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THE hub on Chestnut

PHILADELPHIA, PA

Technical Assignment 3

November 21, 2006

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Executive Summary

Structural Technical Report 3

The contents of this report provide a detailed analysis of the lateral force resisting system of The HUB on Chestnut located in Philadelphia, Pennsylvania. The original designed lateral system is an ordinary moment frame. Structurally, the building is constructed of monolithically poured concrete columns and flat slabs to integrate all elements of the structure. The design features large uniform concrete columns with the tops and bottoms overly reinforced to provide strength due to an abundance of moment. The structural design does not incorporate any shear walls, braced frames, or any other special constraints. Analysis will include the interaction of gravity, wind, and seismic loading conditions. The main wind force resisting system (MWFRS) was investigated considering a fully enclosed, rigid building. The seismic-resisting system was analyzed with an ordinary concrete moment frame. Gravity loads have been taken from previous analysis and technical reports. Loading includes live load and snow load reduction where they are applicable. All loading conditions have been determined in conjunction with the use of industry codes and standards (*ASCE 7-02, ACI 318-03, IBC 2003).* Although, the building is located in Philadelphia, a non-hurricane and low-seismic region, the structure must be designed to accommodate an event of an earthquake.

Two analytical methods have been used in determining the lateral distribution throughout the structure. A preliminary hand-calculated analysis was performed using industry codes and then the results were compared to the output data of ETABS v8.5. Both procedures produced the wind and seismic forces that are exerted onto the building. Base shear and overturning moment are the focal points used in comparison. In both cases, the seismic condition was the controlling case over wind. The controlling load combination was $0.9D + 1.0E$. Seismic forces had created significantly higher values in both methods.

The performance of the lateral system was also evaluated on horizontal drift. A chosen criterion on $L/400$ was set as a controlling limit. The structural system produced a ratio well within this parameter. The final drift ratio was found to be $L/635$.

With the aid of ETABS, a model was created to represent the entire structure as well as several simulations to replicate deflections and movement with various loading combinations. I felt that ETABS was a great advantage in understanding the lateral force resisting system because of its ability to present the user with thorough and direct output data.

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Lateral System Analysis

The objective of this report is to analyze the designed lateral force resisting system of The HUB on Chestnut located in the University City section of Philadelphia, Pennsylvania. I would like to first reintroduce the building. The HUB, located at the northeast corner of Chestnut and 40th streets, is a mid-rise, mixed-use structure. The building is predominantly a concrete structure that stands 9-levels with one sub-grade level covering a footprint of approximately 11,000 square-feet. The North/South length of the building extends one-hundred forty-eight feet down 40th Street and the East/West width extends sixty-eight feet along Chestnut Street. The HUB provides the local community with 110 apartment units and 3-levels of retail and mercantile use. Levels three to nine are designed for a residential occupancy, while the sub-grade, first, and second levels are designed primarily for commercial occupancy.

The basic structural system is classified as a 'moment resisting frame' consisting of post-tensioned, two-way flat slabs and rectangular concrete columns. The structure is supported by large 20"x 30" and 30"x 30" concrete columns that are monolithically poured with the flat slabs. The HUB is designed with an ordinary concrete moment frame system without the use of any shear walls. A concrete moment resisting frame is implemented into the building to resists both vertical and lateral loads.

The loading distribution has been designed using ETABS v8.5, a computer-aided design program, as well as hand-calculated values assisted by multiple spreadsheets. This program has allowed me to create a working model to analyze the lateral force resisting system of The HUB on Chestnut. Analysis data consists of story drift, story shear, and column reactions due to wind and seismic forces. The loading throughout the building will be selected based on member sizes, occupancy, and location. All applicable loading conditions have been determined in conjunction with the use of industry codes and standards (*ASCE 7-02*, *ACI 318-03*, *IBC 2003).*

LOADING

All gravity loads are taken from the applicable codes. The International Building Code 2003 was the main document used in designing The HUB. Many items cited below where found in the IBC 2003. Often, the IBC directs items and guidelines to be referenced in ASCE 7-02. The live loads have been selected based the occupancy of a particular floor. A 100 PSF live load has been placed in all corridors located in the residential levels. In certain loading areas, a live load reduction has been incorporated. The dead loads that are listed below have been modified from the original design. A few loads have been added to incorporate some features that may not have been taken into account previously. The collateral loads have been modified and a MEP dead load has been added. MEP has been considered to account for an excessive amount of plumbing due to fire protection and multiple water closets from residences. A reducible snow load has been designed and applied to the roof level.

Live Load Reduction

$$L = L_o\left(0.25 + \frac{15}{\sqrt{K_{LL}A_T}}\right)$$

Roof Live Load Reduction

$$L_r = 20R_1R_2 \text{ where } 12 \leq L_r \leq 20$$

The International Building Code has defined multiple loading combinations for strength design. I have selected all combinations and removed any factors that are not applicable in analysis. These equations have been incorporated into the ETABS model to account for all loading conditions due to dead, live, roof, wind, and seismic loads.

Loading Combinations presented by the International Building Code 2003 Edition	$1.4(D + F)$ $1.2(D + F + T) + 1.6(L + H) + 0.5(Lr \text{ or } S \text{ or } R)$ $1.2D + 1.6(Lr \text{ or } S \text{ or } R) + (L \text{ or } 0.8W)$ $1.2D + 1.6W + L + 0.5(Lr \text{ or } S \text{ or } R)$ $1.2D + 1.0E + L + 0.2S$ $0.9D + 1.6W + 1.6H$ $0.9D + 1.0E + 1.6H$

Loading Combinations used in coordination with ETABS modeling analysis	$1.4D$ $1.2D + 1.6L + 0.5(Lr \text{ or } S)$ $1.2D + 1.6(Lr \text{ or } S) + (L \text{ or } 0.8W)$ $1.2D + 1.6W + L + 0.5(Lr \text{ or } S)$ $1.2D + 1.0E + L + 0.2S$ $0.9D + 1.6W$ $0.9D + 1.0E$

DEAD/LIVE LOADS *ASCE 7-02 Chapter 6*

Dead Loads					
Concrete (Reinforced)					
12"	150 lbs/ft^2		X		
9"	113 lbs/ft^2			X	X
4"	50 lbs/ft^2	X			
Partitions	20 lbs/ft^2			X	
MEP	5 lbs/ft^2	X	X	X	X
Collateral					
Mechanical	15 lbs/ft^2	X			X
Commercial	10 lbs/ft^2		X		
Residential	5 lbs/ft^2			X	
Live Loads [ASCE 7-02 T4-1]					
Stores (Retail)	100 lbs/ft^2	X			
Assembles (Lobbies)	100 lbs/ft^2		X		
Residental (Private Rooms)	40 lbs/ft^2			X	
Roof	30 lbs/ft^2				X

Slab on Grade *Dead* 70 lbs/ft^2
Live 100 lbs/ft^2

1st - 2nd Levels *Dead* 165 lbs/ft^2
Live 100 lbs/ft^2

3rd - 9th Levels *Dead* 143 lbs/ft^2
Live 40 lbs/ft^2

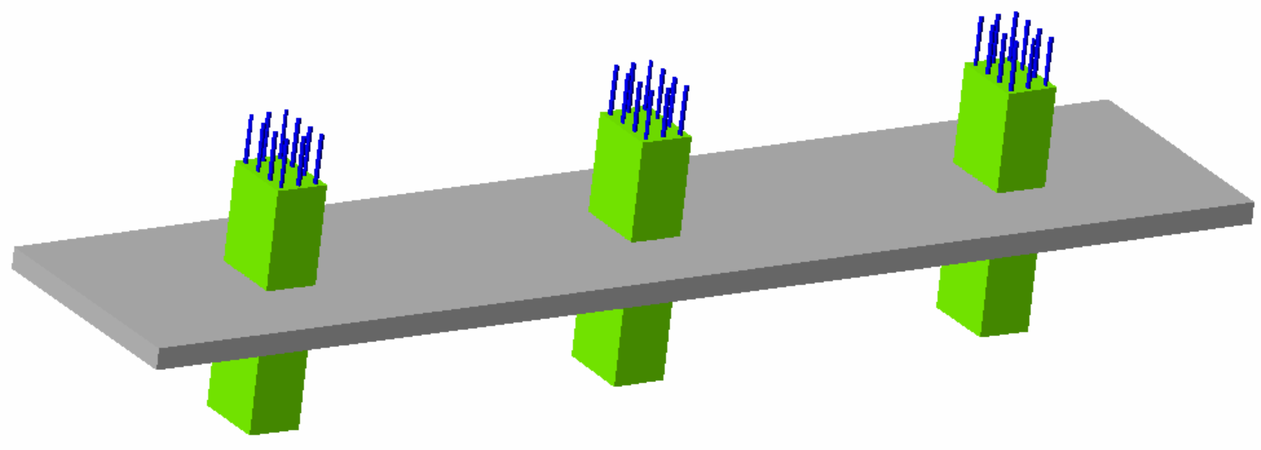
Roof Level *Dead* 133 lbs/ft^2
Live 30 lbs/ft^2

SNOW LOAD *IBC 2003 Edition*

P_g	25	FIGURE 1608.2
C_e	1	TABLE 1608.3.1
I_s	1	TABLE 1604.5
C_t	1	TABLE 1608.3.2
$P_f = 0.7C_e C_t I P_g$	18	

LATERAL SYSTEM

The lateral system is classified as a concrete moment resisting frame consisting of post-tensioned, two-way slabs and concrete columns. All floors are supported by twenty-two reinforced concrete columns. A typical bay sizing is 25' x 25'. Levels 4 through the roof are comprised of 20"x 30" concrete columns. The lower levels are supported by seven 20"x 30" columns and fifteen 30"x 30" columns. The typical reinforcing consists of (10-14) vertical bars ranging from #7- #10 in size. All ties are made up of #3 bars spaced at 12" on-center. All concrete columns and slabs are poured with high strength 5000 PSI concrete.



A monolithically poured slab and column is formed to create a simple moment connection. The design is based on this type of construction. No integration of shear walls or braced frames are used to distribute any of the lateral loads. The moment frames are designed to absorb, or resist, any and all forces that are distributed through the slab and the column itself.

In common design, the dimensioned columns are considered to be very large. The columns are uniform in dimension but are different in reinforcement throughout the structure. As the elevation of the building increases the need for larger reinforcement decreases. This effect is caused by lesser axial loading. The original designer may have considered several factors in selecting the uniform column sizes. First, it may be a request of the architectural. This aesthetic detail could be the main factor. Second, by choosing a uniform dimension construction can be greatly increased. The use of common concrete forms can greatly increase productivity and have less chance of error from story to story. Lastly, the current price of steel is significantly higher compared to concrete. The larger dimensions can add greater strengths to the concrete which will decrease reinforcement, hence lowering costs.

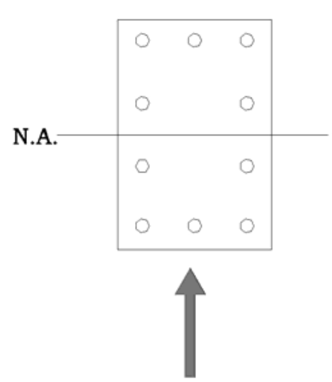
LATERAL LOADING ANALYSIS

The lateral loads performed on The HUB were analyzed by standard practice and the guidelines recognized in the 2003 IBC along with ASCE 7-02. Both load calculations are based on the size, geometry, type, and geologic location of the structure. The wind load analysis is performed on the main wind force-resisting system (MWFRS), which is guided by ASCE 7-02 Chapter 6 and the seismic loading is performed on the structural framing, which is guided by ASCE 7-02 Chapter 8.

Wind

The wind loads on the MWFRS are calculated based the geometry, height, type, and geological location of the building. The geometry of the building is 148-ft in length and 68-ft in its largest width. The HUB is classified as a mid-rise structure with a mean roof height of 99'-6". The building is categorized with exposure B due to its urban setting and surrounding dwellings. The topography is homogenous. Philadelphia is not located in a special wind region or within a hurricane region of the United States but is subjected to substantially high wind. The basic wind speed is 90 mph. Although the building's glazing is not blast proof, I believe that the glazing is able to withstand most windborne debris therefore classifying the structure as fully enclosed. In the case of a 'breached' building envelope it is possible to increase the internal pressure by almost three times (±0.18 → ±0.55). The wind analysis will be designed considering a rigid structure because the fundamental frequency of the building is greater than 1 Hz.

The data obtained has proven that the East-to-West wind direction is the most critical orientation because higher pressures are to be exerted on the structure. This conclusion is based on adding both the windward and leeward pressures and observing which produces higher result. Another observation is that when the interior pressure is negative the windward pressure is greatest. Contrary to this assumption, when the interior pressure is positive the leeward pressures are greatest. The rectangular columns have been oriented to resist this controlling direction. The columns are arranged so that their strong-axis, where the moment of inertia is greatest, will receive forces from the East-to-West direction. The calculated results have been summarized in the illustration and tables below.



WIND ANALYSIS

ASCE 7-02 Chapter 6

Location	Philadelphia, PA			
Typography	Homogeneous			
Dimensions	148'	Length	99' - 6"	Height
	68'	Wide		
Framing	Moment Resisting Frame System			
Cladding	Rainscreen Panel Assembly			
Frequency	Rigid Structure	f = 1.11 Hz *[6.2]*		
Enclosure Class	Enclosed			

Velocity Pressure

q_z	$0.00256 K_z K_{zt} K_d V^2 I$
V_3	90
I_w	1.00
K_d	0.85
K_{zt}	1.00

Gust Effect Factor

c	0.3	
l	320	
e	1/3.0	
z_{min}	30	
z	59.7	(0.6h = z_{min})
L_z	390	
$g_Q = g_v$	3.4	
Q	0.85	
I_z	0.27	
G	0.84	*0.85*

G = 0.85 ASCE7 6.5.81

Internal Pressure Coefficient

GC_{pi}	± 0.18

External Pressure Coefficients

North/South			East/West		
Wall	*Cp*		*Wall*	*Cp*	
	0.80	Windward		0.80	Windward
	-0.30	Leeward		-0.50	Leeward
	-0.70	Side		-0.70	Side
Roof	-0.95	0 to h/2	*Roof*	-1.04	0 to h/2
	-0.83	h/2 to h		-0.70	> h/2
	-0.57	h to 2h			

Wall Pressures

Height (FT)	K_z	q_z	Windward North/South +0.18	Windward North/South -0.18	Windward East/West +0.18	Windward East/West -0.18	Leeward North/South +0.18	Leeward North/South -0.18	Leeward East/West +0.18	Leeward East/West -0.18	MWFRS North/South	MWFRS East/West
0-15	0.57	10.05	3.69	9.97	3.69	9.97	-7.59	-1.31	-10.56	-4.28	11.28	14.25
20	0.62	10.93	4.29	10.57	4.29	10.57	-7.59	-1.31	-10.56	-4.28	11.88	14.85
25	0.66	11.63	4.77	11.05	4.77	11.05	-7.59	-1.31	-10.56	-4.28	12.36	15.33
30	0.70	12.34	5.25	11.53	5.25	11.53	-7.59	-1.31	-10.56	-4.28	12.84	15.81
40	0.76	13.40	5.97	12.25	5.97	12.25	-7.59	-1.31	-10.56	-4.28	13.56	16.52
50	0.81	14.28	6.57	12.85	6.57	12.85	-7.59	-1.31	-10.56	-4.28	14.16	17.12
60	0.85	14.98	7.05	13.33	7.05	13.33	-7.59	-1.31	-10.56	-4.28	14.64	17.60
70	0.89	15.69	7.53	13.81	7.53	13.81	-7.59	-1.31	-10.56	-4.28	15.12	18.08
80	0.93	16.39	8.01	14.29	8.01	14.29	-7.59	-1.31	-10.56	-4.28	15.60	18.56
90	0.96	16.92	8.37	14.65	8.37	14.65	-7.59	-1.31	-10.56	-4.28	15.96	18.92
100	0.99	17.45	8.72	15.01	8.72	15.01	-7.59	-1.31	-10.56	-4.28	16.32	19.28

Roof Pressures

Zone	North/South +0.18	North/South -0.18	East/West +0.18	East/West -0.18
0 to h/2	-17.23	-10.95	-18.57	-10.95
h/2 to h	-15.45	-9.17	-13.52	-9.17
h to 2h	-11.60	-5.31		

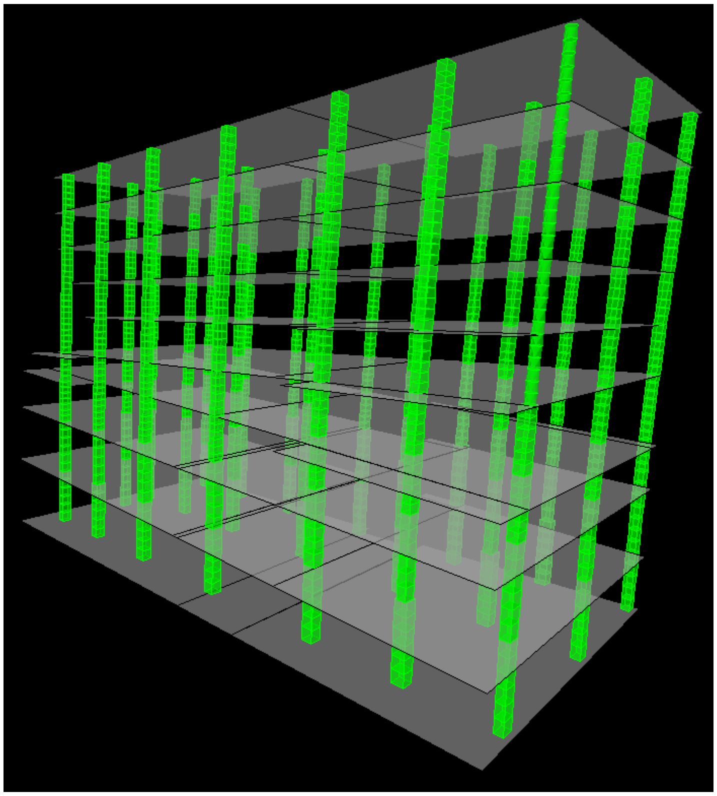
MWRS Forces and Moments

Wind Zone	North/South	East/West	Level	Height (FT)	Floor-to-Floor	Level A_{TNS}	Level A_{TEW}	F_{WIND} (K) North/South	F_{WIND} (K) East/West	M_{WIND} (K-FT) North/South	M_{WIND} (K-FT) East/West
0-15	*11.28*	*14.25*	1	0	0	510	1110	5.75	15.81	0	0
20	*11.88*	*14.85*	2	15	15	1020	2220	11.89	32.47	178.4	487.1
25	*12.36*	*15.33*	3	30	10	850	1850	11.08	29.60	332.3	887.9
30	*12.84*	*15.81*	4	40	10	680	1480	9.42	24.90	376.9	996.0
40	*13.56*	*16.52*	5	50	10	680	1480	9.79	25.70	489.5	1284.9
50	*14.16*	*17.12*	6	60	10	680	1480	10.12	26.41	607.0	1584.5
60	*14.64*	*17.60*	7	70	10	680	1480	10.44	27.12	731.0	1898.2
70	*15.12*	*18.08*	8	80	10	680	1480	10.73	27.74	858.2	2219.1
80	*15.60*	*18.56*	9	90	10	680	1480	10.97	28.27	987.5	2544.4
90	*15.96*	*18.92*	Roof	100	0	340	740	5.55	14.27	554.7	1426.8
100	*16.32*	*19.28*								5115.5	13328.9
			N/S B(FT) 68		*E/W* B(FT) 148				*CONTROLS*		

Seismic

Seismic activity can be catastrophic to a building structure. A lateral load produced by an earthquake causes the structure to absorb a tremendous amount of moment at its connections and distributes forces horizontally as well as vertical. Moment frames are less influenced by lateral loads because there joints are more heavily reinforced than braced frames. To calculate the effects of seismic movement the building is classified as an ordinary concrete moment frame. This denotes a response modification coefficient of 3. After all preliminary criterion was gathered it was found to determine the seismic loading using the equivalent lateral force analysis procedure. From the data collected, seismic lateral loads are the controlling factor over wind. The HUB is not a very heavy structure, in regards to its gravity loads and self-weight, therefore it is less prone to damage from seismic activity. Although the building in not located in a very active seismic area, the structure must be designed to resist lateral movement in the event of an earthquake. With seismic controlling, the structure is more likely to be a moment framed system without the use of shear walls to incorporate a desired open floor plan and flat slab floor system.

The seismic calculations provide the effects of shear distribution through each floor as well as overturning. A comparison table located in Appendix I will provide the substantially higher seismic values measured to the effects of wind. Below is an illustration taking from a seismic simulation modeled by ETABS v8.5. Please see section on *ETABS Analysis* for total drift and criteria.



SEISMIC ANALYSIS

ASCE 7-02 Chapter 9

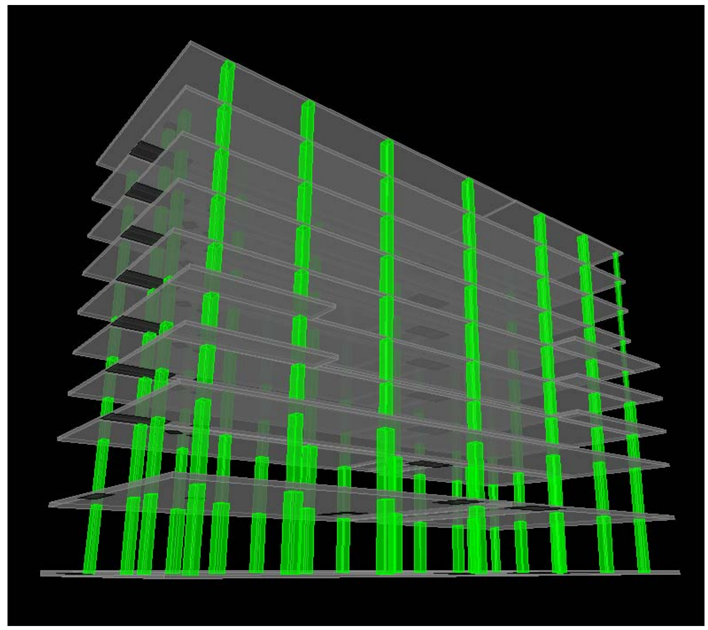
Location	Philadelphia, PA			
Dimensions	148'	*Length*	99' - 6"	*Height*
	68'	*Wide*		
Occupancy Category	II			
Seismic Use Group	II			
Importance Factor	1.00			
Site Classification	D			
Basic Structural System	Moment Resisting Frame System			
Seismic Resisting System	Ordinary Reinforcement Moment Frame			
Frequency	Rigid Structure	*f* = 1.11 Hz *[6.2]*		

I_E	1	S_{DS}	0.329
S_S	0.32	S_{D1}	0.131
S_1	0.082	R	3
F_a	1.54	C_d	2.5
F_V	2.40	V	527
S_{MS}	0.493	C_s	0.039
S_{M1}	0.197	k	1.2

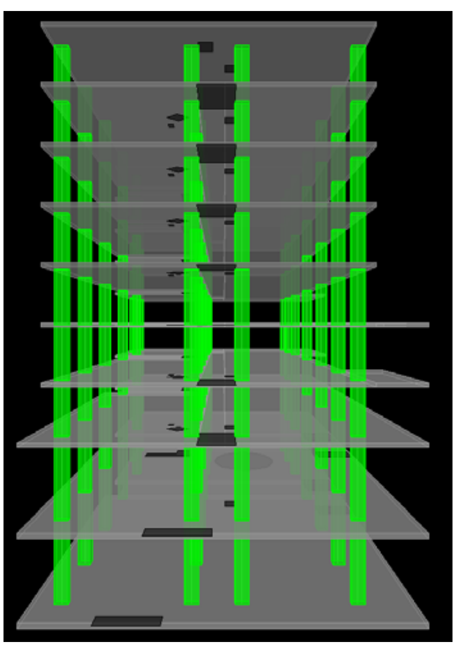
Level	w_x (K)	h_x (FT)	$w_x h^k_x$	C_{vx}	F_x (K)	M_x (FT-K)
Roof	1390	100	349152.2	0.191	100.49	10049.46
9	1489	90	329598.9	0.180	94.87	8538.00
8	1489	80	286155.9	0.156	82.36	6589.01
7	1489	70	243788.0	0.133	70.17	4911.77
6	1489	60	202617.1	0.111	58.32	3499.09
5	1489	50	162801.6	0.089	46.86	2342.91
4	1489	40	124556.6	0.068	35.85	1434.02
3	1489	30	88194.2	0.048	25.38	761.53
2	1711	15	44112.3	0.024	12.70	190.45
1	0	0	0	0	0	0
?	*13524*		*1830977*	*1*	*527*	*38316.24*

ETABS ANALYSIS

ETABS v8.5 is a windows-based, computer-aided design program that is commonly used in industry practice. This program allows the user to model the desired structure and generate a complete integrated building analysis. Based on the user's input criteria, a model can be produced to represent the entire structure as well as several simulations to replicate deflections and movement due to gravity, wind, and seismic loading conditions. I felt that ETABS would be a great advantage in understanding the lateral force resisting system because of its ability to present the user with thorough and direct output data, as well as creating a visually stimulating model.



First, I was able to construct an exact model of The HUB on Chestnut from the construction documents. Each floor was assembled and placed at its particular elevation referenced from the base. All columns were created based on their geometric shape and reinforcement detail. Next, I applied the appropriate loading conditions to each floor. A better advantage of using ETABS is that the program will apply all reducible loads. Due to the fact that the design has an irregular grid pattern, using ETABS will allow for a quick and accurate live load reduction analysis. A 100 PSF non-reducible live load has been designated in the corridors of the seven residential levels. As previously calculated, the structure had to be recognized as a rigid diaphragm. Each floor was then 'tagged' as being rigid. The concrete columns were placed continuously to generate a monolithically poured system.



After the model was constructed, I assigned the wind and seismic loading conditions that were previously calculated. This particular version of ETABS is only limited to the codes and standards that were implemented when the program was created. Wind analysis was based on the ASCE 7-98, and seismic conditions were based on IBC 2000. With all the design criteria inputted I then ran the analysis. The analysis provided a selection of data: *Story Drift, Story Shear, Support Reactions, Column Forces, and Center Mass Rigidity*. In particular, I was primarily interested in story shear, story drift, and column forces. These three categories of data allowed me to analyze the data that I have obtained through previous calculations. Please see *Appendix V* for a complete listing of tabled analysis.

Drift

The lateral performance of the building will be evaluating based on the amount of vertical deflection that it is subjected to. The total amount of vertical drift is found by adding up the story drift of all levels. From the ETABS analysis, each inter-story drift can be found. The upper stories are prone to a higher drift due to the fact that the supported and self-weights are increased as the building elevation decreases. The roof had demonstrated a significantly high drift reaching a value close to one-quarter inch. Level two had reached a displacement close to one-eight inch. A steady decrease in deflection was observed as the stories neared the base.

After all the loading cases had been considered, the 1.9*D* +1.0*E* combination was the controlling case. Under this condition the drift values were greatest. The HUB on Chestnut had reached a maximum building drift of 1.89-inches. This value was then compared to a chosen design criteria of L/400. This ratio is very commonly used as a limit to allowable vertical deflection. Results indicate that this structure is limited to an allowable drift of L/635. This is well within the evaluated ratio. A more conservative ratio, such as L/500 or higher, could be chosen based on the mean roof height and the ductility of concrete. The structure would still perform well under a stricter ratio. Below is a table of each inter-story drift controlled by dead and seismic loading.

Story	*Item*	*Load*	*Point*	*X*	*Y*	*Z*	*Drift X (in)*
ROOF	Max Drift X	09D1E	6	609.63	0	1200	0.244
STORY9	Max Drift X	09D1E	6	609.63	0	1080	0.243
STORY8	Max Drift X	09D1E	6	609.63	0	960	0.240
STORY7	Max Drift X	09D1E	6	609.63	0	840	0.234
STORY6	Max Drift X	09D1E	6	609.63	0	720	0.224
STORY5	Max Drift X	09D1E	6	609.63	0	600	0.211
STORY4	Max Drift X	09D1E	6	609.63	0	480	0.192
STORY3	Max Drift X	09D1E	157	843.63	0	360	0.166
STORY2	Max Drift X	09D1E	13	1755	0	180	0.139
TOTAL DRIFT							*1.893*

L/400 = 3.00” < L/635 = 1.89”

Shear and Torsion

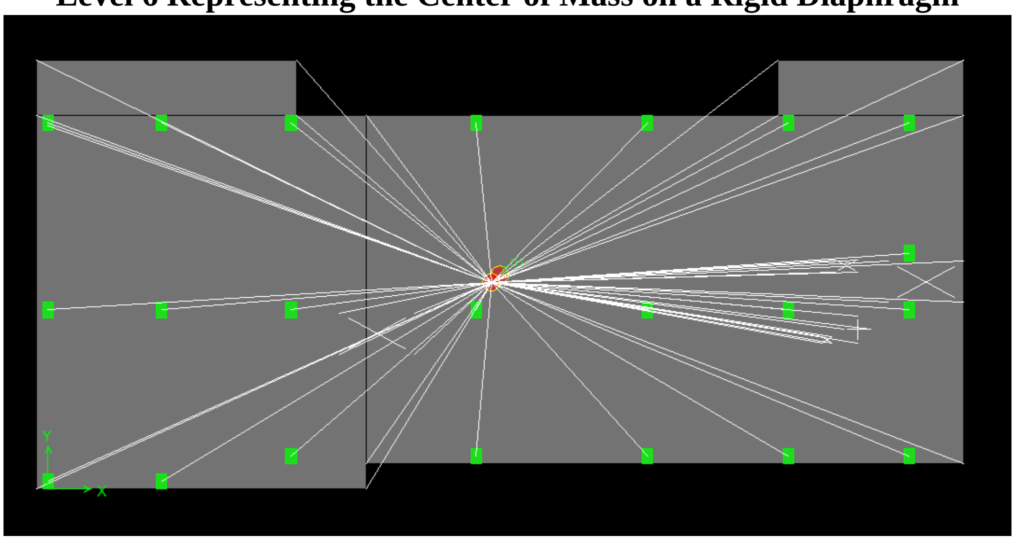
The building's components are subject to shear and torsion due to lateral and vertical loads. ETABS was highly considered in calculating these values. The architectural design displays an irregular (X,Y) grid which exhibits no symmetry or uniformity. The structural design does not incorporate any shear walls to be taken into account or to be evaluated. With these two considerations, I felt that ETABS would display a more accurate and speedy analysis of both shear and torsion. When modeling the structure I considered all geometric shapes, penetrations, and openings in the floor system. This would allow for a more accurate value for calculating center mass rigidity.

Shear was controlled by the 0.9D + 1.0E loading combination. These values for all floors were significantly higher than others. Torsion was also controlled by the same combination. Please see *Appendix V* for shear and torsion values of each floor. The controlling loading condition is highlighted for a quick overview.

Location of Center Mass of Rigidity (X,Y)

Story	*MassX*	*MassY*	*XCM*	*YCM*	*CumMassX*	*CumMassY*	*XCCM*	*YCCM*	*XCR*	*YCR*
ROOF	2.6282	2.6282	853.50	371.273	2.6282	2.6282	853.50	371.273	824.151	485.916
STORY9	2.8022	2.8022	854.805	370.567	2.8022	2.8022	854.805	370.567	822.027	492.078
STORY8	2.8022	2.8022	854.805	370.567	2.8022	2.8022	854.805	370.567	820.386	497.724
STORY7	2.8022	2.8022	854.805	370.567	2.8022	2.8022	854.805	370.567	819.286	502.802
STORY6	2.9069	2.9069	832.181	384.809	2.9069	2.9069	832.181	384.809	818.779	507.255
STORY5	2.9856	2.9856	849.793	394.786	2.9856	2.9856	849.793	394.786	818.85	511.02
STORY4	2.9945	2.9945	848.847	395.81	2.9945	2.9945	848.847	395.81	819.187	514.23
STORY3	3.4155	3.4155	864.981	405.483	3.4155	3.4155	864.981	405.483	819.70	516.581
STORY2	4.5675	4.5675	864.311	405.317	4.5675	4.5675	864.311	405.317	820.653	517.556

Level 6 Representing the Center of Mass on a Rigid Diaphragm



CONCLUSION

By analyzing the lateral loading conditions for The HUB on Chestnut, with both hand calculations and a computer-aided analysis, I feel that I have investigated the building's structural performance under gravity, wind, and seismic forces. Each design procedure indicates that seismic loading conditions are the controlling factor in both shear and overturning moment. In the event of an earthquake the structure is subjected to the highest and most critical loads. Therefore the building must be designed to accommodate these forces. The support columns have been sized accordingly to account for all moment that is received and distributed through the building. The two frequently used column dimensions, 20"x 30" and 30"x 30", are considered to be large in the common design. This indicates the amount of moment that must be absorbed, or resisted, through the connections.

Although the structure does include a sub-grade level, I chose to neglect this level based on two thoughts. First, the building is evaluated by base shear and overturning moment at elevation zero. Second, to evaluate this level, the foundations and earth pressures must be incorporated. This procedure would need a longer analysis

APPENDIX I

ANALYTICAL WIND CALCULATIONS

Wind Calculations

Location	Philadelphia, PA	Typography	Homogeneous
Dimensions	PLAN 148' x 68'	Enclosure Class	Fully Enclosed
	HEIGHT 99'-6"	Framing System	Moment Frame
Occupancy Category	II		
Importance Factor	1.00		
Exposure Category	B		

Building Frequency $T_a = 0.1N \rightarrow \frac{1}{T} = 1.11$ [9.5.5.3.2]

$\frac{1}{T} \geq 1 \rightarrow$ Rigid Structure

*Analytical Procedure

Velocity Pressure

$q_z = 0.00256\, K_z\, K_{zt}\, K_d\, V^2 I$

V_3	90	FIGURE 6-1
I_w	1.00	TABLE 6-1
K_d	0.85	TABLE 6-4
K_{zt}	1.00	

Internal Pressure Coefficient

$GCpi$ ±0.18 FIGURE 6-5

Gust Effect Factor

B	68	
h	99.5	
c	0.3	TABLE 6-2
ℓ	320	TABLE 6-2
$\in$	1/3.0	TABLE 6-2
z_{min}	30	TABLE 6-2
z	59.7	$(0.6h \geq z_{min})$
L_z	390	
$g_Q = g_v$	3.4	
Q	0.854	
I_z	0.272	
G	0.842	→ use 0.85

External Pressure Coefficient

North/South		C_p
L/B = 148/68	Windward	0.80
= 2.18 → 2.00	Leeward	- 0.30
h/L = 100/148	Side	- 0.70
= 0.68 → ≥ 1.0	0 to h/2	-0.95
	h/2 to h	- 0.83
	h to 2h	- 0.57

East/West		C_p
L/B = 68/148	Windward	0.80
= 0.46 → 0-1	Leeward	- 0.50
h/L = 100/68	Side	- 0.70
= 1.47 → ≥ 1.0	0 to h/2	- 1.04
	> h/2	- 0.70

Area Reduction Factor

(h/2)(148) ≥ 1000→ 0.8(-1.3)

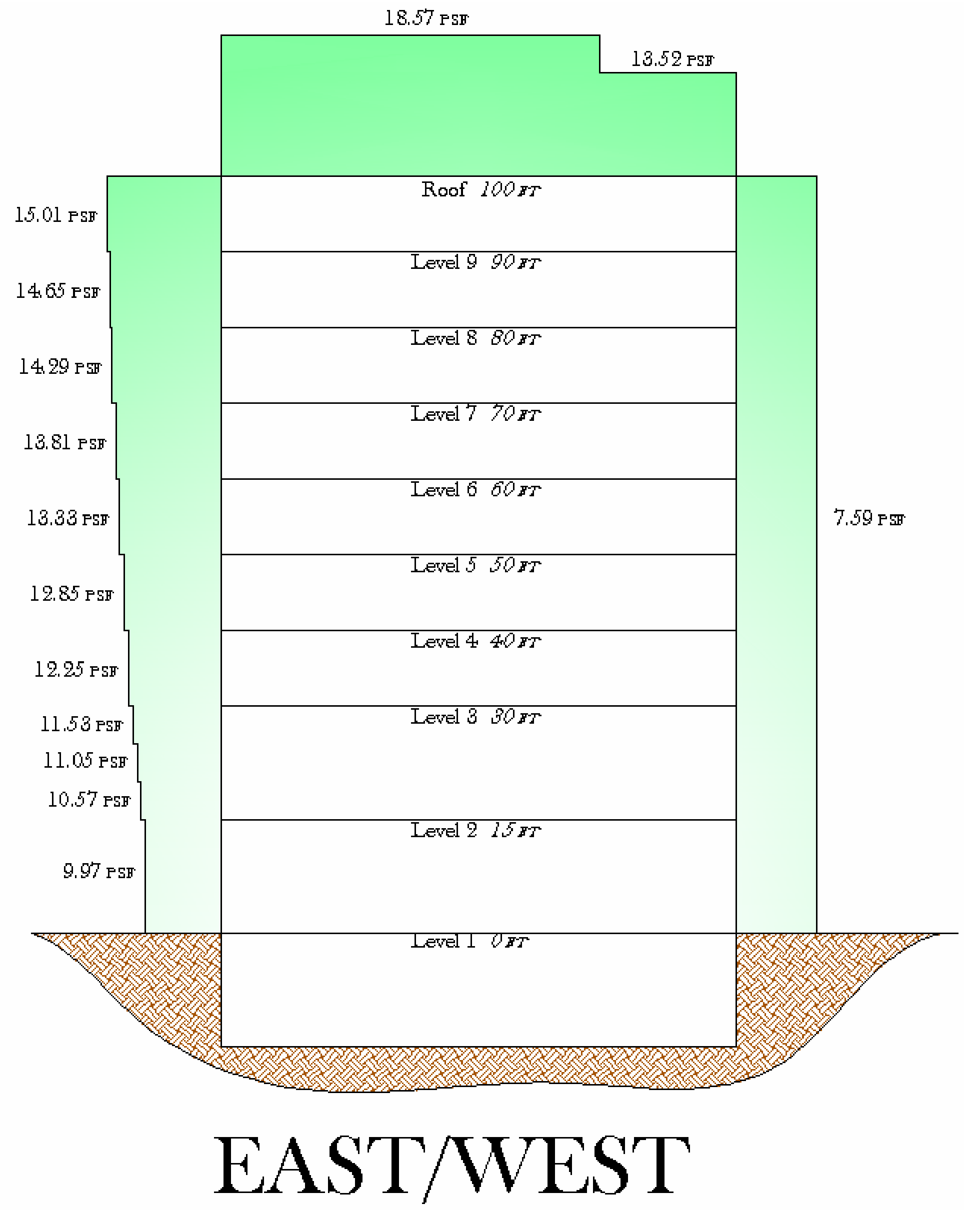
Main Wind Force-Resisting Systems

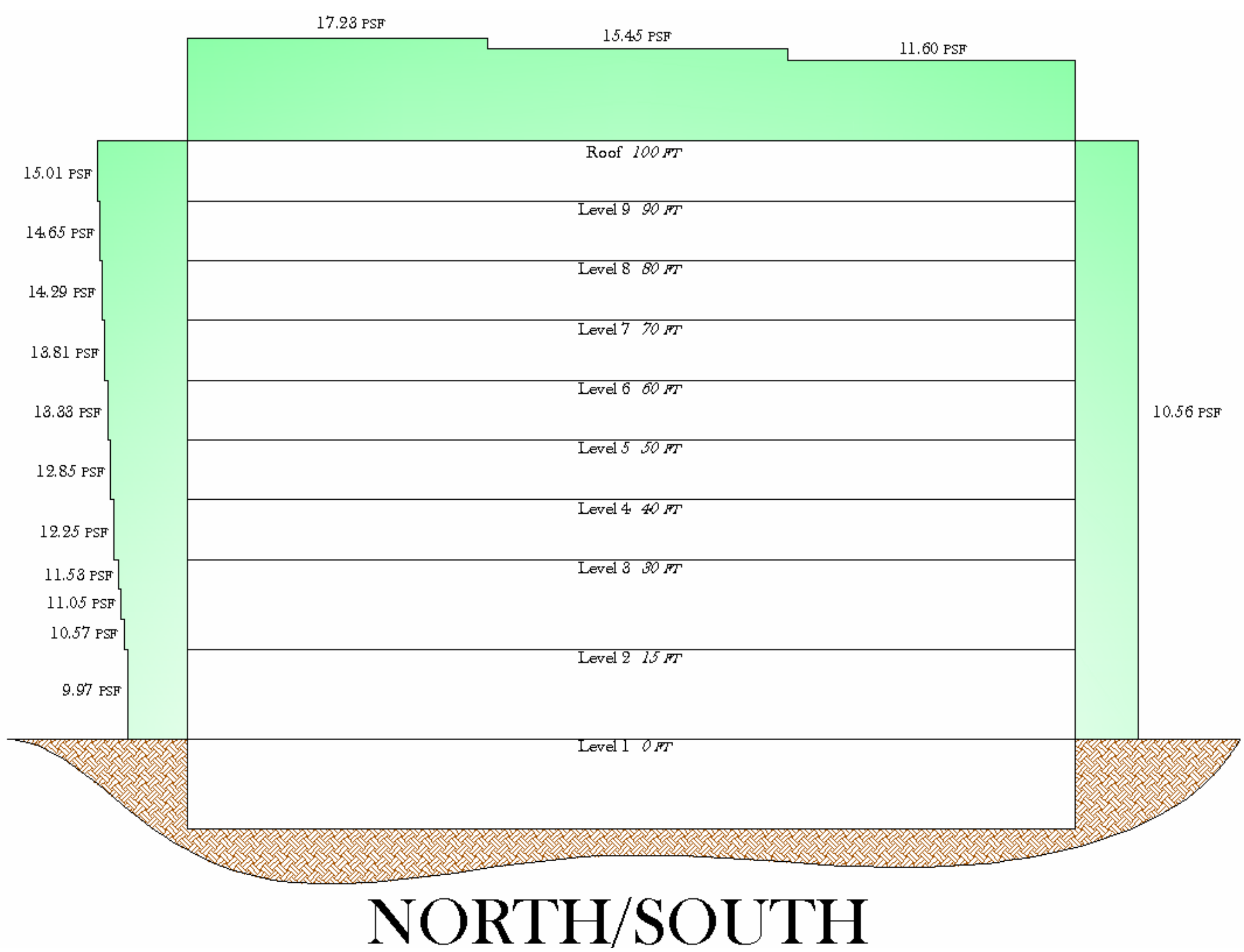
$p = qGC_p - q_i(GC_{pi})$

Windward

$0 < z < h$ $p = q_z GC_p - q_h(GC_{pi})$

$z = h$ $p = q_h GC_p - q_h(GC_{pi})$


18.57 PSF
13.52 PSF
Roof 100 FT
Level 9 90 FT
Level 8 80 FT
Level 7 70 FT
Level 6 60 FT
Level 5 50 FT
Level 4 40 FT
Level 3 30 FT
Level 2 15 FT
Level 1 0 FT
15.01 PSF
14.65 PSF
14.29 PSF
13.81 PSF
13.33 PSF
12.85 PSF
12.25 PSF
11.53 PSF
11.05 PSF
10.57 PSF
9.97 PSF
7.59 PSF
EAST/WEST


17.23 PSF
15.45 PSF
11.60 PSF
15.01 PSF
14.65 PSF
14.29 PSF
13.81 PSF
13.33 PSF
12.85 PSF
12.25 PSF
11.53 PSF
11.05 PSF
10.57 PSF
9.97 PSF
10.56 PSF
Roof 100 FT
Level 9 90 FT
Level 8 80 FT
Level 7 70 FT
Level 6 60 FT
Level 5 50 FT
Level 4 40 FT
Level 3 30 FT
Level 2 15 FT
Level 1 0 FT
NORTH/SOUTH

APPENDIX II

ANALYTICAL SEISMIC CALCULATIONS

Seismic Calculations

Occupancy Category	*II*
Seismic Use Group	*II*
Importance Factor	1.00
Site Classification	*D*
Structural System	*Moment Resisting Frame System*
Seismic-Resisting System	*Ordinary Reinforced Concrete Moment Frame*

Philadelphia, PA
9 Levels
100 ft
10’ Stories
68’ x 148’ Building Plan

Philadelphia, PA

$S_s = 32\%$ FIGURE 9.4.1.1(a) $F_a = 1.54$ TABLE 9.4.1.2.4a

$S_1 = 8.2\%$ FIGURE 9.4.1.1(b) $F_v = 2.40$ TABLE 9.4.1.2.4b

$S_{MS} = F_a S_s \rightarrow S_{DS} = \frac{2}{3} S_{MS} = 0.329$

$S_{M1} = F_v S_1 \rightarrow S_{D1} = \frac{2}{3} S_{M1} = 0.131$

Seismic Use Group *II*

$0.167g \leq S_{DS} < 0.33g \rightarrow$ Seismic Design Category *B* TABLE 9.4.1.2a

$0.067g \leq S_{D1} < 0.133g \rightarrow$ Seismic Design Category *B* TABLE 9.4.1.2b

Moment Resisting Frame Systems

Ordinary Reinforced Concrete Moment Frames $\rightarrow$ $R = 3$ TABLE 9.5.2.2

$W_0 = 3$

$C_d = 2\frac{1}{2}$

Analytical Procedure

Equivalent Lateral Force Analysis TABLE 9.5.2.5.1

Base Shear

$$C_s = \frac{0.329}{(3/1.00)} = 0.110 > C_s = \frac{0.131}{(1.11)(3/1.00)} = 0.039 > C_s = 0.044(0.329)(1.0) = .015$$

$W \rightarrow W_R = (138 \text{ PSF})(148 \text{ FT})(68 \text{ FT}) = 1390^K$

$W_{3\text{-}9} = (148 \text{ PSF})(148 \text{ FT})(68 \text{ FT}) = 1489^K$

$W_{1\text{-}2} = (170 \text{ PSF})(148 \text{ FT})(68 \text{ FT}) = 1711^K$

$W_T = 1390^K + 7(1489^K) + 1711^K = 13524^K$

$V = C_s W \rightarrow (0.039)(13524^K) = 527^K$

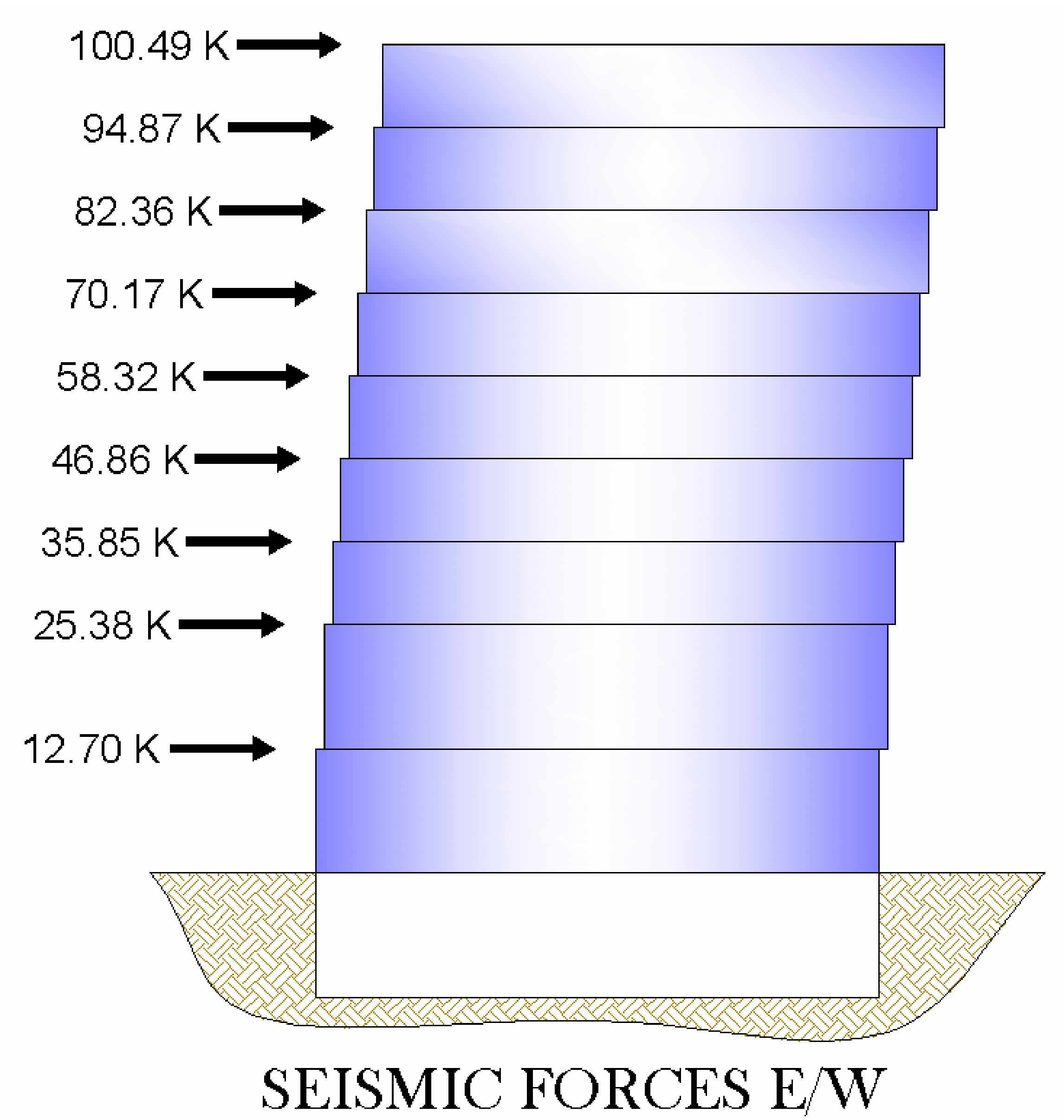
Vertical Distribution

$F_x = C_{vx} V$ *See Spreadsheet*

$C_{vx} \rightarrow w_x h^k_x / \sum w_i h^k_i \rightarrow k = 1.20 \quad (0.5 < T < 2.5)$

Overturning

$M_x = \sum F_i(h_i - h_x)$ *See Spreadsheet*


100.49 K
94.87 K
82.36 K
70.17 K
58.32 K
46.86 K
35.85 K
25.38 K
12.70 K
SEISMIC FORCES E/W

Appendix III

Lateral Forces Summary

Summary of Lateral Forces

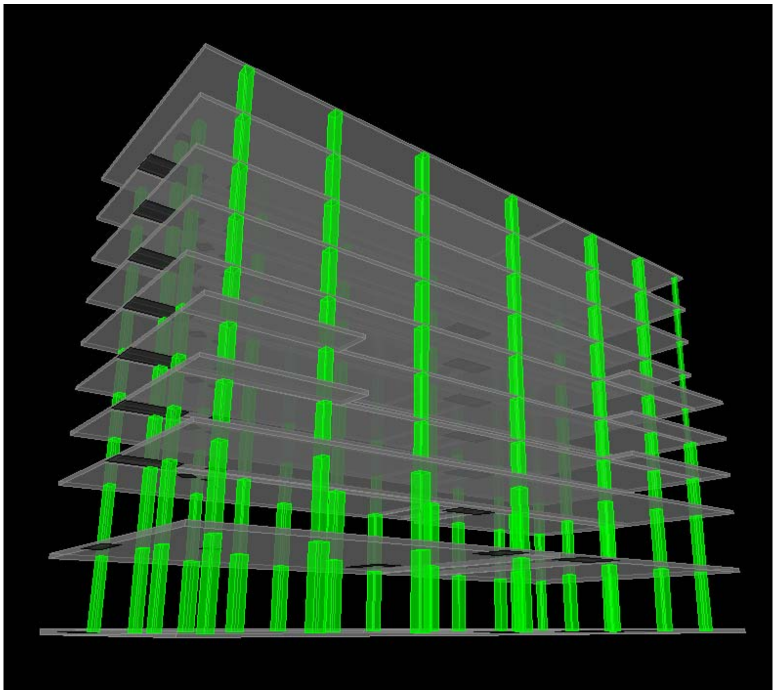
Wind/Seismic Shear Forces

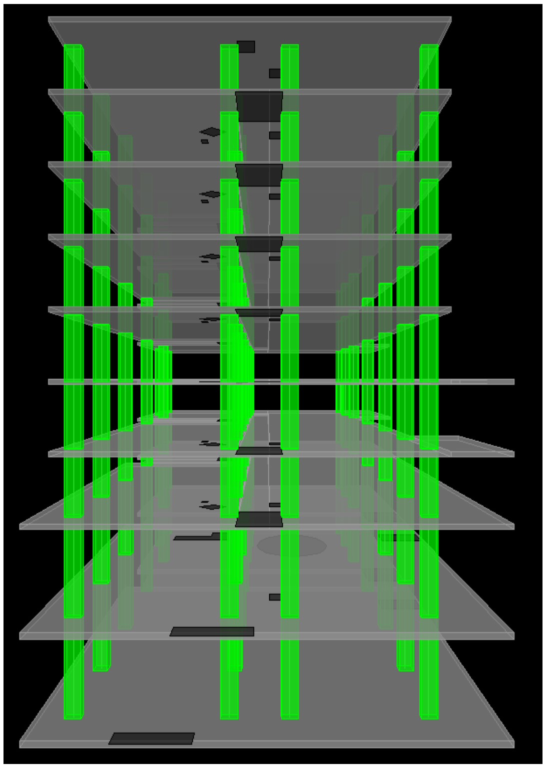
	Wind		Seismic	
Shear Level	*North/South*	*East/West*	*N/S/E/W*	*Total*
Roof	5.55	14.27	100.49	114.76
9	10.97	28.27	94.87	123.14
8	10.73	27.74	82.36	110.10
7	10.44	27.12	70.17	97.29
6	10.12	26.41	58.32	84.73
5	9.79	25.70	46.86	72.56
4	9.42	24.90	35.85	60.75
3	11.08	29.60	25.38	54.98
2	11.89	32.47	12.70	45.17
1	5.75	15.81	0.00	15.81
Base Shear (K)	95.74	252.28	527.0	779.28
Overturning (FT-K)	5115.50	13328.86	38316.24	51645.10

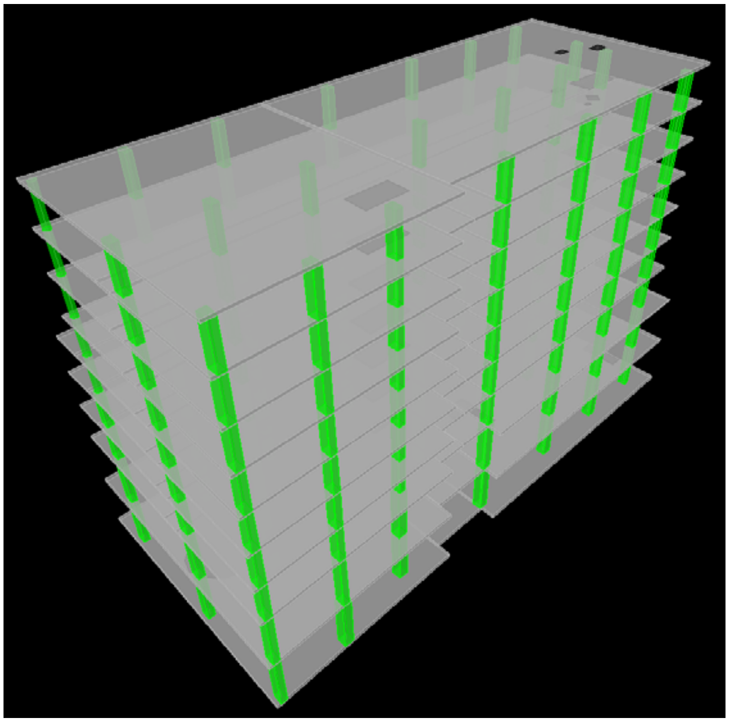
APPENDIX IV

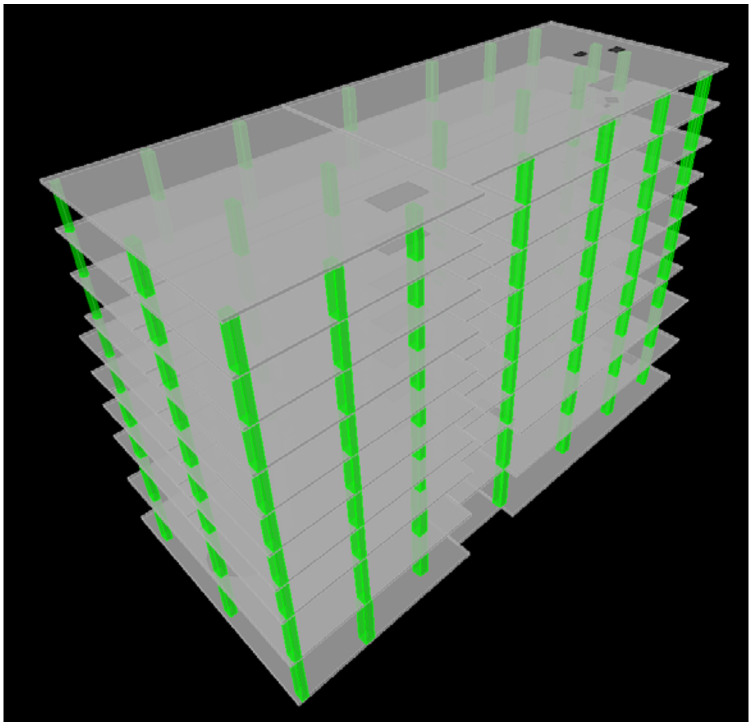
ETABS MODEL RENDERINGS

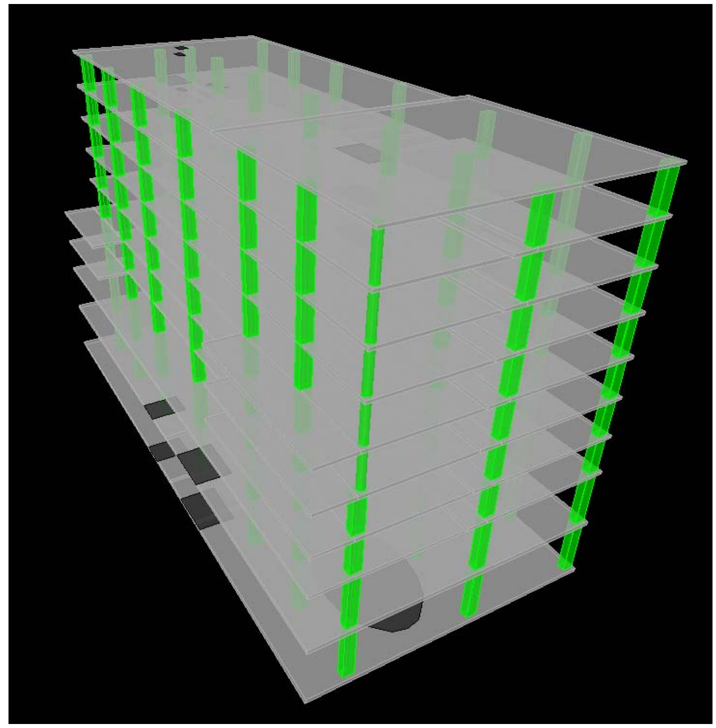
ETABS MODEL RENDERINGS

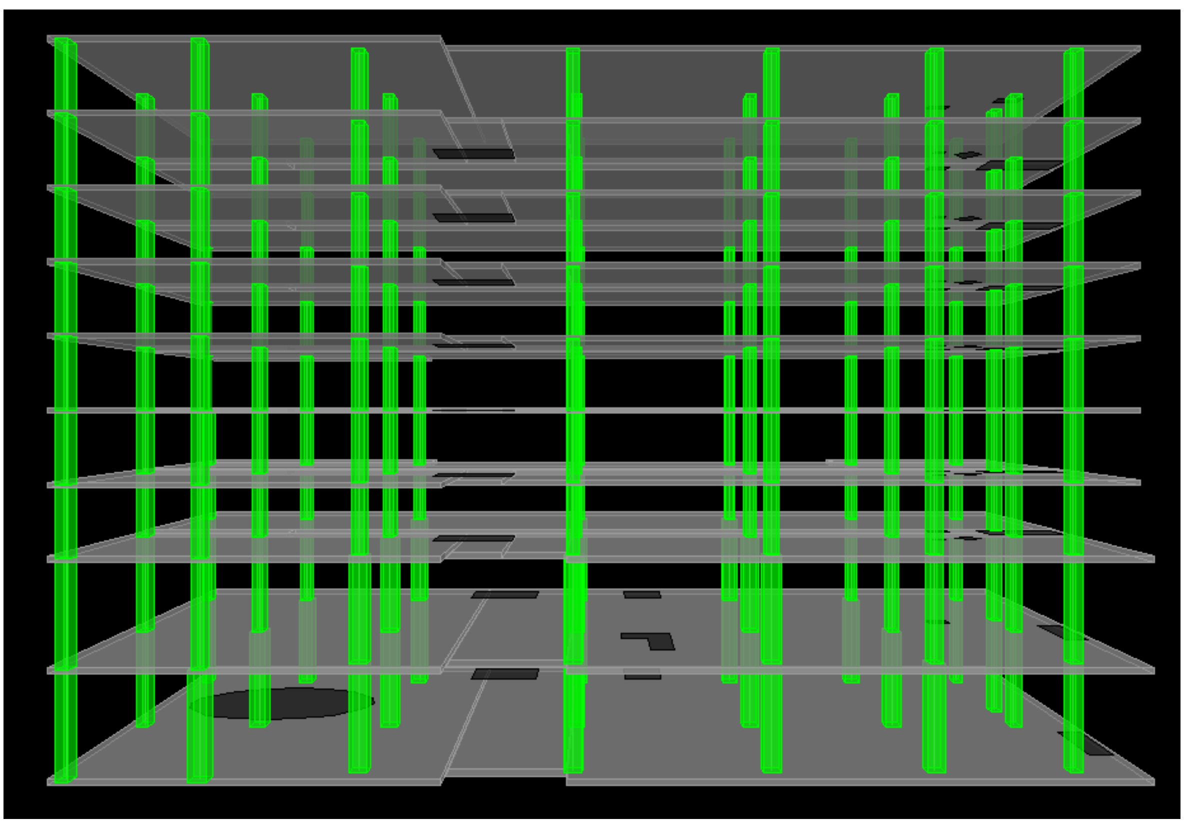












APPENDIX V

ETABS DATA RESULTS

ETABS DATA RESULTS

STORY DRIFT 0.9D + 1.0E Controls

Story	Item	Load	Point	X	Y	Z	DriftX	DriftY
ROOF	Max Drift X	14D	6	609.63	0	1200	0.069092	
ROOF	Max Drift Y	14D	14	1755	48	1200		0.0135
ROOF	Max Drift X	12D16L05LR	6	609.63	0	1200	0.091073	
ROOF	Max Drift Y	12D16L05LR	14	1755	48	1200		0.0182
ROOF	Max Drift X	12D16L05S	6	609.63	0	1200	0.091073	
ROOF	Max Drift Y	12D16L05S	14	1755	48	1200		0.0182
ROOF	Max Drift X	12D16LR1L	6	609.63	0	1200	0.079129	
ROOF	Max Drift Y	12D16LR1L	14	1755	48	1200		0.0157
ROOF	Max Drift X	12D16LR08W	6	609.63	0	1200	0.070131	
ROOF	Max Drift Y	12D16LR08W	14	1755	48	1200		0.0124
ROOF	Max Drift X	12D16S1L	6	609.63	0	1200	0.079129	
ROOF	Max Drift Y	12D16S1L	14	1755	48	1200		0.0157
ROOF	Max Drift X	12D16S08W	6	609.63	0	1200	0.070131	
ROOF	Max Drift Y	12D16S08W	14	1755	48	1200		0.0124
ROOF	Max Drift X	12D16W1L05LR	6	609.63	0	1200	0.100947	
ROOF	Max Drift Y	12D16W1L05LR	14	1755	48	1200		0.0175
ROOF	Max Drift X	12D16W1L05S	6	609.63	0	1200	0.100947	
ROOF	Max Drift Y	12D16W1L05S	14	1755	48	1200		0.0175
ROOF	Max Drift X	12D1E1L02S	6	609.63	0	1200	0.203908	
ROOF	Max Drift Y	12D1E1L02S	14	1755	48	1200		0.0246
ROOF	Max Drift X	09D16W	6	609.63	0	1200	0.066235	
ROOF	Max Drift Y	09D16W	14	1755	48	1200		0.0104
ROOF	Max Drift X	09D1E	6	609.63	0	1200	0.244064	
ROOF	Max Drift Y	09D1E	14	1755	48	1200		0.0228

Story	Item	Load	Point	X	Y	Z	DriftX	DriftY
STORY9	Max Drift X	14D	6	609.63	0	1080	0.069145	
STORY9	Max Drift Y	14D	15	1755	714	1080		0.0136
STORY9	Max Drift X	12D16L05LR	6	609.63	0	1080	0.091145	
STORY9	Max Drift Y	12D16L05LR	15	1755	714	1080		0.0184
STORY9	Max Drift X	12D16L05S	6	609.63	0	1080	0.091145	
STORY9	Max Drift Y	12D16L05S	15	1755	714	1080		0.0184
STORY9	Max Drift X	12D16LR1L	6	609.63	0	1080	0.079191	
STORY9	Max Drift Y	12D16LR1L	15	1755	714	1080		0.0159
STORY9	Max Drift X	12D16LR08W	6	609.63	0	1080	0.070148	
STORY9	Max Drift Y	12D16LR08W	15	1755	714	1080		0.0126
STORY9	Max Drift X	12D16S1L	6	609.63	0	1080	0.079191	
STORY9	Max Drift Y	12D16S1L	15	1755	714	1080		0.0159
STORY9	Max Drift X	12D16S08W	6	609.63	0	1080	0.070148	
STORY9	Max Drift Y	12D16S08W	15	1755	714	1080		0.0126
STORY9	Max Drift X	12D16W1L05LR	6	609.63	0	1080	0.100952	
STORY9	Max Drift Y	12D16W1L05LR	15	1755	714	1080		0.0177
STORY9	Max Drift X	12D16W1L05S	6	609.63	0	1080	0.100952	
STORY9	Max Drift Y	12D16W1L05S	15	1755	714	1080		0.0177
STORY9	Max Drift X	12D1E1L02S	6	609.63	0	1080	0.203229	
STORY9	Max Drift Y	12D1E1L02S	15	1755	714	1080		0.0249
STORY9	Max Drift X	09D16W	6	609.63	0	1080	0.066212	
STORY9	Max Drift Y	09D16W	15	1755	714	1080		0.0105
STORY9	Max Drift X	09D1E	6	609.63	0	1080	0.242912	
STORY9	Max Drift Y	09D1E	15	1755	714	1080		0.0232

Story	Item	Load	Point	X	Y	Z	DriftX	DriftY
STORY8	Max Drift X	14D	6	609.63	0	960	0.069252	
STORY8	Max Drift Y	14D	51	1755	435	960		0.0139
STORY8	Max Drift X	12D16L05LR	6	609.63	0	960	0.091289	
STORY8	Max Drift Y	12D16L05LR	51	1755	435	960		0.0188
STORY8	Max Drift X	12D16L05S	6	609.63	0	960	0.091289	
STORY8	Max Drift Y	12D16L05S	51	1755	435	960		0.0188
STORY8	Max Drift X	12D16LR1L	6	609.63	0	960	0.079315	
STORY8	Max Drift Y	12D16LR1L	51	1755	435	960		0.0162
STORY8	Max Drift X	12D16LR08W	6	609.63	0	960	0.070141	
STORY8	Max Drift Y	12D16LR08W	51	1755	435	960		0.0128
STORY8	Max Drift X	12D16S1L	6	609.63	0	960	0.079315	
STORY8	Max Drift Y	12D16S1L	51	1755	435	960		0.0162
STORY8	Max Drift X	12D16S08W	6	609.63	0	960	0.070141	
STORY8	Max Drift Y	12D16S08W	51	1755	435	960		0.0128
STORY8	Max Drift X	12D16W1L05LR	6	609.63	0	960	0.100879	
STORY8	Max Drift Y	12D16W1L05LR	51	1755	435	960		0.018
STORY8	Max Drift X	12D16W1L05S	6	609.63	0	960	0.100879	
STORY8	Max Drift Y	12D16W1L05S	51	1755	435	960		0.018
STORY8	Max Drift X	12D1E1L02S	6	609.63	0	960	0.201353	
STORY8	Max Drift Y	12D1E1L02S	14	1755	48	960		0.0255
STORY8	Max Drift X	09D16W	6	609.63	0	960	0.066083	
STORY8	Max Drift Y	09D16W	51	1755	435	960		0.0107
STORY8	Max Drift X	09D1E	6	609.63	0	960	0.239779	
STORY8	Max Drift Y	09D1E	14	1755	48	960		0.0238

Story	Item	Load	Point	X	Y	Z	DriftX	DriftY
STORY7	Max Drift X	14D	6	609.63	0	840	0.069414	
STORY7	Max Drift Y	14D	51	1755	435	840		0.0143
STORY7	Max Drift X	12D16L05LR	6	609.63	0	840	0.09151	
STORY7	Max Drift Y	12D16L05LR	51	1755	435	840		0.0193
STORY7	Max Drift X	12D16L05S	6	609.63	0	840	0.09151	
STORY7	Max Drift Y	12D16L05S	51	1755	435	840		0.0193
STORY7	Max Drift X	12D16LR1L	6	609.63	0	840	0.079505	
STORY7	Max Drift Y	12D16LR1L	51	1755	435	840		0.0166
STORY7	Max Drift X	12D16LR08W	6	609.63	0	840	0.07006	
STORY7	Max Drift Y	12D16LR08W	51	1755	435	840		0.0132
STORY7	Max Drift X	12D16S1L	6	609.63	0	840	0.079505	
STORY7	Max Drift Y	12D16S1L	51	1755	435	840		0.0166
STORY7	Max Drift X	12D16S08W	6	609.63	0	840	0.07006	
STORY7	Max Drift Y	12D16S08W	51	1755	435	840		0.0132
STORY7	Max Drift X	12D16W1L05LR	6	609.63	0	840	0.100631	
STORY7	Max Drift Y	12D16W1L05LR	51	1755	435	840		0.0186
STORY7	Max Drift X	12D16W1L05S	6	609.63	0	840	0.100631	
STORY7	Max Drift Y	12D16W1L05S	51	1755	435	840		0.0186
STORY7	Max Drift X	12D1E1L02S	6	609.63	0	840	0.197743	
STORY7	Max Drift Y	12D1E1L02S	51	1755	435	840		0.0264
STORY7	Max Drift X	09D16W	6	609.63	0	840	0.065749	
STORY7	Max Drift Y	09D16W	51	1755	435	840		0.0111
STORY7	Max Drift X	09D1E	6	609.63	0	840	0.233804	
STORY7	Max Drift Y	09D1E	51	1755	435	840		0.0248

Story	Item	Load	Point	X	Y	Z	DriftX	DriftY
STORY6	Max Drift X	14D	6	609.63	0	720	0.069635	
STORY6	Max Drift Y	14D	51	1755	435	720		0.0148
STORY6	Max Drift X	12D16L05LR	6	609.63	0	720	0.091809	
STORY6	Max Drift Y	12D16L05LR	51	1755	435	720		0.02
STORY6	Max Drift X	12D16L05S	6	609.63	0	720	0.091809	
STORY6	Max Drift Y	12D16L05S	51	1755	435	720		0.02
STORY6	Max Drift X	12D16LR1L	6	609.63	0	720	0.079763	
STORY6	Max Drift Y	12D16LR1L	51	1755	435	720		0.0173
STORY6	Max Drift X	12D16LR08W	6	609.63	0	720	0.069861	
STORY6	Max Drift Y	12D16LR08W	14	1755	48	720		0.0137
STORY6	Max Drift X	12D16S1L	6	609.63	0	720	0.079763	
STORY6	Max Drift Y	12D16S1L	51	1755	435	720		0.0173
STORY6	Max Drift X	12D16S08W	6	609.63	0	720	0.069861	
STORY6	Max Drift Y	12D16S08W	14	1755	48	720		0.0137
STORY6	Max Drift X	12D16W1L05LR	6	609.63	0	720	0.100112	
STORY6	Max Drift Y	12D16W1L05LR	51	1755	435	720		0.0193
STORY6	Max Drift X	12D16W1L05S	6	609.63	0	720	0.100112	
STORY6	Max Drift Y	12D16W1L05S	51	1755	435	720		0.0193
STORY6	Max Drift X	12D1E1L02S	6	609.63	0	720	0.191958	
STORY6	Max Drift Y	12D1E1L02S	51	1755	435	720		0.0277
STORY6	Max Drift X	09D16W	6	609.63	0	720	0.065114	
STORY6	Max Drift Y	09D16W	14	1755	48	720		0.0115
STORY6	Max Drift X	09D1E	6	609.63	0	720	0.224277	
STORY6	Max Drift Y	09D1E	51	1755	435	720		0.0263

Story	Item	Load	Point	X	Y	Z	DriftX	DriftY
STORY5	Max Drift X	14D	6	609.63	0	600	0.069934	
STORY5	Max Drift Y	14D	51	1755	435	600		0.0155
STORY5	Max Drift X	12D16L05LR	6	609.63	0	600	0.092214	
STORY5	Max Drift Y	12D16L05LR	51	1755	435	600		0.021
STORY5	Max Drift X	12D16L05S	6	609.63	0	600	0.092214	
STORY5	Max Drift Y	12D16L05S	51	1755	435	600		0.021
STORY5	Max Drift X	12D16LR1L	6	609.63	0	600	0.080112	
STORY5	Max Drift Y	12D16LR1L	51	1755	435	600		0.0181
STORY5	Max Drift X	12D16LR08W	6	609.63	0	600	0.069509	
STORY5	Max Drift Y	12D16LR08W	51	1755	435	600		0.0144
STORY5	Max Drift X	12D16S1L	6	609.63	0	600	0.080112	
STORY5	Max Drift Y	12D16S1L	51	1755	435	600		0.0181
STORY5	Max Drift X	12D16S08W	6	609.63	0	600	0.069509	
STORY5	Max Drift Y	12D16S08W	51	1755	435	600		0.0144
STORY5	Max Drift X	12D16W1L05LR	6	609.63	0	600	0.099244	
STORY5	Max Drift Y	12D16W1L05LR	51	1755	435	600		0.0203
STORY5	Max Drift X	12D16W1L05S	6	609.63	0	600	0.099244	
STORY5	Max Drift Y	12D16W1L05S	51	1755	435	600		0.0203
STORY5	Max Drift X	12D1E1L02S	6	609.63	0	600	0.183628	
STORY5	Max Drift Y	12D1E1L02S	15	1755	714	600		0.0294
STORY5	Max Drift X	09D16W	6	609.63	0	600	0.064089	
STORY5	Max Drift Y	09D16W	51	1755	435	600		0.0121
STORY5	Max Drift X	09D1E	6	609.63	0	600	0.210582	
STORY5	Max Drift Y	09D1E	15	1755	714	600		0.0281

Story	Item	Load	Point	X	Y	Z	DriftX	DriftY
STORY4	Max Drift X	14D	6	609.63	0	480	0.068399	
STORY4	Max Drift Y	14D	51	1755	435	480		0.0174
STORY4	Max Drift X	12D16L05LR	6	609.63	0	480	0.090461	
STORY4	Max Drift Y	12D16L05LR	51	1755	435	480		0.0236
STORY4	Max Drift X	12D16L05S	6	609.63	0	480	0.090461	
STORY4	Max Drift Y	12D16L05S	51	1755	435	480		0.0236
STORY4	Max Drift X	12D16LR1L	6	609.63	0	480	0.078523	
STORY4	Max Drift Y	12D16LR1L	51	1755	435	480		0.0203
STORY4	Max Drift X	12D16LR08W	6	609.63	0	480	0.067338	
STORY4	Max Drift Y	12D16LR08W	51	1755	435	480		0.0161
STORY4	Max Drift X	12D16S1L	6	609.63	0	480	0.078523	
STORY4	Max Drift Y	12D16S1L	51	1755	435	480		0.0203
STORY4	Max Drift X	12D16S08W	6	609.63	0	480	0.067338	
STORY4	Max Drift Y	12D16S08W	51	1755	435	480		0.0161
STORY4	Max Drift X	12D16W1L05LR	6	609.63	0	480	0.095944	
STORY4	Max Drift Y	12D16W1L05LR	51	1755	435	480		0.0227
STORY4	Max Drift X	12D16W1L05S	6	609.63	0	480	0.095944	
STORY4	Max Drift Y	12D16W1L05S	51	1755	435	480		0.0227
STORY4	Max Drift X	12D1E1L02S	6	609.63	0	480	0.170765	
STORY4	Max Drift Y	12D1E1L02S	51	1755	435	480		0.0327
STORY4	Max Drift X	09D16W	6	609.63	0	480	0.061391	
STORY4	Max Drift Y	09D16W	51	1755	435	480		0.0136
STORY4	Max Drift X	09D1E	6	609.63	0	480	0.191557	
STORY4	Max Drift Y	09D1E	51	1755	435	480		0.031

Story	Item	Load	Point	X	Y	Z	DriftX	DriftY
STORY3	Max Drift X	14D	157	843.63	0	360	0.06272	
STORY3	Max Drift Y	14D	13	1755	0	360		0.02
STORY3	Max Drift X	12D16L05LR	157	843.63	0	360	0.08378	
STORY3	Max Drift Y	12D16L05LR	13	1755	0	360		0.0273
STORY3	Max Drift X	12D16L05S	157	843.63	0	360	0.08378	
STORY3	Max Drift Y	12D16L05S	13	1755	0	360		0.0273
STORY3	Max Drift X	12D16LR1L	157	843.63	0	360	0.072522	
STORY3	Max Drift Y	12D16LR1L	13	1755	0	360		0.0235
STORY3	Max Drift X	12D16LR08W	157	843.63	0	360	0.06137	
STORY3	Max Drift Y	12D16LR08W	13	1755	0	360		0.0185
STORY3	Max Drift X	12D16S1L	157	843.63	0	360	0.072522	
STORY3	Max Drift Y	12D16S1L	13	1755	0	360		0.0235
STORY3	Max Drift X	12D16S08W	157	843.63	0	360	0.06137	
STORY3	Max Drift Y	12D16S08W	13	1755	0	360		0.0185
STORY3	Max Drift X	12D16W1L05LR	157	843.63	0	360	0.087742	
STORY3	Max Drift Y	12D16W1L05LR	13	1755	0	360		0.0262
STORY3	Max Drift X	12D16W1L05S	157	843.63	0	360	0.087742	
STORY3	Max Drift Y	12D16W1L05S	13	1755	0	360		0.0262
STORY3	Max Drift X	12D1E1L02S	157	843.63	0	360	0.15134	
STORY3	Max Drift Y	12D1E1L02S	13	1755	0	360		0.0376
STORY3	Max Drift X	09D16W	157	843.63	0	360	0.05554	
STORY3	Max Drift Y	09D16W	13	1755	0	360		0.0155
STORY3	Max Drift X	09D1E	157	843.63	0	360	0.166428	
STORY3	Max Drift Y	09D1E	13	1755	0	360		0.0354

Story	Item	Load	Point	X	Y	Z	DriftX	DriftY
STORY2	Max Drift X	14D	13	1755	0	180	0.052988	
STORY2	Max Drift Y	14D	13	1755	0	180		0.0209
STORY2	Max Drift X	12D16L05LR	13	1755	0	180	0.071382	
STORY2	Max Drift Y	12D16L05LR	13	1755	0	180		0.0287
STORY2	Max Drift X	12D16L05S	13	1755	0	180	0.071382	
STORY2	Max Drift Y	12D16L05S	13	1755	0	180		0.0287
STORY2	Max Drift X	12D16LR1L	13	1755	0	180	0.061646	
STORY2	Max Drift Y	12D16LR1L	13	1755	0	180		0.0247
STORY2	Max Drift X	12D16LR08W	13	1755	0	180	0.051854	
STORY2	Max Drift Y	12D16LR08W	13	1755	0	180		0.0195
STORY2	Max Drift X	12D16S1L	13	1755	0	180	0.061646	
STORY2	Max Drift Y	12D16S1L	13	1755	0	180		0.0247
STORY2	Max Drift X	12D16S08W	13	1755	0	180	0.051854	
STORY2	Max Drift Y	12D16S08W	13	1755	0	180		0.0195
STORY2	Max Drift X	12D16W1L05LR	13	1755	0	180	0.074518	
STORY2	Max Drift Y	12D16W1L05LR	13	1755	0	180		0.0278
STORY2	Max Drift X	12D16W1L05S	13	1755	0	180	0.074518	
STORY2	Max Drift Y	12D16W1L05S	13	1755	0	180		0.0278
STORY2	Max Drift X	12D1E1L02S	13	1755	0	180	0.127427	
STORY2	Max Drift Y	12D1E1L02S	13	1755	0	180		0.0413
STORY2	Max Drift X	09D16W	13	1755	0	180	0.046935	
STORY2	Max Drift Y	09D16W	13	1755	0	180		0.0166
STORY2	Max Drift X	09D1E	13	1755	0	180	0.139313	
STORY2	Max Drift Y	09D1E	1	1755	818	180		0.0401

STORY SHEAR 0.9D + 1.0E Controls SHEAR and TORSION

Story	Load	Loc	P	VX	VY	T	MX	MY
ROOF	14D	Top	-22.99	0	0	0	-15958.6	0
ROOF	14D	Bottom	165.33	0	0	0	51818.4	-164694
ROOF	12D16L05LR	Top	-19.71	0	0	0	-13678.8	0
ROOF	12D16L05LR	Bottom	141.71	0	0	0	44415.7	-141166
ROOF	12D16L05S	Top	-19.71	0	0	0	-13678.8	0
ROOF	12D16L05S	Bottom	141.71	0	0	0	44415.7	-141166
ROOF	12D16LR1L	Top	-19.71	0	0	0	-13678.8	0
ROOF	12D16LR1L	Bottom	141.71	0	0	0	44415.7	-141166
ROOF	12D16LR08W	Top	-19.71	-2.75	0	983.37	-13678.8	0
ROOF	12D16LR08W	Bottom	141.71	-2.75	0	983.37	44415.7	-141497
ROOF	12D16S1L	Top	-19.71	0	0	0	-13678.8	0
ROOF	12D16S1L	Bottom	141.71	0	0	0	44415.7	-141166
ROOF	12D16S08W	Top	-19.71	-2.75	0	983.37	-13678.8	0
ROOF	12D16S08W	Bottom	141.71	-2.75	0	983.37	44415.7	-141497
ROOF	12D16W1L05LR	Top	-19.71	-5.51	0	1966.7	-13678.8	0
ROOF	12D16W1L05LR	Bottom	141.71	-5.51	0	1966.7	44415.7	-141827
ROOF	12D16W1L05S	Top	-19.71	-5.51	0	1966.7	-13678.8	0
ROOF	12D16W1L05S	Bottom	141.71	-5.51	0	1966.7	44415.7	-141827
ROOF	12D1E1L02S	Top	-19.71	-74.91	0	27811	-13678.8	0
ROOF	12D1E1L02S	Bottom	141.71	-74.91	0	27811	44415.7	-150155
ROOF	09D16W	Top	-14.78	-5.51	0	1966.7	-10259.1	0
ROOF	09D16W	Bottom	106.28	-5.51	0	1966.7	33311.8	-106536
ROOF	09D1E	Top	-14.78	-119.9	0	44497	-10259.1	0
ROOF	09D1E	Bottom	106.28	-119.9	0	44497	33311.8	-120257

Story	Load	Loc	P	VX	VY	T	MX	MY
STORY9	14D	Top	165.18	0	0	0	51717.6	-164694
STORY9	14D	Bottom	353.5	0	0	0	119495	-329388
STORY9	12D16L05LR	Top	141.59	0	0	0	44329.4	-141166
STORY9	12D16L05LR	Bottom	303	0	0	0	102424	-282333
STORY9	12D16L05S	Top	141.59	0	0	0	44329.4	-141166
STORY9	12D16L05S	Bottom	303	0	0	0	102424	-282333
STORY9	12D16LR1L	Top	141.59	0	0	0	44329.4	-141166
STORY9	12D16LR1L	Bottom	303	0	0	0	102424	-282333
STORY9	12D16LR08W	Top	141.59	-8.19	0	2925.6	44329.4	-141497
STORY9	12D16LR08W	Bottom	303	-8.19	0	2925.6	102424	-283647
STORY9	12D16S1L	Top	141.59	0	0	0	44329.4	-141166
STORY9	12D16S1L	Bottom	303	0	0	0	102424	-282333
STORY9	12D16S08W	Top	141.59	-8.19	0	2925.6	44329.4	-141497
STORY9	12D16S08W	Bottom	303	-8.19	0	2925.6	102424	-283647
STORY9	12D16W1L05LR	Top	141.59	-16.39	0	5851.2	44329.4	-141827
STORY9	12D16W1L05LR	Bottom	303	-16.39	0	5851.2	102424	-284960
STORY9	12D16W1L05S	Top	141.59	-16.39	0	5851.2	44329.4	-141827
STORY9	12D16W1L05S	Bottom	303	-16.39	0	5851.2	102424	-284960
STORY9	12D1E1L02S	Top	141.59	-143.6	0	53271	44329.4	-150155
STORY9	12D1E1L02S	Bottom	303	-143.6	0	53271	102424	-308555
STORY9	09D16W	Top	106.19	-16.39	0	5851.2	33247	-106536
STORY9	09D16W	Bottom	227.25	-16.39	0	5851.2	76817.9	-214377
STORY9	09D1E	Top	106.19	-229.8	0	85233	33247	-120257
STORY9	09D1E	Bottom	227.25	-229.8	0	85233	76817.9	-253705

Story	Load	Loc	P	VX	VY	T	MX	MY
STORY8	14D	Top	353.83	0	0	0	119721	-329388
STORY8	14D	Bottom	542.15	0	0	0	187498	-494082
STORY8	12D16L05LR	Top	303.28	0	0	0	102618	-282333
STORY8	12D16L05LR	Bottom	464.7	0	0	0	160712	-423499
STORY8	12D16L05S	Top	303.28	0	0	0	102618	-282333
STORY8	12D16L05S	Bottom	464.7	0	0	0	160712	-423499
STORY8	12D16LR1L	Top	303.28	0	0	0	102618	-282333
STORY8	12D16LR1L	Bottom	464.7	0	0	0	160712	-423499
STORY8	12D16LR08W	Top	303.28	-13.53	0	4828.6	102618	-283647
STORY8	12D16LR08W	Bottom	464.7	-13.53	0	4828.6	160712	-426436
STORY8	12D16S1L	Top	303.28	0	0	0	102618	-282333
STORY8	12D16S1L	Bottom	464.7	0	0	0	160712	-423499
STORY8	12D16S08W	Top	303.28	-13.53	0	4828.6	102618	-283647
STORY8	12D16S08W	Bottom	464.7	-13.53	0	4828.6	160712	-426436
STORY8	12D16W1L05LR	Top	303.28	-27.05	0	9657.3	102618	-284960
STORY8	12D16W1L05LR	Bottom	464.7	-27.05	0	9657.3	160712	-429373
STORY8	12D16W1L05S	Top	303.28	-27.05	0	9657.3	102618	-284960
STORY8	12D16W1L05S	Bottom	464.7	-27.05	0	9657.3	160712	-429373
STORY8	12D1E1L02S	Top	303.28	-201.7	0	74787	102618	-308555
STORY8	12D1E1L02S	Bottom	464.7	-201.7	0	74787	160712	-473922
STORY8	09D16W	Top	227.46	-27.05	0	9657.3	76963.2	-214377
STORY8	09D16W	Bottom	348.52	-27.05	0	9657.3	120534	-323498
STORY8	09D1E	Top	227.46	-322.7	0	119659	76963.2	-253705
STORY8	09D1E	Bottom	348.52	-322.7	0	119659	120534	-398301

Story	Load	Loc	P	VX	VY	T	MX	MY
STORY7	14D	Top	542.19	0	0	0	187528	-494082
STORY7	14D	Bottom	730.51	0	0	0	255305	-658776
STORY7	12D16L05LR	Top	464.74	0	0	0	160738	-423499
STORY7	12D16L05LR	Bottom	626.15	0	0	0	218833	-564665
STORY7	12D16L05S	Top	464.74	0	0	0	160738	-423499
STORY7	12D16L05S	Bottom	626.15	0	0	0	218833	-564665
STORY7	12D16LR1L	Top	464.74	0	0	0	160738	-423499
STORY7	12D16LR1L	Bottom	626.15	0	0	0	218833	-564665
STORY7	12D16LR08W	Top	464.74	-18.74	0	6688.9	160738	-426436
STORY7	12D16LR08W	Bottom	626.15	-18.74	0	6688.9	218833	-569851
STORY7	12D16S1L	Top	464.74	0	0	0	160738	-423499
STORY7	12D16S1L	Bottom	626.15	0	0	0	218833	-564665
STORY7	12D16S08W	Top	464.74	-18.74	0	6688.9	160738	-426436
STORY7	12D16S08W	Bottom	626.15	-18.74	0	6688.9	218833	-569851
STORY7	12D16W1L05LR	Top	464.74	-37.47	0	13378	160738	-429373
STORY7	12D16W1L05LR	Bottom	626.15	-37.47	0	13378	218833	-575036
STORY7	12D16W1L05S	Top	464.74	-37.47	0	13378	160738	-429373
STORY7	12D16W1L05S	Bottom	626.15	-37.47	0	13378	218833	-575036
STORY7	12D1E1L02S	Top	464.74	-249.7	0	92566	160738	-473922
STORY7	12D1E1L02S	Bottom	626.15	-249.7	0	92566	218833	-645047
STORY7	09D16W	Top	348.55	-37.47	0	13378	120554	-323498
STORY7	09D16W	Bottom	469.61	-37.47	0	13378	164125	-433870
STORY7	09D1E	Top	348.55	-399.4	0	148105	120554	-398301
STORY7	09D1E	Bottom	469.61	-399.4	0	148105	164125	-552109

Story	Load	Loc	P	VX	VY	T	MX	MY
STORY6	14D	Top	730.32	0	0	0	255176	-658776
STORY6	14D	Bottom	918.64	0	0	0	322953	-823470
STORY6	12D16L05LR	Top	625.99	0	0	0	218722	-564665
STORY6	12D16L05LR	Bottom	787.41	0	0	0	276817	-705832
STORY6	12D16L05S	Top	625.99	0	0	0	218722	-564665
STORY6	12D16L05S	Bottom	787.41	0	0	0	276817	-705832
STORY6	12D16LR1L	Top	625.99	0	0	0	218722	-564665
STORY6	12D16LR1L	Bottom	787.41	0	0	0	276817	-705832
STORY6	12D16LR08W	Top	625.99	-24.18	0	8915.5	218722	-569851
STORY6	12D16LR08W	Bottom	787.41	-24.18	0	8915.5	276817	-713919
STORY6	12D16S1L	Top	625.99	0	0	0	218722	-564665
STORY6	12D16S1L	Bottom	787.41	0	0	0	276817	-705832
STORY6	12D16S08W	Top	625.99	-24.18	0	8915.5	218722	-569851
STORY6	12D16S08W	Bottom	787.41	-24.18	0	8915.5	276817	-713919
STORY6	12D16W1L05LR	Top	625.99	-48.36	0	17831	218722	-575036
STORY6	12D16W1L05LR	Bottom	787.41	-48.36	0	17831	276817	-722006
STORY6	12D16W1L05S	Top	625.99	-48.36	0	17831	218722	-575036
STORY6	12D16W1L05S	Bottom	787.41	-48.36	0	17831	276817	-722006
STORY6	12D1E1L02S	Top	625.99	-289.6	0	107932	218722	-645047
STORY6	12D1E1L02S	Bottom	787.41	-289.6	0	107932	276817	-820963
STORY6	09D16W	Top	469.49	-48.36	0	17831	164042	-433870
STORY6	09D16W	Bottom	590.56	-48.36	0	17831	207612	-545548
STORY6	09D1E	Top	469.49	-463.3	0	172690	164042	-552109
STORY6	09D1E	Bottom	590.56	-463.3	0	172690	207612	-713584

Story	Load	Loc	P	VX	VY	T	MX	MY
STORY5	14D	Top	918.69	0	0	0	322985	-823470
STORY5	14D	Bottom	1111.18	0	0	0	393698	-988164
STORY5	12D16L05LR	Top	787.45	0	0	0	276844	-705832
STORY5	12D16L05LR	Bottom	952.44	0	0	0	337456	-846998
STORY5	12D16L05S	Top	787.45	0	0	0	276844	-705832
STORY5	12D16L05S	Bottom	952.44	0	0	0	337456	-846998
STORY5	12D16LR1L	Top	787.45	0	0	0	276844	-705832
STORY5	12D16LR1L	Bottom	952.44	0	0	0	337456	-846998
STORY5	12D16LR08W	Top	787.45	-29.83	0	11224	276844	-713919
STORY5	12D16LR08W	Bottom	952.44	-29.83	0	11224	337456	-858664
STORY5	12D16S1L	Top	787.45	0	0	0	276844	-705832
STORY5	12D16S1L	Bottom	952.44	0	0	0	337456	-846998
STORY5	12D16S08W	Top	787.45	-29.83	0	11224	276844	-713919
STORY5	12D16S08W	Bottom	952.44	-29.83	0	11224	337456	-858664
STORY5	12D16W1L05LR	Top	787.45	-59.65	0	22449	276844	-722006
STORY5	12D16W1L05LR	Bottom	952.44	-59.65	0	22449	337456	-870330
STORY5	12D16W1L05S	Top	787.45	-59.65	0	22449	276844	-722006
STORY5	12D16W1L05S	Bottom	952.44	-59.65	0	22449	337456	-870330
STORY5	12D1E1L02S	Top	787.45	-321.2	0	120410	276844	-820963
STORY5	12D1E1L02S	Bottom	952.44	-321.2	0	120410	337456	-1000672
STORY5	09D16W	Top	590.59	-59.65	0	22449	207633	-545548
STORY5	09D16W	Bottom	714.33	-59.65	0	22449	253092	-658581
STORY5	09D1E	Top	590.59	-513.9	0	192655	207633	-713584
STORY5	09D1E	Bottom	714.33	-513.9	0	192655	253092	-881127

Story	Load	Loc	P	VX	VY	T	MX	MY
STORY4	14D	Top	2919.64	0	0	0.009	1116442	-2521623
STORY4	14D	Bottom	3112.13	0	0	0.009	1187155	-2686317
STORY4	12D16L05LR	Top	3082.74	0	0	0.012	1188819	-2653352
STORY4	12D16L05LR	Bottom	3247.73	0	0	0.012	1249430	-2794519
STORY4	12D16L05S	Top	3082.74	0	0	0.012	1188819	-2653352
STORY4	12D16L05S	Bottom	3247.73	0	0	0.012	1249430	-2794519
STORY4	12D16LR1L	Top	2865.17	0	0	0.01	1101868	-2468867
STORY4	12D16LR1L	Bottom	3030.16	0	0	0.01	1162479	-2610033
STORY4	12D16LR08W	Top	2502.55	-35.27	0	13452	956950	-2173057
STORY4	12D16LR08W	Bottom	2667.54	-35.27	0	13452	1017561	-2318456
STORY4	12D16S1L	Top	2865.17	0	0	0.01	1101868	-2468867
STORY4	12D16S1L	Bottom	3030.16	0	0	0.01	1162479	-2610033
STORY4	12D16S08W	Top	2502.55	-35.27	0	13452	956950	-2173057
STORY4	12D16S08W	Bottom	2667.54	-35.27	0	13452	1017561	-2318456
STORY4	12D16W1L05LR	Top	2865.17	-70.54	0	26904	1101868	-2492199
STORY4	12D16W1L05LR	Bottom	3030.16	-70.54	0	26904	1162479	-2641830
STORY4	12D16W1L05S	Top	2865.17	-70.54	0	26904	1101868	-2492199
STORY4	12D16W1L05S	Bottom	3030.16	-70.54	0	26904	1162479	-2641830
STORY4	12D1E1L02S	Top	2865.17	-344.2	0	129532	1101868	-2622541
STORY4	12D1E1L02S	Bottom	3030.16	-344.2	0	129532	1162479	-2805016
STORY4	09D16W	Top	1876.91	-70.54	0	26904	717712	-1644375
STORY4	09D16W	Bottom	2000.65	-70.54	0	26904	763171	-1758715
STORY4	09D1E	Top	1876.91	-550.8	0	207251	717712	-1866922
STORY4	09D1E	Bottom	2000.65	-550.8	0	207251	763171	-2038890

Story	Load	Loc	P	VX	VY	T	MX	MY
STORY3	14D	Top	5110.72	0	0	0.009	2010568	-4419898
STORY3	14D	Bottom	5458.51	0	0	0.009	2138371	-4714893
STORY3	12D16L05LR	Top	5601.99	0	0	0.012	2219379	-4836610
STORY3	12D16L05LR	Bottom	5900.09	0	0	0.012	2328925	-5089463
STORY3	12D16L05S	Top	5601.99	0	0	0.012	2219379	-4836610
STORY3	12D16L05S	Bottom	5900.09	0	0	0.012	2328925	-5089463
STORY3	12D16LR1L	Top	5143.97	0	0	0.01	2033366	-4443563
STORY3	12D16LR1L	Bottom	5442.08	0	0	0.01	2142912	-4696415
STORY3	12D16LR08W	Top	4380.62	-41.72	0	16089	1723344	-3804383
STORY3	12D16LR08W	Bottom	4678.72	-41.72	0	16089	1832889	-4064745
STORY3	12D16S1L	Top	5143.97	0	0	0.01	2033366	-4443563
STORY3	12D16S1L	Bottom	5442.08	0	0	0.01	2142912	-4696415
STORY3	12D16S08W	Top	4380.62	-41.72	0	16089	1723344	-3804383
STORY3	12D16S08W	Bottom	4678.72	-41.72	0	16089	1832889	-4064745
STORY3	12D16W1L05LR	Top	5143.97	-83.44	0	32177	2033366	-4475361
STORY3	12D16W1L05LR	Bottom	5442.08	-83.44	0	32177	2142912	-4743232
STORY3	12D16W1L05S	Top	5143.97	-83.44	0	32177	2033366	-4475361
STORY3	12D16W1L05S	Bottom	5442.08	-83.44	0	32177	2142912	-4743232
STORY3	12D1E1L02S	Top	5143.97	-361.7	0	136598	2033366	-4638546
STORY3	12D1E1L02S	Bottom	5442.08	-361.7	0	136598	2142912	-4956498
STORY3	09D16W	Top	3285.46	-83.44	0	32177	1292508	-2873161
STORY3	09D16W	Bottom	3509.04	-83.44	0	32177	1374667	-3077819
STORY3	09D1E	Top	3285.46	-578.7	0	218557	1292508	-3153336
STORY3	09D1E	Bottom	3509.04	-578.7	0	218557	1374667	-3447134

Story	Load	Loc	P	VX	VY	T	MX	MY
STORY2	14D	Top	7772.65	0	0	0.009	3091790	-6722183
STORY2	14D	Bottom	8159.81	0	0	0.009	3233767	-7049408
STORY2	12D16L05LR	Top	9486.6	0	0	0.012	3806556	-8200408
STORY2	12D16L05LR	Bottom	9818.46	0	0	0.012	3928251	-8480887
STORY2	12D16L05S	Top	9486.6	0	0	0.012	3806556	-8200408
STORY2	12D16L05S	Bottom	9818.46	0	0	0.012	3928251	-8480887
STORY2	12D16LR1L	Top	8427.48	0	0	0.01	3372887	-7285957
STORY2	12D16LR1L	Bottom	8759.33	0	0	0.01	3494582	-7566436
STORY2	12D16LR08W	Top	6662.27	-48.93	0	19038	2650106	-5785279
STORY2	12D16LR08W	Bottom	6994.12	-48.93	0	19038	2771800	-6074565
STORY2	12D16S1L	Top	8427.48	0	0	0.01	3372887	-7285957
STORY2	12D16S1L	Bottom	8759.33	0	0	0.01	3494582	-7566436
STORY2	12D16S08W	Top	6662.27	-48.93	0	19038	2650106	-5785279
STORY2	12D16S08W	Bottom	6994.12	-48.93	0	19038	2771800	-6074565
STORY2	12D16W1L05LR	Top	8427.48	-97.86	0	38077	3372887	-7332773
STORY2	12D16W1L05LR	Bottom	8759.33	-97.86	0	38077	3494582	-7630867
STORY2	12D16W1L05S	Top	8427.48	-97.86	0	38077	3372887	-7332773
STORY2	12D16W1L05S	Bottom	8759.33	-97.86	0	38077	3494582	-7630867
STORY2	12D1E1L02S	Top	8427.48	-370.3	0	140106	3372887	-7546039
STORY2	12D1E1L02S	Bottom	8759.33	-370.3	0	140106	3494582	-7893175
STORY2	09D16W	Top	4996.7	-97.86	0	38077	1987579	-4368219
STORY2	09D16W	Bottom	5245.59	-97.86	0	38077	2078850	-4596194
STORY2	09D1E	Top	4996.7	-592.5	0	224170	1987579	-4737535
STORY2	09D1E	Bottom	5245.59	-592.5	0	224170	2078850	-5054546