UNION STATION EXPANSION AND RESTORATION

WASHINGTON DC

TECHNICAL REPORT III: LATERAL SYSTEM ANALYSIS

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Structural Option

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November 21, 2008

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ADDENDUM

In the first technical report done by the author, a mistake in looking at the drawings caused inaccurate calculations for the wind and seismic loads applied to Union Station. While there is an expansion joint separating the existing portion of Union Station from the expansion, there is another expansion joint located within the new portion of the building. The joint is located along column line C (See Appendix A, Figure A for a visual location), which is at the center length along the north-south direction length.

Since an expansion joint is within the expansion, each level must be treated as two individual masses instead of one (See Figure i). In technical report one, the author only treated each level a one mass instead of two therefore there the calculations for wind and seismic were incorrect.

Because the third technical report deals with the lateral system and lateral loads, the author revisited the steps to determine the wind and seismic forces and corrected to have two separate areas for both calculations. Appendix B and C have the revised calculations which were used throughout this technical report.

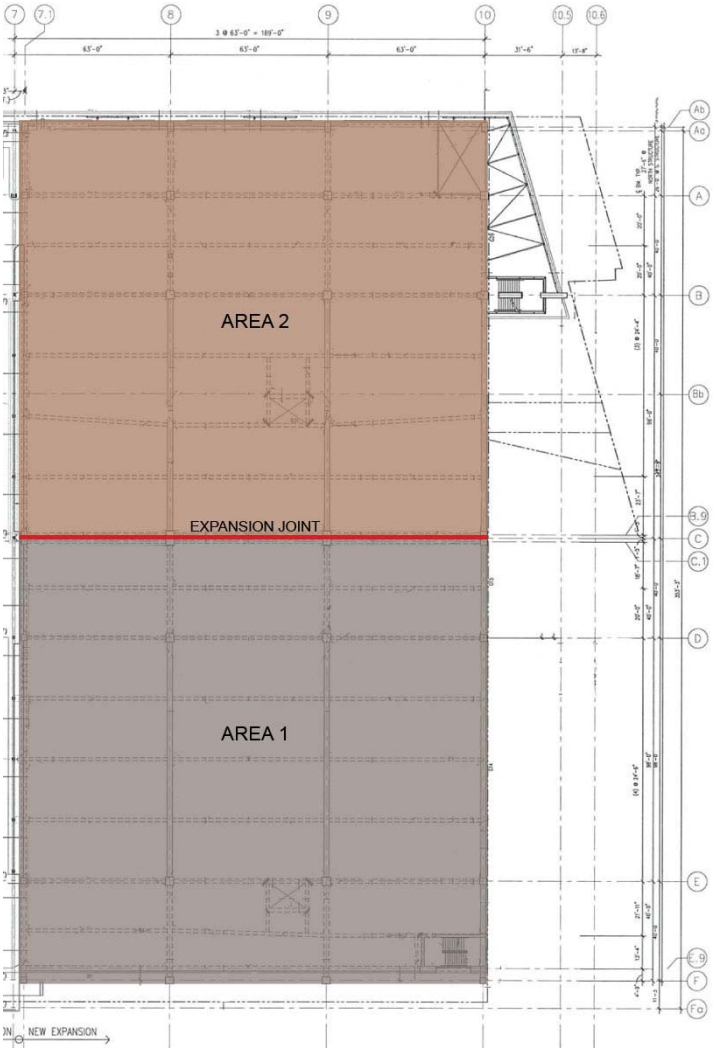


Figure i: Location of Expansion Joint

EXECUTIVE SUMMARY

In this third technical report, a detailed lateral analysis for the expansion to Union Station was conducted by using STAAD, SAP, and hand calculations. Concrete moment frames are the lateral system used throughout the structure and a total of fifteen, eight located in Area1 of Union Station and seven in Area 2, are within the building.

Since the expansion to Union Station was designed by using post-tension within the slab, beams, and girders, getting accurate results from a computer program offered at The Pennsylvania State University or by hand calculations would be a challenge. After a discussion with Professor Parfitt, the ideas to use the properties of ordinary concrete were within this report (Cracking Inertia, Ultimate Rupture, etc.). Recognizing that some of the properties in regular concrete are weaker than post-tension, the author realizes some of the drift results that failed could be from not using the post-tension properties.

Within the body of the report, a detailed description of the foundation, floor system and lateral system can be located. Focusing on the lateral system for this report, the author mentions the wind and seismic criteria in order to determine the initial loads on the expansion to Union Station. As mentioned above, there are fifteen moment frames and the author decided to focus on two of the frames within the body of the report (Refer to the Lateral System section of the report located on page 6 to see what frames will be reported on). Each of the frames relative stiffness, forces, and drift from wind and seismic loads will be looked. Within the appendixes of the report, there are detailed calculations for all fifteen moment frames. The author included all the calculations to show how the complete process of the lateral analysis was done for Union Station.

For both moment frames 2 and E, the allowable drift for the wind and seismic loads were within the limits. However, there were other moment frames that did not pass the drift criteria for wind and/or seismic loads. One main cause for this could be how the section properties for ordinary concrete were used instead of post-tension. More reasons the author believes the frames did not pass can be located within the conclusion, located on page 25.

EXISTING STRUCTURAL SYSTEM

Foundation:

Union Station's expansion main foundation system consists of concrete piles, which carry the load from the train track stations to the soil and supportive columns for all the levels above the track level. Each one rests upon a square footer that is either six feet or twelve feet in length and width, with a height of two feet.

All the columns and piles are located between the eight locomotive rail ways that are part of Union Station. Maximum diameter size of the columns and the piles are 1 ½' and are spaced 22'-0" spanning in the north-south direction of the building between the railroads.

From the provided geotechnical report, the net soil bearing capacity for the site is 1000 PSF, which is considered weak for the soil. Fine to coarse sandy clay fill is the soil designation on the site for Union Station. After examining the geotechnical report, each column supporting the structure above the track level was designed to carry a typical load of 1000 kips to the ground.

Existing Floor System:

Union Station's typical floor system is a two-way post-tension cast-in-place concrete slab with a thickness of 7". All the beams and girders are post-tension cast-in-place as well. In Union Station, the beams span a length of 63'-0". The girders located in the expansion, carry the load from the beams to the columns and have a typical span of 24'-4" throughout the expansion. The concrete compressive strength for the slabs, beams, and girders is f'_c = 5000 psi while the columns supporting the floors are cast-in-place with a compressive strength of 8000 psi. It is to be noted that the floor systems for the expansion and the existing structure for Union Station do not connect with each other.

For the Ground Level, a rigid 6 ½" concrete slab was used for majority of the floor. A composite design located along the west elevation was utilized to help reduce the weight within the weakest are of the site. A 5" light weight concrete slab over 1 ½" gage LOK-Floor was used which makes the ground floor total thickness to be 6 ½". Shear studs sized at ¾" x 4 ½" were used in the composite floor design. Typical member size for the beams is W27x84 which span 63'-0" and tie into a W33x118 girder. Each girder ties into the concrete columns that are part of the foundation system.

There are two typical bay sizes located in the expansion of Union Station, 63'-0" x 27'-6" and 63'-0" x 40'-0". Since the tracks running through Union Station were the major consideration in the design as well as the bus terminal, the use of long spans was concluded as the best approach for the design.

Lateral System:

Union Station's lateral load system is composed of ordinary reinforced concrete moment frames. As mentioned in the executive summary, two of the moment frames will be focused on in the body of the report (See Figure 1 to the right). Frame 2 is located within Area 1 of Union Station as spans in the north-south elevation while Frame E spans east-west within Area 2. To see a plan view of all moment frames with their designation for this technical report can be found in Appendix A, Figure 1.

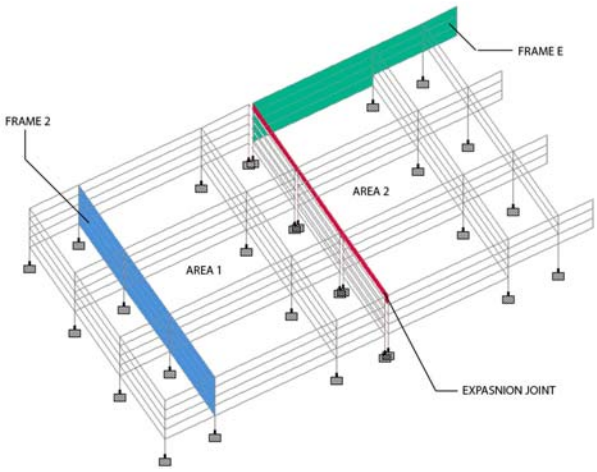


Figure 1: Moment Frames Used In Report

Lateral loads, as well as the gravity loads, reach the foundation of Union Station by first traveling through the beams, then carry through the girders which connect to the columns. From there, all loads travel down in the columns to the ground level and then the columns take all the loads into the square footers. Figure 2 below shows a visual representation of how loads travel in the frames. Not all beams and girders take part of the lateral system in Union Station. Figure 1 above only shows the beams and girders that act as part of the lateral system. Intermediate beams and girders were left out of the figure.

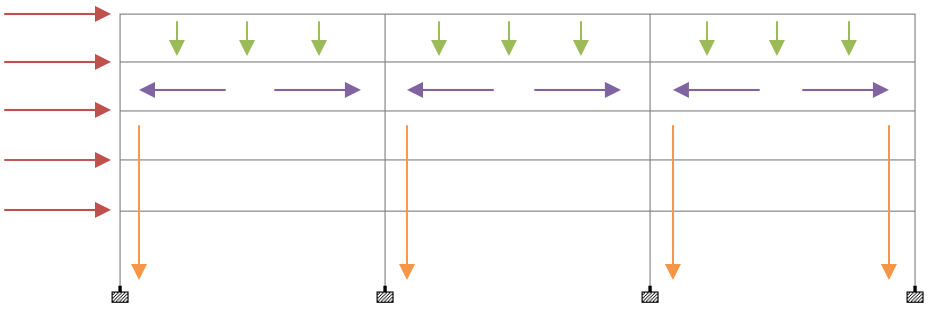


Figure 2: Visual Representation of Loads Traveling Through Moment Frame

An expansion joint was placed between column lines 7 and 7-1 (Refer to Appendix A, Figure 1) is located between the existing structure and the expansion to Union Station. As stated in the addendum, there is also an expansion joint within the expansion. This joint is used to create two separate areas that can move independent of each other due to forces acting upon the building.

CODES AND LOAD COMBINATIONS

Codes and References:

The following tables represent codes used for the design of Union Station by the engineers in practice and the codes used by the author of this technical report. Since Union Station was designed with different edition of codes, values for loads and member sizes could be off depending if any significant changes were to the codes. For this technical report, no significant changes to the codes will have an impact on the values the author will obtain from the calculations.

CODES & REFRENCES (USED BY DESIGN TEAM)
"DC Building Code 2003"
"International Building Code 2000" (as amended) – International Code Council
"DC Building Code Supplement 2000" (DCMR 12A)
"Building Code Requirements for Structural Concrete (ACI 318-02)" – American Concrete Institute
"ACI Manual of Concrete Practice 2003" – American Concrete Institute
"CRSI Handbook", 2002 Edition – Concrete Reinforcing Steel Institute
"PCI Design Handbook, Fifth Edition" – Precast/Prestressed Concrete Institute
"PTI Design Manual, Fourth Edition" – Post Tensioning Institute
"Manual of Steel Construction" – American Institute of Steel Construction, Inc.
"ASCE 7-05", Minimum Design Loads for Buildings and Other Structures – American Society of Civil Engineers

Table 1: Codes & References Used by Design Team

CODES & REFRENCES (USED IN TECHNICAL REPORT III)
"International Building Code 2006"
"ASCE 7-05", Minimum Design Loads for Buildings and Other Structures – American Society of Civil Engineers
"Building Code Requirements for Structural Concrete (ACI 318-08)" – American Concrete Institute

Table 2: Codes & References Used in Technical Report III

Drift Criteria:

In ordinance with the International Building Code, 2006 edition, the following allowable drift criteria will be used to check the deflection of the expansion to Union Station.

$\Delta_{Wind} = H/400$ [Allowable Building Drift]

$\Delta_{Seismic} = 0.015h_{SX}$ [Allowable Story Drift]

Load Combinations:

The following table represents the LRFD load cases used in the analysis for this technical report. All load combinations were obtained from the 2006 edition of the International Building Code, Section 1605.

LOAD CASES & COMBINATIONS: IBC 2006, SECTION 1605
1.4(Dead)
1.2(Dead) + 1.6(Live) + 0.5(Roof Live)
1.2(Dead) + 1.6(Roof Live) + (1.0 Live or 0.8 Wind)
1.2(Dead) + 1.6(Wind) + 1.0(Live) + 0.5(Roof Live)
1.2(Dead) + 1.0(Seismic) + 1.0(Live)
0.9(Dead) + 1.6(Wind)
0.9(Dead) + 1.0(Seismic)

Table 3: Load Combinations

LATERAL RESISTING SYSTEM

Building Isometrics:

As previously mentioned, there are fifteen concrete moment frames within the expansion to Union Station. Each frame extends from the ground floor to the roof and do not extend below to the track level. Figure 3 below shows the entire structure, including intermediate beams and girders, while Figure 4 shows only the moment frames and how the interact with each other.

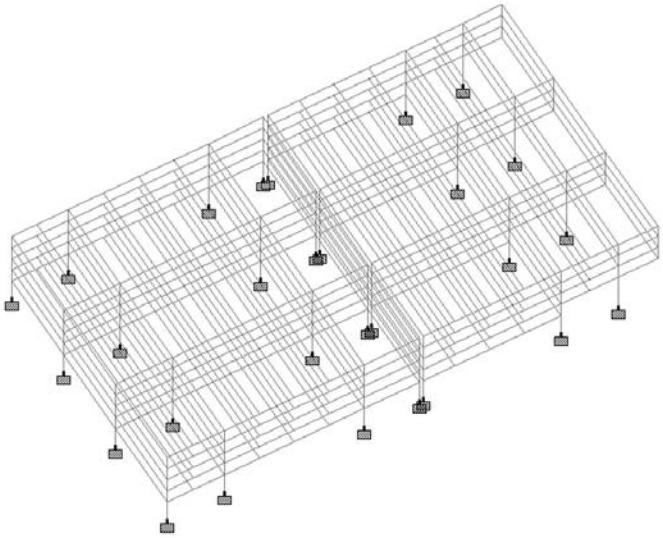


Figure 3: Isometric View of Union Station Structural System

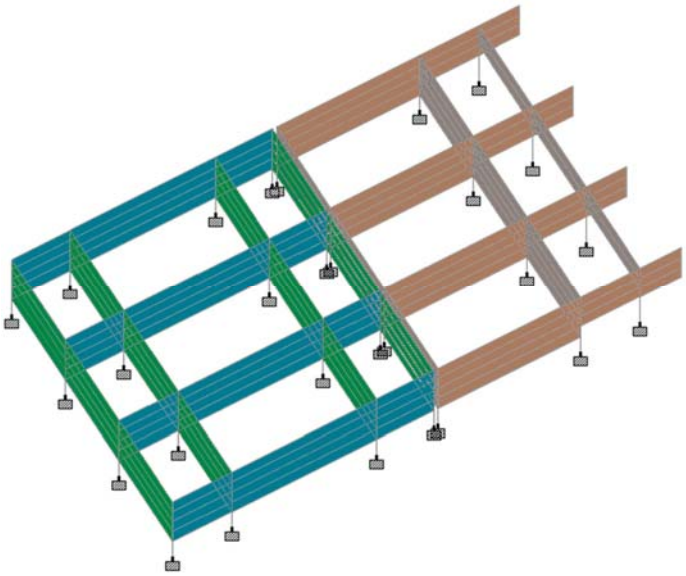


Figure 4: Isometric View of Moment Frames

Building Loads:

In order to determine story shears and member strengths, the following two tables regarding dead and live load will be used. The loads represented in the tables are within the range to what the design team for Union Station used. All the loads in the tables below were referenced out of ASCE 7-05.

Dead Loads			
Typical Floor Loads (psf)		Roof Loads (psf)	
M.E.P.	10	M.E.P.	10
Finishes & Misc.	5	Finishes & Misc.	5
Slab	70	Slab	70
Total	85	Total	85

Table 4: Dead Loads

Live Loads	
Building Space	Load (psf)
Office	50
Stairs	100
Landings	100
Lobbies	100
Mechanical	150
Parking	50
Partition	10

Table 5: Live Loads

Wind & Seismic Criteria:

As mentioned in the addendum in the beginning of the report, the initial wind and seismic loads were re-calculated for this technical report. All the criteria used for them in the first technical report remained the same. The only difference was making two areas for wind and seismic and changing the length used. Wind loads were analyzed using Chapter 6 of ASCE 7-05 and the seismic loads were determined by using Chapter 11 and 12 of ASCE as well. Appendix B and C have all the criteria and load calculations for both wind and seismic.

LOAD DISTRIBUTION AND ANALYSIS

Relative Stiffness:

In order to determine the relative stiffness of each moment frame located in Union Station, each frame was modeled in SAP and each member that acts as part of a moment frame was dimensioned according to the existing drawings. Using the same f'_c values for the beams, girders (5000 psi), and columns (8000 psi) that the design team designed with, the author determined the modulus of elasticity (E_c) for the members by using the equation $E_c = 57{,}000(f'_c)^{1/2}$. A value of 4031 psi was used for the beams and girders while a value of 5098 was used for the columns. Once these two values were inputted into SAP, the program automatically adjusted all the properties for normal concrete to fit this requirement. As mentioned in the executive summary, the author realizes that the values are not of post-tension design.

For each moment frame, a 1 Kip force was induced on the roof level acting in the horizontal plane and then the deflection was checked at each level on the moment frame. By taking the force over the deflection (P/Δ), relative stiffness for each level was then determined and the relative stiffness for the entire moment frame was calculated by taking the average of all five levels.

As stated in the lateral system portion of the report, Frames 2 and E will be looked in depth for this report. The following two tables are the relative stiffness for Frames 2 and E and the relative stiffness for all fifteen moment frames can be located in Appendix D of this report.

Moment Frame 2: Area 1		
Level	Displacement (In)	Stiffness (Kip/in)
Roof	0.0047	212.77
3	0.0038	263.16
2	0.0027	370.37
1	0.0017	588.24
Mezzaine	0.0007	1428.57
Total		572.62

Table 6: Relative Stiffness for Frame 2

Moment Frame E: Area 2		
Level	Displacement (In)	Stiffness (Kip/in)
Roof	0.005	200.00
3	0.0042	238.10
2	0.0035	285.71
1	0.0027	370.37
Mezzaine	0.0015	666.67
Total		352.17

Table 7: Relative Stiffness for Frame E

Center of Rigidity:

Making the assumption that the center of mass for each floor within each area is located at the center of the slab, the author was able to determine the center of rigidity for each floor. Table 8 breaks down the relative stiffness for each moment frame floor by floor and the eccentricity, distance from the center of mass to the center of rigidity, is shown in both the x and y direction, located from the origins. Figure 6 to the right shows the coordinate system used for determining the center of rigidity for each level (the blue dots indicate the origins location on the figure).

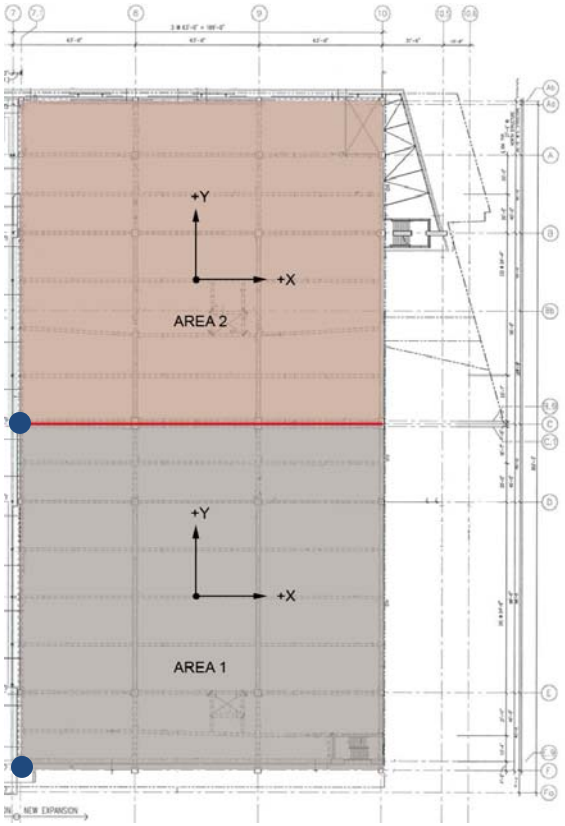


Figure 6: Center of Rigidity Coordinate Axis

Story	Frame Stiffness: Area 1								Center of Rigidity	
	1	2	3	4	A	B	C	D	X_R (ft)	Y_R (ft)
Roof	256.41	212.77	204.08	178.57	238.10	909.09	909.09	434.78	101.96	80.37
3	322.58	263.16	256.41	217.39	277.78	1000.00	1000.00	526.32	102.88	79.85
2	476.19	370.37	357.14	294.12	344.83	1428.57	1428.57	714.29	103.42	77.75
1	833.33	588.24	625.00	454.55	476.19	2000.00	2000.00	1250.00	107.27	76.24
Mezzaine	2000.00	1428.57	1428.57	1000.00	769.23	3333.33	3333.33	2500.00	110.96	73.80

Story	Frame Stiffness Area 2								Center of Rigidity	
	5	6	7	-	E	F	G	H	X_R (ft)	Y_R (ft)
Roof	178.571	185.2	217.391	-	200.00	476.19	476.19	434.78	108.48	82.85
3	217.391	227.3	270.27	-	238.10	555.56	555.56	526.32	109.02	83.32
2	294.118	303.0	384.615	-	285.71	714.29	714.29	714.29	111.18	84.31
1	454.545	476.2	-	-	370.37	1000.00	1000.00	1000.00	112.15	50.14
Mezzaine	1000	1111.1	-	-	666.67	1666.67	1666.67	2000.00	115.50	51.58

Table 8: Center of Rigidity for Area 1 and Area 2

Direct, Torsional, & Net Forces:

In order to determine net forces acting on the frames, the calculation of direct and torsional forces need to be done. Direct forces relate to the relative stiffness of each frame on each level. Appendix E gives detailed calculations on how to solve for the direct forces for wind in both the north-south as well the east-west direction. Appendix H is for the direct forces due to seismic loads.

Torsional forces come from the torsional moment on a floor that is due to wind and/or seismic load. Appendixes F and I give the necessary calculations to determine the torsional forces due to wind (Appendix F) and seismic (Appendix I).

The following table show all three forces for Frames 2 and E in both wind and seismic. By inspection, wind forces will control, in north-south direction as well as the east-west direction, the drift of the building since the values are greater than the seismic.

Momet Frame 2 Net Forces: Wind				Moment Frame E Net Forces: Wind			
Level	Direct Forces (Kips)	Torsional Forces (Kips)	Net Forces (Kips)	Level	Direct Forces (Kips)	Torsional Forces (Kips)	Net Forces (Kips)
Roof	10.72	-0.52	11.24	Roof	5.19	-1.52	6.71
3rd	42.35	-2.25	44.60	3rd	20.81	-6.24	27.05
2nd	94.14	-6.05	100.19	2nd	43.02	-14.98	58.01
1st	160.02	-11.79	171.81	1st	71.75	-31.08	102.83
Mezzaine	283.73	-27.15	310.88	Mezzaine	123.90	-61.06	184.96

Momet Frame 2 Net Forces: Seismic				Moment Frame E Net Forces: Seismic			
Level	Direct Forces (Kips)	Torsional Forces (Kips)	Net Forces (Kips)	Level	Direct Forces (Kips)	Torsional Forces (Kips)	Net Forces (Kips)
Roof	17.73	-0.43	18.16	Roof	7.81	-2.27	10.08
3rd	101.58	-2.72	104.30	3rd	52.18	-15.63	67.81
2nd	62.07	-2.01	64.08	2nd	29.65	-10.33	39.98
1st	32.46	-1.20	33.66	1st	15.27	-6.60	21.87
Mezzaine	12.20	-0.59	12.79	Mezzaine	5.56	-2.75	8.31

Table 9: Net Force Results for Frame 2 and Frame E

Serviceability Check:

From the previous section of this report, the net forces figured out for Frames 2 and E determined and the loads were applied to the respected moment frames in SAP as well as the remaining thirteen frames. After comparing all the frames, it was determined by the author that Frame 2 controls the drift from wind in the north-south direction of Area 1 of Union Station while Frame E controls in the east-west direction of Area 2 for wind as well. This was concluded by noticing both of the frames deflect the most when the net forces are applied to each of them. However, neither Frame 2 nor E control in their respected direction in the area they are located in for seismic drift. Appendix K shows each the drift in both wind and seismic for each frame. The following frames will control in their respected direction and area for both wind and seismic.

Controlling Wind Drift: Area 1

N-S Direction: Moment Frame 2 E-W Direction: Moment Frame A

Controlling Wind Drift: Area 2

N-S Direction: Moment Frame 5 E-W Direction: Moment Frame E

Controlling Seismic Drift: Area 1

N-S Direction: Moment Frame 4 E-W Direction: Moment Frame A

Controlling Seismic Drift: Area 2

N-S Direction: Moment Frame 5 E-W Direction: Moment Frame E

Below are the tables for allowable drifts in Frames 2 and E for both wind and seismic. Wind drift was compared against $\triangle_{Wind}$ = H/400 while seismic drift was analyzed with $\triangle_{Seismic} = 0.015h_{SX}$. From looking at the tables, both moment frames pass the drift criteria for wind and seismic. However, while doing the other moment frames, some of them did not pass wind and/or seismic drift calculations. One possibility is how the author used properties or ordinary concrete instead of post tension. Another is the wind and seismic criteria for the loads are incorrect and there was a variable not taken into account throughout the calculations.

Wind Drift: Frame 2									
Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) Δ_{wind} = H/400			Total Drift (in)	Allowable Total Drift (in) Δ_{wind} = H/400		
Roof	11.500	0.187	<	0.345	Acceptable	1.108	<	1.94	Acceptable
3rd	11.500	0.147	<	0.345	Acceptable	0.921	<	1.595	Acceptable
2nd	11.500	0.226	<	0.345	Acceptable	0.774	<	1.25	Acceptable
1st	12.250	0.285	<	0.368	Acceptable	0.548	<	0.905	Acceptable
Mezzaine	17.917	0.263	<	0.538	Acceptable	0.263	<	0.5375	Acceptable

Wind Drift: Frame E									
Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) Δ_{wind} = H/400			Total Drift (in)	Allowable Total Drift (in) Δ_{wind} = H/400		
Roof	11.500	0.044	<	0.345	Acceptable	0.906	<	1.94	Acceptable
3rd	11.500	0.055	<	0.345	Acceptable	0.863	<	1.595	Acceptable
2nd	11.500	0.072	<	0.345	Acceptable	0.807	<	1.25	Acceptable
1st	12.250	0.256	<	0.368	Acceptable	0.735	<	0.905	Acceptable
Mezzaine	17.917	0.479	<	0.538	Acceptable	0.479	<	0.5375	Acceptable

Table 10: Wind Drift for Moment Frames 2 & E

Seismic Drift: Frame 2									
Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) $\Delta_{SEISMIC} = 0.015h_{sx}$			Total Drift (in)	Allowable Story Drift (in) $\Delta_{SEISMIC} = 0.015h_{sx}$		
Roof	11.500	0.102	<	0.173	Acceptable	0.727	<	0.97	Acceptable
3rd	11.500	0.139	<	0.173	Acceptable	0.625	<	0.7975	Acceptable
2nd	11.500	0.171	<	0.173	Acceptable	0.486	<	0.625	Acceptable
1st	12.250	0.173	<	0.184	Acceptable	0.315	<	0.4525	Acceptable
Mezzaine	17.917	0.142	<	0.269	Acceptable	0.142	<	0.2688	Acceptable

Seismic Drift: Frame E									
Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) $\Delta_{SEISMIC} = 0.015h_{sx}$			Total Drift (in)	Allowable Story Drift (in) $\Delta_{SEISMIC} = 0.015h_{sx}$		
Roof	11.500	0.047	<	0.173	Acceptable	0.554	<	0.97	Acceptable
3rd	11.500	0.061	<	0.173	Acceptable	0.507	<	0.7975	Acceptable
2nd	11.500	0.070	<	0.173	Acceptable	0.446	<	0.625	Acceptable
1st	12.250	0.162	<	0.184	Acceptable	0.376	<	0.4525	Acceptable
Mezzaine	17.917	0.214	<	0.269	Acceptable	0.214	<	0.2688	Acceptable

Table 11: Seismic Drift for Moment Frames 2 & E

Overturning Check:

One important aspect of designing is to determine if there will be overturning affects due to the moment caused by the building. A quick check was done for the expansion to Union Station for both areas for overturning moment. Table 12 shows how the check was done for both wind and seismic loads. By taking the controlling moment for each area and dividing by half the length in the direction that gives the controlling moment, a force (P) was determined. Comparing the value of P to half the weight of the area was done and since the weight in both areas is greater than P, overturning moment will not be an issue for both wind and seismic.

Overturning Check: Wind									
Area 1					Area 2				
Moment (ft-K)	L/2 (ft)	P (Kips)	W/2 (Kips)	Overturning Issue	Moment (ft-K)	L/2 (ft)	P (Kips)	W/2 (Kips)	Overturning Issue
45500	89	511.24	11055	No	44000	82.75	531.72	11055	No
Overturning Check: Seismic									
Area 1					Area 2				
Moment (ft-K)	L/2 (ft)	P (Kips)	W/2 (Kips)	Overturning Issue	Moment (ft-K)	L/2 (ft)	P (Kips)	W/2 (Kips)	Overturning Issue
22110	89	248.43	11055	No	21200	82.75	256.19	11055	No

Table 12: Overturning Check

Member Verification:

Hand calculations were done for the highlighted members on Frame 2. The column was done with PCA Column and the results show indicated the column is adequate to handle to loads that travel through it. The beam calculations were all done by hand and according to the results, the beam cable of handling the loads on the second floor by a factor of 2. Since the same beam is being used on each floor within the frame, the design of the beam makes sense when you reach the first and mezzanine level. Since the author used the assumption of regular concrete instead of post-tension, the values for the beam were designed by a conservative approach.

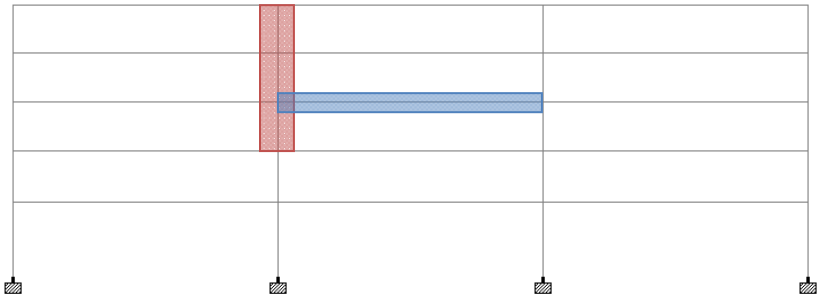
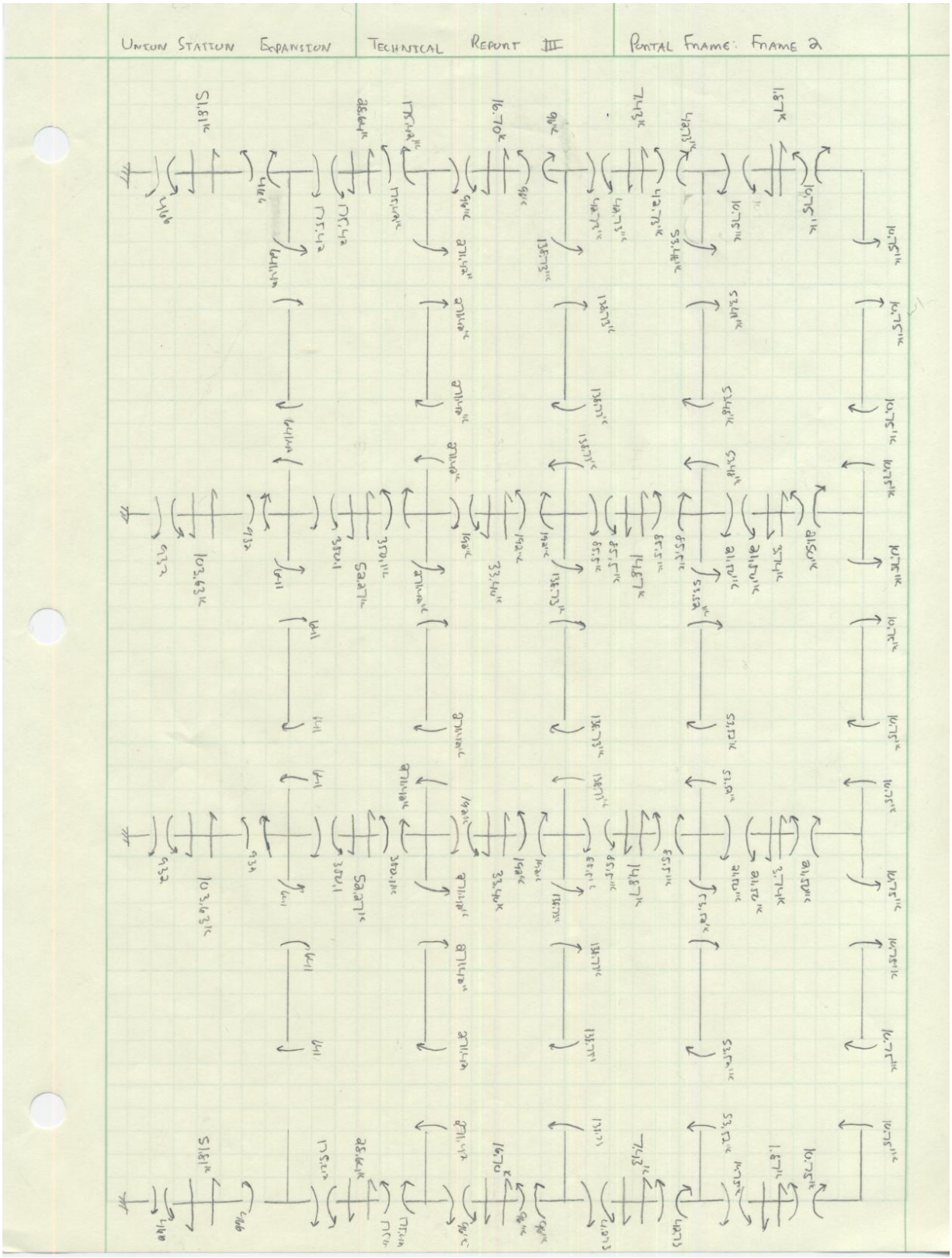
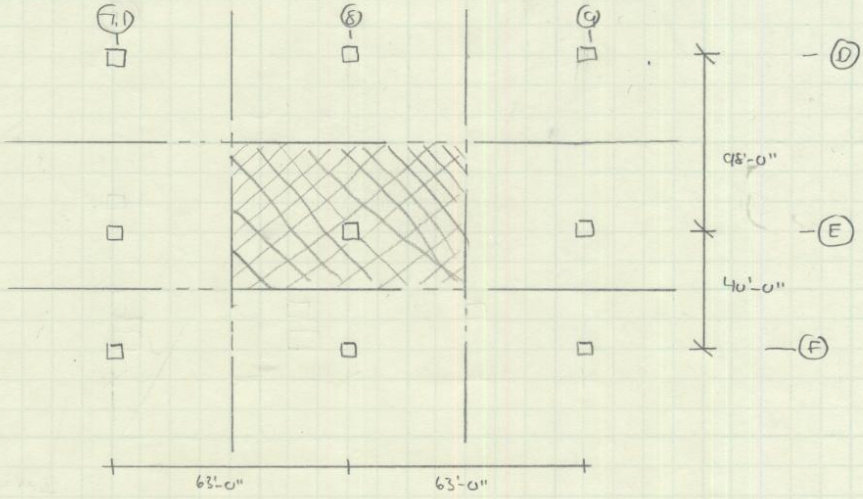


Figure 7: Designation of Members Checked By Hand Calculations


UNION STATION EXPANSION
TECHNICAL REPORT III
PENTAL FRAME: FRAME 2

UNION STATION EXPANSION | TECHNICAL REPORT III | COLUMN SPOT CHECK : FRAME 2



+ WILL LOOK AT COLUMN E/8 FROM 1ST LEVEL TO ROOF [3 FLOORS]

PROPERTIES: 40" x 40"
f'_c = 8ksi
f_y = 60 ksi
(20) #11 bars

LOADS =>

	DL	LL
ROOF :	70 psf	50 psf
3rd :	85 psf	50 psf
2nd :	85 psf	50 psf
1st :	85 psf	50 psf
	325 psf	200 psf

TRIB. AREA = $\left(\frac{63ft + 63ft}{2}\right)\left(\frac{95ft + 40ft}{2}\right)$ = 4347 ft²

DL = $\frac{325\,psf(4347\,ft^2)}{1000}$ = 1413 K

LL = $\frac{200\,psf(4347\,ft^2)}{1000}$ = 869 K

WIND = 21.5 ft-k @ TOP OF COLUMN
142 ft-k @ BOTTOM OF COLUMN
} SEE PORTAL METHOD PAGE

SEISMIC : WON'T CONTROL :: WON'T USE IN CALCULATIONS

SEE PCA COLUMN PAGES FOR VERIFICATION

```
pcaColumn v3.64 © Portland Cement Association                          Page   1
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 OOOOOOO    OOOOO    OOOOO    OOOOO    OOOOO   OO
 OO    OO  OO   OO  OO   OO  OO   OO  OO   OO  OO
 OO    OO  OO   OO  OO   OO  OO   OO  OO   OO  OO
 OO    OO  OO       OO   OO  OO       OO   OO  OO
 OO    OO  OO       OOOOOOO  OO       OO   OO  OO
 OOOOOOO   OO   OO  OO   OO  OO   OO  OO   OO  OO
 OO        OO   OO  OO   OO  OO   OO  OO   OO  OO
 OO         OOOOO   OO   OO   OOOOO    OOOOO   OOOOO  (TM)
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========================================================================
Computer program for the Strength Design of Reinforced Concrete Sections
========================================================================
```

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General Information:

File Name: untitled.col
Project: Tech III
Column: Grid Line 7 — Engineer: JWW
Code: ACI 318-02 — Units: English

Run Option: Investigation — Slenderness: Not considered
Run Axis: Y-axis — Column Type: Structural

Material Properties:

f'c = 8 ksi — fy = 60 ksi
Ec = 5098.24 ksi — Es = 30000 ksi
Ultimate strain = 0.003 in/in
Beta1 = 0.65

Section:

Rectangular: Width = 40 in — Depth = 40 in

Gross section area, Ag = 1600 in^2
Ix = 213333 in^4 — Iy = 213333 in^4
Xo = 0 in — Yo = 0 in

Reinforcement:

Rebar Database: ASTM A615

Size	Diam (in)	Area (in^2)	Size	Diam (in)	Area (in^2)	Size	Diam (in)	Area (in^2)
# 3	0.38	0.11	# 4	0.50	0.20	# 5	0.63	0.31
# 6	0.75	0.44	# 7	0.88	0.60	# 8	1.00	0.79
# 9	1.13	1.00	# 10	1.27	1.27	# 11	1.41	1.56
# 14	1.69	2.25	# 18	2.26	4.00			

Confinement: Tied; #3 ties with #10 bars, #4 with larger bars.
phi(a) = 0.8, phi(b) = 0.9, phi(c) = 0.65

Layout: Rectangular
Pattern: Equal Bar Spacing (Cover to transverse reinforcement)
Total steel area, As = 45.00 in^2 at 2.81%
20 #14 Cover = 1.5 in

Load Combinations:

U1 = 1.400*Dead + 0.000*Live + 0.000*Wind + 0.000*EarthQuake
U2 = 1.200*Dead + 1.600*Live + 0.000*Wind + 0.000*EarthQuake
U3 = 1.200*Dead + 1.000*Live + 0.000*Wind + 0.000*EarthQuake
U4 = 1.200*Dead + 0.000*Live + 0.800*Wind + 0.000*EarthQuake
U5 = 1.200*Dead + 1.000*Live + 1.600*Wind + 0.000*EarthQuake
U6 = 0.900*Dead + 0.000*Live + 1.600*Wind + 0.000*EarthQuake
U7 = 1.200*Dead + 0.000*Live - 0.800*Wind + 0.000*EarthQuake
U8 = 1.200*Dead + 1.000*Live - 1.600*Wind + 0.000*EarthQuake
U9 = 0.900*Dead + 0.000*Live - 1.600*Wind + 0.000*EarthQuake
U10 = 1.200*Dead + 1.000*Live + 0.000*Wind + 1.000*EarthQuake
U11 = 0.900*Dead + 0.000*Live + 0.000*Wind + 1.000*EarthQuake
U12 = 1.200*Dead + 1.000*Live + 0.000*Wind - 1.000*EarthQuake
U13 = 0.900*Dead + 0.000*Live + 0.000*Wind - 1.000*EarthQuake

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Service Loads:

No.	Load Case	Axial Load kip	Mx @ Top k-ft	Mx @ Bot k-ft	My @ Top k-ft	My @ Bot k-ft
1	Dead	1413.0	0.0	0.0	0.0	0.0
	Live	869.0	0.0	0.0	0.0	0.0
	Wind	0.0	0.0	0.0	21.5	192.0
	E.Q.	0.0	0.0	0.0	0.0	0.0

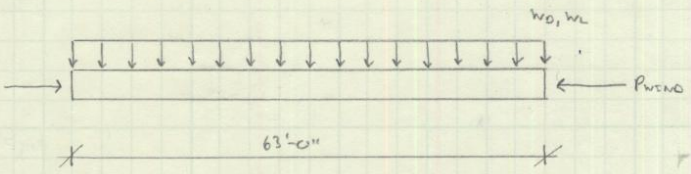
Factored Loads and Moments with Corresponding Capacities: (see user's manual for notation)

NOTE: Each loading combination includes the following cases:
First line - at column top
Second line - at column bottom

No.	Load Combo	Pu kip	Muy k-ft	fMny k-ft	fMn/Mu
1	1 U1	1978.2	0.0	4911.4	999.999
2		1978.2	0.0	4911.4	999.999
3	1 U2	3086.0	0.0	4260.8	999.999
4		3086.0	0.0	4260.8	999.999
5	1 U3	2564.6	0.0	4383.2	999.999
6		2564.6	0.0	4383.2	999.999
7	1 U4	1695.6	17.2	5172.2	300.710
8		1695.6	-153.6	-5172.2	33.673
9	1 U5	2564.6	34.4	4383.2	127.420
10		2564.6	-307.2	-4383.2	14.268
11	1 U6	1271.7	34.4	4825.9	140.287
12		1271.7	-307.2	-4825.9	15.709
13	1 U7	1695.6	-17.2	-5172.2	300.710
14		1695.6	153.6	5172.2	33.673
15	1 U8	2564.6	-34.4	-4383.2	127.420
16		2564.6	307.2	4383.2	14.268
17	1 U9	1271.7	-34.4	-4825.9	140.287
18		1271.7	307.2	4825.9	15.709
19	1 U10	2564.6	0.0	4383.2	999.999
20		2564.6	0.0	4383.2	999.999
21	1 U11	1271.7	0.0	4825.9	999.999
22		1271.7	0.0	4825.9	999.999
23	1 U12	2564.6	0.0	4383.2	999.999
24		2564.6	0.0	4383.2	999.999
25	1 U13	1271.7	0.0	4825.9	999.999
26		1271.7	0.0	4825.9	999.999

*** Program completed as requested! ***

UNION STATION EXPANSION | TECHNICAL REPORT III | BEAM SPOT CHECK : FRAME 2 | 1



20x36 P/T BEAM — d = 37" — (8) #8 BARS [REGULAR REINF.]
f'_c = 5000 psi — h = 36" — P/T TENDONS
f_y = 60,000 psi — b = 20"

W_D = 70 psf [SLAB]
+ 15 psf [MISC, FINISH, & MEP]
85 psf

W_L = 50 psf [OFFICE]

TRIB AREA = $63ft\left[\frac{40ft + 98ft}{2}\right] = 4347\ ft^2$

$\frac{85\ psf(4347\ ft^2)}{1000} = 369^k = P_D$

$\frac{50\ psf(4347\ ft^2)}{1000} = 217^k = P_L$

$P_{WIND} = 100^k$

$V_u = 1.2D + 1.6L + 1.0W$

$V_u = 1.2(369^k) + 1.6(217^k) + 1.0(100^k)$

$V_u = 890^k$

$M_u = 138.73\ ft\text{-}k(1.0) + \frac{[1.2(85) + 1.0(50)](69ft)(63ft)}{12(1000)}$

$M_u = 205\ ft\text{-}k$

THE 138.73 ft-k CAME FROM PORTAL FRAME CALCULATIONS DUE TO WIND

Union Station Expansion | Technical Report III | Beam Spot Check: Frame 2 | 2

Compressive Axial Force:

$M_m = M_u - N_u\left(\frac{4h-d}{6}\right) = 205 - 100\left(\frac{4(34)-33}{6(12)}\right) = 89.44^{k-ft}$

$V_c = \left(1.9\sqrt{f'_c} + 2500\frac{\rho_w V_u d}{M_u}\right) b_w d \qquad \rho_w = \frac{0.78(6)}{(20)(36)} = 0.00567$

$V_c = \left(1.9\sqrt{5000} + 2500\left(\frac{0.00567(89.4)(33)}{205}\right)\right)\frac{(20)(33)}{1000} = 21.38^{k}$

$a = \frac{A_s f_y}{0.85 f'_c b} = \frac{6(0.79in^2)(60ksi)}{0.85(5ksi)(20in)} = 4.45in$

$\beta = 0.85 - \frac{0.05}{1000}(5000-4000) = 0.80$

$c = \frac{a}{\beta} = \frac{4.45in}{0.80} = 5.56in$

$\varepsilon_s = \frac{0.003(d-c)}{c} = \frac{0.003(33in-5.56in)}{5.56in} = 0.0148in/in \gg 0.005\ in/in \therefore \phi = 0.9$

$\phi V_c = 21.38^{k}(0.9)$

$\phi V_c = 19.24^{k} > V_u = 89.4^{k}$ ∴ OKAY In Compression

* Tension is the same value ∴ OKAY In Tension

CONCLUSION

Throughout this technical report, a detailed look at the lateral system for two of the fifteen frames in the expansion to Union Station was accomplished as well as spot checks on a beam and column in Frame 2. Both of the frames past the allowable wind and seismic drift and the members checked were adequate to carry the required loads.

While Frames 2 and E in the report past the criteria, Frames 5 through 7 did not pass either the wind or seismic drift. As stated within the executive summary and throughout the body of the report, one possibility for this was using the properties of ordinary concrete instead of post-tension. Another possibility that the author believes that all three frames did not pass was excluding a moment frame that did not seem representative of one. By inspecting Figure 1 from Appendix A, the end of Area 2 is an overhang. Here there are no columns running from the roof to the ground floor, but there are columns that run from the roof to the second floor.

After reviewing the drawings and all calculations for this technical report, the author determined that the column line Aa is indeed a moment frame for the supporting floors of the overhang. If the author was to include this moment frame within the report, there is the possibility that Frames 5 through 7 would pass because there would be an additional frame that would take lateral load from the other three frames spanning in the respective direction.

Moment Frames 1 through 3 with respect to seismic forces had one level not pass the criteria. Not using the properties of post-tension concrete is the best beliefs for the frames to have a floor not passing the criteria.

From inspection by the calculations done for this technical report, the wind loads will act as the controlling lateral load. Each area of Union Station is capable of handling the wind load, as well as the seismic, if the worst case scenario load came in contact with the building.

APPENDIX A: PLANS & SECTIONS

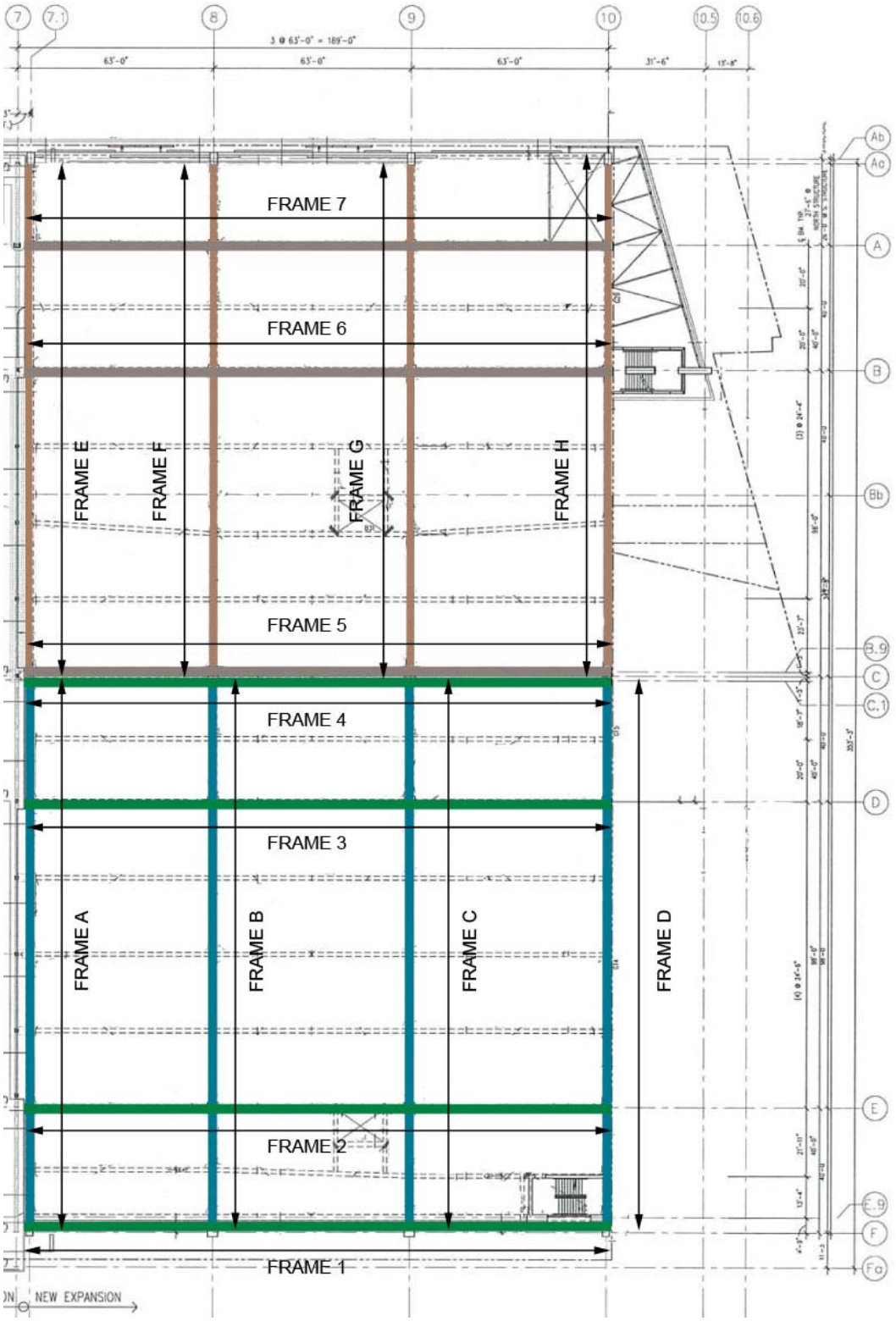


Figure 1: Moment Frame Designation for Technical Report III

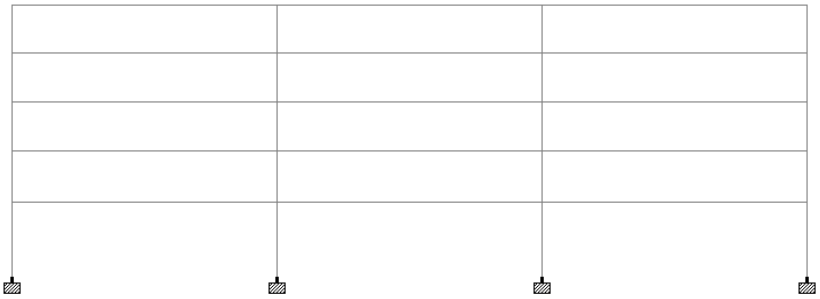


Figure 2: Moment Frames 1 Through 6

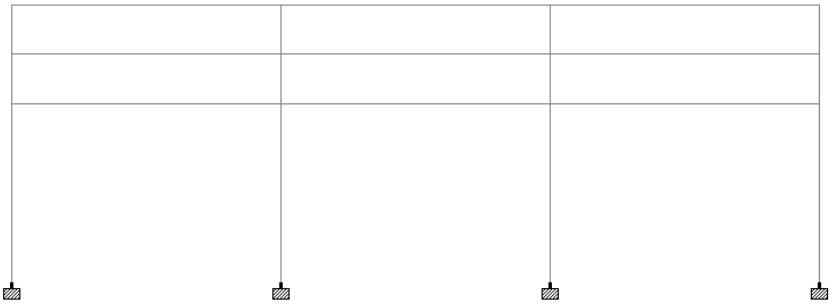


Figure 3: Moment Frame 7

Figure 4: Moment Frames A Through D

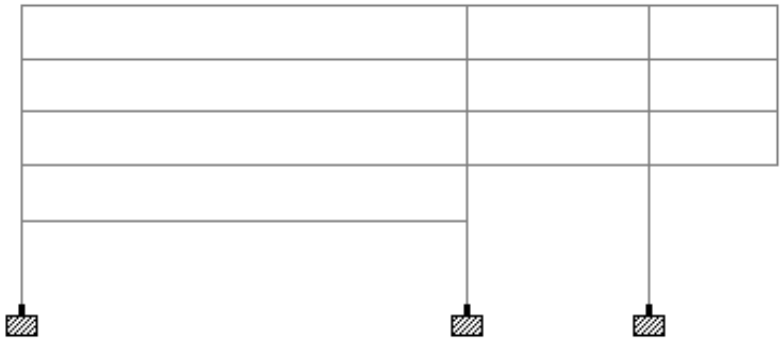


Figure 5: Moment Frames E Through H

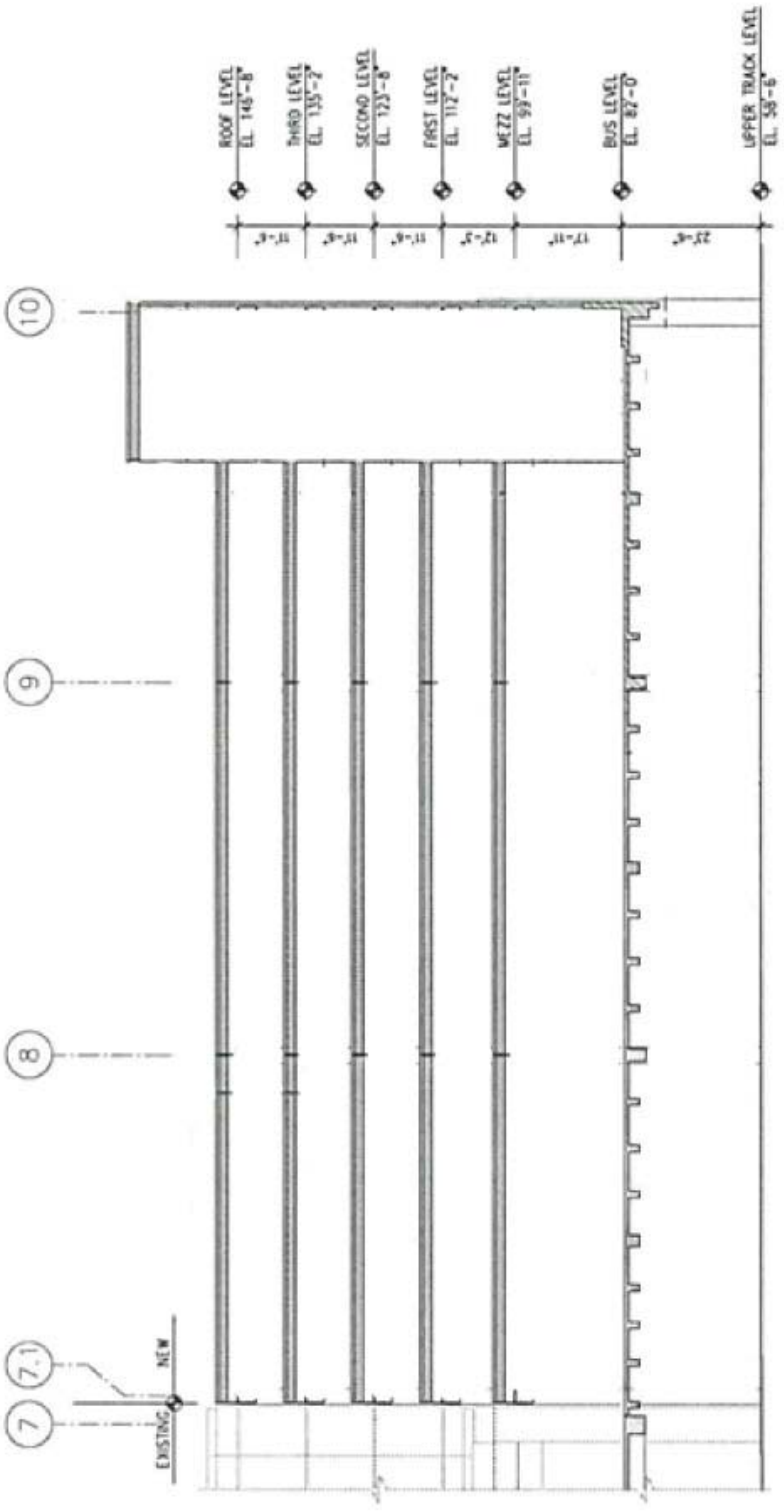


Figure 6: Section of Union Station

APPENDIX B: WIND CRITERIA & LOADS

General Information	
Basic Wind Speed (V)	90 mph
Wind Exposure Category	B
Building Category	III
Importance Factor	1.15
Wind Directionality Factor (K_d)	0.85
Topographic factor (K_{zt})	1.0

Number of Stories	5
Building Height (Feet)[1]	90.62
N-S Building Length (Feet)	178
E-W Building Length (Feet)	189
L/B in N-S Direction	0.942
L/B in E-W Direction	1.06

1) Height Includes Parapet On Roof & Track

Table 1: General Wind Information for Union Station: Area 1

Gust Factor		
Variable	Wind Direction	
	N-S	E-W
Stiffness	Rigid	Rigid
B (Feet)	189	178
L (Feet)	178	189
h (Feet)[2]	65.67	65.67
c	0.30	0.30
z (Feet)	52.9	52.9
I_z	0.291	0.291
l (Feet)	320	320
$\in$	1/3.0	1/3.0
L_z (Feet)	340	340
Q	0.81	0.77
g_Q & g_v	3.4	3.4
G	0.81	0.81

2) Doesn't Include Track Level

Table 2: Gust Factor Variables for Union Station: Area 1

Wind Direction	C_p, Windward	C_p, Leeward	Gust Factor	GC_{pi}[3]
N-S Direction	0.8	-0.5	0.81	±0.55
E-W Direction	0.8	-0.25	0.81	±0.55

3) Used since there are multiple openings in the façade

Table 3: Variables for Wind Calculations for Union Station: Area 1

Wind (North-South)										
Level	Height (Feet)	Tributary Area (Feet)	K_z	q_z (psf)	Windward (psf)	Leeward (psf)	Total (psf)	Story Force (Kips)	Story Shear (Kips)	Overturning Moment (Ft-Kips)
Roof	90.62	5.75	0.96	19.5	23.3	-18.6	41.9	42.9	42.9	246.6
3	76.67	11.5	0.92	18.6	22.3	-18.6	40.9	170.5	213.4	1720.2
2	65.17	11.5	0.87	17.6	21.1	-18.6	39.7	380.7	594.1	6363.3
1	53.67	11.875	0.82	16.6	19.9	-18.6	38.5	680.4	1274.5	17457.8
Mezzaine	41.42	15.1	0.77	15.6	18.7	-18.6	37.3	1163.3	2437.7	45484.8
Ground	23.5	10.96	0.65	13.2	15.8	-18.6	34.4	1163.3	2437.7	45484.8
Track Level	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2437.7	45484.8

Table 4: North-South Pressures, Forces, & Overturning Moment for Union Station: Area 1

Wind (East-West)										
Level	Height (Feet)	Tributary Area (Feet)	K_z	q_z (psf)	Windward (psf)	Leeward (psf)	Total (psf)	Story Force (Kips)	Story Shear (Kips)	Overturning Moment (Ft-Kips)
Roof	90.62	5.75	0.96	19.5	23.3	-14.6	38.0	41.2	41.2	237.2
3	76.67	11.5	0.92	18.6	22.3	-14.6	37.0	163.9	205.2	1654.1
2	65.17	11.5	0.87	17.6	21.1	-14.6	35.8	365.7	570.9	6116.3
1	53.67	11.875	0.82	16.6	19.9	-14.6	34.6	652.9	1223.8	16771.9
Mezzaine	41.42	15.1	0.77	15.6	18.7	-14.6	33.3	1115.1	2338.8	43669.6
Ground	23.5	10.96	0.65	13.2	15.8	-14.6	30.4	1115.1	2338.8	43669.6
Track Level	0	0	0	0.0	0.0	-14.6	14.6	0.0	2338.8	43669.6

Table 5: East-West Pressures, Forces, & Overturning Moment for Union Station: Area 1

General Information	
Basic Wind Speed (V)	90 mph
Wind Exposure Category	B
Building Category	III
Importance Factor	1.15
Wind Directionality Factor (K_d)	0.85
Topographic factor (K_{zt})	1.0

Number of Stories	5
Building Height (Feet)[1]	90.62
N-S Building Length (Feet)	165.5
E-W Building Length (Feet)	189
L/B in N-S Direction	0.876
L/B in E-W Direction	1.14

1) Height Includes Parapet On Roof & Track

Table 6: General Wind Information for Union Station: Area 2

Gust Factor		
Variable	Wind Direction	
	N-S	E-W
Stiffness	Rigid	Rigid
B (Feet)	189	165.5
L (Feet)	165.5	189
h (Feet)^2	65.67	65.67
c	0.30	0.30
z (Feet)	52.9	52.9
I_z	0.291	0.291
l (Feet)	320	320
$\in$	1/3.0	1/3.0
L_z (Feet)	340	340
Q	0.81	0.77
g_Q & g_v	3.4	3.4
G	0.81	0.81

2) Doesn't Include Track Level

Table 7: Gust Factor Variables for Union Station: Area 2

Wind Direction	C_p, Windward	C_p, Leeward	Gust Factor	GC_{pi}[3]
N-S Direction	0.8	-0.5	0.81	±0.55
E-W Direction	0.8	-0.25	0.81	±0.55

3) Used since there are multiple openings in the façade

Table 8: Variables for Wind Calculations for Union Station: Area 2

Wind (North-South)										
Level	Height (Feet)	Tributary Area (Feet)	K_z	q_z (psf)	Windward (psf)	Leeward (psf)	Total (psf)	Story Force (Kips)	Story Shear (Kips)	Overturning Moment (Ft-Kips)
Roof	90.62	5.75	0.96	19.5	23.3	-18.6	41.9	39.9	39.9	229.2
3	76.67	11.5	0.92	18.6	22.3	-18.6	40.9	158.5	198.4	1599.4
2	65.17	11.5	0.87	17.6	21.1	-18.6	39.7	354.0	552.4	5916.4
1	53.67	11.875	0.82	16.6	19.9	-18.6	38.5	632.6	1185.0	16231.8
Mezzaine	41.42	15.1	0.77	15.6	18.7	-18.6	37.3	1081.6	2266.5	42290.6
Ground	23.5	10.96	0.65	13.2	15.8	-18.6	34.4	1081.6	2266.5	42290.6
Track Level	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2266.5	42290.6

Table 9: North-South Pressures, Forces, & Overturning Moment for Union Station: Area 2

Wind (East-West)										
Level	Height (Feet)	Tributary Area (Feet)	K_z	q_z (psf)	Windward (psf)	Leeward (psf)	Total (psf)	Story Force (Kips)	Story Shear (Kips)	Overturning Moment (Ft-Kips)
Roof	90.62	5.75	0.96	19.5	23.3	-14.6	38.0	41.2	41.2	237.2
3	76.67	11.5	0.92	18.6	22.3	-14.6	37.0	163.9	205.2	1654.1
2	65.17	11.5	0.87	17.6	21.1	-14.6	35.8	365.7	570.9	6116.3
1	53.67	11.875	0.82	16.6	19.9	-14.6	34.6	652.9	1223.8	16771.9
Mezzaine	41.42	15.1	0.77	15.6	18.7	-14.6	33.3	1115.1	2338.8	43669.6
Ground	23.5	10.96	0.65	13.2	15.8	-14.6	30.4	1115.1	2338.8	43669.6
Track Level	0	0	0	0.0	0.0	-14.6	14.6	0.0	2338.8	43669.6

Table 10: East-West Pressures, Forces, & Overturning Moment for Union Station: Area 2

APPENDIX C: SEISMIC CRITERIA & LOADS

Seismic Parameters													
S_s	S_1	Site Class	Occupancy Category	Importance Factor	F_a	F_v	S_{MS}	S_{M1}	S_{DS}	S_{D1}	Seismic Design Category	R	C_u
0.153	0.05	D	III	1.25	1.6	2.4	0.245	0.120	0.163	0.080	B	3	1.7
T_a	T	T_s	C_s	Roof Dead Load (psf)	Floor Dead Load (psf)[1]	Snow Load (psf)	Wall Load (psf)	W_{roof} (kips)	W_{floor} (kips)[2]	W (Kips)	A (ft^2)	P (ft)	V (kips)
0.901	1.53	0.490	0.0218	75	140	21	35	3268	38840	42108	33642	734	918

1) Floor dead loads include the weight of the slab, beams, girders, and columns
2) Total force for all levels not including roof

Table 1: Seismic Design Parameters for Union Station: Area 1

Level	Height (Feet)	Tributary Area (Feet)	C_{vx}	F_x (Kips)	Overturning Moment (Ft-Kips)
Roof	88.12	5.75	0.08	71	405.8
3	76.67	11.5	0.45	409	3566.5
2	65.17	11.5	0.27	251	10518.9
1	53.67	11.875	0.15	138	20007.4
Mezzaine	41.42	15.1	0.05	50	33491.7
Ground	23.5	10.96	1.00	918	33491.7
Track Level	0	0	1.00	918	33491.7

Table 2: Seismic Shear & Overturning Moment for Union Station: Area 1

Seismic Parameters													
S_s	S_1	Site Class	Occupancy Category	Importance Factor	F_a	F_v	S_{MS}	S_{M1}	S_{DS}	S_{D1}	Seismic Design Category	R	C_u
0.153	0.05	D	III	1.25	1.6	2.4	0.245	0.120	0.163	0.080	B	3	1.7
T_a	T	T_s	C_s	Roof Dead Load (psf)	Floor Dead Load (psf)[1]	Snow Load (psf)	Wall Load (psf)	W_{roof} (kips)	W_{floor} (kips)[2]	W (Kips)	A (ft^2)	P (ft)	V (kips)
0.901	1.53	0.490	0.0218	75	140	21	35	3044	38840	41884	31279.5	709	913

1) Floor dead loads include the weight of the slab, beams, girders, and columns
2) Total force for all levels not including roof

Table 3: Seismic Design Parameters for Union Station: Area 2

Level	Height (Feet)	Tributary Area (Feet)	C_{vx}	F_x (Kips)	Overturning Moment (Ft-Kips)
Roof	88.12	5.75	0.07	62	353.8
3	76.67	11.5	0.45	411	3421.9
2	65.17	11.5	0.28	252	10300.5
1	53.67	11.875	0.15	139	19724.0
Mezzaine	41.42	15.1	0.05	50	33132.6
Ground	23.5	10.96	1.00	913	33132.6
Track Level	0	0	1.00	913	33132.6

Table 4: Seismic Shear & Overturning Moment for Union Station: Area 2

APPENDIX D: RELATIVE STIFFNESS FOR MOMENT FRAMES

Moment Frame 1: Area 1		
Level	Displacement (In)	Stiffness (Kip/in)
Roof	0.0039	256.41
3	0.0031	322.58
2	0.0021	476.19
1	0.0012	833.33
Mezzaine	0.0005	2000.00
Total		777.70

Moment Frame 2: Area 1		
Level	Displacement (In)	Stiffness (Kip/in)
Roof	0.0047	212.77
3	0.0038	263.16
2	0.0027	370.37
1	0.0017	588.24
Mezzaine	0.0007	1428.57
Total		572.62

Moment Frame 3: Area 1		
Level	Displacement (In)	Stiffness (Kip/in)
Roof	0.0049	204.08
3	0.0039	256.41
2	0.0028	357.14
1	0.0016	625.00
Mezzaine	0.0007	1428.57
Total		574.24

Moment Frame 4: Area 1		
Level	Displacement (In)	Stiffness (Kip/in)
Roof	0.0056	178.57
3	0.0046	217.39
2	0.0034	294.12
1	0.0022	454.55
Mezzaine	0.001	1000.00
Total		428.93

Moment Frame 5: Area 2		
Level	Displacement (In)	Stiffness (Kip/in)
Roof	0.0056	178.57
3	0.0046	217.39
2	0.0034	294.12
1	0.0022	454.55
Mezzaine	0.001	1000.00
Total		428.93

Moment Frame 6: Area 2		
Level	Displacement (In)	Stiffness (Kip/in)
Roof	0.0054	185.19
3	0.0044	227.27
2	0.0033	303.03
1	0.0021	476.19
Mezzaine	0.0009	1111.11
Total		460.56

Moment Frame 7: Area 2		
Level	Displacement (In)	Stiffness (Kip/in)
Roof	0.0046	217.39
3	0.0037	270.27
2	0.0026	384.62
1	-	-
Mezzaine	-	-
Total		174.46

Table 1: Moment Frames 1 Through 7 Level & Total Stiffness

Moment Frame A: Area 1		
Level	Displacement (In)	Stiffness (Kip/in)
Roof	0.0042	238.10
3	0.0036	277.78
2	0.0029	344.83
1	0.0021	476.19
Mezzaine	0.0013	769.23
Total		421.22

Moment Frame B: Area 1		
Level	Displacement (In)	Stiffness (Kip/in)
Roof	0.0011	909.09
3	0.001	1000.00
2	0.0007	1428.57
1	0.0005	2000.00
Mezzaine	0.0003	3333.33
Total		1734.20

Moment Frame C: Area 1		
Level	Displacement (In)	Stiffness (Kip/in)
Roof	0.0011	909.09
3	0.001	1000.00
2	0.0007	1428.57
1	0.0005	2000.00
Mezzaine	0.0003	3333.33
Total		1734.20

Moment Frame D: Area 1		
Level	Displacement (In)	Stiffness (Kip/in)
Roof	0.0023	434.78
3	0.0019	526.32
2	0.0014	714.29
1	0.0008	1250.00
Mezzaine	0.0004	2500.00
Total		1085.08

Moment Frame E: Area 2		
Level	Displacement (In)	Stiffness (Kip/in)
Roof	0.005	200.00
3	0.0042	238.10
2	0.0035	285.71
1	0.0027	370.37
Mezzaine	0.0015	666.67
Total		352.17

Moment Frame F: Area 2		
Level	Displacement (In)	Stiffness (Kip/in)
Roof	0.0021	476.19
3	0.0018	555.56
2	0.0014	714.29
1	0.001	1000.00
Mezzaine	0.0006	1666.67
Total		882.54

Moment Frame G: Area 2		
Level	Displacement (In)	Stiffness (Kip/in)
Roof	0.0021	476.19
3	0.0018	555.56
2	0.0014	714.29
1	0.001	1000.00
Mezzaine	0.0006	1666.67
Total		882.54

Moment Frame H: Area 2		
Level	Displacement (In)	Stiffness (Kip/in)
Roof	0.0023	434.78
3	0.0019	526.32
2	0.0014	714.29
1	0.001	1000.00
Mezzaine	0.0005	2000.00
Total		935.08

Table 2: Moment Frames A Through H Level & Total Stiffness

APPENDIX E: DIRECT FORCES DUE TO WIND

Direct Forces: Area 1 (N-S Direction)				
Roof	K_i	P	ΣK_i	Force (Kips)
1.00	256.41	42.90	851.83	12.91
2.00	212.77	42.90	851.83	10.72
3.00	204.08	42.90	851.83	10.28
4.00	178.57	42.90	851.83	8.99
			Total	42.90
Direct Forces: Area 1 (E-W Direction)				
Roof	K_i	P	ΣK_i	Force (Kips)
A	238.10	41.20	2491.06	3.94
B	909.09	41.20	2491.06	15.04
C	909.09	41.20	2491.06	15.04
D	434.78	41.20	2491.06	7.19
			Total	41.20

Direct Forces: Area 1 (N-S Direction)				
3rd Floor	K_i	P	ΣK_i	Force (Kips)
1.00	322.58	170.50	1059.54	51.91
2.00	263.16	170.50	1059.54	42.35
3.00	256.41	170.50	1059.54	41.26
4.00	217.39	170.50	1059.54	34.98
			Total	170.50
Direct Forces: Area 1 (E-W Direction)				
3rd Floor	K_i	P	ΣK_i	Force (Kips)
A	277.78	163.90	2804.10	16.24
B	1000.00	163.90	2804.10	58.45
C	1000.00	163.90	2804.10	58.45
D	526.32	163.90	2804.10	30.76
			Total	163.90

Direct Forces: Area 1 (N-S Direction)				
2nd Floor	K_i	P	ΣK_i	Force (Kips)
1.00	476.19	380.70	1497.82	121.03
2.00	370.37	380.70	1497.82	94.14
3.00	357.14	380.70	1497.82	90.77
4.00	294.12	380.70	1497.82	74.76
			Total	380.70
Direct Forces: Area 1 (E-W Direction)				
2nd Floor	K_i	P	ΣK_i	Force (Kips)
A	344.83	365.70	3916.26	32.20
B	1428.57	365.70	3916.26	133.40
C	1428.57	365.70	3916.26	133.40
D	714.29	365.70	3916.26	66.70
			Total	365.70

Table 1: Direct Forces Due to Wind on Union Station: Area 1

Direct Forces: Area 1 (N-S Direction)				
1st Floor	K_i	P	ΣK_i	Force (Kips)
1.00	833.33	680.40	2501.12	226.70
2.00	588.24	680.40	2501.12	160.02
3.00	625.00	680.40	2501.12	170.02
4.00	454.55	680.40	2501.12	123.65
			Total	680.40
Direct Forces: Area 1 (E-W Direction)				
1st Floor	K_i	P	ΣK_i	Force (Kips)
A	476.19	652.90	5726.19	54.30
B	2000.00	652.90	5726.19	228.04
C	2000.00	652.90	5726.19	228.04
D	1250.00	652.90	5726.19	142.52
			Total	652.90

Direct Forces: Area 1 (N-S Direction)				
Mezzaine	K_i	P	ΣK_i	Force (Kips)
1.00	2000.00	1163.30	5857.14	397.22
2.00	1428.57	1163.30	5857.14	283.73
3.00	1428.57	1163.30	5857.14	283.73
4.00	1000.00	1163.30	5857.14	198.61
			Total	1163.30
Direct Forces: Area 1 (E-W Direction)				
Mezzaine	K_i	P	ΣK_i	Force (Kips)
A	769.23	1115.10	9935.89	86.33
B	3333.33	1115.10	9935.89	374.10
C	3333.33	1115.10	9935.89	374.10
D	2500.00	1115.10	9935.89	280.57
			Total	1115.10

Table 1 Continued

Direct Forces: Area 2 (N-S Direction)				
Roof	K_i	P	ΣK_i	Force (Kips)
5.00	178.57	39.90	581.15	12.26
6.00	185.19	39.90	581.15	12.71
7.00	217.39	39.90	581.15	14.93
-	-	-	-	-
			Total	39.90
Direct Forces: Area 2 (E-W Direction)				
Roof	K_i	P	ΣK_i	Force (Kips)
E	200.00	41.20	1587.16	5.19
F	476.19	41.20	1587.16	12.36
G	476.19	41.20	1587.16	12.36
H	434.78	41.20	1587.16	11.29
			Total	41.20

Direct Forces: Area 2 (N-S Direction)				
3rd Floor	K_i	P	ΣK_i	Force (Kips)
5.00	217.39	158.50	714.93	48.20
6.00	227.27	158.50	714.93	50.39
7.00	270.27	158.50	714.93	59.92
-	-	-	-	-
			Total	158.50
Direct Forces: Area 2 (E-W Direction)				
3rd Floor	K_i	P	ΣK_i	Force (Kips)
E	238.10	163.90	1875.54	20.81
F	555.56	163.90	1875.54	48.55
G	555.56	163.90	1875.54	48.55
H	526.32	163.90	1875.54	45.99
			Total	163.90

Direct Forces: Area 2 (N-S Direction)				
2nd Floor	K_i	P	ΣK_i	Force (Kips)
5.00	294.12	354.00	981.77	106.05
6.00	303.03	354.00	981.77	109.26
7.00	384.62	354.00	981.77	138.68
-	-	-	-	-
			Total	354.00
Direct Forces: Area 2 (E-W Direction)				
2nd Floor	K_i	P	ΣK_i	Force (Kips)
E	285.71	365.70	2428.58	43.02
F	714.29	365.70	2428.58	107.56
G	714.29	365.70	2428.58	107.56
H	714.29	365.70	2428.58	107.56
			Total	365.70

Table 2: Direct Forces Due to Wind on Union Station: Area 2

Direct Forces: Area 2 (N-S Direction)				
1st Floor	K_i	P	ΣK_i	Force (Kips)
5.00	454.55	632.60	930.74	308.95
6.00	476.19	632.60	930.74	323.65
7.00	-	-	-	-
-	-	-	-	-
			Total	632.60
Direct Forces: Area 2 (E-W Direction)				
1st Floor	K_i	P	ΣK_i	Force (Kips)
E	370.37	652.90	3370.37	71.75
F	1000.00	652.90	3370.37	193.72
G	1000.00	652.90	3370.37	193.72
H	1000.00	652.90	3370.37	193.72
			Total	652.90

Direct Forces: Area 2 (N-S Direction)				
Mezzaine	K_i	P	ΣK_i	Force (Kips)
5.00	1000.00	1081.60	2111.11	512.34
6.00	1111.11	1081.60	2111.11	569.26
7.00	-	-	-	-
-	-	-	-	-
			Total	1081.60
Direct Forces: Area 2 (E-W Direction)				
Mezzaine	K_i	P	ΣK_i	Force (Kips)
E	666.67	1115.10	6000.01	123.90
F	1666.67	1115.10	6000.01	309.75
G	1666.67	1115.10	6000.01	309.75
H	2000.00	1115.10	6000.01	371.70
			Total	1115.10

Table 2 Continued

APPENDIX F: TORSIONAL FORCES DUE TO WIND

Torsional Moment Due To Wind: Area 1						
Level	Story Force (Kips) North-South	Story Force (Kips) East-West	e_{N-S} (ft)	e_{E-W} (ft)	M_{N-S} (ft-kips)	M_{E-W} (ft-kips)
Roof	42.88	41.25	8.63	7.46	370.14	307.76
3	170.52	163.93	9.15	8.38	1559.90	1373.07
2	380.69	365.68	11.25	8.92	4283.33	3260.05
1	680.37	652.92	12.76	12.77	8680.52	8337.96
Mezzaine	1163.26	1115.05	15.20	16.46	17675.92	18355.20

Torsional Moment Due To Wind: Area 2						
Level	Story Force (Kips) North-South	Story Force (Kips) East-West	e_{N-S} (ft)	e_{E-W} (ft)	M_{N-S} (ft-kips)	M_{E-W} (ft-kips)
Roof	39.87	41.25	6.15	13.98	245.18	576.59
3	158.55	163.93	5.68	14.52	900.17	2380.65
2	353.96	365.68	4.69	16.68	1659.55	6098.22
1	632.59	652.92	38.86	17.65	24582.69	11526.54
Mezzaine	1081.57	1115.05	2.58	21.00	2789.32	23416.10

Table 1: Torsional Moments Due to Wind

Forces By Torsional Moment: N-S Direction (Area 1)				
Roof	K_i	d_i	$K_i d_i^2$	Force (Kips)
1	256.41	-80.37	1656239	-1.255
2	212.77	-40.37	346759	-0.523
3	204.08	57.63	677794	0.717
4	178.57	97.63	1702061	1.062
A	238.10	-101.96	2475250	-1.479
B	909.09	-38.96	1379891	-2.158
C	909.09	24.04	525383	1.331
D	434.78	87.04	3293877	2.306
		Total	12057253	0.00

Forces By Torsional Moment: E-W Direction (Area 1)				
Roof	K_i	d_i	$K_i d_i^2$	Force (Kips)
1	256.41	-80.37	1656148	-0.526
2	212.77	-40.37	346714	-0.219
3	204.08	57.63	677852	0.300
4	178.57	97.63	1702152	0.445
A	238.10	-101.96	2475272	-0.620
B	909.09	-38.96	1379996	-0.904
C	909.09	24.04	525319	0.558
D	434.78	87.04	3293785	0.966
		Total	12057239	0.00

Forces By Torsional Moment: N-S Direction (Area 1)				
3rd Floor	K_i	d_i	$K_i d_i^2$	Force (Kips)
1	322.58	-79.85	2056777	-5.536
2	263.16	-39.85	417904	-2.254
3	256.41	58.15	867031	3.204
4	217.39	98.15	2094210	4.586
A	277.78	-102.88	2940105	-6.142
B	1000.00	-39.88	1590414	-8.571
C	1000.00	23.12	534534	4.969
D	526.32	86.12	3903534	9.741
		Total	14404509	0.00

Forces By Torsional Moment: E-W Direction (Area 1)				
3rd Floor	K_i	d_i	$K_i d_i^2$	Force (Kips)
1	322.58	-79.85	2056894	-2.455
2	263.16	-39.85	417946	-1.000
3	256.41	58.15	866966	1.421
4	217.39	98.15	2094117	2.034
A	277.78	-102.88	2939848	-2.724
B	1000.00	-39.88	1590088	-3.801
C	1000.00	23.12	534723	2.204
D	526.32	86.12	3903904	4.321
		Total	14404486	0.00

Table 2: Torsional Forces Due to Wind: Area 1

Forces By Torsional Moment: N-S Direction (Area 1)				
2nd Floor	K_i	d_i	$K_i d_i^2$	Force (Kips)
1	476.19	-77.75	2878598	-16.024
2	370.37	-37.75	527800	-6.051
3	357.14	60.25	1296441	9.313
4	294.12	100.25	2955924	12.761
A	344.83	-103.42	3688197	-15.435
B	1428.57	-40.42	2333964	-24.991
C	1428.57	22.58	728366	13.961
D	714.29	85.58	5231415	26.457
		Total	19640705	-0.01

Forces By Torsional Moment: E-W Direction (Area 1)				
2nd Floor	K_i	d_i	$K_i d_i^2$	Force (Kips)
1	476.19	-77.75	2878598	-6.145
2	370.37	-37.75	527800	-2.321
3	357.14	60.25	1296441	3.572
4	294.12	100.25	2955924	4.894
A	344.83	-103.42	3688197	-5.919
B	1428.57	-40.42	2333964	-9.584
C	1428.57	22.58	728366	5.354
D	714.29	85.58	5231415	10.146
		Total	19640705	0.00

Forces By Torsional Moment: N-S Direction (Area 1)				
1st Floor	K_i	d_i	$K_i d_i^2$	Force (Kips)
1	833.33	-76.24	4843762	-35.127
2	588.24	-36.24	772558	-11.787
3	625.00	61.76	2383936	21.342
4	454.55	101.76	4706910	25.574
A	476.19	-107.27	5479448	-28.242
B	2000.00	-44.27	3919666	-48.953
C	2000.00	18.73	701626	20.711
D	1250.00	81.73	8349741	56.485
		Total	31157646	0.00

Forces By Torsional Moment: E-W Direction (Area 1)				
1st Floor	K_i	d_i	$K_i d_i^2$	Force (Kips)
1	833.33	-76.24	4843762	-17.002
2	588.24	-36.24	772558	-5.705
3	625.00	61.76	2383936	10.330
4	454.55	101.76	4706910	12.378
A	476.19	-107.27	5479448	-13.670
B	2000.00	-44.27	3919666	-23.694
C	2000.00	18.73	701626	10.025
D	1250.00	81.73	8349741	27.339
		Total	31157646	0.00

Forces By Torsional Moment: N-S Direction (Area 1)				
Mezzaine	K_i	d_i	$K_i d_i^2$	Force (Kips)
1	2000.00	-73.80	10892880	-82.990
2	1428.57	-33.80	1632056	-27.149
3	1428.57	64.20	5888051	51.568
4	1000.00	104.20	10857640	58.588
A	769.23	-110.96	9470853	-47.991
B	3333.33	-47.96	7667198	-89.887
C	3333.33	15.04	754005	28.188
D	2500.00	78.04	15225604	109.698
		Total	62388286	0.02

Forces By Torsional Moment: E-W Direction (Area 1)				
Mezzaine	K_i	d_i	$K_i d_i^2$	Force (Kips)
1	2000.00	-73.80	10892880	-43.425
2	1428.57	-33.80	1632056	-14.206
3	1428.57	64.20	5888051	26.983
4	1000.00	104.20	10857640	30.657
A	769.23	-110.96	9470853	-25.112
B	3333.33	-47.96	7667198	-47.034
C	3333.33	15.04	754005	14.750
D	2500.00	78.04	15225604	57.400
		Total	62388286	0.01

Table 2 Continued

Forces By Torsional Moment: N-S Direction (Area 2)				
Roof	K_i	d_i	$K_i d_i^2$	Force (Kips)
5	178.57	-82.85	1225726	-0.940
6	185.19	15.15	42505	0.178
7	217.39	55.15	661197	0.762
-	-	-	-	-
E	200.00	-108.48	2353582	-1.379
F	476.19	-45.48	984966	-1.377
G	476.19	17.52	146167	0.530
H	434.78	80.52	2818883	2.225
		Total	8233026	0.00

Forces By Torsional Moment: E-W Direction (Area 2)				
Roof	K_i	d_i	$K_i d_i^2$	Force (Kips)
5	178.57	-82.85	1225726	-1.036
6	185.19	15.15	42505	0.196
7	217.39	55.15	661197	0.840
-	-	-	-	-
E	200.00	-108.48	2353582	-1.519
F	476.19	-45.48	984966	-1.517
G	476.19	17.52	146167	0.584
H	434.78	80.52	2818883	2.452
		Total	8233026	0.00

Forces By Torsional Moment: N-S Direction (Area 2)				
3rd Floor	K_i	d_i	$K_i d_i^2$	Force (Kips)
5	217.39	-83.32	1509170	-3.515
6	227.27	14.68	48977	0.648
7	270.27	54.68	808081	2.868
-	-	-	-	-
E	238.10	-109.02	2829904	-5.038
F	555.56	-46.02	1176587	-4.962
G	555.56	16.98	160179	1.831
H	526.32	79.98	3366764	8.170
		Total	9899663	0.00

Forces By Torsional Moment: E-W Direction (Area 2)				
3rd Floor	K_i	d_i	$K_i d_i^2$	Force (Kips)
5	217.39	-83.32	1509170	-4.356
6	227.27	14.68	48977	0.802
7	270.27	54.68	808081	3.554
-	-	-	-	-
E	238.10	-109.02	2829904	-6.242
F	555.56	-46.02	1176587	-6.148
G	555.56	16.98	160179	2.269
H	526.32	79.98	3366764	10.123
		Total	9899663	0.00

Forces By Torsional Moment: N-S Direction (Area 2)				
2nd Floor	K_i	d_i	$K_i d_i^2$	Force (Kips)
5	294.12	-84.31	2090657	-6.794
6	303.03	13.69	56793	1.137
7	384.62	53.69	1108712	5.658
-	-	-	-	-
E	285.71	-111.18	3531659	-8.703
F	714.29	-48.18	1658090	-9.429
G	714.29	14.82	156881	2.900
H	714.29	77.82	4325706	15.230
		Total	12928498	0.00

Forces By Torsional Moment: E-W Direction (Area 2)				
2nd Floor	K_i	d_i	$K_i d_i^2$	Force (Kips)
5	294.12	-84.31	2090657	-11.697
6	303.03	13.69	56793	1.957
7	384.62	53.69	1108712	9.740
-	-	-	-	-
E	285.71	-111.18	3531659	-14.983
F	714.29	-48.18	1658090	-16.233
G	714.29	14.82	156881	4.993
H	714.29	77.82	4325706	26.219
		Total	12928498	0.00

Forces By Torsional Moment: N-S Direction (Area 2)				
1st Floor	K_i	d_i	$K_i d_i^2$	Force (Kips)
5	454.55	-50.14	1142748	-77.626
6	476.19	47.86	1090751	77.624
7	-	-	-	-
-	-	-	-	-
E	370.37	-112.15	4658374	-141.474
F	1000.00	-49.15	2415723	-167.404
G	1000.00	13.85	191823	47.173
H	1000.00	76.85	5905923	261.750
		Total	15405340	0.04

Forces By Torsional Moment: E-W Direction (Area 2)				
1st Floor	K_i	d_i	$K_i d_i^2$	Force (Kips)
5	454.55	-50.14	1142748	-17.053
6	476.19	47.86	1090751	17.052
7	-	-	-	-
-	-	-	-	-
E	370.37	-112.15	4658374	-31.079
F	1000.00	-49.15	2415723	-36.775
G	1000.00	13.85	191823	10.363
H	1000.00	76.85	5905923	57.500
		Total	15405340	0.01

Forces By Torsional Moment: N-S Direction (Area 2)				
Mezzaine	K_i	d_i	$K_i d_i^2$	Force (Kips)
5	1000.00	-51.58	2660496	-10.399
6	1111.11	46.42	2394238	10.399
7	-	-	-	-
-	-	-	-	-
E	666.67	-115.50	8893544	-15.524
F	1666.67	-52.50	4593759	-17.641
G	1666.67	10.50	183750	3.528
H	2000.00	73.50	10804500	29.637
		Total	29530288	0.00

Forces By Torsional Moment: E-W Direction (Area 2)				
Mezzaine	K_i	d_i	$K_i d_i^2$	Force (Kips)
5	1000.00	-51.58	2660496	-40.900
6	1111.11	46.42	2394238	40.899
7	-	-	-	-
-	-	-	-	-
E	666.67	-115.50	8893544	-61.058
F	1666.67	-52.50	4593759	-69.383
G	1666.67	10.50	183750	13.877
H	2000.00	73.50	10804500	116.564
		Total	29530288	0.00

Table 3: Torsional Forces Due to Wind: Area 2

APPENDIX G: NET FORCES DUE TO WIND

Net Force On Frames (N-S Direction): Area 1			
Roof	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
1	12.91	-1.26	14.17
2	10.72	-0.52	11.24
3	10.28	0.72	10.99
4	8.99	1.06	10.06
A	-	-1.48	1.48
B	-	-2.16	2.16
C	-	1.33	1.33
D	-	2.31	2.31

Net Force On Frames (E-W Direction): Area 1			
Roof	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
1	-	-0.53	0.53
2	-	-0.22	0.22
3	-	0.30	0.30
4	-	0.45	0.45
A	3.94	-0.62	4.56
B	15.04	-0.90	15.94
C	15.04	0.56	15.59
D	7.19	0.97	8.16

Net Force On Frames (N-S Direction): Area 1			
3rd Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
1	51.91	-5.54	57.44
2	42.35	-2.25	44.60
3	41.26	3.20	44.47
4	34.98	4.59	39.57
A	-	-6.14	6.14
B	-	-8.57	8.57
C	-	4.97	4.97
D	-	9.74	9.74

Net Force On Frames (E-W Direction): Area 1			
3rd Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
1	-	-2.46	2.46
2	-	-1.00	1.00
3	-	1.42	1.42
4	-	2.03	2.03
A	16.24	-2.72	18.96
B	58.45	-3.80	62.25
C	58.45	2.20	60.65
D	30.76	4.32	35.08

Net Force On Frames (N-S Direction): Area 1			
2nd Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
1	121.03	-16.02	137.06
2	94.14	-6.05	100.19
3	90.77	9.31	100.09
4	74.76	12.76	87.52
A	-	-15.43	15.43
B	-	-24.99	24.99
C	-	13.96	13.96
D	-	26.46	26.46

Net Force On Frames (E-W Direction): Area 1			
2nd Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
1	-	-6.15	6.15
2	-	-2.32	2.32
3	-	3.57	3.57
4	-	4.89	4.89
A	32.20	-5.92	38.12
B	133.40	-9.58	142.98
C	133.40	5.35	138.75
D	66.70	10.15	76.85

Net Force On Frames (N-S Direction): Area 1			
1st Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
1	226.70	-35.13	261.82
2	160.02	-11.79	171.81
3	170.02	21.34	191.37
4	123.65	25.57	149.23
A	-	-28.24	28.24
B	-	-48.95	48.95
C	-	20.71	20.71
D	-	56.49	56.49

Net Force On Frames (E-W Direction): Area 1			
1st Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
1	-	-17.00	17.00
2	-	-5.70	5.70
3	-	10.33	10.33
4	-	12.38	12.38
A	54.30	-13.67	67.96
B	228.04	-23.69	251.73
C	228.04	10.02	238.06
D	142.52	27.34	169.86

Net Force On Frames (N-S Direction): Area 1			
Mezzaine	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
1	397.22	-82.99	480.21
2	283.73	-27.15	310.88
3	283.73	51.57	335.30
4	198.61	58.59	257.20
A	-	-47.99	47.99
B	-	-89.89	89.89
C	-	28.19	28.19
D	-	109.70	109.70

Net Force On Frames (E-W Direction): Area 1			
Mezzaine	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
1	-	-43.43	43.43
2	-	-14.21	14.21
3	-	26.98	26.98
4	-	30.66	30.66
A	86.33	-25.11	111.44
B	374.10	-47.03	421.13
C	374.10	14.75	388.85
D	280.57	57.40	337.97

Table 1: Net Forces Due to Wind: Area 1

Net Force On Frames (N-S Direction): Area 2			
Roof	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
5	12.26	-0.94	13.20
6	12.71	0.18	12.89
7	14.93	0.76	15.69
-	-	-	-
E	-	-1.38	1.38
F	-	-1.38	1.38
G	-	0.53	0.53
H	-	2.23	2.23

Net Force On Frames (E-W Direction): Area 2			
Roof	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
5	-	-1.04	1.04
6	-	0.20	0.20
7	-	0.84	0.84
-	-	-	-
E	5.19	-1.52	6.71
F	12.36	-1.52	13.88
G	12.36	0.58	12.95
H	11.29	2.45	13.74

Net Force On Frames (N-S Direction): Area 2			
3rd Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
5	48.20	-3.52	51.71
6	50.39	0.65	51.03
7	59.92	2.87	62.79
-	-	-	-
E	-	-5.04	5.04
F	-	-4.96	4.96
G	-	1.83	1.83
H	-	8.17	8.17

Net Force On Frames (E-W Direction): Area 2			
3rd Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
5	-	-4.36	4.36
6	-	0.80	0.80
7	-	3.55	3.55
-	-	-	-
E	20.81	-6.24	27.05
F	48.55	-6.15	54.70
G	48.55	2.27	50.82
H	45.99	10.12	56.12

Net Force On Frames (N-S Direction): Area 2			
2nd Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
5	106.05	-6.79	112.85
6	109.26	1.14	110.40
7	138.68	5.66	144.34
-	-	-	-
E	-	-8.70	8.70
F	-	-9.43	9.43
G	-	2.90	2.90
H	-	15.23	15.23

Net Force On Frames (E-W Direction): Area 2			
2nd Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
5	-	-11.70	11.70
6	-	1.96	1.96
7	-	9.74	9.74
-	-	-	-
E	43.02	-14.98	58.01
F	107.56	-16.23	123.79
G	107.56	4.99	112.55
H	107.56	26.22	133.78

Net Force On Frames (N-S Direction): Area 2			
1st Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
5	308.95	-77.63	386.57
6	323.65	77.62	401.28
7	-	-	-
-	-	-	-
E	-	-141.47	141.47
F	-	-167.40	167.40
G	-	47.17	47.17
H	-	261.75	261.75

Net Force On Frames (E-W Direction): Area 2			
1st Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
5	-	-17.05	17.05
6	-	17.05	17.05
7	-	-	-
-	-	-	-
E	71.75	-31.08	102.83
F	193.72	-36.77	230.49
G	193.72	10.36	204.08
H	193.72	57.50	251.22

Net Force On Frames (N-S Direction): Area 2			
Mezzaine	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
5	512.34	-40.90	553.24
6	569.26	40.90	610.16
7	-	-	-
-	-	-	-
E	-	-61.06	61.06
F	-	-69.38	69.38
G	-	13.88	13.88
H	-	116.56	116.56

Net Force On Frames (E-W Direction): Area 2			
Mezzaine	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
5	-	-40.90	40.90
6	-	40.90	40.90
7	-	-	-
-	-	-	-
E	123.90	-61.06	184.96
F	309.75	-69.38	379.13
G	309.75	13.88	323.63
H	371.70	116.56	488.26

Table 2: Net Forces Due to Wind: Area 2

APPENDIX H: DIRECT FORCES DUE TO SEISMIC

Direct Forces: Area 1 (N-S Direction)				
Roof	K_i	P	ΣK_i	Force (Kips)
1.00	256.41	71.00	851.83	21.37
2.00	212.77	71.00	851.83	17.73
3.00	204.08	71.00	851.83	17.01
4.00	178.57	71.00	851.83	14.88
			Total	71.00
Direct Forces: Area 1 (E-W Direction)				
Roof	K_i	P	ΣK_i	Force (Kips)
A	238.10	71.00	2491.06	6.79
B	909.09	71.00	2491.06	25.91
C	909.09	71.00	2491.06	25.91
D	434.78	71.00	2491.06	12.39
			Total	71.00

Direct Forces: Area 1 (N-S Direction)				
3rd Floor	K_i	P	ΣK_i	Force (Kips)
1.00	322.58	409.00	1059.54	124.52
2.00	263.16	409.00	1059.54	101.58
3.00	256.41	409.00	1059.54	98.98
4.00	217.39	409.00	1059.54	83.92
			Total	409.00
Direct Forces: Area 1 (E-W Direction)				
3rd Floor	K_i	P	ΣK_i	Force (Kips)
A	277.78	409.00	2804.10	40.52
B	1000.00	409.00	2804.10	145.86
C	1000.00	409.00	2804.10	145.86
D	526.32	409.00	2804.10	76.77
			Total	409.00

Direct Forces: Area 1 (N-S Direction)				
2nd Floor	K_i	P	ΣK_i	Force (Kips)
1.00	476.19	251.00	1497.82	79.80
2.00	370.37	251.00	1497.82	62.07
3.00	357.14	251.00	1497.82	59.85
4.00	294.12	251.00	1497.82	49.29
			Total	251.00
Direct Forces: Area 1 (E-W Direction)				
2nd Floor	K_i	P	ΣK_i	Force (Kips)
A	344.83	251.00	3916.26	22.10
B	1428.57	251.00	3916.26	91.56
C	1428.57	251.00	3916.26	91.56
D	714.29	251.00	3916.26	45.78
			Total	251.00

Table 1: Seismic Forces Due to Wind on Union Station: Area 1

Direct Forces: Area 1 (N-S Direction)				
1st Floor	K_i	P	ΣK_i	Force (Kips)
1.00	833.33	138.00	2501.12	45.98
2.00	588.24	138.00	2501.12	32.46
3.00	625.00	138.00	2501.12	34.48
4.00	454.55	138.00	2501.12	25.08
			Total	138.00
Direct Forces: Area 1 (E-W Direction)				
1st Floor	K_i	P	ΣK_i	Force (Kips)
A	476.19	138.00	5726.19	11.48
B	2000.00	138.00	5726.19	48.20
C	2000.00	138.00	5726.19	48.20
D	1250.00	138.00	5726.19	30.12
			Total	138.00

Direct Forces: Area 1 (N-S Direction)				
Mezzaine	K_i	P	ΣK_i	Force (Kips)
1.00	2000.00	50.00	5857.14	17.07
2.00	1428.57	50.00	5857.14	12.20
3.00	1428.57	50.00	5857.14	12.20
4.00	1000.00	50.00	5857.14	8.54
			Total	50.00
Direct Forces: Area 1 (E-W Direction)				
Mezzaine	K_i	P	ΣK_i	Force (Kips)
A	769.23	50.00	9935.89	3.87
B	3333.33	50.00	9935.89	16.77
C	3333.33	50.00	9935.89	16.77
D	2500.00	50.00	9935.89	12.58
			Total	50.00

Table 1 Continued

Direct Forces: Area 2 (N-S Direction)				
Roof	K_i	P	ΣK_i	Force (Kips)
5.00	178.57	62.00	581.15	19.05
6.00	185.19	62.00	581.15	19.76
7.00	217.39	62.00	581.15	23.19
-	-	-	-	-
			Total	62.00
Direct Forces: Area 2 (E-W Direction)				
Roof	K_i	P	ΣK_i	Force (Kips)
E	200.00	62.00	1587.16	7.81
F	476.19	62.00	1587.16	18.60
G	476.19	62.00	1587.16	18.60
H	434.78	62.00	1587.16	16.98
			Total	62.00

Direct Forces: Area 2 (N-S Direction)				
3rd Floor	K_i	P	ΣK_i	Force (Kips)
5.00	217.39	411.00	714.93	124.97
6.00	227.27	411.00	714.93	130.65
7.00	270.27	411.00	714.93	155.37
-	-	-	-	-
			Total	411.00
Direct Forces: Area 2 (E-W Direction)				
3rd Floor	K_i	P	ΣK_i	Force (Kips)
E	238.10	411.00	1875.54	52.18
F	555.56	411.00	1875.54	121.74
G	555.56	411.00	1875.54	121.74
H	526.32	411.00	1875.54	115.34
			Total	411.00

Direct Forces: Area 2 (N-S Direction)				
2nd Floor	K_i	P	ΣK_i	Force (Kips)
5.00	294.12	252.00	981.77	75.49
6.00	303.03	252.00	981.77	77.78
7.00	384.62	252.00	981.77	98.72
-	-	-	-	-
			Total	252.00
Direct Forces: Area 2 (E-W Direction)				
2nd Floor	K_i	P	ΣK_i	Force (Kips)
E	285.71	252.00	2428.58	29.65
F	714.29	252.00	2428.58	74.12
G	714.29	252.00	2428.58	74.12
H	714.29	252.00	2428.58	74.12
			Total	252.00

Table 2: Seismic Forces Due to Wind on Union Station: Area 2

Direct Forces: Area 2 (N-S Direction)				
1st Floor	K_i	P	ΣK_i	Force (Kips)
5.00	454.55	139.00	930.74	67.88
6.00	476.19	139.00	930.74	71.12
7.00	-	-	-	-
-	-	-	-	-
			Total	139.00
Direct Forces: Area 2 (E-W Direction)				
1st Floor	K_i	P	ΣK_i	Force (Kips)
E	370.37	139.00	3370.37	15.27
F	1000.00	139.00	3370.37	41.24
G	1000.00	139.00	3370.37	41.24
H	1000.00	139.00	3370.37	41.24
			Total	139.00

Direct Forces: Area 2 (N-S Direction)				
Mezzaine	K_i	P	ΣK_i	Force (Kips)
5.00	1000.00	50.00	2111.11	23.68
6.00	1111.11	50.00	2111.11	26.32
7.00	-	-	-	-
-	-	-	-	-
			Total	50.00
Direct Forces: Area 2 (E-W Direction)				
Mezzaine	K_i	P	ΣK_i	Force (Kips)
E	666.67	50.00	6000.01	5.56
F	1666.67	50.00	6000.01	13.89
G	1666.67	50.00	6000.01	13.89
H	2000.00	50.00	6000.01	16.67
			Total	50.00

Table 2 Continued

APPENDIX I: TORSIONAL FORCES DUE TO SEISMIC

Torsional Moment Due To Seismic: Area 1					
Level	Story Force (Kips)	e_{N-S} (ft)	e_{E-W} (ft)	M_{N-S} (ft-kips)	M_{E-W} (ft-kips)
Roof	70.58	8.63	7.46	609.25	526.62
3	408.52	9.15	8.38	3737.11	3421.76
2	250.92	11.25	8.92	2823.18	2236.96
1	138.02	12.76	12.77	1760.95	1762.56
Mezzaine	49.91	15.20	16.46	758.45	821.65

Torsional Moment Due To Seismic: Area 2					
Level	Story Force (Kips)	e_{N-S} (ft)	e_{E-W} (ft)	M_{N-S} (ft-kips)	M_{E-W} (ft-kips)
Roof	61.53	6.15	13.98	378.40	860.11
3	410.53	5.68	14.52	2330.84	5961.84
2	252.15	4.69	16.68	1182.22	4204.98
1	138.70	38.86	17.65	5389.90	2448.57
Mezzaine	50.16	2.58	21.00	129.36	1053.34

Table 1: Torsional Moments Due to Seismic

Forces By Torsional Moment: Area 1 Roof (N-S Direction)				
	K_i	d_i	$K_i d_i^2$	Force (Kips)
1	256.41	-80.37	1656239	-1.041
2	212.77	-40.37	346759	-0.434
3	204.08	57.63	677794	0.594
4	178.57	97.63	1702061	0.881
A	238.10	-101.96	2475250	-1.227
B	909.09	-38.96	1379891	-1.790
C	909.09	24.04	525383	1.104
D	434.78	87.04	3293877	1.912
		Total	12057253	0.00

Forces By Torsional Moment: Area 1 Roof (E-W Direction)				
	K_i	d_i	$K_i d_i^2$	Force (Kips)
1	256.41	-80.37	1656148	-0.900
2	212.77	-40.37	346714	-0.375
3	204.08	57.63	677852	0.514
4	178.57	97.63	1702152	0.761
A	238.10	-101.96	2475272	-1.060
B	909.09	-38.96	1379996	-1.547
C	909.09	24.04	525319	0.954
D	434.78	87.04	3293785	1.653
		Total	12057239	0.00

Forces By Torsional Moment: Area 1 3rd (N-S Direction)				
	K_i	d_i	$K_i d_i^2$	Force (Kips)
1	322.58	-79.85	2056777	-6.683
2	263.16	-39.85	417904	-2.721
3	256.41	58.15	867031	3.868
4	217.39	98.15	2094210	5.536
A	277.78	-102.88	2940105	-7.414
B	1000.00	-39.88	1590414	-10.346
C	1000.00	23.12	534534	5.998
D	526.32	86.12	3903534	11.760
		Total	14404509	0.00

Forces By Torsional Moment: Area 1 3rd (E-W Direction)				
	K_i	d_i	$K_i d_i^2$	Force (Kips)
1	322.58	-79.85	2056894	-6.119
2	263.16	-39.85	417946	-2.491
3	256.41	58.15	866966	3.542
4	217.39	98.15	2094117	5.068
A	277.78	-102.88	2939848	-6.788
B	1000.00	-39.88	1590088	-9.472
C	1000.00	23.12	534723	5.493
D	526.32	86.12	3903904	10.768
		Total	14404486	0.00

Table 2: Torsional Forces Due to Seismic: Area 1

Forces By Torsional Moment: Area 1 2nd (N-S Direction)				
	K_i	d_i	$K_i d_i^2$	Force (Kips)
1	476.19	-77.75	2878598	-5.322
2	370.37	-37.75	527800	-2.010
3	357.14	60.25	1296441	3.093
4	294.12	100.25	2955924	4.238
A	344.83	-103.42	3688197	-5.126
B	1428.57	-40.42	2333964	-8.300
C	1428.57	22.58	728366	4.637
D	714.29	85.58	5231415	8.787
		Total	19640705	0.00

Forces By Torsional Moment: Area 1 2nd (E-W Direction)				
	K_i	d_i	$K_i d_i^2$	Force (Kips)
1	476.19	-77.75	2878598	-4.217
2	370.37	-37.75	527800	-1.592
3	357.14	60.25	1296441	2.451
4	294.12	100.25	2955924	3.358
A	344.83	-103.42	3688197	-4.062
B	1428.57	-40.42	2333964	-6.577
C	1428.57	22.58	728366	3.674
D	714.29	85.58	5231415	6.962
		Total	19640705	0.00

Forces By Torsional Moment: Area 1 1st (N-S Direction)				
	K_i	d_i	$K_i d_i^2$	Force (Kips)
1	833.33	-76.24	4843762	-3.591
2	588.24	-36.24	772558	-1.205
3	625.00	61.76	2383936	2.182
4	454.55	101.76	4706910	2.614
A	476.19	-107.27	5479448	-2.887
B	2000.00	-44.27	3919666	-5.004
C	2000.00	18.73	701626	2.117
D	1250.00	81.73	8349741	5.774
		Total	31157646	0.00

Forces By Torsional Moment: Area 1 1st (E-W Direction)				
	K_i	d_i	$K_i d_i^2$	Force (Kips)
1	833.33	-76.24	4843762	-3.594
2	588.24	-36.24	772558	-1.206
3	625.00	61.76	2383936	2.184
4	454.55	101.76	4706910	2.617
A	476.19	-107.27	5479448	-2.890
B	2000.00	-44.27	3919666	-5.009
C	2000.00	18.73	701626	2.119
D	1250.00	81.73	8349741	5.779
		Total	31157646	0.00

Forces By Torsional Moment: Area 1 Mez. (N-S Direction)				
	K_i	d_i	$K_i d_i^2$	Force (Kips)
1	2000.00	-73.80	10892880	-1.794
2	1428.57	-33.80	1632056	-0.587
3	1428.57	64.20	5888051	1.115
4	1000.00	104.20	10857640	1.267
A	769.23	-110.96	9470853	-1.038
B	3333.33	-47.96	7667198	-1.943
C	3333.33	15.04	754005	0.609
D	2500.00	78.04	15225604	2.372
		Total	62388286	0.00

Forces By Torsional Moment: Area 1 Mez. (E-W Direction)				
	K_i	d_i	$K_i d_i^2$	Force (Kips)
1	2000.00	-73.80	10892880	-1.944
2	1428.57	-33.80	1632056	-0.636
3	1428.57	64.20	5888051	1.208
4	1000.00	104.20	10857640	1.372
A	769.23	-110.96	9470853	-1.124
B	3333.33	-47.96	7667198	-2.105
C	3333.33	15.04	754005	0.660
D	2500.00	78.04	15225604	2.569
		Total	62388286	0.00

Table 2 Continued

Forces By Torsional Moment: Area 2 Roof (N-S Direction)				
	K_i	d_i	$K_i d_i^2$	Force (Kips)
5	178.57	-82.85	1225726	-0.680
6	185.19	15.15	42505	0.129
7	217.39	55.15	661197	0.551
-	-	-	-	-
E	200.00	-108.48	2353582	-0.997
F	476.19	-45.48	984966	-0.995
G	476.19	17.52	146167	0.383
H	434.78	80.52	2818883	1.609
		Total	8233026	0.00

Forces By Torsional Moment: Area 2 Roof (E-W Direction)				
	K_i	d_i	$K_i d_i^2$	Force (Kips)
5	178.57	-82.85	1225726	-1.546
6	185.19	15.15	42505	0.293
7	217.39	55.15	661197	1.253
-	-	-	-	-
E	200.00	-108.48	2353582	-2.267
F	476.19	-45.48	984966	-2.263
G	476.19	17.52	146167	0.872
H	434.78	80.52	2818883	3.657
		Total	8233026	0.00

Forces By Torsional Moment: Area 2 3rd (N-S Direction)				
	K_i	d_i	$K_i d_i^2$	Force (Kips)
5	217.39	-83.32	1509170	-4.265
6	227.27	14.68	48977	0.786
7	270.27	54.68	808081	3.480
-	-	-	-	-
E	238.10	-109.02	2829904	-6.112
F	555.56	-46.02	1176587	-6.020
G	555.56	16.98	160179	2.221
H	526.32	79.98	3366764	9.911
		Total	9899663	0.00

Forces By Torsional Moment: Area 2 3rd (E-W Direction)				
	K_i	d_i	$K_i d_i^2$	Force (Kips)
5	217.39	-83.32	1509170	-10.908
6	227.27	14.68	48977	2.009
7	270.27	54.68	808081	8.900
-	-	-	-	-
E	238.10	-109.02	2829904	-15.632
F	555.56	-46.02	1176587	-15.397
G	555.56	16.98	160179	5.681
H	526.32	79.98	3366764	25.351
		Total	9899663	0.00

Forces By Torsional Moment: Area 2 2nd (N-S Direction)				
	K_i	d_i	$K_i d_i^2$	Force (Kips)
5	294.12	-84.31	2090657	-2.268
6	303.03	13.69	56793	0.379
7	384.62	53.69	1108712	1.888
-	-	-	-	-
E	285.71	-111.18	3531659	-2.905
F	714.29	-48.18	1658090	-3.147
G	714.29	14.82	156881	0.968
H	714.29	77.82	4325706	5.083
		Total	12928498	0.00

Forces By Torsional Moment: Area 2 2nd (E-W Direction)				
	K_i	d_i	$K_i d_i^2$	Force (Kips)
5	294.12	-84.31	2090657	-8.065
6	303.03	13.69	56793	1.349
7	384.62	53.69	1108712	6.716
-	-	-	-	-
E	285.71	-111.18	3531659	-10.332
F	714.29	-48.18	1658090	-11.193
G	714.29	14.82	156881	3.443
H	714.29	77.82	4325706	18.079
		Total	12928498	0.00

Forces By Torsional Moment: Area 2 1st (N-S Direction)				
	K_i	d_i	$K_i d_i^2$	Force (Kips)
5	454.55	-50.14	1142748	-7.973
6	476.19	47.86	1090751	7.973
7	-	-	-	-
-	-	-	-	-
E	370.37	-112.15	4658374	-14.533
F	1000.00	-49.15	2415723	-17.196
G	1000.00	13.85	191823	4.846
H	1000.00	76.85	5905923	26.888
		Total	15405340	0.00

Forces By Torsional Moment: Area 2 1st (E-W Direction)				
	K_i	d_i	$K_i d_i^2$	Force (Kips)
5	454.55	-50.14	1142748	-3.622
6	476.19	47.86	1090751	3.622
7	-	-	-	-
-	-	-	-	-
E	370.37	-112.15	4658374	-6.602
F	1000.00	-49.15	2415723	-7.812
G	1000.00	13.85	191823	2.201
H	1000.00	76.85	5905923	12.215
		Total	15405340	0.00

Forces By Torsional Moment: Area 2 Mez. (N-S Direction)				
	K_i	d_i	$K_i d_i^2$	Force (Kips)
5	1000.00	-51.58	2660496	-0.226
6	1111.11	46.42	2394238	0.226
7	-	-	-	-
-	-	-	-	-
E	666.67	-115.50	8893544	-0.337
F	1666.67	-52.50	4593759	-0.383
G	1666.67	10.50	183750	0.077
H	2000.00	73.50	10804500	0.644
		Total	29530288	0.00

Forces By Torsional Moment: Area 2 Mez. (E-W Direction)				
	K_i	d_i	$K_i d_i^2$	Force (Kips)
5	1000.00	-51.58	2660496	-1.840
6	1111.11	46.42	2394238	1.840
7	-	-	-	-
-	-	-	-	-
E	666.67	-115.50	8893544	-2.747
F	1666.67	-52.50	4593759	-3.121
G	1666.67	10.50	183750	0.624
H	2000.00	73.50	10804500	5.243
		Total	29530288	0.00

Table 3: Torsional Forces Due to Seismic: Area 2

APPENDIX J: NET FORCES DUE TO SEISMIC

Net Force On Frames (N-S Direction): Area 1			
Roof	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
1	21.37	-1.04	22.41
2	17.73	-0.43	18.17
3	17.01	0.59	17.60
4	14.88	0.88	15.76
A	-	-1.23	1.23
B	-	-1.79	1.79
C	-	1.10	1.10
D	-	1.91	1.91

Net Force On Frames (E-W Direction): Area 1			
Roof	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
1	-	-0.90	0.90
2	-	-0.38	0.38
3	-	0.51	0.51
4	-	0.76	0.76
A	6.79	-1.06	7.85
B	25.91	-1.55	27.46
C	25.91	0.95	26.87
D	12.39	1.65	14.04

Net Force On Frames (N-S Direction): Area 1			
3rd Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
1	124.52	-6.68	131.20
2	101.58	-2.72	104.30
3	98.98	3.87	102.85
4	83.92	5.54	89.45
A	-	-7.41	7.41
B	-	-10.35	10.35
C	-	6.00	6.00
D	-	11.76	11.76

Net Force On Frames (E-W Direction): Area 1			
3rd Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
1	-	-6.12	6.12
2	-	-2.49	2.49
3	-	3.54	3.54
4	-	5.07	5.07
A	40.52	-6.79	47.30
B	145.86	-9.47	155.33
C	145.86	5.49	151.35
D	76.77	10.77	87.54

Net Force On Frames (N-S Direction): Area 1			
2nd Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
1	79.80	-5.32	85.12
2	62.07	-2.01	64.08
3	59.85	3.09	62.94
4	49.29	4.24	53.53
A	-	-5.13	5.13
B	-	-8.30	8.30
C	-	4.64	4.64
D	-	8.79	8.79

Net Force On Frames (E-W Direction): Area 1			
2nd Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
1	-	-4.22	4.22
2	-	-1.59	1.59
3	-	2.45	2.45
4	-	3.36	3.36
A	79.80	-4.06	83.86
B	62.07	-6.58	68.64
C	59.85	3.67	63.52
D	49.29	6.96	56.25

Net Force On Frames (N-S Direction): Area 1			
1st Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
1	45.98	-3.59	49.57
2	32.46	-1.20	33.66
3	34.48	2.18	36.67
4	25.08	2.61	27.69
A	-	-2.89	2.89
B	-	-5.00	5.00
C	-	2.12	2.12
D	-	5.77	5.77

Net Force On Frames (E-W Direction): Area 1			
1st Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
1	-	-3.59	3.59
2	-	-1.21	1.21
3	-	2.18	2.18
4	-	2.62	2.62
A	11.48	-2.89	14.37
B	48.20	-5.01	53.21
C	48.20	2.12	50.32
D	30.12	5.78	35.90

Net Force On Frames (N-S Direction): Area 1			
Mezzaine	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
1	17.07	-1.79	18.87
2	12.20	-0.59	12.78
3	12.20	1.11	13.31
4	8.54	1.27	9.80
A	-	-1.04	1.04
B	-	-1.94	1.94
C	-	0.61	0.61
D	-	2.37	2.37

Net Force On Frames (E-W Direction): Area 1			
Mezzaine	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
1	-	-1.94	1.94
2	-	-0.64	0.64
3	-	1.21	1.21
4	-	1.37	1.37
A	3.87	-1.12	5.00
B	16.77	-2.11	18.88
C	16.77	0.66	17.43
D	12.58	2.57	15.15

Table 1: Net Forces Due to Seismic: Area 1

Net Force On Frames (N-S Direction): Area 2			
Roof	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
5	19.05	-0.68	19.73
6	19.76	0.13	19.89
7	23.19	0.55	23.74
-	-	-	-
E	-	-1.00	1.00
F	-	-1.00	1.00
G	-	0.38	0.38
H	-	1.61	1.61

Net Force On Frames (E-W Direction): Area 2			
Roof	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
5	-	-1.55	1.55
6	-	0.29	0.29
7	-	1.25	1.25
-	-	-	-
E	7.81	-2.27	10.08
F	18.60	-2.26	20.86
G	18.60	0.87	19.47
H	16.98	3.66	20.64

Net Force On Frames (N-S Direction): Area 2			
3rd Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
5	124.97	-4.26	129.24
6	130.65	0.79	131.44
7	155.37	3.48	158.85
-	-	-	-
E	-	-6.11	6.11
F	-	-6.02	6.02
G	-	2.22	2.22
H	-	9.91	9.91

Net Force On Frames (E-W Direction): Area 2			
3rd Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
5	-	-10.91	10.91
6	-	2.01	2.01
7	-	8.90	8.90
-	-	-	-
E	52.18	-15.63	67.81
F	121.74	-15.40	137.14
G	121.74	5.68	127.42
H	115.34	25.35	140.69

Net Force On Frames (N-S Direction): Area 2			
2nd Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
5	75.49	-2.27	77.76
6	77.78	0.38	78.16
7	98.72	1.89	100.61
-	-	-	-
E	-	-2.90	2.90
F	-	-3.15	3.15
G	-	0.97	0.97
H	-	5.08	5.08

Net Force On Frames (E-W Direction): Area 2			
2nd Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
5	-	-8.07	8.07
6	-	1.35	1.35
7	-	6.72	6.72
-	-	-	-
E	29.65	-10.33	39.98
F	74.12	-11.19	85.31
G	74.12	3.44	77.56
H	74.12	18.08	92.20

Net Force On Frames (N-S Direction): Area 2			
1st Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
5	67.88	-7.97	75.86
6	71.12	7.97	79.09
7	-	-	-
-	-	-	-
E	-	-14.53	14.53
F	-	-17.20	17.20
G	-	4.85	4.85
H	-	26.89	26.89

Net Force On Frames (E-W Direction): Area 2			
1st Floor	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
5	-	-3.62	3.62
6	-	3.62	3.62
7	-	-	-
-	-	-	-
E	15.27	-6.60	21.88
F	41.24	-7.81	49.05
G	41.24	2.20	43.44
H	41.24	12.21	53.46

Net Force On Frames (N-S Direction): Area 2			
Mezzaine	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
5	23.68	-0.23	23.91
6	26.32	0.23	26.54
7	-	-	-
-	-	-	-
E	-	-0.34	0.34
F	-	-0.38	0.38
G	-	0.08	0.08
H	-	0.64	0.64

Net Force On Frames (E-W Direction): Area 2			
Mezzaine	Direct Force (Kips)	Torsional Force (Kips)	Net Force (Kips)
5	-	-1.84	1.84
6	-	1.84	1.84
7	-	-	-
-	-	-	-
E	5.56	-2.75	8.30
F	13.89	-3.12	17.01
G	13.89	0.62	14.51
H	16.67	5.24	21.91

Table 2: Net Forces Due to Seismic: Area 2

APPENDIX K: WIND & SEISMIC DRIFT RESULTS

Wind Drift: Frame 1

Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) Δ_{wind} = H/400			Total Drift (in)	Allowable Total Drift (in) Δ_{wind} = H/400		
Roof	11.500	0.077	<	0.345	Acceptable	1.077	<	1.94	Acceptable
3rd	11.500	0.143	<	0.345	Acceptable	1.000	<	1.595	Acceptable
2nd	11.500	0.269	<	0.345	Acceptable	0.857	<	1.25	Acceptable
1st	12.250	0.312	<	0.368	Acceptable	0.588	<	0.905	Acceptable
Mezzaine	17.917	0.276	<	0.538	Acceptable	0.276	<	0.5375	Acceptable

Wind Drift: Frame 2

Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) Δ_{wind} = H/400			Total Drift (in)	Allowable Total Drift (in) Δ_{wind} = H/400		
Roof	11.500	0.187	<	0.345	Acceptable	1.108	<	1.94	Acceptable
3rd	11.500	0.147	<	0.345	Acceptable	0.921	<	1.595	Acceptable
2nd	11.500	0.226	<	0.345	Acceptable	0.774	<	1.25	Acceptable
1st	12.250	0.285	<	0.368	Acceptable	0.548	<	0.905	Acceptable
Mezzaine	17.917	0.263	<	0.538	Acceptable	0.263	<	0.5375	Acceptable

Wind Drift: Frame 3

Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) Δ_{wind} = H/400			Total Drift (in)	Allowable Total Drift (in) Δ_{wind} = H/400		
Roof	11.500	0.082	<	0.345	Acceptable	1.071	<	1.94	Acceptable
3rd	11.500	0.144	<	0.345	Acceptable	0.989	<	1.595	Acceptable
2nd	11.500	0.247	<	0.345	Acceptable	0.845	<	1.25	Acceptable
1st	12.250	0.312	<	0.368	Acceptable	0.598	<	0.905	Acceptable
Mezzaine	17.917	0.286	<	0.538	Acceptable	0.286	<	0.5375	Acceptable

Wind Drift: Frame 4

Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) Δ_{wind} = H/400			Total Drift (in)	Allowable Total Drift (in) Δ_{wind} = H/400		
Roof	11.500	0.085	<	0.345	Acceptable	1.120	<	1.94	Acceptable
3rd	11.500	0.138	<	0.345	Acceptable	1.035	<	1.595	Acceptable
2nd	11.500	0.222	<	0.345	Acceptable	0.897	<	1.25	Acceptable
1st	12.250	0.322	<	0.368	Acceptable	0.675	<	0.905	Acceptable
Mezzaine	17.917	0.354	<	0.538	Acceptable	0.354	<	0.5375	Acceptable

Wind Drift: Frame A

Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) Δ_{wind} = H/400			Total Drift (in)	Allowable Total Drift (in) Δ_{wind} = H/400		
Roof	11.500	0.008	<	0.345	Acceptable	0.488	<	1.94	Acceptable
3rd	11.500	0.024	<	0.345	Acceptable	0.480	<	1.595	Acceptable
2nd	11.500	0.057	<	0.345	Acceptable	0.455	<	1.25	Acceptable
1st	12.250	0.123	<	0.368	Acceptable	0.399	<	0.905	Acceptable
Mezzaine	17.917	0.276	<	0.538	Acceptable	0.276	<	0.5375	Acceptable

Wind Drift: Frame B

Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) Δ_{wind} = H/400			Total Drift (in)	Allowable Total Drift (in) Δ_{wind} = H/400		
Roof	11.500	0.007	<	0.345	Acceptable	0.404	<	1.94	Acceptable
3rd	11.500	0.038	<	0.345	Acceptable	0.397	<	1.595	Acceptable
2nd	11.500	0.071	<	0.345	Acceptable	0.359	<	1.25	Acceptable
1st	12.250	0.117	<	0.368	Acceptable	0.288	<	0.905	Acceptable
Mezzaine	17.917	0.172	<	0.538	Acceptable	0.172	<	0.5375	Acceptable

Wind Drift: Frame C

Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) Δ_{wind} = H/400			Total Drift (in)	Allowable Total Drift (in) Δ_{wind} = H/400		
Roof	11.500	0.012	<	0.345	Acceptable	0.385	<	1.94	Acceptable
3rd	11.500	0.031	<	0.345	Acceptable	0.373	<	1.595	Acceptable
2nd	11.500	0.068	<	0.345	Acceptable	0.341	<	1.25	Acceptable
1st	12.250	0.111	<	0.368	Acceptable	0.274	<	0.905	Acceptable
Mezzaine	17.917	0.162	<	0.538	Acceptable	0.162	<	0.5375	Acceptable

Wind Drift: Frame D

Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) Δ_{wind} = H/400			Total Drift (in)	Allowable Total Drift (in) Δ_{wind} = H/400		
Roof	11.500	0.016	<	0.345	Acceptable	0.458	<	1.94	Acceptable
3rd	11.500	0.044	<	0.345	Acceptable	0.442	<	1.595	Acceptable
2nd	11.500	0.093	<	0.345	Acceptable	0.398	<	1.25	Acceptable
1st	12.250	0.138	<	0.368	Acceptable	0.305	<	0.905	Acceptable
Mezzaine	17.917	0.167	<	0.538	Acceptable	0.167	<	0.5375	Acceptable

Table 1: Drift Results for Wind: Area 1

Wind Drift: Frame 5

Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) Δ_{wind} = H/400			Total Drift (in)	Allowable Total Drift (in) Δ_{wind} = H/400		
Roof	11.500	0.139	<	0.345	Acceptable	2.102	>	1.94	Unacceptable
3rd	11.500	0.201	<	0.345	Acceptable	1.963	>	1.595	Unacceptable
2nd	11.500	0.440	>	0.345	Unacceptable	1.763	>	1.25	Unacceptable
1st	12.250	0.619	>	0.368	Unacceptable	1.323	>	0.905	Unacceptable
Mezzaine	17.917	0.703	>	0.538	Unacceptable	0.703	>	0.5375	Unacceptable

Wind Drift: Frame 6

Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) Δ_{wind} = H/400			Total Drift (in)	Allowable Total Drift (in) Δ_{wind} = H/400		
Roof	11.500	0.147	<	0.345	Acceptable	2.057	>	1.94	Unacceptable
3rd	11.500	0.240	<	0.345	Acceptable	1.911	>	1.595	Unacceptable
2nd	11.500	0.400	>	0.345	Unacceptable	1.671	>	1.25	Unacceptable
1st	12.250	0.603	>	0.368	Unacceptable	1.271	>	0.905	Unacceptable
Mezzaine	17.917	0.669	>	0.538	Unacceptable	0.669	>	0.5375	Unacceptable

Wind Drift: Frame 7

Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) Δ_{wind} = H/400			Total Drift (in)	Allowable Total Drift (in) Δ_{wind} = H/400		
Roof	11.500	0.128	<	0.345	Acceptable	0.701	<	1.94	Acceptable
3rd	11.500	0.144	<	0.345	Acceptable	0.573	<	1.595	Acceptable
2nd	11.500	0.429	>	0.345	Unacceptable	0.429	<	1.25	Acceptable
1st	12.250	-	-	-	-	-	-	-	-
Mezzaine	17.917	-	-	-	-	-	-	-	-

Wind Drift: Frame E

Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) Δ_{wind} = H/400			Total Drift (in)	Allowable Total Drift (in) Δ_{wind} = H/400		
Roof	11.500	0.044	<	0.345	Acceptable	0.906	<	1.94	Acceptable
3rd	11.500	0.055	<	0.345	Acceptable	0.863	<	1.595	Acceptable
2nd	11.500	0.072	<	0.345	Acceptable	0.807	<	1.25	Acceptable
1st	12.250	0.256	<	0.368	Acceptable	0.735	<	0.905	Acceptable
Mezzaine	17.917	0.479	<	0.538	Acceptable	0.479	<	0.5375	Acceptable

Wind Drift: Frame F

Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) Δ_{wind} = H/400			Total Drift (in)	Allowable Total Drift (in) Δ_{wind} = H/400		
Roof	11.500	0.040	<	0.345	Acceptable	0.773	<	1.94	Acceptable
3rd	11.500	0.050	<	0.345	Acceptable	0.733	<	1.595	Acceptable
2nd	11.500	0.075	<	0.345	Acceptable	0.683	<	1.25	Acceptable
1st	12.250	0.173	<	0.368	Acceptable	0.608	<	0.905	Acceptable
Mezzaine	17.917	0.435	<	0.538	Acceptable	0.435	<	0.5375	Acceptable

Wind Drift: Frame G

Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) Δ_{wind} = H/400			Total Drift (in)	Allowable Total Drift (in) Δ_{wind} = H/400		
Roof	11.500	0.036	<	0.345	Acceptable	0.689	<	1.94	Acceptable
3rd	11.500	0.047	<	0.345	Acceptable	0.652	<	1.595	Acceptable
2nd	11.500	0.068	<	0.345	Acceptable	0.605	<	1.25	Acceptable
1st	12.250	0.155	<	0.368	Acceptable	0.538	<	0.905	Acceptable
Mezzaine	17.917	0.382	<	0.538	Acceptable	0.382	<	0.5375	Acceptable

Wind Drift: Frame H

Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) Δ_{wind} = H/400			Total Drift (in)	Allowable Total Drift (in) Δ_{wind} = H/400		
Roof	11.500	0.080	<	0.345	Acceptable	0.848	<	1.94	Acceptable
3rd	11.500	0.091	<	0.345	Acceptable	0.769	<	1.595	Acceptable
2nd	11.500	0.116	<	0.345	Acceptable	0.677	<	1.25	Acceptable
1st	12.250	0.139	<	0.368	Acceptable	0.561	<	0.905	Acceptable
Mezzaine	17.917	0.423	<	0.538	Acceptable	0.423	<	0.5375	Acceptable

Table 2: Drift Results for Wind Area 2

Seismic Drift: Frame 1

Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) $\Delta_{SEISMIC} = 0.015h_{sx}$			Total Drift (in)	Allowable Story Drift (in) $\Delta_{SEISMIC} = 0.015h_{sx}$		
Roof	11.500	0.089	<	0.173	Acceptable	0.739	<	0.97	Acceptable
3rd	11.500	0.151	<	0.173	Acceptable	0.650	<	0.7975	Acceptable
2nd	11.500	0.194	>	0.173	Unacceptable	0.499	<	0.625	Acceptable
1st	12.250	0.170	<	0.184	Acceptable	0.305	<	0.4525	Acceptable
Mezzaine	17.917	0.135	<	0.269	Acceptable	0.135	<	0.2688	Acceptable

Seismic Drift: Frame 2

Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) $\Delta_{SEISMIC} = 0.015h_{sx}$			Total Drift (in)	Allowable Story Drift (in) $\Delta_{SEISMIC} = 0.015h_{sx}$		
Roof	11.500	0.102	<	0.173	Acceptable	0.727	<	0.97	Acceptable
3rd	11.500	0.139	<	0.173	Acceptable	0.625	<	0.7975	Acceptable
2nd	11.500	0.171	<	0.173	Acceptable	0.486	<	0.625	Acceptable
1st	12.250	0.173	<	0.184	Acceptable	0.315	<	0.4525	Acceptable
Mezzaine	17.917	0.142	<	0.269	Acceptable	0.142	<	0.2688	Acceptable

Seismic Drift: Frame 3

Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) $\Delta_{SEISMIC} = 0.015h_{sx}$			Total Drift (in)	Allowable Story Drift (in) $\Delta_{SEISMIC} = 0.015h_{sx}$		
Roof	11.500	0.093	<	0.173	Acceptable	0.734	<	0.97	Acceptable
3rd	11.500	0.140	<	0.173	Acceptable	0.641	<	0.7975	Acceptable
2nd	11.500	0.179	>	0.173	Unacceptable	0.501	<	0.625	Acceptable
1st	12.250	0.178	<	0.184	Acceptable	0.322	<	0.4525	Acceptable
Mezzaine	17.917	0.144	<	0.269	Acceptable	0.144	<	0.2688	Acceptable

Seismic Drift: Frame 4

Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) $\Delta_{SEISMIC} = 0.015h_{sx}$			Total Drift (in)	Allowable Story Drift (in) $\Delta_{SEISMIC} = 0.015h_{sx}$		
Roof	11.500	0.091	<	0.173	Acceptable	0.751	<	0.97	Acceptable
3rd	11.500	0.108	<	0.173	Acceptable	0.661	<	0.7975	Acceptable
2nd	11.500	0.185	>	0.173	Unacceptable	0.553	<	0.625	Acceptable
1st	12.250	0.192	>	0.184	Unacceptable	0.368	<	0.4525	Acceptable
Mezzaine	17.917	0.176	<	0.269	Acceptable	0.176	<	0.2688	Acceptable

Seismic Drift: Frame A

Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) $\Delta_{SEISMIC} = 0.015h_{sx}$			Total Drift (in)	Allowable Story Drift (in) $\Delta_{SEISMIC} = 0.015h_{sx}$		
Roof	11.500	0.018	<	0.173	Acceptable	0.487	<	0.97	Acceptable
3rd	11.500	0.050	<	0.173	Acceptable	0.469	<	0.7975	Acceptable
2nd	11.500	0.091	<	0.173	Acceptable	0.419	<	0.625	Acceptable
1st	12.250	0.128	<	0.184	Acceptable	0.329	<	0.4525	Acceptable
Mezzaine	17.917	0.201	<	0.269	Acceptable	0.201	<	0.2688	Acceptable

Seismic Drift: Frame B

Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) $\Delta_{SEISMIC} = 0.015h_{sx}$			Total Drift (in)	Allowable Story Drift (in) $\Delta_{SEISMIC} = 0.015h_{sx}$		
Roof	11.500	0.019	<	0.173	Acceptable	0.260	<	0.97	Acceptable
3rd	11.500	0.039	<	0.173	Acceptable	0.241	<	0.7975	Acceptable
2nd	11.500	0.057	<	0.173	Acceptable	0.202	<	0.625	Acceptable
1st	12.250	0.067	<	0.184	Acceptable	0.145	<	0.4525	Acceptable
Mezzaine	17.917	0.078	<	0.269	Acceptable	0.078	<	0.2688	Acceptable

Seismic Drift: Frame C

Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) $\Delta_{SEISMIC} = 0.015h_{sx}$			Total Drift (in)	Allowable Story Drift (in) $\Delta_{SEISMIC} = 0.015h_{sx}$		
Roof	11.500	0.020	<	0.173	Acceptable	0.251	<	0.97	Acceptable
3rd	11.500	0.037	<	0.173	Acceptable	0.231	<	0.7975	Acceptable
2nd	11.500	0.055	<	0.173	Acceptable	0.194	<	0.625	Acceptable
1st	12.250	0.064	<	0.184	Acceptable	0.139	<	0.4525	Acceptable
Mezzaine	17.917	0.075	<	0.269	Acceptable	0.075	<	0.2688	Acceptable

Seismic Drift: Frame D

Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) $\Delta_{SEISMIC} = 0.015h_{sx}$			Total Drift (in)	Allowable Story Drift (in) $\Delta_{SEISMIC} = 0.015h_{sx}$		
Roof	11.500	0.027	<	0.173	Acceptable	0.313	<	0.97	Acceptable
3rd	11.500	0.054	<	0.173	Acceptable	0.286	<	0.7975	Acceptable
2nd	11.500	0.077	<	0.173	Acceptable	0.232	<	0.625	Acceptable
1st	12.250	0.079	<	0.184	Acceptable	0.155	<	0.4525	Acceptable
Mezzaine	17.917	0.076	<	0.269	Acceptable	0.076	<	0.2688	Acceptable

Table 3: Drift Results for Seismic: Area 1

Seismic Drift: Frame 5

Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) $\Delta_{SEISMIC} = 0.015h_{sx}$			Total Drift (in)	Allowable Story Drift (in) $\Delta_{SEISMIC} = 0.015h_{sx}$		
Roof	11.500	0.132	<	0.173	Acceptable	1.158	>	0.97	Unacceptable
3rd	11.500	0.190	>	0.173	Unacceptable	1.026	>	0.7975	Unacceptable
2nd	11.500	0.252	>	0.173	Unacceptable	0.836	>	0.625	Unacceptable
1st	12.250	0.302	>	0.184	Unacceptable	0.584	>	0.4525	Unacceptable
Mezzaine	17.917	0.282	>	0.269	Unacceptable	0.282	>	0.2688	Unacceptable

Seismic Drift: Frame 6

Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) $\Delta_{SEISMIC} = 0.015h_{sx}$			Total Drift (in)	Allowable Story Drift (in) $\Delta_{SEISMIC} = 0.015h_{sx}$		
Roof	11.500	0.135	<	0.173	Acceptable	1.129	>	0.97	Unacceptable
3rd	11.500	0.189	>	0.173	Unacceptable	0.994	>	0.7975	Unacceptable
2nd	11.500	0.247	>	0.173	Unacceptable	0.805	>	0.625	Unacceptable
1st	12.250	0.291	>	0.184	Unacceptable	0.558	>	0.4525	Unacceptable
Mezzaine	17.917	0.267	<	0.269	Acceptable	0.267	<	0.2688	Acceptable

Seismic Drift: Frame 7

Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) $\Delta_{SEISMIC} = 0.015h_{sx}$			Total Drift (in)	Allowable Story Drift (in) $\Delta_{SEISMIC} = 0.015h_{sx}$		
Roof	11.500	0.184	>	0.173	Unacceptable	0.977	<	0.5175	Unacceptable
3rd	11.500	0.204	>	0.173	Unacceptable	0.793	<	0.345	Unacceptable
2nd	11.500	0.589	>	0.173	Unacceptable	0.589	<	0.1725	Unacceptable
1st	-	-	-	-	-	-	-	-	-
Mezzaine	-	-	-	-	-	-	-	-	-

Seismic Drift: Frame E

Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) $\Delta_{SEISMIC} = 0.015h_{sx}$			Total Drift (in)	Allowable Story Drift (in) $\Delta_{SEISMIC} = 0.015h_{sx}$		
Roof	11.500	0.047	<	0.173	Acceptable	0.554	<	0.97	Acceptable
3rd	11.500	0.061	<	0.173	Acceptable	0.507	<	0.7975	Acceptable
2nd	11.500	0.070	<	0.173	Acceptable	0.446	<	0.625	Acceptable
1st	12.250	0.162	<	0.184	Acceptable	0.376	<	0.4525	Acceptable
Mezzaine	17.917	0.214	<	0.269	Acceptable	0.214	<	0.2688	Acceptable

Seismic Drift: Frame F

Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) $\Delta_{SEISMIC} = 0.015h_{sx}$			Total Drift (in)	Allowable Story Drift (in) $\Delta_{SEISMIC} = 0.015h_{sx}$		
Roof	11.500	0.042	<	0.173	Acceptable	0.474	<	0.97	Acceptable
3rd	11.500	0.059	<	0.173	Acceptable	0.432	<	0.7975	Acceptable
2nd	11.500	0.072	<	0.173	Acceptable	0.373	<	0.625	Acceptable
1st	12.250	0.118	<	0.184	Acceptable	0.301	<	0.4525	Acceptable
Mezzaine	17.917	0.183	<	0.269	Acceptable	0.183	<	0.2688	Acceptable

Seismic Drift: Frame G

Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) $\Delta_{SEISMIC} = 0.015h_{sx}$			Total Drift (in)	Allowable Story Drift (in) $\Delta_{SEISMIC} = 0.015h_{sx}$		
Roof	11.500	0.039	<	0.173	Acceptable	0.435	<	0.97	Acceptable
3rd	11.500	0.054	<	0.173	Acceptable	0.396	<	0.7975	Acceptable
2nd	11.500	0.067	<	0.173	Acceptable	0.342	<	0.625	Acceptable
1st	12.250	0.108	<	0.184	Acceptable	0.275	<	0.4525	Acceptable
Mezzaine	17.917	0.167	<	0.269	Acceptable	0.167	<	0.2688	Acceptable

Seismic Drift: Frame H

Story	Story Height (ft)	Story Drift (in)	Allowable Story Drift (in) $\Delta_{SEISMIC} = 0.015h_{sx}$			Total Drift (in)	Allowable Story Drift (in) $\Delta_{SEISMIC} = 0.015h_{sx}$		
Roof	11.500	0.073	<	0.173	Acceptable	0.520	<	0.97	Acceptable
3rd	11.500	0.082	<	0.173	Acceptable	0.447	<	0.7975	Acceptable
2nd	11.500	0.090	<	0.173	Acceptable	0.365	<	0.625	Acceptable
1st	12.250	0.112	<	0.184	Acceptable	0.275	<	0.4525	Acceptable
Mezzaine	17.917	0.164	<	0.269	Acceptable	0.164	<	0.2688	Acceptable

Table 4: Drift Results for Seismic: Area 2