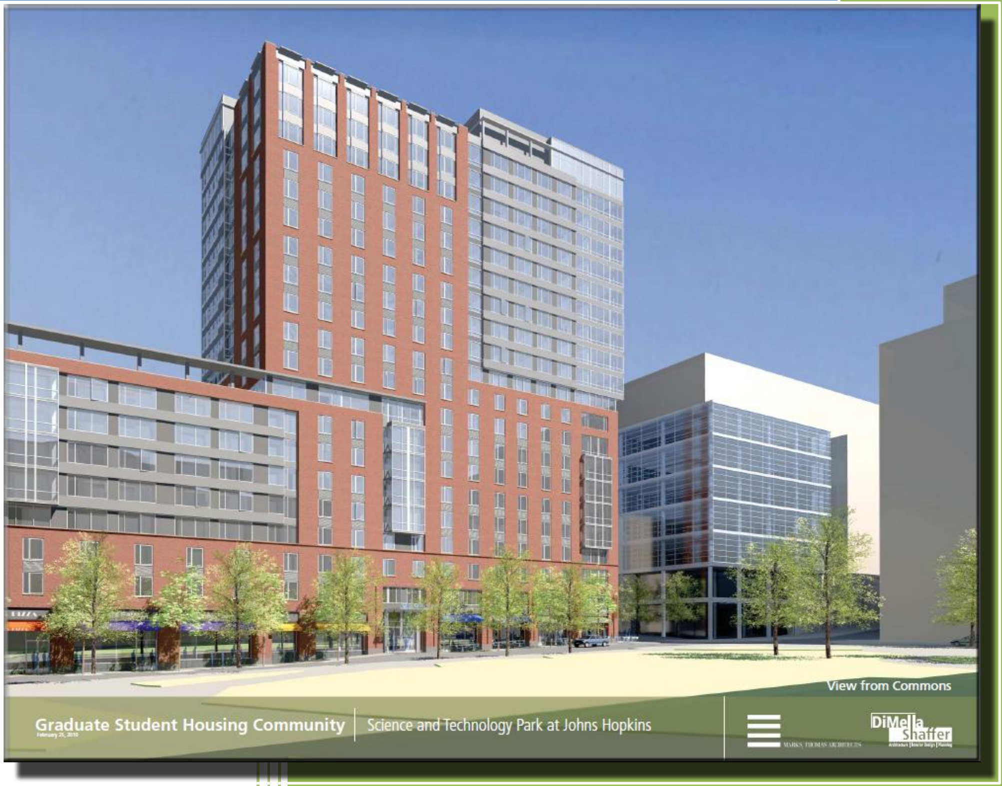
John Hopkins Graduate Student Housing

Technical Report 3



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11/16/2011

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Executive Summary -

Technical 3 is an analysis and confirmation of the lateral systems in the John Hopkins Graduate Student Housing project, and 21 floor apartment complex in Baltimore, Maryland. The building is constructed entirely of concrete with a PT slab resisting gravity loads, and ordinary reinforced concrete shear walls resisting lateral loads. Wall strengths in the tall tower range from 8ksi concrete at the base (1^{st} – 7^{th} floor), 6ksi in the middle (7^{th} to 14^{th} floor), and 4ksi in the top portion (14^{th} to roof). To assist in the lateral analysis, ETABS was used to create a 3D model. The model took into account a pinned base, small mesh sizes, cracking in the shear walls, and a rigid diaphragm. Periods of 4 seconds were found for the computer model which is very similar to 4.2 seconds using the .2N rule of thumb as discussed later. Further verification of an accurate model was found when the hand calculations of center of mass and rigidity were similar to the model calculations.

The structural engineer for the project listed base shears due to only Earthquake loads; therefore, it was assumed that earthquakes are the controlling case with a base shear of 675 K in the tall tower. The hand seismic calculation found a base shear with 798 K resulting in an error of 18%. Sources of error are discussed in the report.

The model was used to calculate maximum displacements, drift values, and story shears. Results confirmed that Earthquake loads were the controlling case producing the largest drifts and shears. This result was expected because the building is heavy and would produce significant inertial loads. It was found that although the wind was not controlling, the building still complied to the ASCE7-05 recommendations. For seismic, the building was within the allowable drift limitations.

Finally, the largest story shear was applied at the bottom floor and distributed to the shear walls taking into account eccentricity and torsion. Strength checks were then performed for every shear wall to prove that it could take the applied loads. Overall, the lateral system implemented in the John Hopkins Housing Project was found to be feasible and code compliant.

Introduction –

Located just outside the heart of Baltimore, 2 blocks from John Hopkins campus, is the site for the new John Hopkins Graduate Student Housing. This housing project is being constructed in the science and technology park of John Hopkins. A developing "neighborhood", the science and technology park is over 277,000 sq. ft. which is planned to host at least five more buildings dedicated to research for John Hopkins University. The site is also directly across from a 3 acre green space. This location is ideal because it places graduate students within walking distance of the schools hospitals, shopping, dining and relaxing.

Figure 1 - Showing glass and brick facade along with curtain wall

John Hopkins Graduate Student Housing project is a new building constructed with brick and glass facades for a modern look. Upon completion, the building's main function is predominantly for graduate residential use, providing 929 bedrooms over 20 floors. There are efficiencies, 1, 2, and 4 bedroom apartments available. Other features include a fitness room and rooftop terrace. A secondary function of the building is three separate commercial spaces located on the first floor. Retail spaces provide a mixed use floor, creating a welcoming environment and bringing in additional revenue. At the 10^{th} floor, the typical floor size decreases, creating a low roof and a tower for the remaining ten floors. Glass curtain walls on two corners of the building also begin on the 10^{th} floor and extend to the upper roof.

The façade of John Hopkins GSH is composed mainly of red brick and tempered glass with metal cladding. Large storefront windows will be located on the first floor and approximately 6' x 6' windows in the apartments. The curtain wall is to be constructed of glass and metal cladding that can withstand wind loads without damage. There is a mechanical shading system in the windows to assist in the LEED silver certification.

Figure 2 - an overhead showing the green roof and large green area across the street

John Hopkins GSH is striving to achieve LEED silver certification. Most of the points accumulated to achieve this level come from the sustainable sites category. A total of 20/26 points were picked up in this category due to a number of achievements such as; community connectivity, public transportation access, and storm water design and quality control. Indoor air quality is the next largest category where the building picks up an additional 11 points for the use of low emitting materials throughout construction. Several miscellaneous points are picked up for using local materials and recycling efforts as well. Shading mechanisms are also implemented throughout the design as well as an accessible green roof.

There are three different types of roofs on this project. Above the concrete slab on the green roof is a hot rubberized waterproofing followed by polystyrene insulation, a composite sheet drying system, and finally the shrubbery. The sections of roof containing pavers will be constructed using the same waterproofing, a separation sheet, the insulation and finally pavers placed on a shim system. The remaining portions of the roof will be constructed using a TPO membrane system.

Structural Systems –

Foundations:

A geotechnical report was created based on 7 soil test borings drilled from 80' to 115' deep. Four soil types were found during these tests: man placed fill from previous construction 7-13 feet deep, Potomac group deposits of silty sands at 40-75 feet, and competent bedrock at 80-105 feet. Soil tests showed a maximum unconfined compressive strength of 12.37 ksi. The expected compression loads from the structure were 2400k and 1100k for the 20 and 9 floor towers, respectively. The foundation system will also have to support an expected uplift and shear force, respectively, of 1400k per column and 180k per column. Based on pre-existing soils and heavy axial loads it was determined that a shallow foundation system was neither suitable nor economical.

In order to reach the competent bedrock, John Hopkins GSH sits on deep caissons 71-91 feet deep. Caissons range in 36-54" in diameter and are composed of 4000psi concrete. Grade beams, 4000psi, sit on top of the caissons followed by the slab on grade. Slab on grade consists of 3500 psi reinforced with W2.9XW2.9 and rests on 6" of granular fill compacted to at least 95% of maximum dry density based on standard proctor.

According to the geotechnical report, the water table is approximately 10 feet below the first floor elevation, therefore a sub drainage system was not necessary.

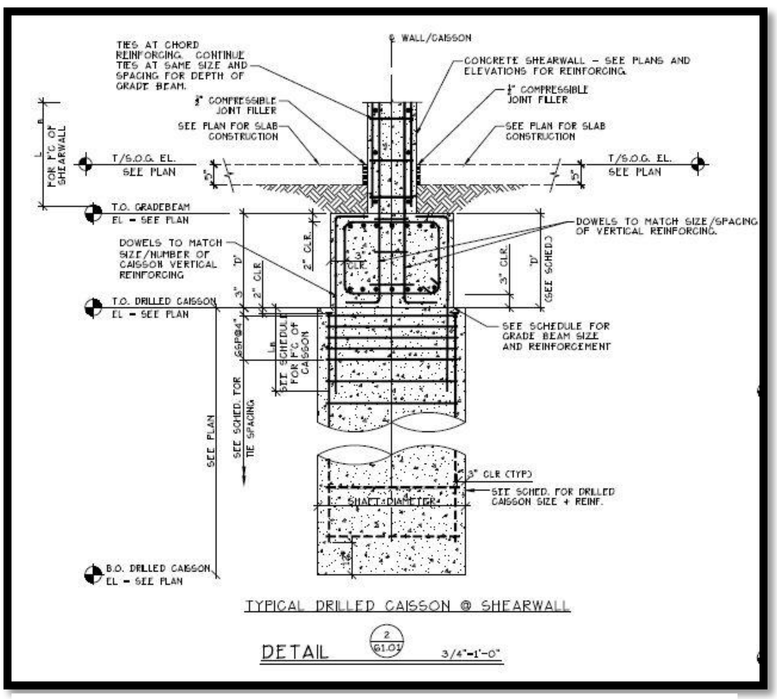


Figure 3 - a detail section of a caisson and column

Floor Framing:

Dead and live loads are supported in John Hopkins GSH through a 2-way post-tensioned slab. The slab is typically 8" thick normal weight 5000 psi concrete reinforced with #4 bars at 24" on center along the bottom in both directions. The tendons are low-relaxation composed of a 7-wire strand according to ASTM A-416. Effective post tensioning forces vary throughout the floor, but the interior bands are typically 240k and 260k. This system is typical for every floor except for the 9th which supports a green roof and accessible terrace. Higher loads on this floor require a 10" thick 2 way post tensioned slab reaching a maximum effective strength of 415k. The bottom layer of reinforcing in this area is also increased to #5 bars spaced every 18". One bay on the 9th floor (grid lines 7-8) is constructed with a 10" cast in place slab. Plans of this floor can be found in appendix E.

Mechanical penthouses exist on the 9th and 20th roof constructed with a steel moment frame. Typical sizes for the 9th floor penthouse are W10's and W12's with 1.5" 20 gage "B" metal deck. As for the 20th floor penthouse, the typical beam size is W16x26. Equipment will be supported on concrete pads typically 4" thick. Two air handling units and cooling towers on the roof will require 6" pads.

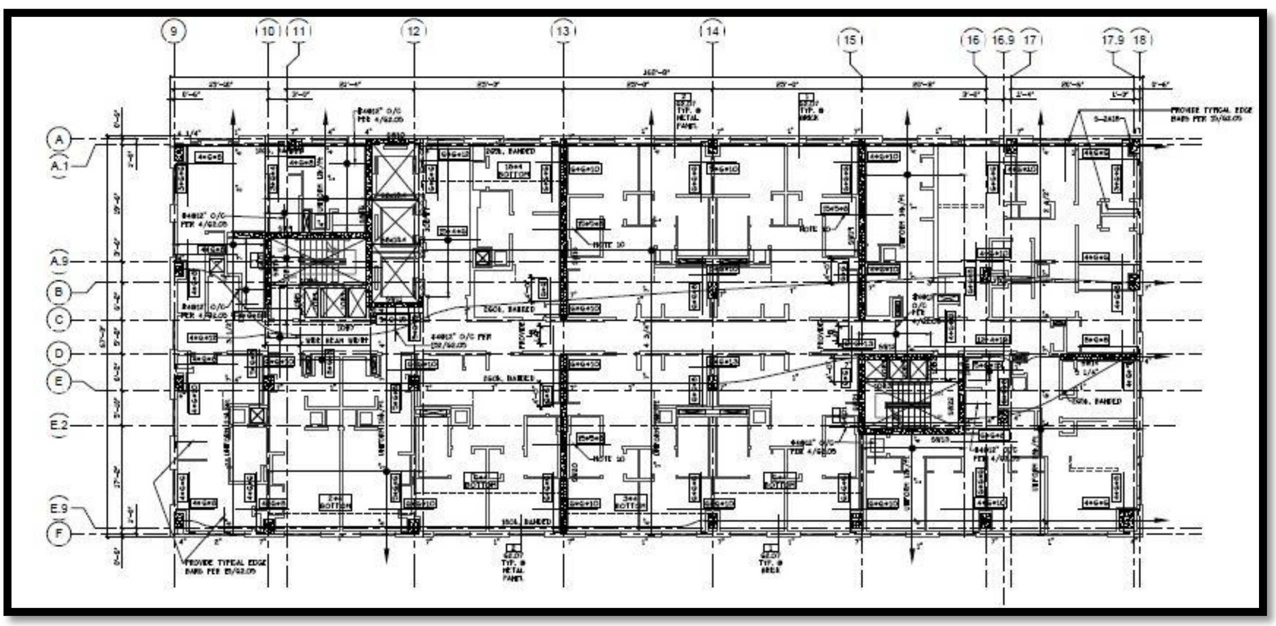


Figure 4 - Typical floor plan of upper tower

The loads will flow through the slab and reinforcement to the columns eventually making their way down to the foundation. To tie the slab and framing system into the columns, two tendons pass through the columns in each direction. To further tie the systems together, bottom bars have hooked bars at discontinuous edges. Dovetail inserts are installed every 2' on center to tie the brick façade in with the superstructure. Columns are typically 30"x20" and composed of 4ksi strength in the northern tower (9 floors), while columns in the southern tower vary from 8ksi at the bottom, and 4 ksi at the top.

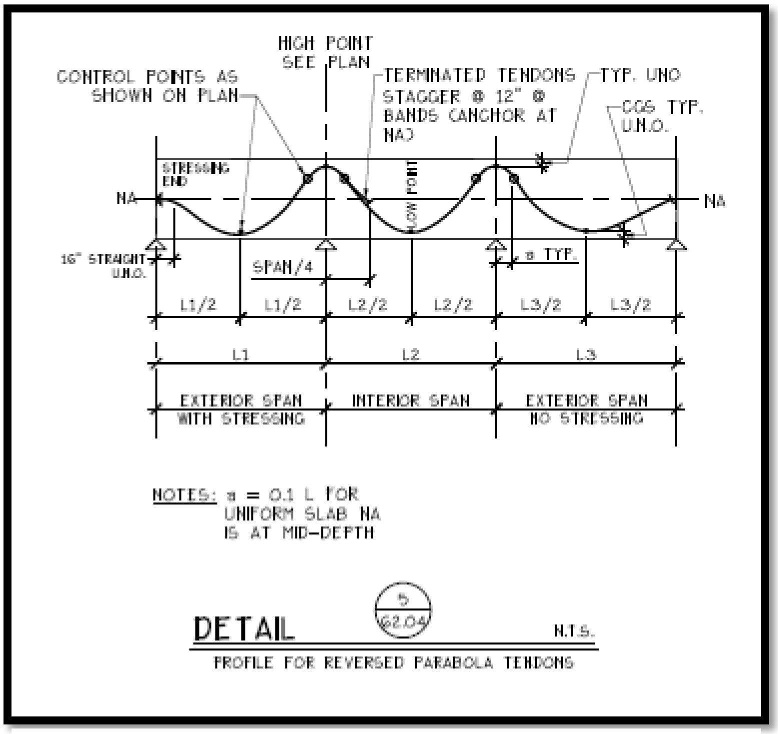


Figure 5- Typical detail for post tensioned tendon profile

Lateral System:

John Hopkins GSH is supported laterally through a cast in place reinforced concrete shear wall system. All of the shear walls are 12" thick and located throughout the building and around stairwells and elevator shafts. Shear walls in the 9 floor tower are poured with 4000psi strength concrete while shear walls in the 20 floor tower vary in three locations. From the foundation to 7th floor, 8ksi concrete is used, 6ksi from 7th to below 14th floor, and 4ksi for walls above the 14th floor. The shear walls are tied into the foundation system through bent vertical bars 1' deep into the grade beam as shown in figure 6. Shear walls are shown below in the figure with N-S walls highlighted in blue and E-W walls red. Walls in the center of the building will support lateral stresses directly, while those on the end support the torsion effects caused by eccentric loads.

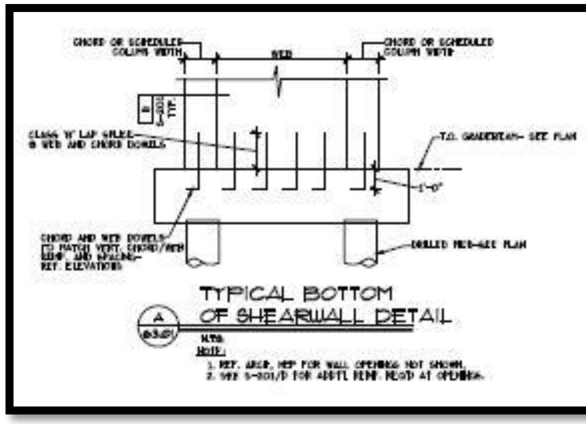


Figure 6 - detail tying shear wall into foundation

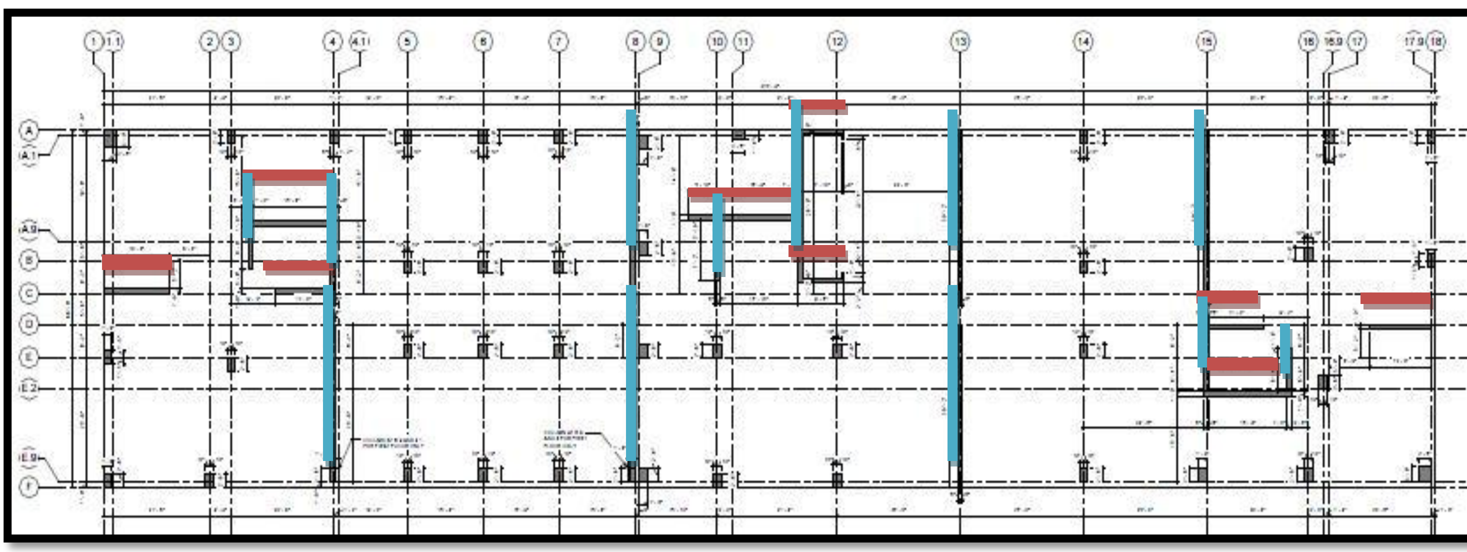


Figure 7 - Shear wall layout

Building Code Summary –

	John Hopkins GSH was designed to comply with:	My Thesis analysis/design will be based on:
General Building Code	IBC 2006	IBC 2006
Lateral Analysis	ASCE7	ASCE7-05
Concrete Specifications	ACI 301, 318, 315	ACI 318-08
Steel Specifications	AISC and AWS D1.1	AISC 2006
Masonry Specifications	ACI 530.1/ASCE 6	ACI 530.1-08/ASCE 6-08

Table 1- Building Code Comparison

Material Strength Summary –

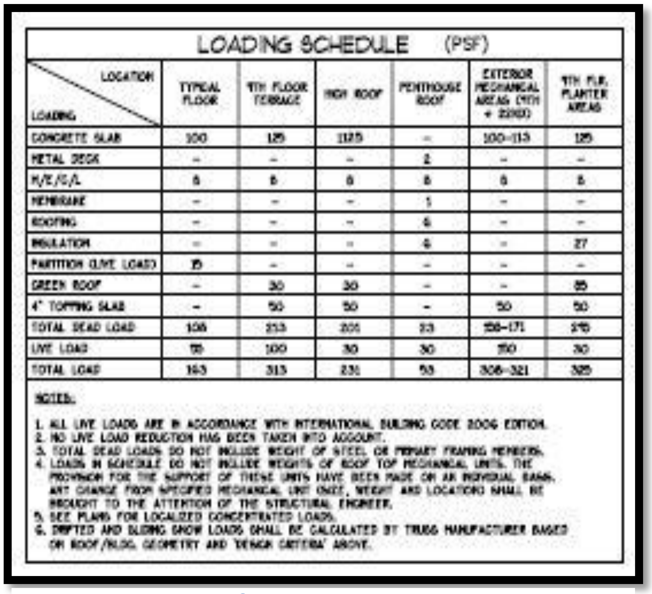
Material Strengths		
Concrete		
Material	**Weight (lbs/ft^3)**	**Strength (psi)**
Footings	145	4000
Pile Caps	145	4000
Caissons	145	4000
Grade Beams	145	4000
Slab-on-grade	145	3500
Slabs/beams	145	5000
Slab on metal deck	115	3500
Columns	145	Vary-see schedule
Shearwalls	145	Vary-see schedule
Steel		
Shape	**Grade**	**Yield Strength** (ksi)
W Shapes	A992	50
S, M and HP Shapes	A36	36
HSS	A500-GR.B	42
Channels, Tees, Angles, Bars, Plates	A36	36
Reinforcing Steel	GR. 60	60

Table 2 - Material Strength Summary

Load Calculations –

Dead Loads:

The dead loads calculated in appendix A have confirmed the dead loads that were provided in the loading schedule as seen in table 3. It appears that the designer used ASD in their analysis because the total load does not have any factors applied to it. The analysis in this tech report will be LRFD which typically results in a more aggressive design.



LOADING SCHEDULE (PSF)

LOCATION / LOADING	TYPICAL FLOOR	9TH FLOOR TERRACE	HIGH ROOF	PENTHOUSE ROOF	EXTERIOR MECHANICAL AREAS (9TH + ROOF)	9TH FLR. PLANTER AREAS
CONCRETE SLAB	100	125	1125	–	100–113	125
METAL DECK	–	–	–	2	–	–
M/E/S/L	8	8	8	8	8	8
MEMBRANE	–	–	–	1	–	–
ROOFING	–	–	–	6	–	–
INSULATION	–	–	–	6	–	27
PARTITION (LIVE LOAD)	15	–	–	–	–	–
GREEN ROOF	–	30	30	–	–	85
4" TOPPING SLAB	–	50	50	–	50	50
TOTAL DEAD LOAD	108	213	201	23	158–171	295
LIVE LOAD	55	100	30	30	150	30
TOTAL LOAD	163	313	231	53	308–321	325

NOTES:

1. ALL LIVE LOADS ARE IN ACCORDANCE WITH INTERNATIONAL BUILDING CODE 2006 EDITION.
2. NO LIVE LOAD REDUCTION HAS BEEN TAKEN INTO ACCOUNT.
3. TOTAL DEAD LOADS DO NOT INCLUDE WEIGHT OF STEEL OR PRIMARY FRAMING MEMBERS.
4. LOADS IN SCHEDULE DO NOT INCLUDE WEIGHTS OF ROOF TOP MECHANICAL UNITS. THE PROVISION FOR THE SUPPORT OF THESE UNITS HAVE BEEN MADE ON AN INDIVIDUAL BASIS. ANY CHANGE FROM SPECIFIED MECHANICAL UNIT SIZE, WEIGHT AND LOCATIONS SHALL BE BROUGHT TO THE ATTENTION OF THE STRUCTURAL ENGINEER.
5. SEE PLANS FOR LOCALIZED CONCENTRATED LOADS.
6. DRIFTED AND SLIDING SNOW LOADS SHALL BE CALCULATED BY TRUSS MANUFACTURER BASED ON ROOF/BLDG. GEOMETRY AND 'DESIGN CRITERIA' ABOVE.

Figure 8 - Summary of loads used by designer

Live Loads:

It seems John Hopkins used loads very similar to the ASCE7-05 standards. Exterior mechanical loads were not specified in the standard, but I am assuming the equipment can cause significant loads while operating. The 30psf on non-assembly roof areas is most likely a judgment call to account for the maintenance that would be required for a green roof. Although not specified on the table, the 100psf required in the corridor and stairwells are most likely balanced by the large banded post tensioned tendons running parallel to the corridor and around the stairwells.

Area	Designed for – (psf)	ASCE7-05 (psf)
Typical Floor	55 (includes partitions)	40 (residential) + 15 (partitions)
Corridors	N/A	100
Stairs	N/A	100
Assembly	N/A	100
First story retail	N/A	100
Roof used for garden/assembly	100	100
Exterior Mechanical areas	150	N/A
High Roof	30	N/A
Penthouse Roof	30	N/A
Planter Areas	30	N/A

Table 3 - Live Load Comparison

Lateral Load Analysis –

The fundamental principle behind structural engineering is that force follows stiffness. If one member is stronger than another, it will resist more force. Lateral loads will follow this principle by traveling through the building and eventually down shear walls into the foundation. The John Hopkins Graduate Student Housing structure utilizes an effective load path to resist lateral loads.

As discussed earlier in this report, lateral loads are resisted through ordinary reinforced concrete shear walls with varying strengths. Wind loads are applied as a force on the façade. The loads are transferred from the façade to the concrete slab. An 8 inch concrete floor slab can be assumed to be rigid because it has high stiffness values. A rigid diaphragm allows the lateral loads to be distributed to the shear walls based on rigidity instead of tributary area. The lateral loads are then transferred from the diaphragm to the shear walls, and down to the foundation system. Seismic loads differ from wind loads only in their source. Instead of a force being applied to the façade of the building, seismic loads originate in the mass of the structure and forces occur due to the building's inertial forces.

Due to the simple geometric shape, and continuity of structural members, there are no areas of major concern at this time. Due to time constraints, only the tall tower was modeled and analyzed. The tall tower would produce the largest loads and deflections which of more interest for this technical report. It is reasonable to model the tall tower separately from the other due a construction joint at gridline 9. A comparison to the structural engineer's seismic findings is still viable because they also separated the structure at the construction joint.

Computer Model:

To assist with the lateral analysis, a computer model was created using ETABS. In order to create a functioning and accurate model, several assumptions needed to be made. The base of the building was assumed to a pin connection. This is a reasonable and conservative assumption. In real life, it is very difficult to construct a truly fixed connection which makes a pin connection reasonable. With a pin connection, the displacement and drift values that could govern the design are larger, creating more conservative results.

Walls were created using 8, 6, and 4 ksi concrete as specified in the shear wall schedule. To tie the walls into one another and work as a system, a rigid diaphragm was used. As discussed earlier, the rigid diaphragm has a high stiffness value and will transfer the loads to the walls based on their relative stiffness. According to ACI 318-08, the in-plane moment of inertia values are limited to 50% of the gross values to account for cracking. This reduction in strength is relevant to this model because it is torsionally sensitive and ASCE7-05 requires torsionally sensitive buildings in SDC B to model with this criteria. This code requirement was applied in ETABS, by applying a .5 modifier to the f_{22} values of all shear walls. F_{22} in ETABS corresponds to the in-plane force values and is show below in figure 9.

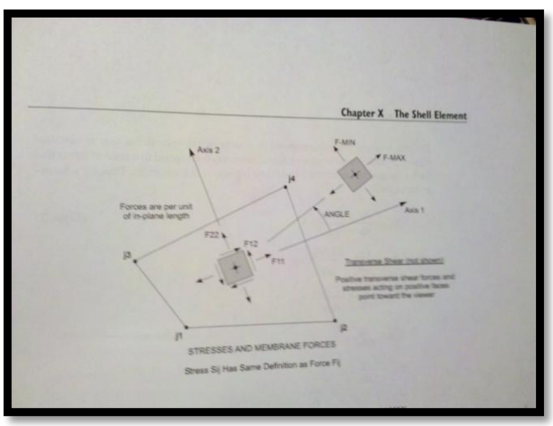


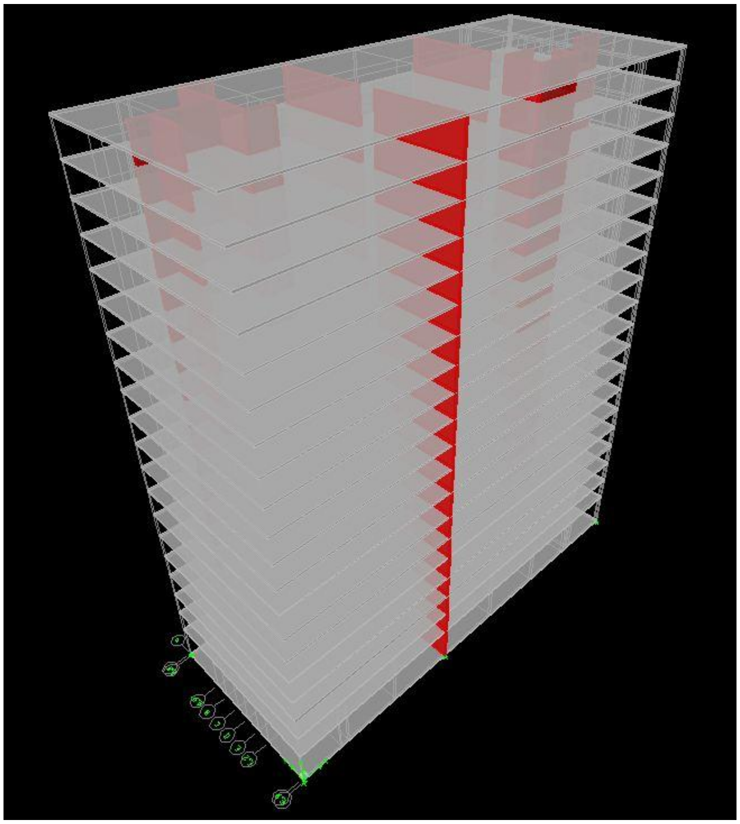
Figure 9 - Figure from CSI Analysis Reference Manual

The walls were modeled as a shell instead of a membrane. Shells were required due to the height of the building and shear walls being the only form of lateral resistance. To negate the effects of bending and create an accurate model, the bending thickness was analyzed using 10% of the membrane thickness. For example, the 12" thick shear walls were inputted using 12" as membrane thickness, and 1.2" for bending thickness.

The structure was meshed so that the maximum mesh size was 24" by 24". This ensures a more accurate model resulting in larger and more realistic deflections. The structure was analyzing using dynamic analysis and including P-delta effects. Periods for the first 6 modes were found with the largest being 4.06 seconds. This was a reasonable period based the Coast and Geodetic Survey's article "Earthquake Investigations in California". The source states that for a structure where the lateral stiffness is primarily shear walls, the period can be estimated at T= N/20. For the John Hopkins Housing project, that comes out to be 21*.2 = 4.2 seconds. This is one check to ensure that the model was created accurately.

The mass of the structure was lumped at every story level by assigning it to the rigid diaphragm. Weight values were obtained from the seismic calculations. The weight includes all of the dead load except for shear walls. There is an option for ETABS to calculate the lateral weight itself, and lump it at each floor level, so to avoid double counting, shear wall weight wasn't used in additional mass. To convert the weight calculated into mass/area, the weight was divided by the floor area, gravity (32.2) and 12^3 for unit conversions.

A complete 3d view of the structure can be found below in figure 10 as well as the modal information.



Mode	Period
1	4.064757
2	3.013227
3	2.139216
4	0.907834
5	0.907402
6	0.907265

Figure 10 - 3d view of model and mode information

Center of Mass and Rigidity:

For analysis purposes, it is necessary to lump the mass of a floor at one location called the center of mass which is where the lateral loads will act. For the John Hopkins Graduate Student Housing project, the center of mass can be assumed to be in the direct center of the building due to the rectangular shape. This assumption is confirmed through ETABS. The center of rigidity is calculated through relating the stiffness to the total stiffness and centroid of the wall. Specific calculation can be found in Appendix D. A summary of the hand calculations of the center of rigidity can be found below in table 5 and 6. These values are relatively close to those found through ETABS (Appendix D) which is more evidence of an accurate model.

Center of Rigidity - Y direction							
Shearwall	Thickness (in)	Length (in)	I_g (in^4)	Stiffness (K/in)	Centroid (in)	Relative Stiffness	Center of Rigidity (in)
1	12	272	20123648	927845	598	0.5009	**469.2**
4	8	104	749909	84237	788	0.0455	
6	8	104	749909	84237	460	0.0455	
11	12	138	2628072	166019	356	0.0896	
13	12	200	8000000	399934	206	0.2159	
15	12	147	3176523	189901	356	0.1025	
				1852174			

Table 4

Center of Rigidity - X direction							
Shearwall	Thickness (in)	Length (in)	I_g (in^4)	Stiffness (K/in)	Centroid (in)	Relative Stiffness	Center of Rigidity (in)
2	12	138	2628072	166019	190	0.0196	**864.73**
3	12	328	35287552	1588141	392	0.1874	
5	8	12	1152	51633	496	0.0061	
7	8	12	1152	51633	496	0.0061	
8	12	362	47437928	2117216	782	0.2499	
9	12	362	47437928	2117216	782	0.2499	
10	12	362	47437928	2117216	1382	0.2499	
12	12	138	2628072	166019	1382	0.0196	
14	12	102	1061208	97792	1582	0.0115	
				8472886			

Table 5

Wind Loads:

Wind loads were calculated based on ASCE7-05 standards in accordance with method 2. The structure was divided into a tall tower and a short tower along the construction joint as the design engineer did. Upon performing calculations, it was found that the John Hopkins project is not a rigid building, so gust factors were calculated. Most of the calculations were rather repetitive so a spreadsheet was used and can be found below. Calculations were performed in the North-South direction and East-West, and it was found that the E-W direction causes a larger force due to the large area of façade. The largest base shear due to Wind Loads was found to be 592 K. A summary of the results as well as loading diagrams can be found below.

Criteria		E-W Direction					
Tall Tower		**Floor**	**Height (ft)**	**K_z**	**q_z**	**p (windward) (psf)**	**p(leeward) (psf)**
G_f	0.83	Penthouse	208.42	1.21	21.327	18.00	-12.69
C_p (Windward)	0.8	Roof	194.25	1.19	20.974	17.70	-12.69
C_p (Leeward)	-0.5	20	183.9	1.17	20.622	17.40	-12.69
GC_{pi}	0.18	19	174.6	1.15	20.269	17.11	-12.69
Lower Tower		18	165.3	1.13	19.917	16.81	-12.69
G_f	0.84	17	155.9	1.12	19.741	16.66	-12.69
C_p (Windward)	0.8	16	146.6	1.1	19.388	16.36	-12.69
C_p (Leeward)	-0.5	15	137.2	1.09	19.212	16.21	-12.69
GC_{pi}	0.18	14	127.9	1.07	18.859	15.92	-12.69
		13	118.6	1.04	18.331	15.47	-12.69
		12	109.3	1	17.626	14.88	-12.69
		11	99.9	0.99	17.449	14.73	-12.69
		10	90.6	0.96	16.921	14.28	-12.69
		9	81.3	0.93	16.392	13.97	-9.84
		8	71	0.89	15.687	13.37	-9.84
		7	61.7	0.85	14.982	12.76	-9.84
		6	52.3	0.81	14.277	12.16	-9.84
		5	43	0.76	13.395	11.41	-9.84
		4	33.7	0.7	12.338	10.51	-9.84
		3	24.3	0.7	12.338	10.51	-9.84
		2	15	0.7	12.338	10.51	-9.84
		1	1	0.7	12.338	10.51	-9.84

Table 6

E-W Direction Tall Tower					
Floor	**Height (ft)**	**Height Below (ft)**	**Heigh Above (ft)**	**Trib Area (ft2)**	**Story Force (K)**
Penthouse	208.42	15.2	0	1236.52	22.26
Roof	194.25	10.33	15.2	2076.87	36.77
20	183.9	9.33	10.33	1599.34	27.84
19	174.6	9.33	9.33	1517.99	25.97
18	165.3	9.33	9.33	1517.99	25.52
17	155.9	9.33	9.33	1517.99	25.29
16	146.6	9.33	9.33	1517.99	24.84
15	137.2	9.33	9.33	1517.99	24.61
14	127.9	9.33	9.33	1517.99	24.16
13	118.6	9.33	9.33	1517.99	23.48
12	109.3	9.33	9.33	1517.99	22.58
11	99.9	9.33	9.33	1517.99	22.36
10	90.6	9.33	9.33	1517.99	21.68
9	81.3	10.25	9.33	1592.83	22.25
8	71	9.33	10.25	1592.83	21.29
7	61.7	9.33	9.33	1517.99	19.38
6	52.3	9.33	9.33	1517.99	18.46
5	43	9.33	9.33	1517.99	17.32
4	33.7	9.33	9.33	1517.99	15.96
3	24.3	9.33	9.33	1517.99	15.96
2	15	14	9.33	1897.90	19.95
1	1	1	14	1220.25	12.83
				Base Shear (K)	**491**
				Overturning moment (k ft)	**56618**

Table 7

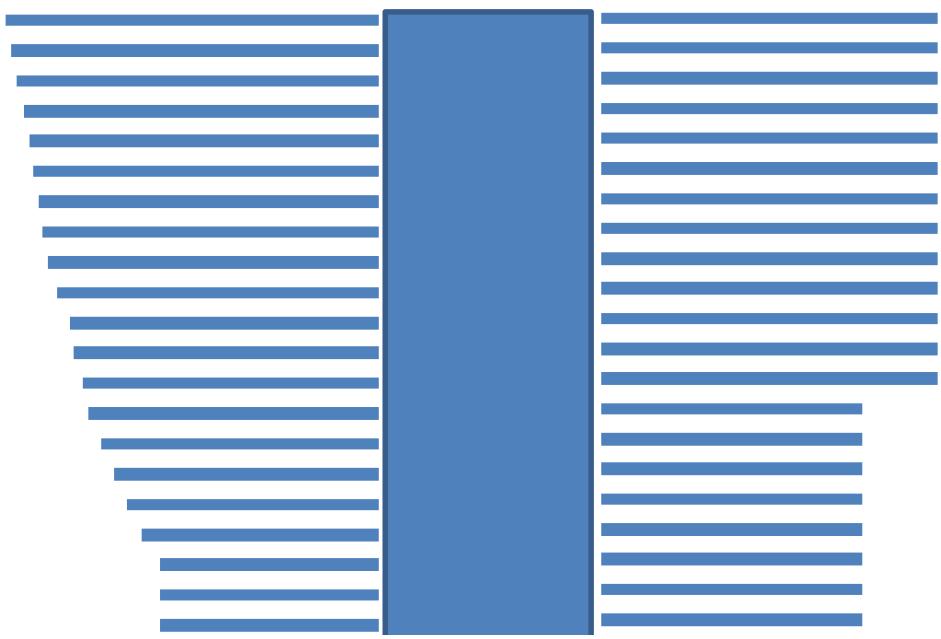


Figure 11 – loading Diagram

Criteria		**N-S Direction**					
Tall Tower		**Floor**	**Height (ft)**	**K_z**	**q_z (psf)**	**p (windward) (psf)**	**p(leeward) (psf)**
G_f	0.855	Penthouse	208.42	1.21	21.327	18.43	-8.94
C_p (Windward)	0.8	Roof	194.25	1.19	20.974	18.12	-8.94
C_p (Leeward)	-0.28	20	183.9	1.17	20.622	17.82	-8.94
GC_{pi}	0.18	19	174.6	1.15	20.269	17.51	-8.94
Lower Tower		18	165.3	1.13	19.917	17.21	-8.94
G_f	0.87	17	155.9	1.12	19.741	17.06	-8.94
C_p (Windward)	0.8	16	146.6	1.1	19.388	16.75	-8.94
C_p (Leeward)	-0.2	15	137.2	1.09	19.212	16.60	-8.94
GC_{pi}	0.18	14	127.9	1.07	18.859	16.29	-8.94
		13	118.6	1.04	18.331	15.84	-8.94
		12	109.3	1	17.626	15.23	-8.94
		11	99.9	0.99	17.449	15.08	-8.94
		10	90.6	0.96	16.921	14.62	-8.94
		9	81.3	0.93	16.392	14.36	-5.80
		8	71	0.89	15.687	13.74	-5.80
		7	61.7	0.85	14.982	13.12	-5.80
		6	52.3	0.81	14.277	12.51	-5.80
		5	43	0.76	13.395	11.73	-5.80
		4	33.7	0.7	12.338	10.81	-5.80
		3	24.3	0.7	12.338	10.81	-5.80
		2	15	0.7	12.338	10.81	-5.80
		1	1	0.7	12.338	10.81	-5.80

Table 8

N-S Direction							
Floor	Height (ft)	Height Below (ft)	Heigh Above (ft)	Trib Area (ft2)	Story Force (K)		
Penthouse	208.42	15.2	0	509.2	9.38		
Roof	194.25	10.33	15.2	855.255	15.50		
20	183.9	9.33	10.33	658.61	11.73		
19	174.6	9.33	9.33	625.11	10.95		
18	165.3	9.33	9.33	625.11	10.76		
17	155.9	9.33	9.33	625.11	10.66		
16	146.6	9.33	9.33	625.11	10.47		
15	137.2	9.33	9.33	625.11	10.38		
14	127.9	9.33	9.33	625.11	10.19		
13	118.6	9.33	9.33	625.11	9.90		
12	109.3	9.33	9.33	625.11	9.52		
11	99.9	9.33	9.33	625.11	9.42		
10	90.6	9.33	9.33	625.11	9.14		
9	81.3	10.25	9.33	655.93	9.42		
8	71	9.33	10.25	655.93	9.01		
7	61.7	9.33	9.33	625.11	8.20		
6	52.3	9.33	9.33	625.11	7.82		
5	43	9.33	9.33	625.11	7.34		
4	33.7	9.33	9.33	625.11	6.76		
3	24.3	9.33	9.33	625.11	6.76		
2	15	14	9.33	781.555	8.45	Base Shear (K)	207
1	1	1	14	502.5	5.43	Overturning moment (k ft)	23882

Table 9

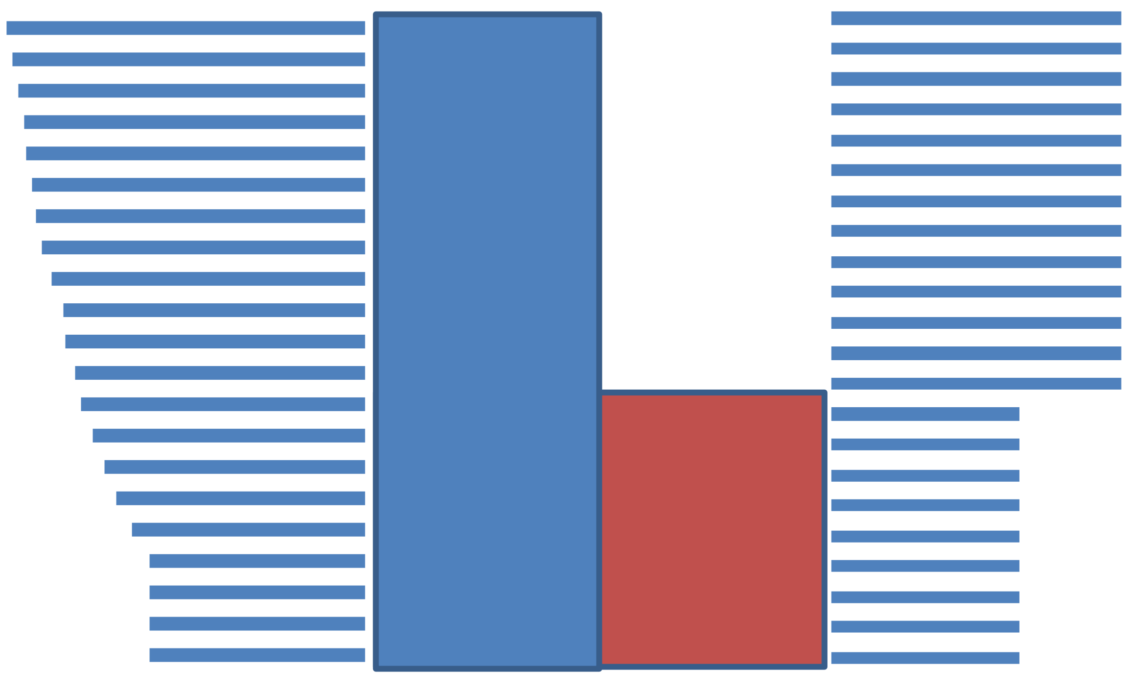


Figure 12 - Loading Diagram

Seismic Loads:

Seismic loads were calculated using the equivalent lateral load method in ASCE7-05. Using the geotechnical report, S_s and S_1 values were found to be 16%g and 5%g respectively. Although the building can be classified in seismic category A, B was used to remain conservative and be able to compare results to the design engineer. An R value of 5 was used because the framing system is classified as ordinary reinforced concrete shear walls. The total weight in the building was calculated through hand and spreadsheet calculation which can be found in appendix C. Slab openings, and the overlap between the slab and columns and shear walls were subtracted from the weight to increase accuracy. In the end a base shear for the tall tower was calculated to be 798 kips. The design engineer found the base shear for the tall tower to be 675 which is within 18%. Potential sources for error when calculating base shear could be in the green roof weight and area. Green roofs are heavy and the amount of area truly subjected to full green roof loads is difficult to obtain from the plans, so when in question, conservative was assumed to be better.

Seismic Force Distribution (Tall Tower) N-S						
Floor	Height (ft)	Weight (k)	$(w_x h_x)^k$	C_{vx}	F_x (K)	Overturning Moment (k ft)
Penthouse	208.42	78.026	5468723.63	0.001	0.98	203.80
Roof	194.25	1447.7505	522983035.79	0.117	93.51	18164.35
20	183.9	1501.059	507653269.10	0.114	90.77	16692.45
19	174.6	1460.012	446931601.28	0.100	79.91	13952.64
18	165.3	1460.012	409455629.24	0.092	73.21	12101.82
17	155.9	1464.548	374696434.45	0.084	67.00	10444.72
16	146.6	1464.548	339578455.44	0.076	60.72	8901.13
15	137.2	1464.548	305416400.42	0.068	54.61	7492.34
14	127.9	1464.548	272972342.91	0.061	48.81	6242.53
13	118.6	1464.548	241914153.79	0.054	43.25	5130.00
12	109.3	1464.548	212284377.82	0.048	37.96	4148.67
11	99.9	1439.924	178915552.45	0.040	31.99	3195.84
10	90.6	1444.892	153865670.85	0.034	27.51	2492.53
9	81.3	1450	130116890.63	0.029	23.27	1891.45
8	71	1450	104761609.37	0.023	18.73	1329.94
7	61.7	1450	83684507.78	0.019	14.96	923.21
6	52.3	1450	64237925.26	0.014	11.49	600.71
5	43	1450	46961107.72	0.011	8.40	361.06
4	33.7	1450	31797768.63	0.007	5.69	191.60
3	24.3	1450	18843381.52	0.004	3.37	81.87
2	15	1450	8708328.79	0.002	1.56	23.36
	Sum	29219.0	4461247166.88	**Base Shear (K)**		**798**
			Base Overturning moment (k ft)			**114566**

Table 10

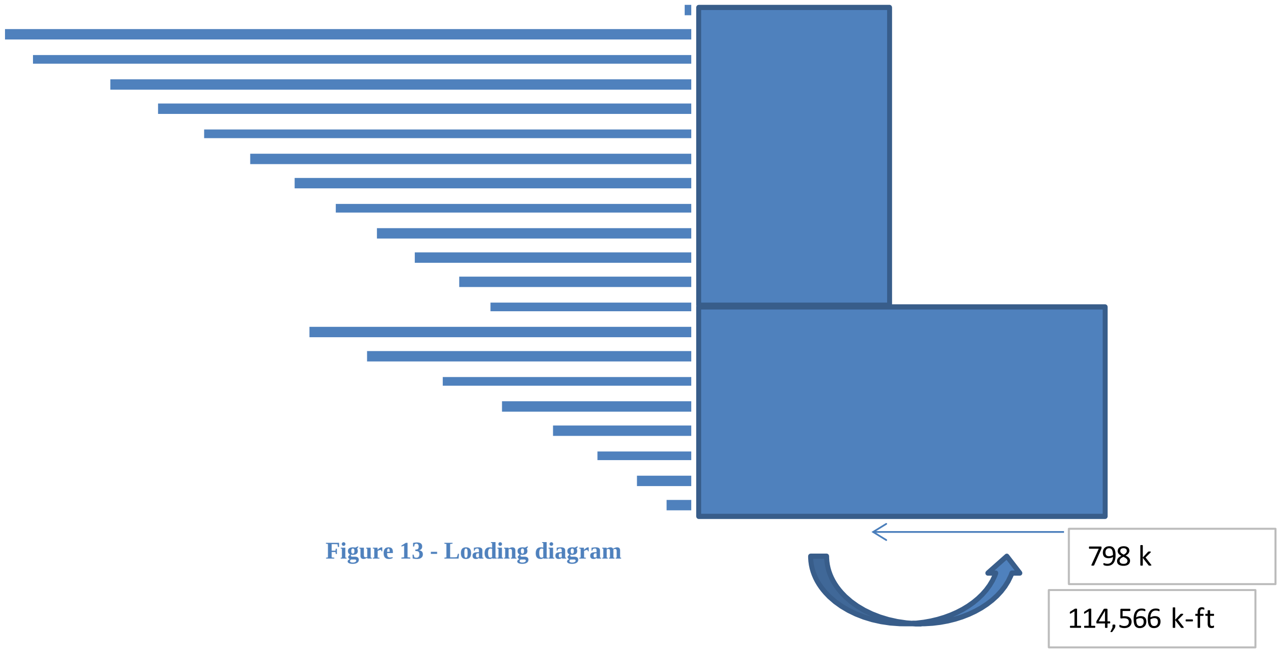


Figure 13 - Loading diagram

Load Combinations:

According to ASCE 7-05, there are 4 load cases to consider for wind as shown below. In the calculations for wind shown above, Case 1 in both cardinal directions was analyzed. It was found that the E-W direction controlled for story shear and maximum displacement which will be summarized later. For case 2, it is reasonable to assume that the same cardinal direction will control. By plotting the center of mass and center of rigidity on the floor plan, the direction of eccentricity for maximum torsional effect is easy to see. This is shown in figure 15 on the next page. Case 3 was checked with 75% of the maximum pressure acting on both faces simultaneously, and Case 4 was checked using the same logic as Case 2. Using this logic limits the number of combinations for wind to 5.

When the analysis was run for deflection and drift values, service wind and EQ loads were used because it is serviceability criteria. Wind and earthquake loads with factors of 1.6, and 1.0 respectively, were used when calculating the strength values because it is the worst case scenario presented by ASCE7-05. The seismic loads also included a 5% eccentricity to account for accidental eccentricity as well as inherent. This calculation can be found in appendix C.

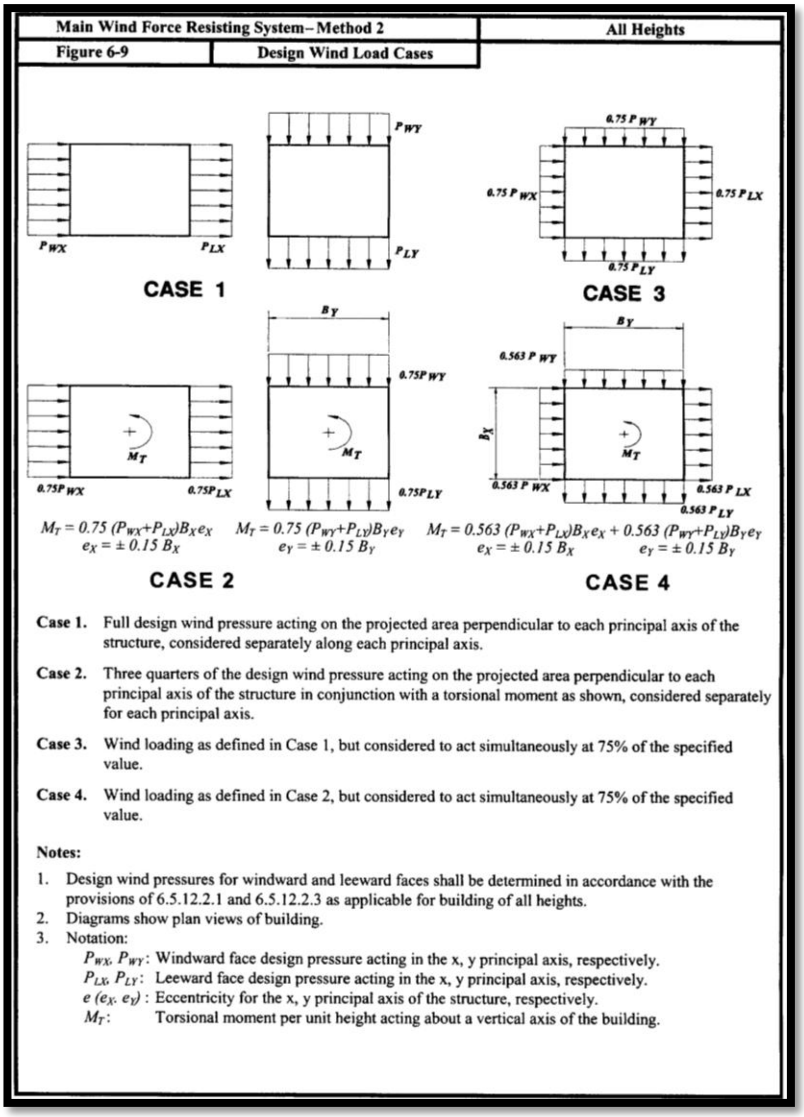


Figure 14 - Wind load cases

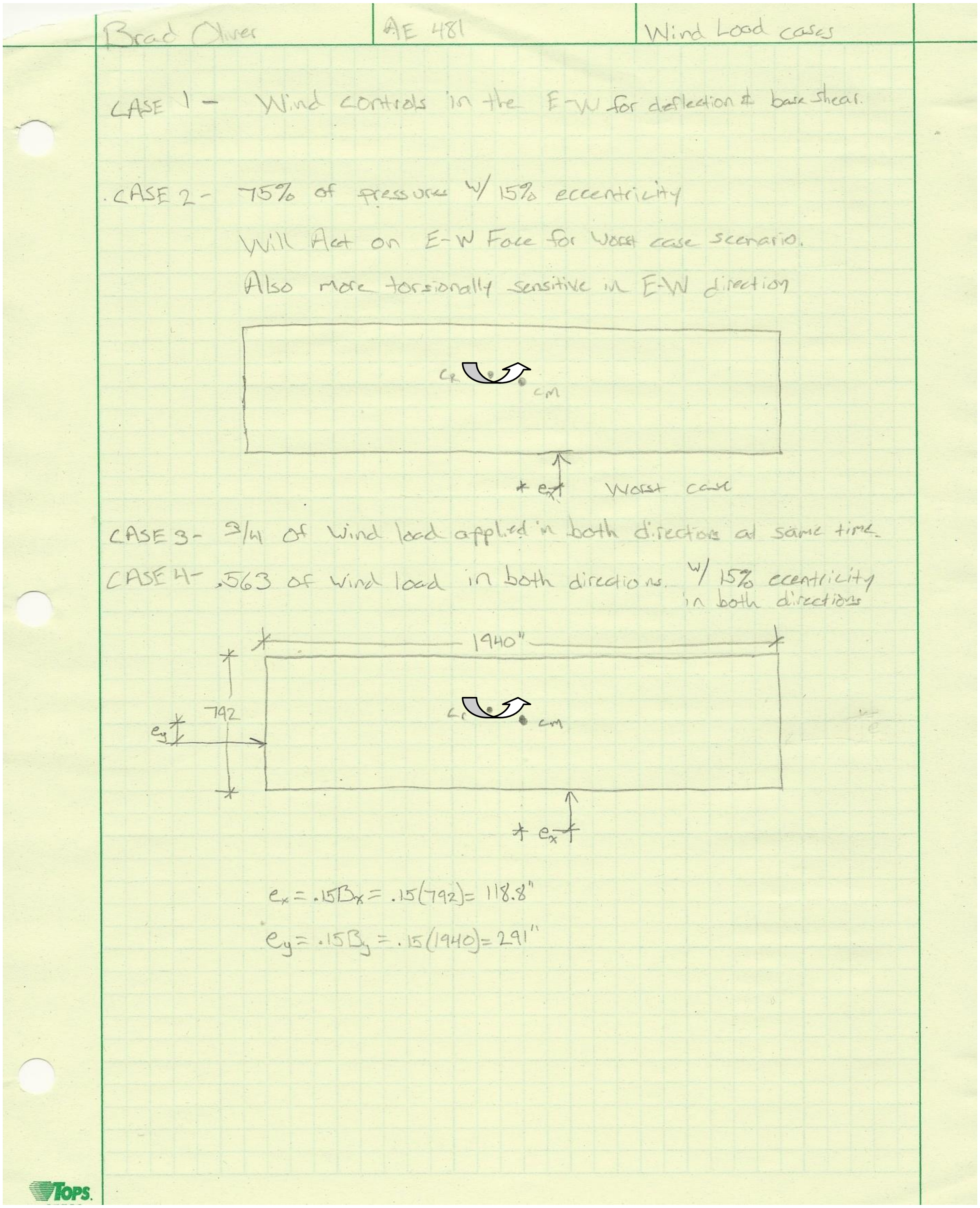


Figure 15 - Wind Combination Logic

Results –

After running the model and obtaining the results based on several load cases, it was determined that the earthquake loads were the controlling load case as seen in the table below. Earthquake loads controlled for drift and strength design which was to be expected due to the large weight of the building.

The maximum displacement for wind was found to be 3.47 inches using case 4 which makes sense based on the torsional pattern seen in the deflection animation. The industry standard for maximum displacement due to wind is L/400. For the John Hopkins building, the maximum displacement would be calculated at 204.2ft * 12in/ft / 400 = 6.1 inches which is well above the actual maximum displacement of 3.47 inches. ASCE 7-05 recommends that drift limits for wind should be limited to 3/8 inches to reduce damage to non-structural entities such as the façade according to the commentary CC1. Maximum drifts were taken from the ETABS tables found in appendix F. The drifts given in these tables are per inch of story height, so the table below already performs this calculation for the worst case drift. A sample calculation can be found in figure 16. The wind drifts are most critical once again in case 4, but are still within the recommended limit.

Summary of Results Wind							
	Case 1		Case 2	Case 3	Case 4	Earthquake	
	X	Y				X	Y
Max Displacement	1.37	3.31	2.45	2.97	3.47	9.02	7.84
Max Story Drift X	0.100812	0.056668	0.04402	0.121148	0.137764	see table below	see table below
Max Story Drift Y	0.049972	0.242048	0.181784	0.221588	0.257796	see table below	see table below
Max Story Shear	323.8	753.08	353.1	353.5	267.2	855.6	827.1

Table 11

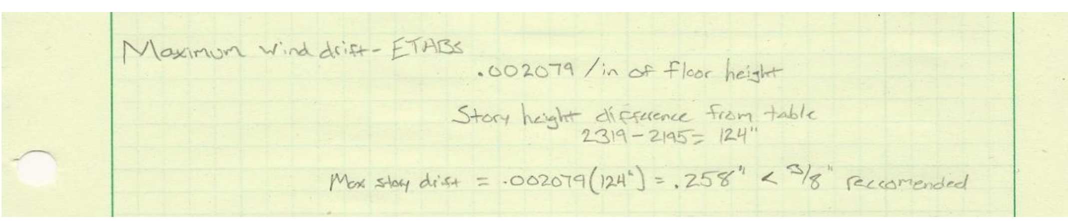


Figure 16

Dift limits for seismic are highlighted below in figure 17 and limited to .02h_x. According the chapter 12 of the ASCE7-05, earthquake deflections are to be amplified using C_d (4.5) which is refleted in the spreadsheet table 12. For calculating seismic drifts, the code allows the drifts to be caluclated at the cetner of mass. This is a viable option for this project because although it is torsionally sensitve, it is SDC B, so it is still permitted by code. John Hopkings Graduate Housing drifts are well within the allowable by code.

TABLE 12.12-1 ALLOWABLE STORY DRIFT, Δ_a[a,b]

Structure	Occupancy Category		
	I or II	III	IV
Structures, other than masonry shear wall structures, 4 stories or less with interior walls, partitions, ceilings and exterior wall systems that have been designed to accommodate the story drifts.	$0.025h_{sx}$[c]	$0.020h_{sx}$	$0.015h_{sx}$
Masonry cantilever shear wall structures[d]	$0.010h_{sx}$	$0.010h_{sx}$	$0.010h_{sx}$
Other masonry shear wall structures	$0.007h_{sx}$	$0.007h_{sx}$	$0.007h_{sx}$
All other structures	$0.020h_{sx}$	$0.015h_{sx}$	$0.010h_{sx}$

[a] h_{sx} is the story height below Level x.
[b] For seismic force–resisting systems comprised solely of moment frames in Seismic Design Categories D, E, and F, the allowable story drift shall comply with the requirements of Section 12.12.1.1.
[c] There shall be no drift limit for single-story structures with interior walls, partitions, ceilings, and exterior wall systems that have been designed to accommodate the story drifts. The structure separation requirement of Section 12.12.3 is not waived.
[d] Structures in which the basic structural system consists of masonry shear walls designed as vertical elements cantilevered from their base or foundation support which are so constructed that moment transfer between shear walls (coupling) is negligible.

Figure 17 - allowable seismic drift limits

Drifts at Center of Mass Including Accidental Torsion - Earthquake

			E-W Loading					N-S Loading				
Story	Height (in)	Allowable Drift	Δx	$Drift_x$	Δy	$Drift_y$	Compliant?	Δx	$Drift_x$	Δy	$Drift_y$	Compliant?
Roof	2319	2.48	0.4576	0.16425	3.8473	1.29645	Ok	6.83	2.31705	0.7385	0.27	Ok
20	2195	2.24	0.4211	0.144	3.5592	1.16685	Ok	6.3151	2.08935	0.6785	0.23085	Ok
19	2083	2.24	0.3891	0.14265	3.2999	1.1646	Ok	5.8508	2.08575	0.6272	0.2295	Ok
18	1971	2.24	0.3574	0.14175	3.0411	1.15785	Ok	5.3873	2.07495	0.5762	0.22725	Ok
17	1859	2.24	0.3259	0.1395	2.7838	1.1466	Ok	4.9262	2.05425	0.5257	0.22455	Ok
16	1747	2.24	0.2949	0.13725	2.529	1.1295	Ok	4.4697	2.0214	0.4758	0.22005	Ok
15	1635	2.24	0.2644	0.13365	2.278	1.1061	Ok	4.0205	1.97505	0.4269	0.2151	Ok
14	1523	2.24	0.2347	0.13005	2.0322	1.07505	Ok	3.5816	1.9152	0.3791	0.20835	Ok
13	1411	2.24	0.2058	0.12465	1.7933	1.0422	Ok	3.156	1.854	0.3328	0.2007	Ok
12	1299	2.24	0.1781	0.1197	1.5617	1.0017	Ok	2.744	1.77255	0.2882	0.19215	Ok
11	1187	2.24	0.1515	0.1125	1.3391	0.9522	Ok	2.3501	1.68255	0.2455	0.1809	Ok
10	1075	2.24	0.1265	0.1044	1.1275	0.89505	Ok	1.9762	1.5741	0.2053	0.1683	Ok
9	963	2.46	0.1033	0.1044	0.9286	0.90495	Ok	1.6264	1.584	0.1679	0.1683	Ok
8	840	2.24	0.0801	0.08415	0.7275	0.74295	Ok	1.2744	1.2933	0.1305	0.13455	Ok
7	728	2.24	0.0614	0.07425	0.5624	0.6597	Ok	0.987	1.14615	0.1006	0.11925	Ok
6	616	2.24	0.0449	0.0639	0.4158	0.576	Ok	0.7323	1.00395	0.0741	0.1044	Ok
5	504	2.24	0.0307	0.0531	0.2878	0.48195	Ok	0.5092	0.8451	0.0509	0.0873	Ok
4	392	2.24	0.0189	0.04095	0.1807	0.37935	Ok	0.3214	0.6687	0.0315	0.0675	Ok
3	280	2.24	0.0098	0.0279	0.0964	0.26685	Ok	0.1728	0.47475	0.0165	0.0468	Ok
2	168	3.36	0.0036	0.0162	0.0371	0.16695	Ok	0.0673	0.30285	0.0061	0.02745	Ok
1	0	0	0	0	0	0	Ok	0	0	0	0	Ok

Table 12

These tables merely summarize the worst case results. They also show that earthquake loads are the controlling lateral loads and that the structure is compliant for wind recommendations and earthquake criteria. Complete tables of the results from ETABS can be found in appendix F.

Overturning:

The largest overturning moment was found to be 114,566 ‘K, caused by seismic loads in the North- South direction. By looking at details of the shear walls and foundation system, it is safe to say that the base constraint does not resemble a fixed connection. This means that the overturning moment must be resisted through the weight of the building. The total weight calculated from the seismic sections comes out to be 29,219 K. Taking this weight and multiplying by ½ of the building width (33 feet) for a moment arm equals 964,227 ‘K. John Hopkins Housing project is able to easily resist overturning through the weight of the building without impacting the foundations.

Load Distribution and Strength Check:

Due to the rigid diaphragm as discussed earlier, the lateral loads can be distributed based on relative stiffness. Using the charts started when finding the center of mass and rigidity, the base shear (worst case) was distributed to each of the shear walls. Direct and torsional shears were calculated in a spreadsheet and distributed. The direction of the resisting shears are shown in appendix E. The strength of shear walls were then checked using the figure 18 equation. A sample calculation can be found in appendix E.

$$\Phi V_n = \Phi A_v(\alpha_c \lambda \sqrt{f'_c} + \rho_t f_y) \qquad \Phi = .75$$

Figure 18

Lateral Load distrubution - 855 K Story Shear								
Shearwall	I_g (in^4)	Stiffness (k/in)	Relative Stiffness	Direct Shear (k)	$D_{i\,(in)}$	K*D_i^2	Torshional Shear (k)	Total Shear (k)
1	20123648	927845	0.5009494	428.31	-158	23162729956	-4.63	423.68
4	749909.3333	84237	0.0454800	38.89	-348	10201421166	-0.93	37.96
6	749909.3333	84237	0.0454800	38.89	-20	33694745.56	-0.05	38.83
11	2628072	166019	0.0896349	76.64	84	1171433025	0.44	77.08
13	8000000	399934	0.2159269	184.62	234	21898796854	2.96	187.57
15	3176523	189901	0.1025288	87.66	84	1339942327	0.50	88.17
		1852174						
2	2628072	166019	0.0195942	0	-665.6	73550481094	-3.49	-3.49
3	35287552	1588141	0.1874380	0	-463.6	3.41331E+11	-23.26	-23.26
5	1152	51633	0.0060939	0	-359.6	6676779691	-0.59	-0.59
7	1152	51633	0.0060939	0	-359.6	6676779691	-0.59	-0.59
8	47437928	2117216	0.2498813	0	-73.6	11468874300	-4.92	-4.92
9	47437928	2117216	0.2498813	0	-73.6	11468874300	-4.92	-4.92
10	47437928	2117216	0.2498813	0	526.4	5.86674E+11	35.22	35.22
12	2628072	166019	0.0195942	0	526.4	46003476471	2.76	2.76
14	1061208	97792	0.0115418	0	726.4	51600643476	2.24	2.24
		8472886			J =	1.19326E+12		

Table 13

Shearwall Strength Checks at Base Level - 855 K							
Shear Wall	Thickness	Length	Area	$?_t$	ϕV_n	V_u	$\phi V_n > V_u$?
1	12	272	3264	0.00204	737.1	423.7	Ok
4	8	104	832	0.00204	187.9	38.0	Ok
6	8	104	832	0.00204	187.9	38.8	Ok
11	12	138	1656	0.00204	374.0	77.1	Ok
13	12	200	2400	0.00204	542.0	187.6	Ok
15	12	147	1764	0.00204	398.4	88.2	Ok
2	12	138	1656	0.00204	374.0	3.5	Ok
3	12	328	3936	0.00204	888.9	23.3	Ok
5	8	12	96	0.00204	21.7	0.6	Ok
7	8	12	96	0.00204	21.7	0.6	Ok
8	12	362	4344	0.00204	981.0	4.9	Ok
9	12	362	4344	0.00204	981.0	4.9	Ok
10	12	362	4344	0.00204	981.0	35.2	Ok
12	12	138	1656	0.00204	374.0	2.8	Ok
14	12	102	1224	0.00204	276.4	2.2	Ok

Table 14

Conclusions –

The John Hopkins Graduate Student Housing project was designed to resist lateral loads through ordinary reinforced concrete shear walls. A thorough analysis involving computer and hand calculation proved that the structure is more than sufficient to support the designed lateral loads.

The goal of this lateral analysis was to confirm the structural engineers controlling load case as well as check it against code restraints. It was confirmed that earthquake loads dominated the design of the building through drift and strength requirements. The structure passed the code criteria for allowable seismic drift, and also met industry standards and code recommendations for allowable wind deflections and drift.

An ETABS model was made of the building in order to assist with the analysis. The model was created as accurately as possible by using varying strength concrete according to the shear wall schedule, rigid diaphragms, lumped masses, and a maximum 24” x 24” mesh size.

Centers of mass and rigidity were calculated by hand to close to those calculated through ETABS. This was used to simplify the wind combinations to 5 and identify the direction in which eccentricity should be applied for wind and seismic cases. Relative stiffness was used to distribute loads from a rigid diaphragm to the shear walls to account for direct and torsional shear. These shear values were then checked against the shear capacity of the walls and found to be sufficient.

Although the earthquake loads produced a large overturning moment, the large mass of the structure was able to resist it without impacting the foundation system. Torsionally, the building is sensitive. In ASCE7-05 the criteria for a torsionally sensitive building with Seismic Design Category B were addressed by placing a .5 strength modifier on the shear walls to account for cracking.

Appendix A – Load verification

Brad Oliver | AE 481 | Load Calculations

Dead Loads
Typical Floor
$\frac{8''}{12'} \times 150\ pcf = 100\ psf$

Superimposed DL - 8 psf (Mech, Elec, Ceiling, lighting etc)

Through online research... (www.bae.ncsu.edu)
green roof typ 30-35 psf

9th floor
$\frac{10''}{12'} \times 150\ pcf = 125\ psf$

High roof - $\frac{9''}{12'} \times 150\ pcf = 112.5\ psf$

4" slabs for Mech equip - $\frac{4''}{12'} \times 150\ pcf = 50\ psf$

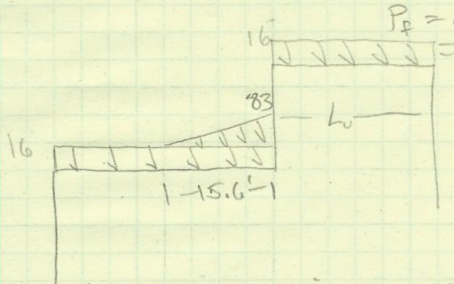
Snow Loads - ASCE 7-05 Ch 7 - Flat roof - $p_f = .7 C_e C_t I p_g$

From Fig 7-1 $p_g = 25\ psf$

From table 7-3 $C_t = 1.0$ (All other structures)
Occupancy category II from table 1-1
∴ $I = 1.0$ from table 7-4

Site Class C from geotechnical report
Fully Exposed roof
∴ $C_e = .9$ from table 7-2

$p_f = .7(.9)(1.0)(1.0)(25)$
$= 15.75\ psf \cong 16\ psf$



$L_u = 163'$

$h_d = 3.9'$

$h_b = 16\ psf \times \frac{ft^3}{17.25\ lbs} = .93' < 3.9'$

$\gamma = .13(25) + 14 < 30$
$= 17.25 < 30\ pcf$

Leeward
$L_u = 163'$ $h_d = 3.9'$

$W_d = 4(3.9') = 15.6'$

$p_d = 3.9'(17.25\ pcf) = 67\ psf$
Max Snow Load $= 67 + 16$
$= 83\ psf$

Wind Ward
$L_u = 271' - 163' = 108'$
$h_d = 3.2' \times .75 = 1.8'$ Leeward controls

Appendix B – Wind Loads

Brad Oliver | AE 481 | WIND LOADS | 1

$V = 90$ mph (Fig 6-1c)

$I = 1.0$ from 6-1 Table & category II occupancy

Exposure B b/c urban & suburban area, houses & bldgs near by.

Using table 6-3 K_z & $K_h = 1.21$ case 1 & 2

$$\frac{250-200}{1.28-1.2} = \frac{208-200}{x-1.2} \quad \text{interp is OK}$$

$$x = 1.21$$

$K_{zt} = 1.0$ b/c no wind speed up effects.

Check if frame is flexible or rigid N-S direction (Tall Towers)

$$T_a = C_t h_n^x \quad \text{Other struc Systems } C_t = .02 \quad x = .75$$

$$T_a = .02(208.4)^{.75} = 1.09 \text{ sec}$$

$$\text{freq} = 1/1.09 = .912 \text{ HZ} < 1 \text{ HZ} \therefore \text{Flexible}$$

$$G_f = .925\left(\frac{1 + 1.7 I_z \sqrt{g_Q^2 Q^2 + g_R^2 R^2}}{1 + 1.7 g_v I_z}\right)$$

$$g_Q = g_v = 3.4$$

$$g_r = \sqrt{2\ln(3600 \cdot n_1)} + \frac{.577}{\sqrt{2\ln(3600 n_1)}} \quad n_1 = .912 \text{ HZ}$$

$$g_r = \sqrt{2\ln(3600 \cdot .912)} + \frac{.577}{\sqrt{2\ln(3600 \cdot .912)}} = 4.167$$

$$R = \sqrt{\tfrac{1}{\beta} R_n R_h R_b (.53 + .47 R_L)} \qquad R_n = \frac{7.47 N_1}{(1 + 10.3 N_1)^{5/3}} = \frac{7.47(5.49)}{(1 + 10.3(5.49))^{5/3}} = .048$$

$$R_\ell = \frac{1}{n} - \frac{1}{2n^2}(1 - e^{-2n}) \qquad N_1 = \frac{n_1 L_{\bar z}}{\bar V_{\bar z}} = \frac{(.912)(498.9)}{82.9} = 5.49$$

For R_h: $n = 4.6 n_1 h / \bar V_z = 4.6(.912)(208.42)/82.9 = 10.55$

$$R_h = \frac{1}{10.55} - \frac{1}{2(10.55^2)}(1 - e^{-2(10.55)}) = .09$$

$$L_{\bar z} = \ell\left(\frac{\bar z}{33}\right)^{\bar\varepsilon} = 320\left(\frac{.6(208.42)}{33}\right)^{1/3} = 498.9$$

$$\bar V_{\bar z} = \bar b\left(\frac{\bar z}{33}\right)^{\bar\alpha} V\left(\frac{88}{60}\right) = .45\left(\frac{125}{33}\right)^{1/4}(40)\left(\frac{88}{60}\right) = 82.9$$

For R_b: $n = 4.6 n_1 B / \bar V_z = 4.6(.912)(67')/82.9 = 3.39$

$$R_b = 1/3.39 - \frac{1}{2(3.39^2)}(1 - e^{-2(3.39)}) = .252$$

For R_L: $n = 15.4 n_1 L / \bar V_z = 15.4(.912)(162.67)/82.9 = 27.56$

$$R_L = 1/27.56 - \frac{1}{2(27.56)^2}(1 - e^{-2(27.56)}) = .036$$

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Damping Ratio $\beta = 1.5\%$ for concrete system. C6.5 ISO [REF 6-55]

$$R = \sqrt{\frac{1}{.015}(.048)(.04)(.25)(.53 + .47(.036))}$$
$$= .198 \quad .199$$

$$I_{\bar{z}} = c\left(\frac{33}{\bar{z}}\right)^{1/6} = .3\left(\frac{33}{125}\right)^{1/6} = .24$$

$$Q = \sqrt{\frac{1}{1+.63\left(\frac{B+h}{L_z}\right)^{.63}}} = \sqrt{\frac{1}{1+.63\left(\frac{67+208}{498.9}\right)^{.63}}} = .8354$$

$$G_f = .925\left(\frac{1+1.7(.24)\sqrt{3.4^2(.8354)^2+(4.167)^2(.198)^2}}{1+1.7(3.4)(.24)}\right) = .855$$

$K_d = .85$ MWFRS & C&C from table 6-4

$$q_z = .00256 K_z K_{zt} K_d V^2 I$$
$$= .00256(1.21)(1)(.85)(90^2)(1)$$
$$= 21.3 \text{ psf}$$

Internal Pressure Coefficients - Fig 6-5
$GC_{pi} = \pm .18$

Ext MWFRS $L/B = 162.67/67 = 2.43$

Fig 6-6
- Windward Wall $C_p = .8$ — use w/ q_z
- Leeward Wall $C_p = -.28$ from interpolation — q_h
- Sidewall $C_p = -.7$ — q_h

Enclosed Flexible Buildings MWFRS

$$P = q G_f C_p - q_i(GC_{pi})$$
$$= 21.3(.855)(.8) - 21.3(\pm .18)$$
$$= 18.4 \text{ psf Windward}$$

$$P = 21.3(.855)(-.28) - 21.3(\pm .18)$$
$$= -8.9 \text{ psf Leeward}$$

N-S direction Top Tower

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N-S direction lower tower

Gust Factor

$$L_z = 320\left(\frac{90.58(.6)}{33}\right)^{1/3} = 377.9$$

$$V_z = .45\left(\frac{55.35}{33}\right)^{1/4}(90)\left(\frac{88}{60}\right) = 67.6$$

$$N_1 = \frac{.912(377.9)}{67.6} = 5.1$$

$$R_n = \frac{7.47(5.1)}{(1+10.3(5.1))^{5/3}} = .05$$

For R_h $\quad n = 4.6(.912)(90.58/67.6) = 5.62$

$$R_h = 1/5.62 - \frac{1}{2(5.62^2)}\left(1-e^{-2(5.62)}\right) = .162$$

For R_b $\quad n = 4.6(.912)(67)/67.6 = 4.16$

$$R_b = 1/4.16 - 1/2(4.16^2)\left(1-e^{-2(4.16)}\right) = .211$$

For R_L $\quad n = 15.4(.912)(271.3)/67.6 = 56.4$

$$R_L = 1/56.4 - 1/2(56.4^2)\left(1-e^{-2(56.4)}\right) = .018$$

$$R = \sqrt{\frac{1}{.015}(.05)(.162)(.211)(.53+.47(.018))} = .248$$

$$I_z = .3\left(\frac{33}{55.35}\right)^{1/6} = .275$$

$$Q = \sqrt{\frac{1}{1+.63\left(\frac{67+90.58}{377.9}\right)^{.63}}} = .857$$

$$G_F = .925\left(\frac{1+1.7(.275)\sqrt{3.4^2(.857^2)+4.167^2(.248^2)}}{1+1.7(3.4)(.275)}\right) = .87$$

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E-W Direction Upper Tower

Gust Factor

$L_{\bar{z}} = 498.9$, $\bar{V}_{\bar{z}} = 82.9$, $N_1 = 5.49$ } $R_n = .048$ Same as previous upper tower

$R_h = .09$

For R_b: $n = 4.6(.912)(162.7)/82.9 = 8.23$

$$R_b = 1/8.23 - 1/2(8.23)^2\left(1 - e^{-2(8.23)}\right) = .114$$

For R_L: $n = 15.4(.912)(67)/82.9 = 11.35$

$$R_L = 1/11.35 - 1/2(11.35^2)\left(1 - e^{-2(11.35)}\right) = .084$$

$$R = \sqrt{\tfrac{1}{.015}(.048)(.09)(.114)(.53 + .47(.084))} = .137$$

$I_{\bar{z}} = .24$

$$Q = \sqrt{\frac{1}{1 + .63\left(\frac{162.7 + 208}{498.9}\right)^{.63}}} = .81$$

$$G_F = .925\left(\frac{1 + 1.7(.24)\sqrt{3.4^2(.81^2) + 4.167^2(.137^2)}}{1 + 1.7(3.4)(.24)}\right) = .83$$

$L/B = 67/162.7 = .41$ ∴ C_p leeward $= -.5$

TOPS

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E-W Direction Lower Tower
Gust Factor

$V_z = 67.6$
$L_z = 377.9$
$N_1 = 5.1$
$R_n = .05$

$R_h = .162$

For R_b $n = 4.6(.912)(271.3)/67.6 = 16.84$

$R_b = 1/16.84 - 1/2(16.84^2)(1 - e^{-2(16.84)}) = .058$

For R_L $n = 15.4(.912)(67)/67.6 = 13.92$

$R_L = 1/13.92 - 1/2(13.92^2)(1 - e^{-2(13.92)}) = .069$

$$R = \sqrt{\frac{1}{.05}(.05)(.162)(.058)(.53 + .47(.069))} = .133$$

$I_z = .275$

$$Q = \sqrt{\frac{1}{1 + .63\left(\frac{271.3 + 9058}{377.9}\right)^{.63}}} = .787$$

$$G_f = .925\left(\frac{1 + 1.7(.275)\sqrt{3.4^2(.787^2) + 4.167^2(.275)^2}}{(1 + 1.7(3.4)(.275))}\right) = .84$$

$L/B = 67/271.3 = .24$ ∴ C_p leeward $= -.5$

Appendix C – Seismic Loads

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From geotechnical report $\begin{cases} S_s = 17.1\%g \\ S_1 \;\; 5.1\%g \end{cases}$

Site Class C based on geotechnical report

Using 11.4.3 $S_{MS} = F_a S_s = 1.2(.171) = .2052$

$S_{M1} = F_v S_1 = 1.7(.051) = .0867$

$S_{DS} = 2/3\, S_{MS} = 2/3(.2052) = .1368$

$S_{D1} = 2/3\, S_{M1} = 2/3(.0867) = .0578$

Importance = 1.0 based on II occupancy

Table 11.6-1 $S_{DS} = .1368 < .167$ ∴ Category A ✓

Table 11.6-2 $S_{D1} = .0578 < .067$ ∴ Category A ✓

To be more conservative & accurate will use equivalent lateral method

$V = C_s W$

$C_s = \frac{S_{DS}}{R/I} = \frac{.1368}{5/1} = .0273$

$C_s > .01$ ✓

R=5 from table 12.2-1 Ordinary reinforced concrete shear walls – Building frame systems

$C_u = 1.7$ b/c $S_{D1} = .0578 < .1$ table 12.8-1

$T_a = C_t h_n^x = .02(208.4)^{.75} = 1.1$ seconds table 12.8-2 All other struc systems

$C_w = \frac{100}{A_B} \sum_{i=1}^{x} \left(\frac{h_n}{h_i}\right)^2 \frac{A_i}{\left(1 + .83\left(\frac{h_i}{D_i}\right)^2\right)}$ Calculation available in spreadsheet upon request

$T_a = \frac{.0019}{\sqrt{C_w}} h_n = \frac{.0019}{\sqrt{.0035}} 208.4 = 1.7\text{ sec}$ N-S direction

∴ k = 1.6 through interp

$\frac{2.5-.5}{2-1} = \frac{1.7-.5}{x-1}$

$T_a = \frac{.0019}{\sqrt{.487}} 208.4 = .57\text{ sec}$ E-W direction

∴ k = 1.035 from interp

N-S direction controls

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Weight Calculation

Penthouse Roof
decking - 2 psf
Super imposed - 8 psf
membrane - 1 psf
roofing - 6 psf
insulation - 6 psf
23 psf X 3392 ft² = 78,026 lbs

High Roof-
Slab 9"/12' (150) = 112.5 psf
Superimposed = 8 psf
120.2 psf X 10,805 ft² = 1,298,761 lbs

Green Roof = 30 psf X (10,805 - 3392) = 222,390 lbs
toppings (4"/12')(150) = 50 psf X 461 ft² = 23,050 lbs

HSS col 4x4x1/4 - 12.21 lbs/ft X 15' = 183 lbs X 4 col = 733 lbs
HSS col 6x6x1/2 - 35.24 lbs/ft X 15' = 529 lbs

Floor 20-
Slab - 8"/12' (150) = 100 psf
Super imposed = 8 psf
108 psf X 10,805 ft² = 1,166,940 lbs

Columns - 30"/12' X 20"/12' X 10.33' X 150 pcf = 6,458 lbs X 10 = 64581 lbs
36"/12" X 30"/12' X 10.33' X 150 pcf = 11,625 lbs

Shear Wall #9 - 1' (22.17)(10.33') X 150 pcf = 34352 lbs
Shear Wall #10 - 8"/12' (9'6) (10.33') X 150 pcf = 9,816 lbs
#11 - = 9,816 lbs
#12 - 1' (11') (10.33) X 150 pcf = 17,044 lbs
#13 - 1' (16.7')(10.33') X 150 pcf = 25,877 lbs
#14 1' (12.25')(10.33')(150) = 18,981 lbs
#15 = 17,044 lbs
#16 1' (26.67')(10.33')(150) = 41,325 lbs
#18 1' (30.17)(10.33)(150) = 46,748 lbs
#19 = 46,748 lbs
#20 = 46,748 lbs
#21 1' (13.5')(10.33)(150) = 20,918 lbs
#22 1' (8')(10.33)(150) = 12,396 lbs

TOPS.

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Floor 19-18

Slab - 8"/12' (150) = 100 psf
SDL = 8 psf
108 psf × 10805 ft² = 1166940 lbs

Columns - used excel spread sheet 68,831 lbs
Same dim different length

Shear Walls used excel spreadsheet 314141 lbs

Floor 17-12

Slab - 100 psf
SDL - 8 psf
108 psf × 10,847 = 1171476 lbs

Col - Same H as Floor 18-19 68,831 lbs
Shear Walls " " 314,141 lbs

Floor 11

Slab & SDL = 108 psf × 10,619 = 1146852 lbs

Col = 68,831 lbs
Shear Wall = 314,141 lbs

Floor 10

Slab & SDL = 108 psf × 10,665 = 115 1820 lbs
Col = 68,831 lbs
Shear = 314,141 lbs

Floor 9

SLAB & SDL grid 9-18 = 108 psf × 10,665 = 1,151,820 lbs
Col = 68,831 lbs
Shear Wall = 314,141 lbs

Slab grid 7-8 = 10"/12' (15.67)(67)(150) = 131,236 lbs
Slab grid 1-7 = 10"/12' (92.33')(67')(150) = 773264 lbs
green roof - 30 psf × (26.3×43 + 14×423) = 86,538 lbs
Planter Areas - 50 psf × 300 ft² = 15,000 lbs
4" pads - 50 psf × 313 ft² = 15,650 lbs
HSS 4×4×1/4 12.21 lb/ft (9.33) = 114 lb × 2 = 228 lbs
6×6×1/2 35.24 lb/ft (9.33) = 329 lbs

Floor 8

Slab & SDL - 108 psf × 17,930 = 1936440 lbs
Col = 126574 lbs
Shear Walls = 580283 lbs

Floor 7-5

Slab & SDL - 108 psf × 17,930 = 1936440 lbs
Col = 114293 lbs
Shear Walls = 524108 lbs

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Floor 4-2 Slab + SDL = 108 psf (17,842) = 1926936 lbs
col = 114293 lbs
Shear walls = 524108 lbs

Floor 1 slab 5"/12" (150) = 62.5 psf
SDL = 8 psf
70.5 psf × 17068 ft² = 1203294 lbs

col = 171500 lbs
Shear walls = 786443 lbs

625 sq ft openings/floor × (8"/12" slab) × 150 lb/ft³ × 20 floors = 1460 Kips subtracted, 62.5 from each floor
roof: 625 × (9"/12") × 150 = 70 K from roof
} tall tower

Small tower openings in slab

219 sq ft openings/flr (8"/12") × 150 = 21.9 Kip subtracted from typ floors

219 × (9"/12") × 150 = 24.6 Kip subtracted from 9th floor,

Shear wall overlaps w/slab
150' × 12"/12" × (8"/12) × 150 = 15 K from typical floor

150 × 12"/12" (9"/12) × 150 = 16.9 K from 9th floor

Column overlaps w/slab
(30/12)(20/12)(8/12) × 150 × 5 col = 2
(36/12)(30/12)(8/12) × 150 × 1 col = 3.75
} 5.75 K from each floor

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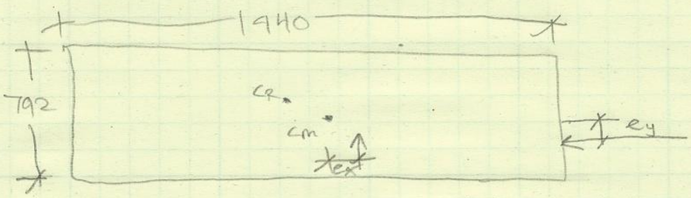
Accidental Torsion - 5% of dimension ⊥ to one being considered



e_y = .05(1940) = 97" below COM

e_x = .05(792) = 39.6" to right of COM

Appendix D – Center of Mass and Rigidity

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Because building is perfectly rectangular, safe to assume center of mass is centered.

$$C_{mx} = \frac{1940''}{2} = 970'' = 80'10''$$

$$C_{my} = \frac{792''}{2} = 396'' = 33'$$

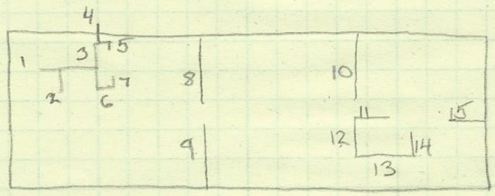
Center of Mass calculated through ETABS

$$X_{CCM} = 969.7 \approx 970'' \checkmark$$
$$Y_{CCM} = 396.3 \approx 396'' \checkmark$$

Calculating center of rigidity – Assume Fixed - Fixed condition

$K = P/\Delta$ - Assume unit load of 1

$$K = \frac{12EI}{h^3} + \frac{AG}{1.2h}$$ Flexural & Axial deformation



Sample calculation - Rest will be done in excel - see table

$$K_1 = \frac{12(5098)(20123648)}{(9.33\times12)^3} + \frac{3264(2124)}{1.2(9.33\times12)}$$
$$= 927845$$

$$E = 57{,}000\sqrt{f'_c}$$
$$= 57{,}000\sqrt{8000} = 5098$$

$$I = \frac{1}{12}bh^3 = \frac{1}{12}(12)(272)^3 = 20123648 \text{ in}^4$$

$$A = 272(12) = 3264 \text{ in}^2$$
$$G = \frac{E}{2(1+\nu)} = \frac{5098}{2(1+.2)} = 2124$$

Hand calculation $COR_x = 864.7$
$COR_y = 469.2$

ETABS $COR_x = 855.6$
$COR_y = 440.1$

relatively close to one another. Within 1' in x direction & 2.4' in y direction.

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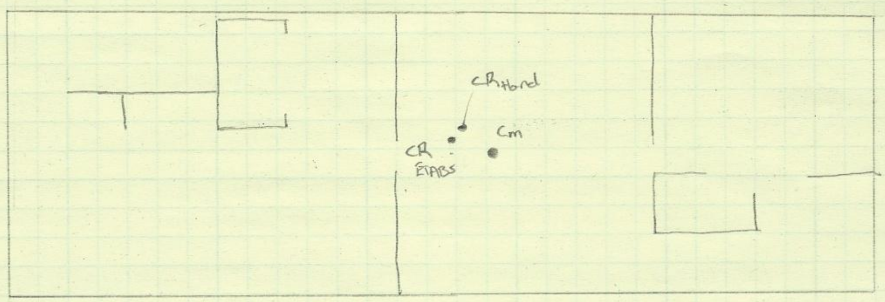

Appendix E – Load Distribution and Strength Check

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Story shear @ ground level due to controlling case - Earthquake N-S

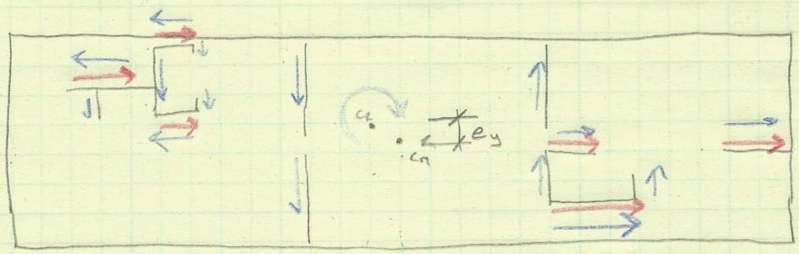
$V = 852$ Kips

$e_{incidental} = 440.1 - 396'' = 44.1'' = 3.7'$

direct shear - $V_i = \frac{R_i}{\Sigma R} \cdot V$ — R = relative stiffness

Torsional shear ; $V_i = \frac{V e d_i R_i}{J}$

J = Torsional Moment of inertia
$= \Sigma R_i d_i^2$



direct
Torsional

$e_y = 440.1 - 396 = 44.1''$

* These are the resisting shears.

Brad Oliver | AE 481 | Shear Wall Strength

$$\phi V_n = \phi A_v(\alpha_c \lambda \sqrt{f'_c} + \rho_t f_y) \qquad \phi = .75$$

$$\alpha_c = 2.0 \text{ for } h_w/L_w > 2.0$$
$$= 3.0 \text{ for } h_w/L_w < 1.5$$

$$h_w = \frac{2450"}{362} = 6.8 \therefore \alpha_c = 2.0 \text{ for all walls}$$

$\lambda = 1.0$ for normal weight concrete.

$$\rho_t = \frac{A_{v\,horiz}}{h s_h} \qquad \#6 @ 18" \qquad = \frac{.44}{12(18)} = .00204$$

$$A_v = \text{thickness} \cdot \text{length}$$

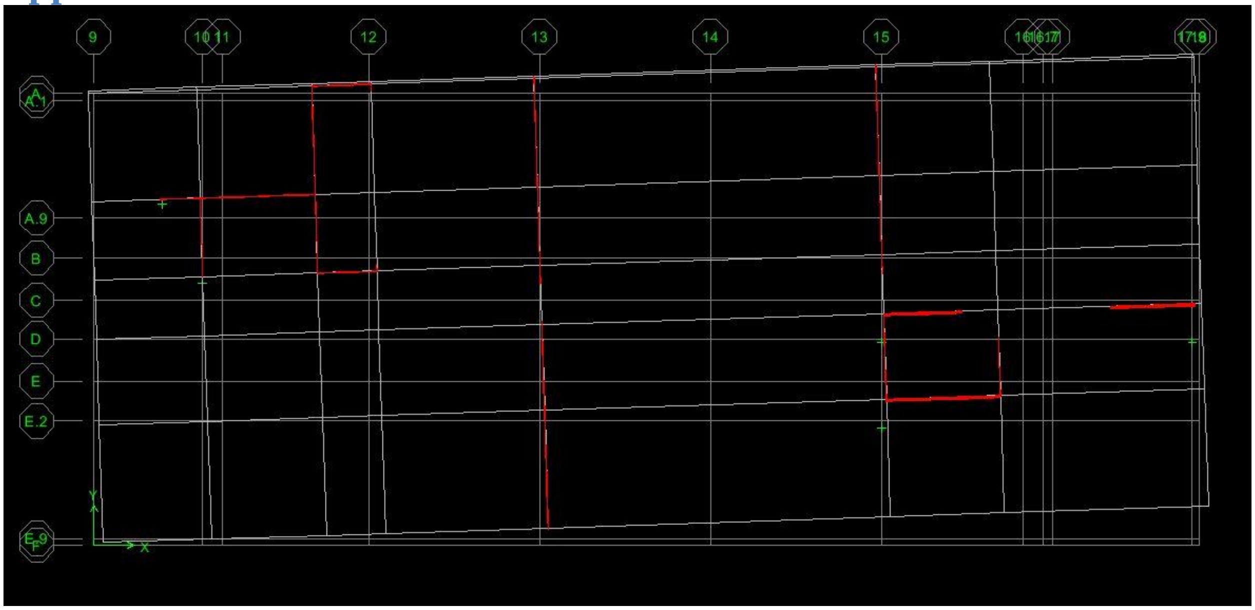
Sample calc for Shearwall 1

$$A_v = 12(272) = 3264 \text{ in}^2$$

$$\phi V_n = .75(3264)\left[2\sqrt{8000} + .00204(60000)\right]/1000$$
$$= 737.5 \text{ Kips}$$

TOPS.

Appendix F – Detailed Results



Sample Displacement of structure under Y EQ loading

Story	Point	Load	UX	UY	UZ	RX	RY	RZ
STORYROOF	1	WINDX	0.9980	-0.4699	0.1232	0.00029	0.00059	0.00062
STORYROOF	2	WINDX	0.9980	-0.3012	-0.0358	0.00018	0.00059	0.00062
STORYROOF	3	WINDX	1.0835	-0.4265	0.0461	0.00026	0.00064	0.00062
STORYROOF	6	WINDX	0.8802	-0.3012	-0.0007	0.00018	0.00051	0.00062
STORYROOF	7	WINDX	1.0835	-0.3012	-0.0609	0.00018	0.00064	0.00062
STORYROOF	8	WINDX	0.8802	-0.2368	-0.0542	0.00014	0.00051	0.00062
STORYROOF	9	WINDX	1.0835	-0.2368	-0.1273	0.00014	0.00064	0.00062
STORYROOF	14	WINDX	0.8777	-0.0594	0.0065	0.00004	0.00051	0.00062
STORYROOF	15	WINDX	1.1021	-0.0594	-0.0065	0.00004	0.00065	0.00062
STORYROOF	16	WINDX	1.3687	-0.0594	-0.0065	0.00004	0.00081	0.00062
STORYROOF	17	WINDX	1.1443	-0.0594	0.0065	0.00004	0.00068	0.00062
STORYROOF	18	WINDX	0.8777	0.3125	-0.0346	-0.00019	0.00051	0.00062
STORYROOF	19	WINDX	1.1021	0.3125	0.0346	-0.00019	0.00065	0.00062
STORYROOF	20	WINDX	1.1480	0.3125	0.0485	-0.00019	0.00068	0.00062
STORYROOF	25	WINDX	1.2410	0.3125	0.0773	-0.00019	0.00073	0.00062
STORYROOF	26	WINDX	1.2410	0.4365	-0.0695	-0.00027	0.00073	0.00062
STORYROOF	27	WINDX	1.1778	0.4365	-0.0967	-0.00027	0.00070	0.00062
STORYROOF	28	WINDX	1.1480	0.6510	-0.0499	-0.00040	0.00068	0.00062
STORYROOF	29	WINDX	1.1480	0.5599	0.0498	-0.00034	0.00068	0.00062
STORYROOF	31	WINDX	0.9980	-0.4265	0.0822	0.00026	0.00059	0.00062
STORYROOF	33	WINDX	1.1480	0.3981	-0.0452	-0.00024	0.00068	0.00062
STORYROOF	40	WINDX	1.0761	-0.2368	-0.1255	0.00014	0.00063	0.00062
STORYROOF	41	WINDX	0.8876	-0.2368	-0.0559	0.00014	0.00052	0.00062
STORYROOF	50	WINDX	1.3687	-0.5443	0.0965	-0.00004	0.00026	0.00062
STORYROOF	51	WINDX	1.3687	0.6585	-0.0394	0.00001	-0.00004	0.00062
STORYROOF	52	WINDX	0.8777	0.6585	-0.1793	-0.00023	0.00009	0.00062
STORYROOF	53	WINDX	0.8777	-0.5443	0.2472	0.00025	0.00064	0.00062

Max displacement values for Service Wind Loads X direction

Story	Point	Load	UX	UY
STORYROOF	18	SERVICEWINDY	-0.4870	2.4212
STORYROOF	19	SERVICEWINDY	0.0864	2.4212
STORYROOF	20	SERVICEWINDY	0.2037	2.4212
STORYROOF	25	SERVICEWINDY	0.4413	2.4212
STORYROOF	26	SERVICEWINDY	0.4413	2.7381
STORYROOF	27	SERVICEWINDY	0.2797	2.7381
STORYROOF	28	SERVICEWINDY	0.2037	3.2862
STORYROOF	29	SERVICEWINDY	0.2037	3.0533
STORYROOF	31	SERVICEWINDY	-0.1797	0.5329
STORYROOF	33	SERVICEWINDY	0.2037	2.6398
STORYROOF	40	SERVICEWINDY	0.0199	1.0176
STORYROOF	41	SERVICEWINDY	-0.4617	1.0176
STORYROOF	50	SERVICEWINDY	0.7676	0.2319
STORYROOF	51	SERVICEWINDY	0.7676	3.3052
STORYROOF	52	SERVICEWINDY	-0.4870	3.3052
STORYROOF	53	SERVICEWINDY	-0.4870	0.2319

Max displacement values for Service Wind Loads Y direction

Story	Point	Load	UX	UY	UZ	RX	RY	RZ
STORYROOF	1	75WINDY	-0.1297	0.2690	-0.0133	-0.00015	-0.00008	0.00120
STORYROOF	2	75WINDY	-0.1297	0.5956	0.0072	-0.00035	-0.00008	0.00120
STORYROOF	3	75WINDY	0.0360	0.3530	0.0203	-0.00021	0.00002	0.00120
STORYROOF	6	75WINDY	-0.3579	0.5956	-0.0593	-0.00035	-0.00021	0.00120
STORYROOF	7	75WINDY	0.0360	0.5956	0.0555	-0.00035	0.00002	0.00120
STORYROOF	8	75WINDY	-0.3579	0.7205	-0.0371	-0.00043	-0.00021	0.00120
STORYROOF	9	75WINDY	0.0360	0.7205	0.0530	-0.00043	0.00002	0.00120
STORYROOF	14	75WINDY	-0.3627	1.0640	-0.1142	-0.00063	-0.00020	0.00120
STORYROOF	15	75WINDY	0.0720	1.0640	0.1142	-0.00063	0.00004	0.00120
STORYROOF	16	75WINDY	0.5885	1.0640	0.1142	-0.00063	0.00033	0.00120
STORYROOF	17	75WINDY	0.1537	1.0640	-0.1142	-0.00063	0.00009	0.00120
STORYROOF	18	75WINDY	-0.3627	1.7846	-0.1924	-0.00106	-0.00020	0.00120
STORYROOF	19	75WINDY	0.0720	1.7846	0.1923	-0.00106	0.00004	0.00120
STORYROOF	20	75WINDY	0.1609	1.7846	-0.0747	-0.00106	0.00010	0.00120
STORYROOF	25	75WINDY	0.3411	1.7846	0.0846	-0.00106	0.00021	0.00120
STORYROOF	26	75WINDY	0.3411	2.0248	0.0431	-0.00121	0.00021	0.00120
STORYROOF	27	75WINDY	0.2185	2.0248	-0.0802	-0.00121	0.00012	0.00120
STORYROOF	28	75WINDY	0.1609	2.4403	-0.0073	-0.00136	0.00010	0.00120
STORYROOF	29	75WINDY	0.1609	2.2638	0.0073	-0.00125	0.00010	0.00120
STORYROOF	31	75WINDY	-0.1297	0.3530	-0.0080	-0.00021	-0.00008	0.00120
STORYROOF	33	75WINDY	0.1609	1.9503	-0.0882	-0.00109	0.00010	0.00120
STORYROOF	40	75WINDY	0.0216	0.7205	0.0479	-0.00043	0.00001	0.00120
STORYROOF	41	75WINDY	-0.3435	0.7205	-0.0320	-0.00043	-0.00020	0.00120
STORYROOF	50	75WINDY	0.5885	0.1248	0.1498	-0.00035	-0.00013	0.00120
STORYROOF	51	75WINDY	0.5885	2.4548	0.3598	-0.00100	-0.00028	0.00120
STORYROOF	52	75WINDY	-0.3627	2.4548	-0.3740	-0.00043	0.00054	0.00120
STORYROOF	53	75WINDY	-0.3627	0.1248	-0.0547	-0.00022	0.00005	0.00120

Max displacement values for Service Wind Loads case 2

Story	Point	Load	UX	UY	UZ	RX	RY	RZ
STORYROOF	1	75WINDXY	0.6221	-0.0995	0.0795	0.00007	0.00037	0.00169
STORYROOF	2	75WINDXY	0.6221	0.3603	-0.0197	-0.00021	0.00037	0.00169
STORYROOF	3	75WINDXY	0.8554	0.0189	0.0538	0.00000	0.00048	0.00169
STORYROOF	6	75WINDXY	0.3009	0.3603	-0.0587	-0.00021	0.00017	0.00169
STORYROOF	7	75WINDXY	0.8554	0.3603	0.0089	-0.00021	0.00051	0.00169
STORYROOF	8	75WINDXY	0.3009	0.5361	-0.0766	-0.00031	0.00017	0.00169
STORYROOF	9	75WINDXY	0.8554	0.5361	-0.0439	-0.00031	0.00051	0.00169
STORYROOF	14	75WINDXY	0.2942	1.0196	-0.1093	-0.00060	0.00015	0.00169
STORYROOF	15	75WINDXY	0.9061	1.0196	0.1093	-0.00060	0.00050	0.00169
STORYROOF	16	75WINDXY	1.6330	1.0196	0.1093	-0.00060	0.00091	0.00169
STORYROOF	17	75WINDXY	1.0211	1.0196	-0.1093	-0.00060	0.00056	0.00169
STORYROOF	18	75WINDXY	0.2942	2.0339	-0.2201	-0.00122	0.00015	0.00169
STORYROOF	19	75WINDXY	0.9061	2.0339	0.2201	-0.00122	0.00050	0.00169
STORYROOF	20	75WINDXY	1.0312	2.0339	-0.0385	-0.00122	0.00061	0.00169
STORYROOF	25	75WINDXY	1.2848	2.0339	0.1440	-0.00122	0.00077	0.00169
STORYROOF	26	75WINDXY	1.2848	2.3720	-0.0094	-0.00142	0.00077	0.00169
STORYROOF	27	75WINDXY	1.1123	2.3720	-0.1544	-0.00142	0.00062	0.00169
STORYROOF	28	75WINDXY	1.0312	2.9569	-0.0451	-0.00166	0.00061	0.00169
STORYROOF	29	75WINDXY	1.0312	2.7084	0.0451	-0.00151	0.00061	0.00169
STORYROOF	31	75WINDXY	0.6221	0.0189	0.0539	0.00000	0.00037	0.00169
STORYROOF	33	75WINDXY	1.0312	2.2672	-0.1231	-0.00127	0.00061	0.00169
STORYROOF	40	75WINDXY	0.8351	0.5361	-0.0476	-0.00031	0.00049	0.00169
STORYROOF	41	75WINDXY	0.3212	0.5361	-0.0729	-0.00031	0.00019	0.00169
STORYROOF	50	75WINDXY	1.6330	-0.3023	0.2157	-0.00037	0.00006	0.00169
STORYROOF	51	75WINDXY	1.6330	2.9772	0.3294	-0.00099	-0.00030	0.00169
STORYROOF	52	75WINDXY	0.2942	2.9772	-0.5048	-0.00059	0.00061	0.00169
STORYROOF	53	75WINDXY	0.2942	-0.3023	0.1308	-0.00003	0.00052	0.00169

Max displacement values for Service Wind Loads case 3

Story	Point	Load	UX	UY	UZ	RX	RY	RZ
STORYROOF	1	563WINDXY	0.4648	-0.7519	0.0607	0.00044	0.00028	0.00232
STORYROOF	2	563WINDXY	0.4648	-0.1203	-0.0147	0.00008	0.00028	0.00232
STORYROOF	3	563WINDXY	0.7852	-0.5894	-0.0081	0.00036	0.00044	0.00232
STORYROOF	6	563WINDXY	0.0236	-0.1203	-0.0002	0.00008	0.00001	0.00232
STORYROOF	7	563WINDXY	0.7852	-0.1203	-0.0250	0.00008	0.00047	0.00232
STORYROOF	8	563WINDXY	0.0236	0.1212	-0.0016	-0.00007	0.00001	0.00232
STORYROOF	9	563WINDXY	0.7852	0.1212	-0.0739	-0.00007	0.00047	0.00232
STORYROOF	14	563WINDXY	0.0143	0.7852	-0.0844	-0.00047	0.00000	0.00232
STORYROOF	15	563WINDXY	0.8549	0.7852	0.0844	-0.00047	0.00048	0.00232
STORYROOF	16	563WINDXY	1.8533	0.7852	0.0844	-0.00047	0.00104	0.00232
STORYROOF	17	563WINDXY	1.0128	0.7852	-0.0844	-0.00047	0.00056	0.00232
STORYROOF	18	563WINDXY	0.0143	2.1784	-0.2355	-0.00130	0.00000	0.00232
STORYROOF	19	563WINDXY	0.8549	2.1784	0.2355	-0.00130	0.00048	0.00232
STORYROOF	20	563WINDXY	1.0267	2.1784	-0.0410	-0.00130	0.00061	0.00232
STORYROOF	25	563WINDXY	1.3750	2.1784	0.1542	-0.00130	0.00082	0.00232
STORYROOF	26	563WINDXY	1.3750	2.6428	-0.0105	-0.00158	0.00082	0.00232
STORYROOF	27	563WINDXY	1.1382	2.6428	-0.1717	-0.00158	0.00064	0.00232
STORYROOF	28	563WINDXY	1.0267	3.4462	-0.0452	-0.00193	0.00062	0.00232
STORYROOF	29	563WINDXY	1.0267	3.1049	0.0452	-0.00172	0.00062	0.00232
STORYROOF	31	563WINDXY	0.4648	-0.5894	0.0413	0.00036	0.00028	0.00232
STORYROOF	33	563WINDXY	1.0267	2.4989	-0.1258	-0.00139	0.00062	0.00232
STORYROOF	40	563WINDXY	0.7574	0.1212	-0.0747	-0.00007	0.00045	0.00232
STORYROOF	41	563WINDXY	0.0515	0.1212	-0.0008	-0.00007	0.00003	0.00232
STORYROOF	50	563WINDXY	1.8533	-1.0306	0.0242	-0.00021	-0.00016	0.00232
STORYROOF	51	563WINDXY	1.8533	3.4741	0.3764	-0.00110	-0.00036	0.00232
STORYROOF	52	563WINDXY	0.0143	3.4741	-0.5395	-0.00059	0.00071	0.00232
STORYROOF	53	563WINDXY	0.0143	-1.0306	0.1715	0.00031	0.00048	0.00232

Max displacement values for Service Wind Loads case 4

Story	Point	Load	UX	UY	UZ	RX	RY	RZ
STORYROOF	1	QUAKEX	5.6867	-2.6874	0.7192	0.00167	0.00343	0.00354
STORYROOF	2	QUAKEX	5.6867	-1.7233	-0.2089	0.00107	0.00342	0.00354
STORYROOF	3	QUAKEX	6.1758	-2.4393	0.2691	0.00152	0.00373	0.00354
STORYROOF	6	QUAKEX	5.0132	-1.7233	-0.0043	0.00107	0.00300	0.00354
STORYROOF	7	QUAKEX	6.1758	-1.7233	-0.3556	0.00107	0.00373	0.00354
STORYROOF	8	QUAKEX	5.0132	-1.3547	-0.3167	0.00084	0.00300	0.00354
STORYROOF	9	QUAKEX	6.1758	-1.3547	-0.7431	0.00084	0.00373	0.00354
STORYROOF	14	QUAKEX	4.9991	-0.3410	0.0382	0.00021	0.00300	0.00354
STORYROOF	15	QUAKEX	6.2821	-0.3410	-0.0382	0.00021	0.00380	0.00354
STORYROOF	16	QUAKEX	7.8063	-0.3410	-0.0382	0.00021	0.00475	0.00354
STORYROOF	17	QUAKEX	6.5232	-0.3410	0.0382	0.00021	0.00395	0.00354
STORYROOF	18	QUAKEX	4.9991	1.7857	-0.2015	-0.00112	0.00300	0.00354
STORYROOF	19	QUAKEX	6.2821	1.7857	0.2015	-0.00112	0.00380	0.00354
STORYROOF	20	QUAKEX	6.5444	1.7857	0.2819	-0.00112	0.00396	0.00354
STORYROOF	25	QUAKEX	7.0761	1.7857	0.4500	-0.00112	0.00429	0.00354
STORYROOF	26	QUAKEX	7.0761	2.4946	-0.4072	-0.00156	0.00429	0.00354
STORYROOF	27	QUAKEX	6.7146	2.4946	-0.5658	-0.00156	0.00407	0.00354
STORYROOF	28	QUAKEX	6.5444	3.7210	-0.2911	-0.00232	0.00396	0.00354
STORYROOF	29	QUAKEX	6.5444	3.1999	0.2911	-0.00200	0.00396	0.00354
STORYROOF	31	QUAKEX	5.6867	-2.4393	0.4796	0.00152	0.00342	0.00354
STORYROOF	33	QUAKEX	6.5444	2.2748	-0.2649	-0.00142	0.00396	0.00354
STORYROOF	40	QUAKEX	6.1333	-1.3547	-0.7329	0.00084	0.00370	0.00354
STORYROOF	41	QUAKEX	5.0558	-1.3547	-0.3269	0.00084	0.00303	0.00354
STORYROOF	50	QUAKEX	7.8063	-3.1127	0.5633	-0.00026	0.00152	0.00354
STORYROOF	51	QUAKEX	7.8063	3.7635	-0.2307	0.00009	-0.00022	0.00354
STORYROOF	52	QUAKEX	4.9991	3.7635	-1.0462	-0.00135	0.00054	0.00354
STORYROOF	53	QUAKEX	4.9991	-3.1127	1.4431	0.00146	0.00372	0.00354

Max displacement values for Service Eq in the X direction

Story	Point	Load	UX	UY	UZ	RX	RY	RZ
STORYROOF	1	QUAKEY	-0.3724	0.8786	-0.0389	-0.00052	-0.00022	0.00329
STORYROOF	2	QUAKEY	-0.3724	1.7723	0.0210	-0.00106	-0.00022	0.00329
STORYROOF	3	QUAKEY	0.0810	1.1086	0.0679	-0.00066	0.00005	0.00329
STORYROOF	6	QUAKEY	-0.9966	1.7723	-0.1803	-0.00106	-0.00060	0.00329
STORYROOF	7	QUAKEY	0.0810	1.7723	0.1673	-0.00106	0.00005	0.00329
STORYROOF	8	QUAKEY	-0.9966	2.1140	-0.1182	-0.00127	-0.00060	0.00329
STORYROOF	9	QUAKEY	0.0810	2.1140	0.1615	-0.00127	0.00005	0.00329
STORYROOF	14	QUAKEY	-1.0098	3.0537	-0.3318	-0.00183	-0.00060	0.00329
STORYROOF	15	QUAKEY	0.1796	3.0537	0.3318	-0.00183	0.00011	0.00329
STORYROOF	16	QUAKEY	1.5924	3.0537	0.3318	-0.00183	0.00096	0.00329
STORYROOF	17	QUAKEY	0.4030	3.0537	-0.3318	-0.00183	0.00025	0.00329
STORYROOF	18	QUAKEY	-1.0098	5.0250	-0.5466	-0.00302	-0.00060	0.00329
STORYROOF	19	QUAKEY	0.1796	5.0250	0.5466	-0.00302	0.00011	0.00329
STORYROOF	20	QUAKEY	0.4227	5.0250	-0.2151	-0.00302	0.00026	0.00329
STORYROOF	25	QUAKEY	0.9155	5.0250	0.2377	-0.00302	0.00056	0.00329
STORYROOF	26	QUAKEY	0.9155	5.6821	0.1257	-0.00342	0.00056	0.00329
STORYROOF	27	QUAKEY	0.5804	5.6821	-0.2230	-0.00342	0.00036	0.00329
STORYROOF	28	QUAKEY	0.4227	6.8189	-0.0191	-0.00410	0.00026	0.00329
STORYROOF	29	QUAKEY	0.4227	6.3359	0.0191	-0.00381	0.00026	0.00329
STORYROOF	31	QUAKEY	-0.3724	1.1086	-0.0235	-0.00066	-0.00022	0.00329
STORYROOF	33	QUAKEY	0.4227	5.4784	-0.2506	-0.00330	0.00026	0.00329
STORYROOF	40	QUAKEY	0.0416	2.1140	0.1463	-0.00127	0.00003	0.00329
STORYROOF	41	QUAKEY	-0.9572	2.1140	-0.1030	-0.00127	-0.00057	0.00329
STORYROOF	50	QUAKEY	1.5924	0.4844	0.4656	-0.00104	-0.00034	0.00329
STORYROOF	51	QUAKEY	1.5924	6.8583	1.0724	-0.00289	-0.00092	0.00329
STORYROOF	52	QUAKEY	-1.0098	6.8583	-1.1147	-0.00127	0.00164	0.00329
STORYROOF	53	QUAKEY	-1.0098	0.4844	-0.1763	-0.00071	0.00011	0.00329

Max displacement values for Service Eq in the Y direction

Story	Item	Load	Point	X	Y	Z	DriftX	DriftY
STORYROOF	Max Drift X	SERVICEWINDY	51	1940.000	0.000	2319.000	0.000457	
STORYROOF	Max Drift Y	SERVICEWINDY	52	1940.000	792.000	2319.000		0.001952
STORY20	Max Drift X	SERVICEWINDY	51	1940.000	0.000	2195.000	0.000456	
STORY20	Max Drift Y	SERVICEWINDY	52	1940.000	792.000	2195.000		0.001951
STORY19	Max Drift X	SERVICEWINDY	51	1940.000	0.000	2083.000	0.000455	
STORY19	Max Drift Y	SERVICEWINDY	52	1940.000	792.000	2083.000		0.001946
STORY18	Max Drift X	SERVICEWINDY	51	1940.000	0.000	1971.000	0.000452	
STORY18	Max Drift Y	SERVICEWINDY	52	1940.000	792.000	1971.000		0.001936
STORY17	Max Drift X	SERVICEWINDY	51	1940.000	0.000	1859.000	0.000448	
STORY17	Max Drift Y	SERVICEWINDY	52	1940.000	792.000	1859.000		0.001919
STORY16	Max Drift X	SERVICEWINDY	51	1940.000	0.000	1747.000	0.000442	
STORY16	Max Drift Y	SERVICEWINDY	52	1940.000	792.000	1747.000		0.001894
STORY15	Max Drift X	SERVICEWINDY	51	1940.000	0.000	1635.000	0.000434	
STORY15	Max Drift Y	SERVICEWINDY	52	1940.000	792.000	1635.000		0.001858
STORY14	Max Drift X	SERVICEWINDY	51	1940.000	0.000	1523.000	0.000423	
STORY14	Max Drift Y	SERVICEWINDY	52	1940.000	792.000	1523.000		0.001813
STORY13	Max Drift X	SERVICEWINDY	51	1940.000	0.000	1411.000	0.000411	
STORY13	Max Drift Y	SERVICEWINDY	52	1940.000	792.000	1411.000		0.001763
STORY12	Max Drift X	SERVICEWINDY	51	1940.000	0.000	1299.000	0.000396	
STORY12	Max Drift Y	SERVICEWINDY	52	1940.000	792.000	1299.000		0.001701
STORY11	Max Drift X	SERVICEWINDY	51	1940.000	0.000	1187.000	0.000378	
STORY11	Max Drift Y	SERVICEWINDY	52	1940.000	792.000	1187.000		0.001626
STORY10	Max Drift X	SERVICEWINDY	51	1940.000	0.000	1075.000	0.000357	
STORY10	Max Drift Y	SERVICEWINDY	52	1940.000	792.000	1075.000		0.001537
STORY9	Max Drift X	SERVICEWINDY	51	1940.000	0.000	963.000	0.000330	
STORY9	Max Drift Y	SERVICEWINDY	52	1940.000	792.000	963.000		0.001426
STORY8	Max Drift X	SERVICEWINDY	51	1940.000	0.000	840.000	0.000299	
STORY8	Max Drift Y	SERVICEWINDY	52	1940.000	792.000	840.000		0.001297
STORY7	Max Drift X	SERVICEWINDY	51	1940.000	0.000	728.000	0.000267	
STORY7	Max Drift Y	SERVICEWINDY	52	1940.000	792.000	728.000		0.001163
STORY6	Max Drift X	SERVICEWINDY	51	1940.000	0.000	616.000	0.000235	
STORY6	Max Drift Y	SERVICEWINDY	52	1940.000	792.000	616.000		0.001024
STORY5	Max Drift X	SERVICEWINDY	51	1940.000	0.000	504.000	0.000198	
STORY5	Max Drift Y	SERVICEWINDY	52	1940.000	792.000	504.000		0.000866
STORY4	Max Drift X	SERVICEWINDY	51	1940.000	0.000	392.000	0.000157	
STORY4	Max Drift Y	SERVICEWINDY	52	1940.000	792.000	392.000		0.000688
STORY3	Max Drift X	SERVICEWINDY	51	1940.000	0.000	280.000	0.000110	
STORY3	Max Drift Y	SERVICEWINDY	52	1940.000	792.000	280.000		0.000489
STORY2	Max Drift X	SERVICEWINDY	51	1940.000	0.000	168.000	0.000045	
STORY2	Max Drift Y	SERVICEWINDY	52	1940.000	792.000	168.000		0.000208

Max Story Drift Values for Service Wind Values X Direction

Story	Item	Load	Point	X	Y	Z	DriftX	DriftY
STORYROOF	Max Drift X	WINDX	51	1940.000	0.000	2319.000	0.000813	
STORYROOF	Max Drift Y	WINDX	52	1940.000	792.000	2319.000		0.000403
STORY20	Max Drift X	WINDX	51	1940.000	0.000	2195.000	0.000813	
STORY20	Max Drift Y	WINDX	52	1940.000	792.000	2195.000		0.000402
STORY19	Max Drift X	WINDX	51	1940.000	0.000	2083.000	0.000812	
STORY19	Max Drift Y	WINDX	52	1940.000	792.000	2083.000		0.000401
STORY18	Max Drift X	WINDX	51	1940.000	0.000	1971.000	0.000808	
STORY18	Max Drift Y	WINDX	52	1940.000	792.000	1971.000		0.000398
STORY17	Max Drift X	WINDX	51	1940.000	0.000	1859.000	0.000801	
STORY17	Max Drift Y	WINDX	52	1940.000	792.000	1859.000		0.000394
STORY16	Max Drift X	WINDX	51	1940.000	0.000	1747.000	0.000790	
STORY16	Max Drift Y	WINDX	52	1940.000	792.000	1747.000		0.000388
STORY15	Max Drift X	WINDX	51	1940.000	0.000	1635.000	0.000774	
STORY15	Max Drift Y	WINDX	52	1940.000	792.000	1635.000		0.000379
STORY14	Max Drift X	WINDX	51	1940.000	0.000	1523.000	0.000754	
STORY14	Max Drift Y	WINDX	51	1940.000	0.000	1523.000		0.000369
STORY13	Max Drift X	WINDX	51	1940.000	0.000	1411.000	0.000732	
STORY13	Max Drift Y	WINDX	52	1940.000	792.000	1411.000		0.000358
STORY12	Max Drift X	WINDX	51	1940.000	0.000	1299.000	0.000705	
STORY12	Max Drift Y	WINDX	52	1940.000	792.000	1299.000		0.000344
STORY11	Max Drift X	WINDX	51	1940.000	0.000	1187.000	0.000673	
STORY11	Max Drift Y	WINDX	52	1940.000	792.000	1187.000		0.000326
STORY10	Max Drift X	WINDX	51	1940.000	0.000	1075.000	0.000633	
STORY10	Max Drift Y	WINDX	51	1940.000	0.000	1075.000		0.000306
STORY9	Max Drift X	WINDX	51	1940.000	0.000	963.000	0.000585	
STORY9	Max Drift Y	WINDX	52	1940.000	792.000	963.000		0.000280
STORY8	Max Drift X	WINDX	51	1940.000	0.000	840.000	0.000529	
STORY8	Max Drift Y	WINDX	52	1940.000	792.000	840.000		0.000251
STORY7	Max Drift X	WINDX	51	1940.000	0.000	728.000	0.000472	
STORY7	Max Drift Y	WINDX	51	1940.000	0.000	728.000		0.000219
STORY6	Max Drift X	WINDX	51	1940.000	0.000	616.000	0.000415	
STORY6	Max Drift Y	WINDX	52	1940.000	792.000	616.000		0.000187
STORY5	Max Drift X	WINDX	51	1940.000	0.000	504.000	0.000352	
STORY5	Max Drift Y	WINDX	52	1940.000	792.000	504.000		0.000155
STORY4	Max Drift X	WINDX	51	1940.000	0.000	392.000	0.000281	
STORY4	Max Drift Y	WINDX	52	1940.000	792.000	392.000		0.000120
STORY3	Max Drift X	WINDX	51	1940.000	0.000	280.000	0.000201	
STORY3	Max Drift Y	WINDX	52	1940.000	792.000	280.000		0.000082
STORY2	Max Drift X	WINDX	51	1940.000	0.000	168.000	0.000088	
STORY2	Max Drift Y	WINDX	52	1940.000	792.000	168.000		0.000032

Max Story Drift Values for Service Wind Values Y Direction

Story	Item	Load	Point	X	Y	Z	DriftX	DriftY
STORYROOF	Max Drift X	75WINDXY	51	1940.000	0.000	2319.000	0.000977	
STORYROOF	Max Drift Y	75WINDXY	52	1940.000	792.000	2319.000		0.001787
STORY20	Max Drift X	75WINDXY	51	1940.000	0.000	2195.000	0.000977	
STORY20	Max Drift Y	75WINDXY	52	1940.000	792.000	2195.000		0.001786
STORY19	Max Drift X	75WINDXY	51	1940.000	0.000	2083.000	0.000974	
STORY19	Max Drift Y	75WINDXY	52	1940.000	792.000	2083.000		0.001781
STORY18	Max Drift X	75WINDXY	51	1940.000	0.000	1971.000	0.000969	
STORY18	Max Drift Y	75WINDXY	52	1940.000	792.000	1971.000		0.001770
STORY17	Max Drift X	75WINDXY	51	1940.000	0.000	1859.000	0.000960	
STORY17	Max Drift Y	75WINDXY	52	1940.000	792.000	1859.000		0.001753
STORY16	Max Drift X	75WINDXY	51	1940.000	0.000	1747.000	0.000946	
STORY16	Max Drift Y	75WINDXY	52	1940.000	792.000	1747.000		0.001727
STORY15	Max Drift X	75WINDXY	51	1940.000	0.000	1635.000	0.000926	
STORY15	Max Drift Y	75WINDXY	52	1940.000	792.000	1635.000		0.001691
STORY14	Max Drift X	75WINDXY	51	1940.000	0.000	1523.000	0.000902	
STORY14	Max Drift Y	75WINDXY	52	1940.000	792.000	1523.000		0.001647
STORY13	Max Drift X	75WINDXY	51	1940.000	0.000	1411.000	0.000875	
STORY13	Max Drift Y	75WINDXY	52	1940.000	792.000	1411.000		0.001599
STORY12	Max Drift X	75WINDXY	51	1940.000	0.000	1299.000	0.000842	
STORY12	Max Drift Y	75WINDXY	52	1940.000	792.000	1299.000		0.001539
STORY11	Max Drift X	75WINDXY	51	1940.000	0.000	1187.000	0.000802	
STORY11	Max Drift Y	75WINDXY	52	1940.000	792.000	1187.000		0.001466
STORY10	Max Drift X	75WINDXY	51	1940.000	0.000	1075.000	0.000755	
STORY10	Max Drift Y	75WINDXY	52	1940.000	792.000	1075.000		0.001380
STORY9	Max Drift X	75WINDXY	51	1940.000	0.000	963.000	0.000696	
STORY9	Max Drift Y	75WINDXY	52	1940.000	792.000	963.000		0.001274
STORY8	Max Drift X	75WINDXY	51	1940.000	0.000	840.000	0.000628	
STORY8	Max Drift Y	75WINDXY	52	1940.000	792.000	840.000		0.001149
STORY7	Max Drift X	75WINDXY	51	1940.000	0.000	728.000	0.000560	
STORY7	Max Drift Y	75WINDXY	52	1940.000	792.000	728.000		0.001021
STORY6	Max Drift X	75WINDXY	51	1940.000	0.000	616.000	0.000491	
STORY6	Max Drift Y	75WINDXY	52	1940.000	792.000	616.000		0.000891
STORY5	Max Drift X	75WINDXY	51	1940.000	0.000	504.000	0.000415	
STORY5	Max Drift Y	75WINDXY	52	1940.000	792.000	504.000		0.000747
STORY4	Max Drift X	75WINDXY	51	1940.000	0.000	392.000	0.000329	
STORY4	Max Drift Y	75WINDXY	52	1940.000	792.000	392.000		0.000588
STORY3	Max Drift X	75WINDXY	51	1940.000	0.000	280.000	0.000234	
STORY3	Max Drift Y	75WINDXY	52	1940.000	792.000	280.000		0.000413
STORY2	Max Drift X	75WINDXY	51	1940.000	0.000	168.000	0.000099	
STORY2	Max Drift Y	75WINDXY	52	1940.000	792.000	168.000		0.000171

Max Story Drift Values for Service Wind Case 2

Story	Item	Load	Point	X	Y	Z	DriftX	DriftY
STORYROOF	Max Drift X	75WINDY	51	1940.000	0.000	2319.000	0.000355	
STORYROOF	Max Drift Y	75WINDY	52	1940.000	792.000	2319.000		0.001466
STORY20	Max Drift X	75WINDY	51	1940.000	0.000	2195.000	0.000355	
STORY20	Max Drift Y	75WINDY	52	1940.000	792.000	2195.000		0.001465
STORY19	Max Drift X	75WINDY	51	1940.000	0.000	2083.000	0.000354	
STORY19	Max Drift Y	75WINDY	52	1940.000	792.000	2083.000		0.001461
STORY18	Max Drift X	75WINDY	51	1940.000	0.000	1971.000	0.000351	
STORY18	Max Drift Y	75WINDY	52	1940.000	792.000	1971.000		0.001453
STORY17	Max Drift X	75WINDY	51	1940.000	0.000	1859.000	0.000348	
STORY17	Max Drift Y	75WINDY	52	1940.000	792.000	1859.000		0.001439
STORY16	Max Drift X	75WINDY	51	1940.000	0.000	1747.000	0.000342	
STORY16	Max Drift Y	75WINDY	52	1940.000	792.000	1747.000		0.001418
STORY15	Max Drift X	75WINDY	51	1940.000	0.000	1635.000	0.000335	
STORY15	Max Drift Y	75WINDY	52	1940.000	792.000	1635.000		0.001390
STORY14	Max Drift X	75WINDY	51	1940.000	0.000	1523.000	0.000326	
STORY14	Max Drift Y	75WINDY	52	1940.000	792.000	1523.000		0.001354
STORY13	Max Drift X	75WINDY	51	1940.000	0.000	1411.000	0.000316	
STORY13	Max Drift Y	75WINDY	52	1940.000	792.000	1411.000		0.001315
STORY12	Max Drift X	75WINDY	51	1940.000	0.000	1299.000	0.000304	
STORY12	Max Drift Y	75WINDY	52	1940.000	792.000	1299.000		0.001267
STORY11	Max Drift X	75WINDY	51	1940.000	0.000	1187.000	0.000289	
STORY11	Max Drift Y	75WINDY	52	1940.000	792.000	1187.000		0.001208
STORY10	Max Drift X	75WINDY	51	1940.000	0.000	1075.000	0.000272	
STORY10	Max Drift Y	75WINDY	52	1940.000	792.000	1075.000		0.001138
STORY9	Max Drift X	75WINDY	51	1940.000	0.000	963.000	0.000250	
STORY9	Max Drift Y	75WINDY	52	1940.000	792.000	963.000		0.001052
STORY8	Max Drift X	75WINDY	51	1940.000	0.000	840.000	0.000225	
STORY8	Max Drift Y	75WINDY	52	1940.000	792.000	840.000		0.000952
STORY7	Max Drift X	75WINDY	51	1940.000	0.000	728.000	0.000200	
STORY7	Max Drift Y	75WINDY	52	1940.000	792.000	728.000		0.000849
STORY6	Max Drift X	75WINDY	51	1940.000	0.000	616.000	0.000175	
STORY6	Max Drift Y	75WINDY	52	1940.000	792.000	616.000		0.000744
STORY5	Max Drift X	75WINDY	51	1940.000	0.000	504.000	0.000147	
STORY5	Max Drift Y	75WINDY	52	1940.000	792.000	504.000		0.000625
STORY4	Max Drift X	75WINDY	51	1940.000	0.000	392.000	0.000115	
STORY4	Max Drift Y	75WINDY	52	1940.000	792.000	392.000		0.000494
STORY3	Max Drift X	75WINDY	51	1940.000	0.000	280.000	0.000081	
STORY3	Max Drift Y	75WINDY	52	1940.000	792.000	280.000		0.000349
STORY2	Max Drift X	75WINDY	51	1940.000	0.000	168.000	0.000033	
STORY2	Max Drift Y	75WINDY	52	1940.000	792.000	168.000		0.000146

Max Story Drift Values for Service Wind Case 3

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Story	Item	Load	Point	X	Y	Z	DriftX	DriftY
STORYROOF	Max Drift X	ECCQUAKEY	51	1940.000	0.000	2319.000	0.001275	
STORYROOF	Max Drift Y	ECCQUAKEY	52	1940.000	792.000	2319.000		0.004736
STORY20	Max Drift X	ECCQUAKEY	51	1940.000	0.000	2195.000	0.001273	
STORY20	Max Drift Y	ECCQUAKEY	52	1940.000	792.000	2195.000		0.004735
STORY19	Max Drift X	ECCQUAKEY	51	1940.000	0.000	2083.000	0.001269	
STORY19	Max Drift Y	ECCQUAKEY	52	1940.000	792.000	2083.000		0.004723
STORY18	Max Drift X	ECCQUAKEY	51	1940.000	0.000	1971.000	0.001261	
STORY18	Max Drift Y	ECCQUAKEY	52	1940.000	792.000	1971.000		0.004695
STORY17	Max Drift X	ECCQUAKEY	51	1940.000	0.000	1859.000	0.001247	
STORY17	Max Drift Y	ECCQUAKEY	52	1940.000	792.000	1859.000		0.004649
STORY16	Max Drift X	ECCQUAKEY	51	1940.000	0.000	1747.000	0.001227	
STORY16	Max Drift Y	ECCQUAKEY	52	1940.000	792.000	1747.000		0.004578
STORY15	Max Drift X	ECCQUAKEY	51	1940.000	0.000	1635.000	0.001199	
STORY15	Max Drift Y	ECCQUAKEY	52	1940.000	792.000	1635.000		0.004479
STORY14	Max Drift X	ECCQUAKEY	51	1940.000	0.000	1523.000	0.001165	
STORY14	Max Drift Y	ECCQUAKEY	52	1940.000	792.000	1523.000		0.004356
STORY13	Max Drift X	ECCQUAKEY	51	1940.000	0.000	1411.000	0.001127	
STORY13	Max Drift Y	ECCQUAKEY	52	1940.000	792.000	1411.000		0.004220
STORY12	Max Drift X	ECCQUAKEY	51	1940.000	0.000	1299.000	0.001081	
STORY12	Max Drift Y	ECCQUAKEY	52	1940.000	792.000	1299.000		0.004054
STORY11	Max Drift X	ECCQUAKEY	51	1940.000	0.000	1187.000	0.001026	
STORY11	Max Drift Y	ECCQUAKEY	52	1940.000	792.000	1187.000		0.003854
STORY10	Max Drift X	ECCQUAKEY	51	1940.000	0.000	1075.000	0.000960	
STORY10	Max Drift Y	ECCQUAKEY	52	1940.000	792.000	1075.000		0.003618
STORY9	Max Drift X	ECCQUAKEY	51	1940.000	0.000	963.000	0.000880	
STORY9	Max Drift Y	ECCQUAKEY	52	1940.000	792.000	963.000		0.003329
STORY8	Max Drift X	ECCQUAKEY	51	1940.000	0.000	840.000	0.000788	
STORY8	Max Drift Y	ECCQUAKEY	52	1940.000	792.000	840.000		0.002995
STORY7	Max Drift X	ECCQUAKEY	51	1940.000	0.000	728.000	0.000698	
STORY7	Max Drift Y	ECCQUAKEY	52	1940.000	792.000	728.000		0.002658
STORY6	Max Drift X	ECCQUAKEY	51	1940.000	0.000	616.000	0.000607	
STORY6	Max Drift Y	ECCQUAKEY	52	1940.000	792.000	616.000		0.002318
STORY5	Max Drift X	ECCQUAKEY	51	1940.000	0.000	504.000	0.000507	
STORY5	Max Drift Y	ECCQUAKEY	52	1940.000	792.000	504.000		0.001940
STORY4	Max Drift X	ECCQUAKEY	51	1940.000	0.000	392.000	0.000397	
STORY4	Max Drift Y	ECCQUAKEY	52	1940.000	792.000	392.000		0.001524
STORY3	Max Drift X	ECCQUAKEY	51	1940.000	0.000	280.000	0.000276	
STORY3	Max Drift Y	ECCQUAKEY	52	1940.000	792.000	280.000		0.001069
STORY2	Max Drift X	ECCQUAKEY	51	1940.000	0.000	168.000	0.000111	
STORY2	Max Drift Y	ECCQUAKEY	52	1940.000	792.000	168.000		0.000441

Max Story Drift Values for EQ in the Y Direction

Story	Item	Load	Point	X	Y	Z	DriftX	DriftY
STORYROOF	Max Drift X	ECCQUAKEX	51	1940.000	0.000	2319.000	0.005505	
STORYROOF	Max Drift Y	ECCQUAKEX	52	1940.000	792.000	2319.000		0.003798
STORY20	Max Drift X	ECCQUAKEX	51	1940.000	0.000	2195.000	0.005507	
STORY20	Max Drift Y	ECCQUAKEX	52	1940.000	792.000	2195.000		0.003793
STORY19	Max Drift X	ECCQUAKEX	51	1940.000	0.000	2083.000	0.005496	
STORY19	Max Drift Y	ECCQUAKEX	52	1940.000	792.000	2083.000		0.003778
STORY18	Max Drift X	ECCQUAKEX	51	1940.000	0.000	1971.000	0.005465	
STORY18	Max Drift Y	ECCQUAKEX	52	1940.000	792.000	1971.000		0.003750
STORY17	Max Drift X	ECCQUAKEX	51	1940.000	0.000	1859.000	0.005407	
STORY17	Max Drift Y	ECCQUAKEX	51	1940.000	0.000	1859.000		0.003704
STORY16	Max Drift X	ECCQUAKEX	51	1940.000	0.000	1747.000	0.005319	
STORY16	Max Drift Y	ECCQUAKEX	52	1940.000	792.000	1747.000		0.003637
STORY15	Max Drift X	ECCQUAKEX	51	1940.000	0.000	1635.000	0.005193	
STORY15	Max Drift Y	ECCQUAKEX	52	1940.000	792.000	1635.000		0.003547
STORY14	Max Drift X	ECCQUAKEX	51	1940.000	0.000	1523.000	0.005036	
STORY14	Max Drift Y	ECCQUAKEX	52	1940.000	792.000	1523.000		0.003439
STORY13	Max Drift X	ECCQUAKEX	51	1940.000	0.000	1411.000	0.004867	
STORY13	Max Drift Y	ECCQUAKEX	52	1940.000	792.000	1411.000		0.003319
STORY12	Max Drift X	ECCQUAKEX	51	1940.000	0.000	1299.000	0.004662	
STORY12	Max Drift Y	ECCQUAKEX	52	1940.000	792.000	1299.000		0.003173
STORY11	Max Drift X	ECCQUAKEX	51	1940.000	0.000	1187.000	0.004416	
STORY11	Max Drift Y	ECCQUAKEX	51	1940.000	0.000	1187.000		0.002999
STORY10	Max Drift X	ECCQUAKEX	51	1940.000	0.000	1075.000	0.004129	
STORY10	Max Drift Y	ECCQUAKEX	52	1940.000	792.000	1075.000		0.002795
STORY9	Max Drift X	ECCQUAKEX	51	1940.000	0.000	963.000	0.003780	
STORY9	Max Drift Y	ECCQUAKEX	52	1940.000	792.000	963.000		0.002549
STORY8	Max Drift X	ECCQUAKEX	51	1940.000	0.000	840.000	0.003382	
STORY8	Max Drift Y	ECCQUAKEX	51	1940.000	0.000	840.000		0.002267
STORY7	Max Drift X	ECCQUAKEX	51	1940.000	0.000	728.000	0.002987	
STORY7	Max Drift Y	ECCQUAKEX	52	1940.000	792.000	728.000		0.001981
STORY6	Max Drift X	ECCQUAKEX	51	1940.000	0.000	616.000	0.002604	
STORY6	Max Drift Y	ECCQUAKEX	52	1940.000	792.000	616.000		0.001706
STORY5	Max Drift X	ECCQUAKEX	51	1940.000	0.000	504.000	0.002182	
STORY5	Max Drift Y	ECCQUAKEX	52	1940.000	792.000	504.000		0.001412
STORY4	Max Drift X	ECCQUAKEX	51	1940.000	0.000	392.000	0.001719	
STORY4	Max Drift Y	ECCQUAKEX	52	1940.000	792.000	392.000		0.001095
STORY3	Max Drift X	ECCQUAKEX	51	1940.000	0.000	280.000	0.001213	
STORY3	Max Drift Y	ECCQUAKEX	52	1940.000	792.000	280.000		0.000756
STORY2	Max Drift X	ECCQUAKEX	51	1940.000	0.000	168.000	0.000509	
STORY2	Max Drift Y	ECCQUAKEX	52	1940.000	792.000	168.000		0.000302

Max Story Drift Values for EQ in the X Direction

Story	Load	Loc	P	VX	VY	T	MX	MY
STORYROOF	FACTWINDY	Top	0.00	-0.15	-60.75	-59541.238	0.000	0.000
STORYROOF	FACTWINDY	Bottom	0.00	-0.16	-61.07	-59929.056	7552.618	-19.030
STORY20	FACTWINDY	Top	0.00	-0.27	-107.09	-105041.793	7552.618	-19.030
STORY20	FACTWINDY	Bottom	0.00	-0.28	-107.37	-105370.815	19562.203	-49.592
STORY19	FACTWINDY	Top	0.00	-0.39	-150.36	-147531.425	19562.203	-49.592
STORY19	FACTWINDY	Bottom	0.00	-0.39	-150.62	-147852.804	36417.150	-93.087
STORY18	FACTWINDY	Top	0.00	-0.50	-192.86	-189268.859	36417.150	-93.087
STORY18	FACTWINDY	Bottom	0.00	-0.50	-193.12	-189581.801	58032.074	-149.181
STORY17	FACTWINDY	Top	0.00	-0.61	-234.95	-230590.598	58032.074	-149.181
STORY17	FACTWINDY	Bottom	0.00	-0.61	-235.20	-230894.255	84360.526	-217.456
STORY16	FACTWINDY	Top	0.00	-0.71	-276.27	-271149.115	84360.526	-217.456
STORY16	FACTWINDY	Bottom	0.00	-0.72	-276.51	-271442.601	115316.154	-297.457
STORY15	FACTWINDY	Top	0.00	-0.81	-317.16	-311279.697	115316.154	-297.457
STORY15	FACTWINDY	Bottom	0.00	-0.82	-317.40	-311562.100	150851.473	-388.733
STORY14	FACTWINDY	Top	0.00	-0.91	-357.28	-350635.072	150851.473	-388.733
STORY14	FACTWINDY	Bottom	0.00	-0.91	-357.50	-350905.659	190879.083	-490.763
STORY13	FACTWINDY	Top	0.00	-1.00	-396.24	-388852.071	190879.083	-490.763
STORY13	FACTWINDY	Bottom	0.00	-1.00	-396.45	-389109.624	235269.812	-602.993
STORY12	FACTWINDY	Top	0.00	-1.09	-433.69	-425581.680	235269.812	-602.993
STORY12	FACTWINDY	Bottom	0.00	-1.09	-433.89	-425825.078	283854.376	-724.834
STORY11	FACTWINDY	Top	0.00	-1.17	-470.71	-461872.857	283854.376	-724.834
STORY11	FACTWINDY	Bottom	0.00	-1.17	-470.90	-462100.958	336584.798	-855.668
STORY10	FACTWINDY	Top	0.00	-1.24	-506.56	-497002.761	336584.798	-855.668
STORY10	FACTWINDY	Bottom	0.00	-1.24	-506.74	-497214.415	393329.886	-994.806
STORY9	FACTWINDY	Top	0.00	-1.31	-543.24	-532901.705	393329.886	-994.806
STORY9	FACTWINDY	Bottom	0.00	-1.31	-543.42	-533122.704	460159.512	-1155.955
STORY8	FACTWINDY	Top	0.00	-1.37	-578.29	-567206.440	460159.512	-1155.955
STORY8	FACTWINDY	Bottom	0.00	-1.37	-578.44	-567380.048	524936.701	-1309.490
STORY7	FACTWINDY	Top	0.00	-1.42	-610.17	-598392.067	524936.701	-1309.490
STORY7	FACTWINDY	Bottom	0.00	-1.43	-610.30	-598546.069	593283.430	-1469.057
STORY6	FACTWINDY	Top	0.00	-1.47	-640.48	-628015.399	593283.430	-1469.057
STORY6	FACTWINDY	Bottom	0.00	-1.47	-640.59	-628148.582	665023.003	-1633.868
STORY5	FACTWINDY	Top	0.00	-1.51	-668.84	-655725.599	665023.003	-1633.868
STORY5	FACTWINDY	Bottom	0.00	-1.51	-668.93	-655836.487	739938.455	-1803.073
STORY4	FACTWINDY	Top	0.00	-1.54	-694.91	-681171.251	739938.455	-1803.073
STORY4	FACTWINDY	Bottom	0.00	-1.54	-694.98	-681258.350	817772.519	-1975.758
STORY3	FACTWINDY	Top	0.00	-1.56	-720.85	-706452.700	817772.519	-1975.758
STORY3	FACTWINDY	Bottom	0.00	-1.56	-720.90	-706514.310	898510.715	-2150.951
STORY2	FACTWINDY	Top	0.00	-1.58	-753.04	-737751.939	898510.715	-2150.951
STORY2	FACTWINDY	Bottom	0.00	-1.58	-753.08	-737800.622	1025024.838	-2415.995

Max Story Shear Factored Wind Loads Y direction

Story	Load	Loc	P	VX	VY	T	MX	MY
STORYROOF	FACTWINDX	Top	0.00	-26.06	-0.06	9983.783	0.000	0.000
STORYROOF	FACTWINDX	Bottom	0.00	-26.28	-0.07	10041.117	8.218	-3244.995
STORY20	FACTWINDX	Top	0.00	-46.02	-0.12	17604.372	8.218	-3244.995
STORY20	FACTWINDX	Bottom	0.00	-46.20	-0.12	17653.149	21.584	-8409.565
STORY19	FACTWINDX	Top	0.00	-64.68	-0.17	24720.243	21.584	-8409.565
STORY19	FACTWINDX	Bottom	0.00	-64.85	-0.17	24768.022	40.677	-15663.240
STORY18	FACTWINDX	Top	0.00	-83.00	-0.22	31712.977	40.677	-15663.240
STORY18	FACTWINDX	Bottom	0.00	-83.17	-0.22	31759.644	65.337	-24969.061
STORY17	FACTWINDX	Top	0.00	-101.13	-0.27	38637.948	65.337	-24969.061
STORY17	FACTWINDX	Bottom	0.00	-101.30	-0.27	38683.382	95.391	-36305.551
STORY16	FACTWINDX	Top	0.00	-118.93	-0.31	45437.821	95.391	-36305.551
STORY16	FACTWINDX	Bottom	0.00	-119.09	-0.32	45481.898	130.647	-49634.744
STORY15	FACTWINDX	Top	0.00	-136.54	-0.36	52176.551	130.647	-49634.744
STORY15	FACTWINDX	Bottom	0.00	-136.70	-0.36	52219.144	170.899	-64936.562
STORY14	FACTWINDX	Top	0.00	-153.82	-0.40	58789.371	170.899	-64936.562
STORY14	FACTWINDX	Bottom	0.00	-153.97	-0.40	58830.560	215.919	-82172.401
STORY13	FACTWINDX	Top	0.00	-170.58	-0.44	65213.714	215.919	-82172.401
STORY13	FACTWINDX	Bottom	0.00	-170.73	-0.44	65253.165	265.460	-101285.617
STORY12	FACTWINDX	Top	0.00	-186.69	-0.48	71391.446	265.460	-101285.617
STORY12	FACTWINDX	Bottom	0.00	-186.83	-0.48	71429.008	319.257	-122202.926
STORY11	FACTWINDX	Top	0.00	-202.60	-0.51	77499.465	319.258	-122202.926
STORY11	FACTWINDX	Bottom	0.00	-202.72	-0.52	77534.985	377.034	-144900.857
STORY10	FACTWINDX	Top	0.00	-218.00	-0.55	83422.962	377.034	-144900.857
STORY10	FACTWINDX	Bottom	0.00	-218.12	-0.55	83456.289	438.490	-169323.112
STORY9	FACTWINDX	Top	0.00	-233.79	-0.58	89516.076	438.490	-169323.112
STORY9	FACTWINDX	Bottom	0.00	-233.91	-0.58	89551.386	509.693	-198086.456
STORY8	FACTWINDX	Top	0.00	-248.87	-0.60	95345.347	509.693	-198086.456
STORY8	FACTWINDX	Bottom	0.00	-248.97	-0.61	95373.601	577.556	-225965.288
STORY7	FACTWINDX	Top	0.00	-262.58	-0.63	100648.296	577.556	-225965.288
STORY7	FACTWINDX	Bottom	0.00	-262.66	-0.63	100673.765	648.129	-255378.798
STORY6	FACTWINDX	Top	0.00	-275.61	-0.65	105700.941	648.129	-255378.798
STORY6	FACTWINDX	Bottom	0.00	-275.69	-0.65	105723.509	721.086	-286251.364
STORY5	FACTWINDX	Top	0.00	-287.80	-0.67	110438.593	721.086	-286251.364
STORY5	FACTWINDX	Bottom	0.00	-287.87	-0.67	110457.927	796.047	-318488.819
STORY4	FACTWINDX	Top	0.00	-298.99	-0.68	114796.261	796.047	-318488.819
STORY4	FACTWINDX	Bottom	0.00	-299.04	-0.68	114812.015	872.601	-351978.371
STORY3	FACTWINDX	Top	0.00	-310.09	-0.69	119139.697	872.601	-351978.371
STORY3	FACTWINDX	Bottom	0.00	-310.13	-0.69	119151.418	950.310	-386710.433
STORY2	FACTWINDX	Top	0.00	-323.80	-0.70	124537.517	950.310	-386710.433
STORY2	FACTWINDX	Bottom	0.00	-323.83	-0.70	124548.530	1067.931	-441112.043

Max Story Shear Factored Wind Loads X direction

Story	Load	Loc	P	VX	VY	T	MX	MY
STORYROOF	75WINDY	Top	0.00	-0.08	-28.48	-27928.507	0.000	0.000
STORYROOF	75WINDY	Bottom	0.00	-0.08	-28.63	-28113.267	3541.113	-9.975
STORY20	75WINDY	Top	0.00	-0.14	-50.21	-49273.858	3541.113	-9.975
STORY20	75WINDY	Bottom	0.00	-0.15	-50.34	-49430.540	9171.975	-26.023
STORY19	75WINDY	Top	0.00	-0.20	-70.50	-69208.358	9171.975	-26.023
STORY19	75WINDY	Bottom	0.00	-0.21	-70.62	-69361.384	17074.879	-48.845
STORY18	75WINDY	Top	0.00	-0.26	-90.43	-88788.656	17074.879	-48.845
STORY18	75WINDY	Bottom	0.00	-0.26	-90.55	-88937.635	27209.644	-78.259
STORY17	75WINDY	Top	0.00	-0.32	-110.16	-108176.279	27209.644	-78.259
STORY17	75WINDY	Bottom	0.00	-0.32	-110.28	-108320.810	39554.824	-114.044
STORY16	75WINDY	Top	0.00	-0.37	-129.54	-127204.194	39554.824	-114.044
STORY16	75WINDY	Bottom	0.00	-0.38	-129.66	-127343.855	54069.755	-155.962
STORY15	75WINDY	Top	0.00	-0.43	-148.72	-146033.872	54069.755	-155.962
STORY15	75WINDY	Bottom	0.00	-0.43	-148.83	-146168.230	70732.498	-203.770
STORY14	75WINDY	Top	0.00	-0.48	-167.53	-164498.026	70732.498	-203.770
STORY14	75WINDY	Bottom	0.00	-0.48	-167.64	-164626.729	89501.906	-257.198
STORY13	75WINDY	Top	0.00	-0.52	-185.80	-182429.555	89501.906	-257.198
STORY13	75WINDY	Bottom	0.00	-0.53	-185.90	-182552.030	110317.592	-315.938
STORY12	75WINDY	Top	0.00	-0.57	-203.37	-199660.596	110317.592	-315.938
STORY12	75WINDY	Bottom	0.00	-0.57	-203.46	-199776.311	133099.891	-379.670
STORY11	75WINDY	Top	0.00	-0.61	-220.72	-216680.922	133099.891	-379.670
STORY11	75WINDY	Bottom	0.00	-0.61	-220.81	-216789.337	157825.784	-448.071
STORY10	75WINDY	Top	0.00	-0.65	-237.53	-233157.704	157825.784	-448.071
STORY10	75WINDY	Bottom	0.00	-0.65	-237.61	-233258.271	184433.933	-520.780
STORY9	75WINDY	Top	0.00	-0.68	-254.72	-249991.587	184433.933	-520.780
STORY9	75WINDY	Bottom	0.00	-0.69	-254.81	-250096.583	215770.159	-604.954
STORY8	75WINDY	Top	0.00	-0.72	-271.16	-266079.525	215770.159	-604.954
STORY8	75WINDY	Bottom	0.00	-0.72	-271.23	-266161.951	246143.708	-685.115
STORY7	75WINDY	Top	0.00	-0.74	-286.10	-280702.593	246143.708	-685.115
STORY7	75WINDY	Bottom	0.00	-0.74	-286.16	-280775.718	278190.530	-768.390
STORY6	75WINDY	Top	0.00	-0.77	-300.31	-294598.284	278190.530	-768.390
STORY6	75WINDY	Bottom	0.00	-0.77	-300.36	-294661.486	311828.433	-854.363
STORY5	75WINDY	Top	0.00	-0.79	-313.61	-307596.213	311828.433	-854.363
STORY5	75WINDY	Bottom	0.00	-0.79	-313.66	-307648.821	346955.681	-942.594
STORY4	75WINDY	Top	0.00	-0.80	-325.83	-319525.857	346955.681	-942.594
STORY4	75WINDY	Bottom	0.00	-0.80	-325.87	-319567.160	383450.972	-1032.611
STORY3	75WINDY	Top	0.00	-0.82	-337.99	-331377.327	383450.972	-1032.611
STORY3	75WINDY	Bottom	0.00	-0.82	-338.02	-331406.517	421307.462	-1123.915
STORY2	75WINDY	Top	0.00	-0.82	-353.08	-346050.901	421307.462	-1123.915
STORY2	75WINDY	Bottom	0.00	-0.82	-353.10	-346074.054	480626.832	-1262.027

Max Story Shear Factored Wind Case 2

Story	Load	Loc	P	VX	VY	T	MX	MY
STORYROOF	75WINDXY	Top	0.00	-12.30	-28.51	-23256.361	0.000	0.000
STORYROOF	75WINDXY	Bottom	0.00	-12.41	-28.67	-23415.179	3545.408	-1531.830
STORY20	75WINDXY	Top	0.00	-21.73	-50.27	-41035.137	3545.408	-1531.830
STORY20	75WINDXY	Bottom	0.00	-21.82	-50.40	-41169.745	9183.263	-3970.399
STORY19	75WINDXY	Top	0.00	-30.53	-70.59	-57641.750	9183.263	-3970.399
STORY19	75WINDXY	Bottom	0.00	-30.62	-70.72	-57773.138	17096.161	-7395.198
STORY18	75WINDXY	Top	0.00	-39.18	-90.54	-73951.569	17096.161	-7395.198
STORY18	75WINDXY	Bottom	0.00	-39.27	-90.67	-74079.399	27243.828	-11788.718
STORY17	75WINDXY	Top	0.00	-47.75	-110.30	-90098.639	27243.828	-11788.718
STORY17	75WINDXY	Bottom	0.00	-47.83	-110.43	-90222.564	39604.731	-17141.089
STORY16	75WINDXY	Top	0.00	-56.15	-129.70	-105944.325	39604.731	-17141.089
STORY16	75WINDXY	Bottom	0.00	-56.23	-129.82	-106063.981	54138.102	-23434.288
STORY15	75WINDXY	Top	0.00	-64.46	-148.91	-121621.736	54138.102	-23434.288
STORY15	75WINDXY	Bottom	0.00	-64.54	-149.02	-121736.748	70821.891	-30658.187
STORY14	75WINDXY	Top	0.00	-72.61	-167.74	-136992.246	70821.891	-30658.187
STORY14	75WINDXY	Bottom	0.00	-72.68	-167.85	-137102.222	89614.831	-38794.429
STORY13	75WINDXY	Top	0.00	-80.52	-186.03	-151917.004	89614.831	-38794.429
STORY13	75WINDXY	Bottom	0.00	-80.59	-186.14	-152021.525	110456.401	-47816.447
STORY12	75WINDXY	Top	0.00	-88.12	-203.62	-166256.907	110456.401	-47816.447
STORY12	75WINDXY	Bottom	0.00	-88.18	-203.71	-166355.512	133266.792	-57689.420
STORY11	75WINDXY	Top	0.00	-95.62	-220.99	-180416.893	133266.792	-57689.420
STORY11	75WINDXY	Bottom	0.00	-95.68	-221.08	-180509.111	158022.843	-68402.448
STORY10	75WINDXY	Top	0.00	-102.88	-237.82	-194121.079	158022.843	-68402.448
STORY10	75WINDXY	Bottom	0.00	-102.94	-237.90	-194206.431	184663.059	-79928.295
STORY9	75WINDXY	Top	0.00	-110.32	-255.02	-208102.401	184663.059	-79928.295
STORY9	75WINDXY	Bottom	0.00	-110.38	-255.11	-208191.254	216036.419	-93501.242
STORY8	75WINDXY	Top	0.00	-117.43	-271.47	-221459.630	216036.419	-93501.242
STORY8	75WINDXY	Bottom	0.00	-117.47	-271.54	-221529.120	246445.341	-106655.620
STORY7	75WINDXY	Top	0.00	-123.88	-286.43	-233598.209	246445.341	-106655.620
STORY7	75WINDXY	Bottom	0.00	-123.93	-286.49	-233659.667	278528.938	-120533.088
STORY6	75WINDXY	Top	0.00	-130.02	-300.65	-245128.270	278528.938	-120533.088
STORY6	75WINDXY	Bottom	0.00	-130.06	-300.70	-245181.115	312204.844	-135097.212
STORY5	75WINDXY	Top	0.00	-135.75	-313.96	-255908.516	312204.844	-135097.212
STORY5	75WINDXY	Bottom	0.00	-135.78	-314.01	-255952.245	347371.116	-150303.166
STORY4	75WINDXY	Top	0.00	-141.01	-326.19	-265797.974	347371.116	-150303.166
STORY4	75WINDXY	Bottom	0.00	-141.03	-326.22	-265832.030	383906.246	-166097.643
STORY3	75WINDXY	Top	0.00	-146.22	-338.35	-275615.589	383906.246	-166097.643
STORY3	75WINDXY	Bottom	0.00	-146.24	-338.38	-275639.398	421803.160	-182475.597
STORY2	75WINDXY	Top	0.00	-152.66	-353.44	-287760.619	421803.160	-182475.597
STORY2	75WINDXY	Bottom	0.00	-152.67	-353.46	-287778.401	481183.716	-208123.144

Max Story Shear Factored Wind Case 3

Story	Load	Loc	P	VX	VY	T	MX	MY
STORYROOF	563WINDXY	Top	0.00	-9.38	-21.56	-22838.515	0.000	0.000
STORYROOF	563WINDXY	Bottom	0.00	-9.48	-21.69	-23008.626	2681.609	-1169.226
STORY20	563WINDXY	Top	0.00	-16.59	-38.03	-40313.107	2681.609	-1169.226
STORY20	563WINDXY	Bottom	0.00	-16.67	-38.14	-40457.322	6947.220	-3031.615
STORY19	563WINDXY	Top	0.00	-23.32	-53.41	-56638.384	6947.220	-3031.615
STORY19	563WINDXY	Bottom	0.00	-23.40	-53.52	-56779.192	12935.294	-5648.142
STORY18	563WINDXY	Top	0.00	-29.94	-68.52	-72671.448	12935.294	-5648.142
STORY18	563WINDXY	Bottom	0.00	-30.01	-68.63	-72808.486	20615.225	-9005.303
STORY17	563WINDXY	Top	0.00	-36.48	-83.47	-88542.757	20615.225	-9005.303
STORY17	563WINDXY	Bottom	0.00	-36.56	-83.58	-88675.659	29970.434	-13095.255
STORY16	563WINDXY	Top	0.00	-42.90	-98.16	-104116.707	29970.434	-13095.255
STORY16	563WINDXY	Bottom	0.00	-42.97	-98.26	-104245.083	40969.858	-17903.996
STORY15	563WINDXY	Top	0.00	-49.25	-112.69	-119523.092	40969.858	-17903.996
STORY15	563WINDXY	Bottom	0.00	-49.32	-112.79	-119646.543	53596.461	-23423.433
STORY14	563WINDXY	Top	0.00	-55.46	-126.94	-134626.051	53596.461	-23423.433
STORY14	563WINDXY	Bottom	0.00	-55.53	-127.03	-134744.151	67818.721	-29639.242
STORY13	563WINDXY	Top	0.00	-61.50	-140.77	-149289.908	67818.721	-29639.242
STORY13	563WINDXY	Bottom	0.00	-61.56	-140.87	-149402.229	83590.626	-36530.886
STORY12	563WINDXY	Top	0.00	-67.30	-154.07	-163378.537	83590.626	-36530.885
STORY12	563WINDXY	Bottom	0.00	-67.36	-154.16	-163484.589	100851.645	-44071.571
STORY11	563WINDXY	Top	0.00	-73.02	-167.21	-177286.825	100851.645	-44071.571
STORY11	563WINDXY	Bottom	0.00	-73.07	-167.29	-177386.112	119583.707	-52252.451
STORY10	563WINDXY	Top	0.00	-78.54	-179.93	-190745.150	119583.707	-52252.451
STORY10	563WINDXY	Bottom	0.00	-78.60	-180.00	-190837.168	139739.918	-61052.329
STORY9	563WINDXY	Top	0.00	-84.20	-192.93	-204478.317	139739.918	-61052.329
STORY9	563WINDXY	Bottom	0.00	-84.25	-193.00	-204574.286	163474.648	-71412.307
STORY8	563WINDXY	Top	0.00	-89.60	-205.35	-217596.768	163474.648	-71412.307
STORY8	563WINDXY	Bottom	0.00	-89.64	-205.41	-217672.002	186477.124	-81449.952
STORY7	563WINDXY	Top	0.00	-94.51	-216.64	-229517.500	186477.124	-81449.952
STORY7	563WINDXY	Bottom	0.00	-94.54	-216.69	-229584.221	210743.932	-92036.681
STORY6	563WINDXY	Top	0.00	-99.16	-227.37	-240837.364	210743.932	-92036.681
STORY6	563WINDXY	Bottom	0.00	-99.19	-227.42	-240894.917	236212.333	-103144.278
STORY5	563WINDXY	Top	0.00	-103.50	-237.41	-251417.640	236212.333	-103144.278
STORY5	563WINDXY	Bottom	0.00	-103.53	-237.45	-251465.432	262804.835	-114738.188
STORY4	563WINDXY	Top	0.00	-107.48	-246.63	-261119.776	262804.835	-114738.188
STORY4	563WINDXY	Bottom	0.00	-107.50	-246.66	-261157.163	290429.189	-126777.445
STORY3	563WINDXY	Top	0.00	-111.42	-255.79	-270743.068	290429.189	-126777.445
STORY3	563WINDXY	Bottom	0.00	-111.43	-255.81	-270769.351	319078.983	-139257.286
STORY2	563WINDXY	Top	0.00	-116.26	-267.14	-282630.708	319078.983	-139257.286
STORY2	563WINDXY	Bottom	0.00	-116.28	-267.16	-282650.956	363959.836	-158790.669

Max Story shear for Factored Wind Load Case 4

Story	Load	Loc	P	VX	VY	T	MX	MY
STORYROOF	ECCQUAKEX	Top	0.00	-98.31	-0.52	27822.236	0.000	0.000
STORYROOF	ECCQUAKEX	Bottom	0.00	-99.11	-0.57	27931.321	67.431	-12240.206
STORY20	ECCQUAKEX	Top	0.00	-193.58	-0.96	54985.293	67.431	-12240.206
STORY20	ECCQUAKEX	Bottom	0.00	-194.26	-1.01	55078.104	178.169	-33959.064
STORY19	ECCQUAKEX	Top	0.00	-277.75	-1.39	78890.721	178.169	-33959.064
STORY19	ECCQUAKEX	Bottom	0.00	-278.42	-1.44	78981.665	336.795	-65104.925
STORY18	ECCQUAKEX	Top	0.00	-355.13	-1.81	100799.058	336.795	-65104.925
STORY18	ECCQUAKEX	Bottom	0.00	-355.77	-1.85	100887.871	541.922	-104915.532
STORY17	ECCQUAKEX	Top	0.00	-426.16	-2.21	120853.110	541.922	-104915.532
STORY17	ECCQUAKEX	Bottom	0.00	-426.79	-2.25	120939.537	792.030	-152680.904
STORY16	ECCQUAKEX	Top	0.00	-490.78	-2.60	139031.988	792.030	-152680.904
STORY16	ECCQUAKEX	Bottom	0.00	-491.38	-2.64	139115.764	1085.455	-207681.995
STORY15	ECCQUAKEX	Top	0.00	-549.14	-2.97	155388.217	1085.455	-207681.995
STORY15	ECCQUAKEX	Bottom	0.00	-549.72	-3.01	155469.091	1420.411	-269217.984
STORY14	ECCQUAKEX	Top	0.00	-601.54	-3.33	170013.636	1420.411	-269217.984
STORY14	ECCQUAKEX	Bottom	0.00	-602.09	-3.36	170092.109	1794.958	-336621.108
STORY13	ECCQUAKEX	Top	0.00	-648.20	-3.66	182981.206	1794.958	-336621.108
STORY13	ECCQUAKEX	Bottom	0.00	-648.72	-3.70	183056.311	2206.994	-409249.086
STORY12	ECCQUAKEX	Top	0.00	-689.39	-3.98	194369.528	2206.994	-409249.086
STORY12	ECCQUAKEX	Bottom	0.00	-689.88	-4.01	194440.982	2654.293	-486487.995
STORY11	ECCQUAKEX	Top	0.00	-724.40	-4.27	203977.750	2654.293	-486487.995
STORY11	ECCQUAKEX	Bottom	0.00	-724.86	-4.30	204045.282	3134.496	-567647.256
STORY10	ECCQUAKEX	Top	0.00	-754.73	-4.54	212249.938	3134.497	-567647.256
STORY10	ECCQUAKEX	Bottom	0.00	-755.15	-4.57	212313.282	3645.077	-652200.879
STORY9	ECCQUAKEX	Top	0.00	-780.58	-4.79	219257.900	3645.077	-652200.879
STORY9	ECCQUAKEX	Bottom	0.00	-781.02	-4.82	219325.037	4236.457	-748240.026
STORY8	ECCQUAKEX	Top	0.00	-801.69	-5.02	224921.621	4236.457	-748240.026
STORY8	ECCQUAKEX	Bottom	0.00	-802.04	-5.04	224975.421	4799.859	-838049.399
STORY7	ECCQUAKEX	Top	0.00	-818.74	-5.22	229452.456	4799.859	-838049.399
STORY7	ECCQUAKEX	Bottom	0.00	-819.04	-5.24	229500.737	5385.290	-929765.319
STORY6	ECCQUAKEX	Top	0.00	-832.05	-5.39	232946.715	5385.290	-929765.319
STORY6	ECCQUAKEX	Bottom	0.00	-832.32	-5.41	232989.633	5989.923	-1022970.548
STORY5	ECCQUAKEX	Top	0.00	-842.01	-5.53	235517.661	5989.923	-1022970.548
STORY5	ECCQUAKEX	Bottom	0.00	-842.23	-5.55	235554.502	6610.670	-1117288.741
STORY4	ECCQUAKEX	Top	0.00	-848.98	-5.65	237276.301	6610.670	-1117288.741
STORY4	ECCQUAKEX	Bottom	0.00	-849.15	-5.66	237306.452	7244.260	-1212383.962
STORY3	ECCQUAKEX	Top	0.00	-853.31	-5.74	238336.852	7244.260	-1212383.962
STORY3	ECCQUAKEX	Bottom	0.00	-853.43	-5.74	238359.299	7887.238	-1307961.802
STORY2	ECCQUAKEX	Top	0.00	-855.51	-5.79	238848.059	7887.238	-1307961.802
STORY2	ECCQUAKEX	Bottom	0.00	-855.61	-5.80	238872.042	8860.555	-1451696.776

Max Story shear for EQ Loads in X direction

Story	Load	Loc	P	VX	VY	T	MX	MY
STORYROOF	ECCQUAKEY	Top	0.00	-0.32	-77.13	-78784.415	0.000	0.000
STORYROOF	ECCQUAKEY	Bottom	0.00	-0.34	-77.59	-79347.704	9592.767	-40.955
STORY20	ECCQUAKEY	Top	0.00	-0.58	-152.68	-155857.449	9592.767	-40.955
STORY20	ECCQUAKEY	Bottom	0.00	-0.60	-153.07	-156334.673	26714.590	-107.293
STORY19	ECCQUAKEY	Top	0.00	-0.83	-222.32	-226931.849	26714.590	-107.293
STORY19	ECCQUAKEY	Bottom	0.00	-0.85	-222.70	-227397.435	51635.685	-201.829
STORY18	ECCQUAKEY	Top	0.00	-1.08	-288.20	-294188.365	51635.685	-201.829
STORY18	ECCQUAKEY	Bottom	0.00	-1.10	-288.57	-294641.057	83934.656	-323.788
STORY17	ECCQUAKEY	Top	0.00	-1.32	-350.47	-357779.694	83934.656	-323.788
STORY17	ECCQUAKEY	Bottom	0.00	-1.33	-350.82	-358218.219	123207.297	-472.232
STORY16	ECCQUAKEY	Top	0.00	-1.54	-408.97	-417535.557	123207.297	-472.232
STORY16	ECCQUAKEY	Bottom	0.00	-1.56	-409.31	-417958.586	169030.705	-646.148
STORY15	ECCQUAKEY	Top	0.00	-1.76	-463.65	-473416.745	169030.705	-646.148
STORY15	ECCQUAKEY	Bottom	0.00	-1.78	-463.98	-473822.934	220977.885	-844.492
STORY14	ECCQUAKEY	Top	0.00	-1.97	-514.55	-525454.278	220977.885	-844.492
STORY14	ECCQUAKEY	Bottom	0.00	-1.99	-514.87	-525842.524	278625.588	-1066.119
STORY13	ECCQUAKEY	Top	0.00	-2.17	-561.69	-573659.755	278625.588	-1066.119
STORY13	ECCQUAKEY	Bottom	0.00	-2.18	-561.99	-574028.348	341551.993	-1309.730
STORY12	ECCQUAKEY	Top	0.00	-2.35	-605.07	-618032.371	341551.993	-1309.730
STORY12	ECCQUAKEY	Bottom	0.00	-2.37	-605.35	-618379.718	409335.501	-1573.960
STORY11	ECCQUAKEY	Top	0.00	-2.53	-643.98	-657866.266	409335.501	-1573.960
STORY11	ECCQUAKEY	Bottom	0.00	-2.54	-644.25	-658190.774	481476.464	-1857.437
STORY10	ECCQUAKEY	Top	0.00	-2.68	-679.32	-694047.392	481476.464	-1857.437
STORY10	ECCQUAKEY	Bottom	0.00	-2.69	-679.56	-694347.477	557573.832	-2158.630
STORY9	ECCQUAKEY	Top	0.00	-2.83	-711.05	-726552.377	557573.832	-2158.630
STORY9	ECCQUAKEY	Bottom	0.00	-2.84	-711.30	-726864.593	645049.053	-2507.157
STORY8	ECCQUAKEY	Top	0.00	-2.96	-738.71	-754902.504	645049.053	-2507.157
STORY8	ECCQUAKEY	Bottom	0.00	-2.97	-738.91	-755146.699	727795.949	-2838.888
STORY7	ECCQUAKEY	Top	0.00	-3.07	-762.65	-779442.237	727795.949	-2838.888
STORY7	ECCQUAKEY	Bottom	0.00	-3.08	-762.82	-779658.103	813222.432	-3183.272
STORY6	ECCQUAKEY	Top	0.00	-3.17	-782.86	-800171.472	813222.432	-3183.272
STORY6	ECCQUAKEY	Bottom	0.00	-3.18	-783.01	-800357.283	900910.911	-3538.578
STORY5	ECCQUAKEY	Top	0.00	-3.25	-799.39	-817138.151	900910.911	-3538.578
STORY5	ECCQUAKEY	Bottom	0.00	-3.26	-799.51	-817292.098	990449.463	-3902.998
STORY4	ECCQUAKEY	Top	0.00	-3.32	-812.26	-830359.838	990449.463	-3902.998
STORY4	ECCQUAKEY	Bottom	0.00	-3.32	-812.36	-830480.012	1081428.444	-4274.621
STORY3	ECCQUAKEY	Top	0.00	-3.36	-821.47	-839823.334	1081428.444	-4274.621
STORY3	ECCQUAKEY	Bottom	0.00	-3.37	-821.54	-839907.594	1173437.094	-4651.446
STORY2	ECCQUAKEY	Top	0.00	-3.39	-827.08	-845596.279	1173437.094	-4651.446
STORY2	ECCQUAKEY	Bottom	0.00	-3.39	-827.13	-845662.073	1312391.818	-5221.437

Max Story Shear for EQ Loads in Y direction

Appendix G – References

CSI Analysis Reference Manual

Coast and Geodetic Survey, "Earthquake Investigations in California, 1934-35," Special publication No. 201, U.S. Department of Commerce, Washington, D.C., 1963.