.002747
STORY13	-4.463195	2.283870	0.003795	0.002716
STORY12	-4.041935	1.982438	0.003779	0.002663
STORY11	-3.622444	1.686897	0.003744	0.002584
STORY10	-3.206822	1.400032	0.003684	0.002477
STORY9	-2.797868	1.125094	0.003594	0.002336
STORY8	-2.398976	0.865749	0.003468	0.002160
STORY7	-2.014022	0.626041	0.003304	0.001943
STORY6	-1.647238	0.410386	0.003100	0.001683
STORY5	-1.303086	0.223591	0.002856	0.001375
STORY4	-0.986095	0.071008	0.002573	0.001010
STORY3	-0.700476	-0.041123	0.002263	0.000577
STORY2	-0.449319	-0.105218	0.001945	0.000042
STORY1	-0.233415	-0.109847	0.001667	0.000785

SEISMIC DESIGN

BUILDING ON SITE CLASS B IS 141.23'

LATITUDE: 38.96
LONGITUDE: -77.09

$S_s = .154_g$ $T_L = 8$ sec, CHEVY CHASE MARYLAND
$S_1 = .050$

$F_a = 1.0$
$F_v = 1.0$

$S_{MS} = F_a \cdot S_s = 1.0(.154) = .154g$
$S_{M1} = F_v \cdot S_1 = 1.0(.050) = .050g$

$S_{DS} = 2/3 S_{MS} = 2/3(.154) = .103g$
$S_{D1} = 2/3 S_{M1} = 2/3(.050) = .033g$

DUAL SYSTEMS W/ INTERMEDIATE MOMENT FRAMES CAPABLE OF RESISTING AT LEAST 25% OF PRESCRIBED SEISMIC FORCES

$R \Rightarrow 4\tfrac{1}{2}$

IMPORTANCE FACTOR, I = 1.0
OCCUPANCY CATEGORY = II

SDC = A

$V_b = C_s \cdot W$

$T_a = C_t h_n^x$

$T_a = (.02)(141.23)^{(.75)} = .819s$

$T = C_u \cdot T_a = 1.7(.819) = 1.39s$

$C_s = \dfrac{S_{DS}}{R/I} = \dfrac{.103}{4.5/1.0} = .023$

$C_s = \dfrac{S_{D1}}{T(R/I)}$ for $T \le T_L$ $= \dfrac{.033}{1.39(4.5/1)} = .005$

$C_s \ge \dfrac{S_{D1} \cdot T_L}{T^2(R/I)}$ ⇒ NOT APPLICABLE

min $C_s = .01$ therefore

$C_s = .01$

$V_b = .01(67{,}790^k)$

$V_b = 678^k$

CALCULATION OF STIFFNESS

$$G = \frac{F/A}{\Delta l / h}$$

P_1 = LOAD @ TOP OF WALL DUE TO WIND (x-direction) = $8{,}13^{K}$

Δl = 1,17 inches (ETABS) $E = 57{,}000\sqrt{f'_c} = 6000\,psi$

h = 1694 inches = 141,167'

$$G = \frac{8{,}13^{K} / (12' \times 1')(12''/1)}{1{,}17in / 1694in} = \boxed{81{,}74\ KSI}$$

$$K_s = \frac{1}{\frac{4h^3}{Eb^3} + \frac{1{,}2h}{Gb}} = \frac{1}{\frac{4(1694)^3}{(4415)(144)^3} + \frac{1{,}2(1694)}{81{,}74(144)}}$$

(1.47)   (.173)

$$K_s = \frac{1}{1{,}643} = \boxed{.609}$$

P_2 LOAD @ TOP OF WALL DUE TO WIND IN X-direction = $27{,}34^{k}$

Δl = .709 in

h = 1694 inches

$$G = \frac{27{,}34 / (15 \times 12''/1)}{.709/1694} = \boxed{362.91}$$

$$K_s = \frac{1}{\frac{4\,(1694)^3}{4415\,(180)^3} + \frac{1{,}2\,(1694)}{362{,}91\,(180)}} = \frac{1}{.786} = \boxed{1.27}$$

.755 + .0311

WIND IN X-DIRECTION (N-S of building)

TOTAL STIFFNESS = 1,879

% $\frac{.609}{1.879}$ $\frac{1{,}27}{1.879}$ = 32,4% 67.6%

P9 LOAD @ TOP OF WALL DUE TO WIND IN Y-DIRECTION (EAST-WEST) = 5.76K 2/4

Δl = 2.83in

h = 1694

$G = \dfrac{5.76/(8.5\times12)}{2.83/1694} = 33.80$ ksi

$K_S = \dfrac{1}{\dfrac{4h^3}{Eb^3} + \dfrac{1.2h}{Gb}} = \dfrac{1}{\dfrac{4\,1694^3}{(4415)(8.5\times12)^3} + \dfrac{1.2(1694)}{33.8(8.5\times12)}} = \dfrac{1}{4.74} = \boxed{.211}$

(8.5×12 = 102)

4(1.0375) + .5896
(4.15)

P5 LOAD = 1.09K

Δl = 3.81"

h = 1694

$G = \dfrac{.09/102}{3.81/1694} = .392$

$K_S = \dfrac{1}{\dfrac{1694^3}{4415(102)^3} + \dfrac{1.2(1694)}{.392(102)}} = \dfrac{1}{54.99} = \boxed{.018}$

4(1.03755) + 50.84
(4.15)

P6 LOAD = 1.73K

Δl = 3.81"

h = 1694

$G = \dfrac{1.73/102}{3.81/1694} = 7.54$

$\dfrac{1}{4(1.03755) + \dfrac{1.2(1694)}{7.54(102)}} = \dfrac{1}{6.79} = \boxed{.147}$

3/4

P3 LOAD = 10.93

$\Delta l = 5.58in$

$h = 1694in$

$$G = \frac{10.93/102}{5.58/1694} = 32.53$$

$$\frac{1}{4(1.03755) + \frac{1.2(1694)}{(32.53)(102)}} = \frac{1}{4.76} = \boxed{.210}$$

P4 LOAD = 10.03

$\Delta l = 5.58$

$h = 1694$

$$G = \frac{10.03/102}{5.68/1694} = 29.85$$

$$\frac{1}{4(1.03755) + \frac{1.2(1694)}{29.85(102)}} = \frac{1}{4.817} \boxed{.208}$$

P7 LOAD = 1.15K

$\Delta l = 4.70$

$h = 1694$

$$G = \frac{1.15/102}{4.7/1694} = 4.06KSI$$

$$\frac{1}{4(1.03755) + \frac{1.2(1694)}{4.06(102)}} = \frac{1}{9.06} = \boxed{.110}$$

P8 LOAD = .57^{k} 4/

$\Delta l = 7.32$

$h = 1694$

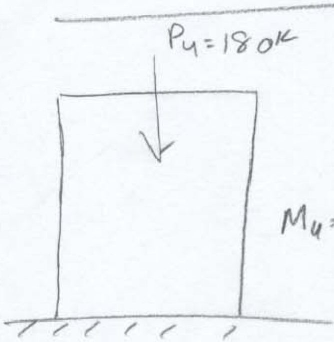
$$6 = \frac{.57/102}{7.32/1694} = 1.29$$

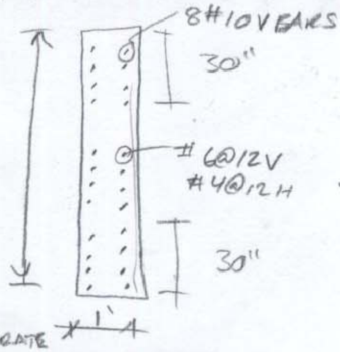
$$\frac{1}{4(1.03755) + \frac{1.2(1694)}{1.29(102}} = \frac{1}{19.60} = \boxed{.051}$$

1/2

SHEARWALL SPOT CHECK

PIER (6)





GOVERNS & IS MORE ACCURATE

← 161.78^k (LOAD FROM ETABS)

OR

USING. DISTRIBUTION LOAD: 599 X .15 = 89.85^k (FROM SPREAD SHT)

ASSUME S.W. TAKES NO GRAVITY LOADS.

SELFWT

ht of wall ⇓

$= 8.5' \times 1' = 8.5 SF \times 150 lb/ft^3 = 1275 lb/ft \times \left(\frac{1694 in}{12}\right) = 180^K$

A.) BE NEEDED IF;

$f'_c > .2 f'_c$

$A_g = (1.0)(8.5') = 8.5 ft^2$

$I_g = \frac{(1.0)(8.5)^3}{12} = 51.18 ft^4$

$\frac{P_u}{A_s} = \frac{180^K}{8.5 ft^2} = 21.18 K/ft^2$

$\frac{M_u \frac{h_w}{2}}{I_g} = \frac{364.805 (8.5/2)}{51.18} = 30.29 K/ft^2$

$30.29 + 21.8 = 51.47 KSF$

$\frac{51.47 KSF}{144} = .357 ksi$

$.2 f'_c = .2(6 ksi) = 1.2 ksi$

$.357 < 1.2$ ✓ OK

NO BE, REQ'd

cont'd on next page

LONGITUDINAL REINFORCEMENT 2/2

$V_n \geq 2 A_{cv} \sqrt{f'c}$ ∴ NEED 2 CURTAINS.

$2(8.5' \times 12''/' \times 12)\sqrt{6{,}000} = 189.6^k > 161.78^k$

2 CURTAINS REQ'D

$A_{cv} = 1224 in^2$

$A_{s\,LONG} = (.0025)\left(\frac{1224}{12}\right) = .255 in^2/ft$

#4 BARS

$A_{s\ell} = 2(.20) = .40 in^2/s\text{-}space$

CHECK SPACING

$\frac{2(.255)}{12} = \frac{.40}{s} \Rightarrow s = 9.41 < 18''$ ✓ OK.

NOMINAL SHEAR CAPACITY

$V_n = A_{cv}(\alpha_c \sqrt{f'c} + \rho_t f_y)$

$\frac{h_w}{\ell_w} > 2 \quad \alpha_c = 2.0$

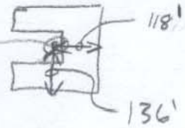
$V_n = 1224 in^2 (2.0 \overset{154.919}{\sqrt{6{,}000}}_{psi} + \overset{168}{.0028(60{,}000)})$

$V_n = 1224 in^2 (322.919 lb/in^2)$

$V_n = 395.253^k$

$\phi V_n = (.6)(395.253) = \boxed{237.152^k \geq 161.78^k}$ ✓OK.

OVERTURNING MOMENT RESISTING



TOTAL WT OF BUILDING = 67,790 KIPS

CENTER OF MASS FROM ETABS = 118' in x-direction
136' in the y-direction

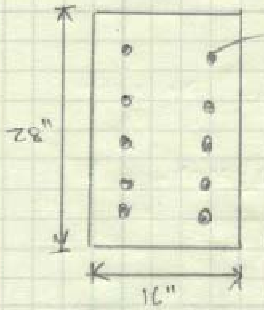
$67{,}790^{k}(118') = 7{,}999{,}220^{k'}$

$67{,}790^{k}(136') = 9{,}219{,}440^{k'}$ $\geq 67{,}171^{k'}$ ✓OK

COLUMN GRAVITY CHECK

@ LVL 1

ASSUME LOAD IS PURE AXIAL.



COL. 153 — 10#10 bars

$DL = 796^k$
$LL = 181^k$
977

ASSUMING LOADS ARE FACTORED

$$P_o = .85f'_c(bh - \Sigma A_s) + \Sigma A_s f_y$$

$$= .85(6)(16 \times 28 - 10(1.27)) + 10(1.27)(60)$$

$$2220 + 76.2 = 2296^k$$

$$\phi P_o = .65(2296) = 1492.53$$

$$.8\phi P_o = .8(1492.53) = 1194.02 > 977$$

This COLUMN IS ADEQUATE ✓ OK