APPENDICES

A. Design Self-Weight Calculations

B. Wind Load Calculations

C. Seismic Load Calculations

D. Distribution by Rigidity: East-West Wind Direction

E. Distribution by Rigidity: North-South Direction

F. Strength Check on Critical Shear Walls

G. Story Drift Calculations

H. Overturning Moment Calculations

APPENDIX A

Design Dead Load (Self-Weight) Calculations

Assumptions based on criteria listed on construction drawings and documents, and verified using the BOCA 1996 Building Code.

Column Self-Weight Calculations

Ground Level

Width (in)	Depth (in)	Area (ft^2)	Height (ft)	Weight (pcf)	Self Wt. (kips)
16.00	36.00	4.00	10.25	147.00	6.03
16.00	52.00	5.78	10.25	147.00	8.71
14.00	24.00	2.33	10.25	147.00	3.52
24.00	28.00	4.67	10.25	147.00	7.03
16.00	36.00	4.00	10.25	147.00	6.03
16.00	36.00	4.00	10.25	147.00	6.03
16.00	20.00	2.22	10.25	147.00	3.35
16.00	36.00	4.00	10.25	147.00	6.03
16.00	36.00	4.00	10.25	147.00	6.03
16.00	36.00	4.00	10.25	147.00	6.03
				Σ (k) =	58.76

Level 2

Width (in)	Depth (in)	Area (ft^2)	Height (ft)	Weight (pcf)	Self Wt. (kips)
16.00	36.00	4.00	10.25	147.00	6.03
16.00	52.00	5.78	10.25	147.00	8.71
14.00	24.00	2.33	10.25	147.00	3.52
24.00	28.00	4.67	10.25	147.00	7.03
16.00	36.00	4.00	10.25	147.00	6.03
16.00	36.00	4.00	10.25	147.00	6.03
16.00	20.00	2.22	10.25	147.00	3.35
16.00	36.00	4.00	10.25	147.00	6.03
16.00	36.00	4.00	10.25	147.00	6.03
16.00	36.00	4.00	10.25	147.00	6.03
14.00	22.00	2.14	10.25	147.00	3.22
				Σ (k) =	61.99

Levels 3 to 7

Width (in)	Depth (in)	Area (ft^2)	Height (ft)	Weight (pcf)	Self Wt. (kips)
16.00	36.00	4.00	10.25	147.00	6.03
16.00	52.00	5.78	10.25	147.00	8.71
14.00	24.00	2.33	10.25	147.00	3.52
24.00	28.00	4.67	10.25	147.00	7.03
16.00	36.00	4.00	10.25	147.00	6.03
16.00	36.00	4.00	10.25	147.00	6.03
16.00	20.00	2.22	10.25	147.00	3.35
16.00	36.00	4.00	10.25	147.00	6.03
16.00	36.00	4.00	10.25	147.00	6.03
14.00	22.00	2.14	10.25	147.00	3.22
				Σ (k) =	55.96

Level 8

Width (in)	Depth (in)	Area (ft^2)	Height (ft)	Weight (pcf)	Self Wt. (kips)
16.00	36.00	4.00	10.25	147.00	6.03
16.00	36.00	4.00	10.25	147.00	6.03
24.00	28.00	4.67	10.25	147.00	7.03
16.00	36.00	4.00	10.25	147.00	6.03
16.00	20.00	2.22	10.25	147.00	3.35
16.00	36.00	4.00	10.25	147.00	6.03
16.00	36.00	4.00	10.25	147.00	6.03
12.00	48.00	4.00	10.25	147.00	6.03
12.00	48.00	4.00	10.25	147.00	6.03
14.00	22.00	2.14	10.25	147.00	3.22
14.00	22.00	2.14	10.25	147.00	3.22
				Σ (k) =	59.01

Column Self-Weight Calculations (continued)

Level 9 to 23					
Width (in)	Depth (in)	Area (ft^2)	Height (ft)	Weight (pcf)	Self Wt. (kips)
16.00	36.00	4.00	10.25	147.00	6.03
16.00	36.00	4.00	10.25	147.00	6.03
16.00	36.00	4.00	10.25	147.00	6.03
16.00	20.00	2.22	10.25	147.00	3.35
16.00	36.00	4.00	10.25	147.00	6.03
12.00	48.00	4.00	10.25	147.00	6.03
12.00	48.00	4.00	10.25	147.00	6.03
14.00	22.00	2.14	10.25	147.00	3.22
				Σ (k) =	42.73

Levels 24 and 25					
Width (in)	Depth (in)	Area (ft^2)	Height (ft)	Weight (pcf)	Self Wt. (kips)
16.00	20.00	2.22	10.0	147.00	3.27
12.00	16.00	1.33	10.0	147.00	1.96
12.00	48.00	4.00	10.0	147.00	5.88
12.00	48.00	4.00	10.0	147.00	5.88
14.00	22.00	2.14	10.0	147.00	3.14
				Σ (k) =	20.13

Shear Wall Self-Weight Calculations

Foundation to Eighth Floor					
Thick (in)	Length (ft)	Area (ft^2)	Height (ft)	Weight (pcf)	Self Wt. (kips)
16.00	44.00	58.67	10.25	147.00	88.40
12.00	28.00	28.00	10.25	147.00	42.19
9.00	19.00	14.25	10.25	147.00	21.47
12.00	18.00	18.00	10.25	147.00	27.12
12.00	30.00	30.00	10.25	147.00	45.20
12.00	12.00	12.00	10.25	147.00	18.08
12.00	9.00	9.00	10.25	147.00	13.56
12.00	18.00	18.00	10.25	147.00	27.12
12.00	42.00	42.00	10.25	147.00	63.28
24.00	15.00	30.00	10.25	147.00	45.20
12.00	25.00	25.00	10.25	147.00	37.67
24	18	36.00	10.25	147.00	54.24
				Σ (k) =	483.54

9th to 22nd Floors					
Thick (in)	Length (ft)	Area (ft^2)	Height (ft)	Weight (pcf)	Self Wt. (kips)
16.00	44.00	58.67	10.25	147.00	88.40
12.00	28.00	28.00	10.25	147.00	42.19
9.00	19.00	14.25	10.25	147.00	21.47
12.00	18.00	18.00	10.25	147.00	27.12
12.00	30.00	30.00	10.25	147.00	45.20
12.00	12.00	12.00	10.25	147.00	18.08
12.00	9.00	9.00	10.25	147.00	13.56
12.00	18.00	18.00	10.25	147.00	27.12
12.00	42.00	42.00	10.25	147.00	63.28
12.00	25.00	25.00	10.25	147.00	37.67
				Σ (k) =	384.10

Shear Wall Self-Weight Calculations (continued)

23rd Level to Roof					
Thick (in)	Length (ft)	Area (ft^2)	Height (ft)	Weight (pcf)	Column Wt. (kips)
16.00	44.00	58.67	10.00	147.00	86.24
12.00	28.00	28.00	10.00	147.00	41.16
9.00	19.00	14.25	10.00	147.00	20.95
12.00	18.00	18.00	10.00	147.00	26.46
12.00	30.00	30.00	10.00	147.00	44.10
12.00	12.00	12.00	10.00	147.00	17.64
12.00	9.00	9.00	10.00	147.00	13.23
12.00	18.00	18.00	10.00	147.00	26.46
12.00	42.00	42.00	10.00	147.00	61.74
12.00	25.00	25.00	10.00	147.00	36.75
				Σ (k) =	374.73

Self-Weight Calculations per Floor

First Floor:
W_{slab} = (8" slab)*(147 pcf)*(1ft/12")*(29449 sf)*(1 kip/1000 lb) = 2886.0 kips
$W_{columns}$ = 58.76 kips
$W_{shear\ wall}$ = 483.54 kips
W_{first} = 3428.30 kips = 0.116 ksf

Second Floor:
W_{slab} = (8" slab)*(147 pcf)*(1ft/12")*(29663 sf)*(1 kip/1000 lb) = 2906.97 kips
$W_{columns}$ = 61.99 kips
$W_{shear\ wall}$ = 483.54 kips
W_{second} = 3452.50 kips = 0.1164 ksf

Third through Sixth Floors (values per floor):
W_{slab} = (8" slab)*(147 pcf)*(1ft/12")*(30486 sf)*(1 kip/1000 lb) = 2987.63 kips
$W_{columns}$ = 55.96 kips
$W_{shear\ wall}$ = 483.54 kips
$W_{3\text{-}6th}$ = 3527.13 kips per floor = 0.1157 ksf per floor

Seventh Floor:
W_{slab} = (8" slab)*(147 pcf)*(1ft/12")*(39560 sf)*(1 kip/1000 lb) = 3876.88 kips
$W_{columns}$ = 55.96 kips
$W_{shear\ wall}$ = 483.54 kips
$W_{seventh}$ = 4416.38 kips = 0.112 ksf

Self-Weight Calculations per Floor (continued)

Eighth Floor:
W_{slab} = (8" slab)*(147 pcf)*(1ft/12")*(31610 sf)*(1 kip/1000 lb) = 3097.78 kips
$W_{columns}$ = 59.01 kips
$W_{shear\ wall}$ = 483.54 kips
W_{eighth} = 3640.33 kips = 0.115 ksf

Ninth through 22nd Floors (values per floor):
W_{slab} = (8" slab)*(147 pcf)*(1ft/12")*(12186 sf)*(1 kip/1000 lb) = 1194.23 kips
$W_{columns}$ = 42.73 kips
$W_{shear\ wall}$ = 384.10 kips
$W_{9\text{-}22nd}$ = 1621.06 kips per floor = 0.133 ksf per floor

23rd Floor:
W_{slab} = (8" slab)*(147 pcf)*(1ft/12")*(9307 sf)*(1 kip/1000 lb) = 912.09 kips
$W_{columns}$ = 42.73 kips
$W_{shear\ wall}$ = 374.73 kips
W_{23rd} = 1329.55 kips = 0.143 ksf

24th to 25th Floor:
W_{slab} = (8" slab)*(147 pcf)*(1ft/12")*(1070 sf)*(1 kip/1000 lb) = 104.86 kips
$W_{columns}$ = 20.13 kips
$W_{shear\ wall}$ = 374.73 kips
$W_{24\text{-}25th}$ = 499.72 kips = 0.467 ksf

Roof:
Because the roof consists of a small amount of mostly steel framing, which is relatively light compared to the mostly concrete construction of the other floors, this floor self-weight was estimated.
W_{roof} = (374.73 kips)$_{shear\ walls}$ + (25 kips)$_{steel,\ etc.}$ ≈ 400 kips = 0.373 ksf

Total Building Weight:
$W_{building}$ = **54469.86 kips**

APPENDIX B

Wind Load Calculations

Assumptions based on criteria listed on construction drawings and documents, and verified using the BOCA 1996 Building Code.

Assumptions:
- In the case of each direction, it was assumed that the wind forces were applied to the longest side of each wall. The shape of the River Tower was adjusted to be as rectangular as possible for simplicity.

Coefficients and Categories

Exposure Category: C	(BOCA 1996 1609.4)
Worst Case L/B Ratio: (73.5 ft)/(164 ft) = 0.448	
Basic Wind Speed (V): 80 mph	(Figure 1609.3 – Wilmington, DE)
Basic Velocity Pressure (P_v): 16.4 psf	(Table 1609.7(3) based on V = 80 mph)
Wall Pressure Coefficients (C_p): For N-S Direction	(Table 1609.7)
- Windward Walls: $C_p = 0.8$	
- Leeward Walls: $C_p = -0.5$	
Wall Pressure Coefficients (C_p): For W-E Direction	(Table 1609.7)
- Windward Walls: $C_p = 0.8$	
- Leeward Walls: $C_p = -0.3$	
Importance Factor (I): 1.04	(Table 1609.5 and interpolation)
Internal Pressure Coefficients (GC_{pi}): +/- 0.25	(Table 1609.7(6))
Velocity Pressure Exposure (K_z and K_h): see below	(Table 1609.7(4))
Gust Response Factors (G_h and G_z): see below	(Table 1609.7(5))

Building Main Windforce-Resisting System:
- Windward wall design pressure, P

$$P = (P_v)(I)[(K_z)(G_h)(C_p) – (K_h)(GC_{pi})]$$

- Leeward wall design pressure, P

$$P = (P_v)(I)[(K_z)(G_h)(C_p) – (K_h)(GC_{pi})]$$

North-South Direction Wind Pressure Totals						
Level	**Elev. (ft)**	**K coeff.**	**G coeff.**	**P (windward)**	**P (leeward)**	**Total P (psf)**
Roof	279.22	1.84	1.09	27.47	-17.17	44.63
25	269.22	1.82	1.10	27.22	-17.17	44.38
24	259.39	1.81	1.10	27.12	-17.17	44.28
23	247.36	1.78	1.10	26.74	-17.17	43.91
22	236.00	1.76	1.10	26.49	-17.17	43.65
21	225.75	1.74	1.11	26.23	-17.17	43.40
20	215.50	1.71	1.11	25.83	-17.17	43.00
19	205.25	1.69	1.11	25.62	-17.17	42.79
18	195.00	1.67	1.11	25.36	-17.17	42.53
17	184.75	1.64	1.12	25.02	-17.17	42.18
16	174.50	1.62	1.12	24.82	-17.17	41.99
15	164.25	1.59	1.13	24.47	-17.17	41.64
14	154.00	1.56	1.13	24.15	-17.17	41.31
13	143.75	1.53	1.14	23.80	-17.17	40.97
12	133.50	1.50	1.15	23.43	-17.17	40.60
11	123.25	1.46	1.15	22.91	-17.17	40.08
10	113.00	1.43	1.16	22.54	-17.17	39.70
9	102.75	1.39	1.16	22.00	-17.17	39.17
8	92.50	1.35	1.17	21.55	-17.17	38.72
7	82.25	1.30	1.18	20.93	-17.17	38.10
6	72.00	1.25	1.19	20.30	-17.17	37.46
5	61.75	1.20	1.20	19.65	-17.17	36.82
4	51.50	1.14	1.21	18.82	-17.17	35.99
3	41.25	1.07	1.23	17.96	-17.17	35.12
2	31.00	0.99	1.26	17.02	-17.17	34.19
1	10.50	0.80	1.32	14.41	-17.17	31.58

North-South Wind Pressure and Forces				
Level	**Trib. Width (ft)**	**Trib Height (ft)**	**P (plf)**	**F (kips)**
Roof	172.5	10.00	7699.19	76.99
25	172.5	9.83	7656.25	75.26
24	172.5	12.03	7638.98	91.90
23	172.5	11.36	7574.01	86.04
22	172.5	10.25	7530.47	77.19
21	172.5	10.25	7486.74	76.74
20	172.5	10.25	7416.76	76.02
19	172.5	10.25	7380.56	75.65
18	172.5	10.25	7336.12	75.20
17	172.5	10.25	7276.83	74.59
16	172.5	10.25	7243.27	74.24
15	172.5	10.25	7182.68	73.62
14	172.5	10.25	7126.73	73.05
13	172.5	10.25	7066.60	72.43
12	172.5	10.25	7003.75	71.79
11	172.5	10.25	6913.13	70.86
10	172.5	10.25	6848.76	70.20
9	172.5	10.25	6756.38	69.25
8	180.75	10.25	6998.37	71.73
7	180.75	10.25	6886.15	70.58
6	180.75	10.25	6771.47	69.41
5	180.75	10.25	6654.32	68.21
4	180.75	10.25	6504.86	66.67
3	180.75	10.25	6348.74	65.07
2	180.75	20.50	6179.31	126.68
1	180.75	10.50	5707.26	59.93
			Sum of F:	1959.30

West-East Direction Wind Pressure Totals						
Level	**Elev. (ft)**	**K coeff.**	**G coeff.**	**P (windward)**	**P (leeward)**	**Total P (psf)**
Roof	279.22	1.84	1.09	27.47	-10.30	37.77
25	269.22	1.82	1.10	27.22	-10.30	37.52
24	259.39	1.81	1.10	27.12	-10.30	37.42
23	247.36	1.78	1.10	26.74	-10.30	37.04
22	236.00	1.76	1.10	26.49	-10.30	36.79
21	225.75	1.74	1.11	26.23	-10.30	36.53
20	215.50	1.71	1.11	25.83	-10.30	36.13
19	205.25	1.69	1.11	25.62	-10.30	35.92
18	195.00	1.67	1.11	25.36	-10.30	35.66
17	184.75	1.64	1.12	25.02	-10.30	35.32
16	174.50	1.62	1.12	24.82	-10.30	35.12
15	164.25	1.59	1.13	24.47	-10.30	34.77
14	154.00	1.56	1.13	24.15	-10.30	34.45
13	143.75	1.53	1.14	23.80	-10.30	34.10
12	133.50	1.50	1.15	23.43	-10.30	33.73
11	123.25	1.46	1.15	22.91	-10.30	33.21
10	113.00	1.43	1.16	22.54	-10.30	32.84
9	102.75	1.39	1.16	22.00	-10.30	32.30
8	92.50	1.35	1.17	21.55	-10.30	31.85
7	82.25	1.30	1.18	20.93	-10.30	31.23
6	72.00	1.25	1.19	20.30	-10.30	30.60
5	61.75	1.20	1.20	19.65	-10.30	29.95
4	51.50	1.14	1.21	18.82	-10.30	29.12
3	41.25	1.07	1.23	17.96	-10.30	28.26
2	31.00	0.99	1.26	17.02	-10.30	27.32
1	10.50	0.80	1.32	14.41	-10.30	24.71

West-East Wind Pressure and Forces				
Level	**Trib. Width (ft)**	**Trib Height (ft)**	**P (plf)**	**F (kips)**
Roof	72.1667	10.00	2725.47	27.25
25	72.1667	9.83	2707.51	26.61
24	72.1667	12.03	2700.28	32.48
23	72.1667	11.36	2673.11	30.37
22	72.1667	10.25	2654.89	27.21
21	72.1667	10.25	2636.59	27.03
20	72.1667	10.25	2607.32	26.73
19	72.1667	10.25	2592.17	26.57
18	72.1667	10.25	2573.58	26.38
17	72.1667	10.25	2548.78	26.12
16	72.1667	10.25	2534.74	25.98
15	72.1667	10.25	2509.39	25.72
14	72.1667	10.25	2485.98	25.48
13	72.1667	10.25	2460.82	25.22
12	72.1667	10.25	2434.53	24.95
11	72.1667	10.25	2396.62	24.57
10	72.1667	10.25	2369.69	24.29
9	72.1667	10.25	2331.04	23.89
8	104.417	10.25	3325.87	34.09
7	104.417	10.25	3261.04	33.43
6	104.417	10.25	3194.79	32.75
5	104.417	10.25	3127.11	32.05
4	104.417	10.25	3040.78	31.17
3	104.417	10.25	2950.59	30.24
2	104.417	20.50	2852.71	58.48
1	104.417	10.50	2580.01	27.09
			Sum of F:	756.16

APPENDIX C

Seismic Load Calculations

Assumptions based on criteria listed on construction drawings and documents, and verified using the BOCA 1996 Building Code.

Seismic Hazard Exposure Group: II (Table 1610.1.5 – Substantial occupancy building)
Effective Peak Velocity-related Acceleration: $A_v = 0.075$
(Wilmington, DE – Figure 1610.1.3(1): halfway between 0.05 and 0.10 regions)
Effective Peak Acceleration Coefficient: $A_a = 0.05$ (Wilmington, DE – Figure 1610.1.3(2))
Seismic Performance Category: B (Table 1610.1.7 since $0.05 < A_v < 0.10$)
Seismic Resisting System: Dual-system with intermediate moment frame of reinforced concrete with reinforced concrete shear walls (Table 1610.3.3 – No height limitations)
- Response Modification Factor (R): 8.0
- Deflection Amplification Factor (Cd): 6.5

Site Coefficient: S_4, 2.0 (Table 1610.3.1)

Use Equivalent Lateral Force Procedure (Section 1610.3.5.2)

$V = (C_s)(W)$

Seismic Design Coefficient (C_s): (Section 1610.4.1.1)
min of $C_s = (1.2A_vS) / (RT)^{(2/3)}$ = See below
…and $(2.5A_a)/(R) = (2.5)(0.05)/(8.0) = 0.0156$

Approximate Fundamental Period (T_a):
$T_a = (C_T)(h_n)^{(3/4)}$
$C_T = 0.02$ (Section 1610.4.1.2.1: Seismic-Resisting System with shear walls)
$h_n = 279.22$ ft (Section 1610.4.1.2.1: Height from base to highest level of building)
$T_a = (0.02)(279.22)^{(3/4)} = 1.366$ seconds

Coefficient for Upper Limit on Calculated Period (C_a): 1.7 (Table 1610.4.1.2)
Fundamental Period (T): $T = (C_a)(T_a)$
$T = (1.7)(1.366) = 2.322$ seconds

$C_s = [(1.2)(0.075)(2.0)]/[(8.0)(2.322)]^{(2/3)} = 0.0257 > 0.0156 \rightarrow$ Use $C_s = 0.0156$

$V = (0.0156)*(54469.86 \text{ kips}) =$ **849.73 kips**

Vertical Distribution of Seismic Forces: $F_x = (C_{vx})(V)$ (Section 1610.4.2)
$C_{vx} = (w_x h^k_x) / (\Sigma\, w_i h^k_i)$

(k determined through linear interpolation: 1.911)

Level	w_x (k)	h_x (ft)	$w_x h_x^k$	C_{vx}	F_x (k)
Roof	375	279.22	17611207	0.028729	24.41
25	499.72	269.22	21889292	0.035707	30.34
24	499.72	259.39	20388130	0.033259	28.26
23	1329.55	247.36	49540908	0.080815	68.67
22	1621.06	236.00	55215501	0.090072	76.54
21	1621.06	225.75	50725707	0.082747	70.31
20	1621.06	215.50	46417675	0.07572	64.34
19	1621.06	205.25	42292167	0.06899	58.62
18	1621.06	195.00	38349985	0.062559	53.16
17	1621.06	184.75	34591977	0.056429	47.95
16	1621.06	174.50	31019041	0.050601	43.00
15	1621.06	164.25	27632130	0.045076	38.30
14	1621.06	154.00	24432261	0.039856	33.87
13	1621.06	143.75	21420524	0.034943	29.69
12	1621.06	133.50	18598088	0.030339	25.78
11	1621.06	123.25	15966220	0.026045	22.13
10	1621.06	113.00	13526297	0.022065	18.75
9	1621.06	102.75	11279826	0.0184	15.64
8	3097.78	92.50	17635236	0.028768	24.44
7	4416.38	82.25	20089819	0.032772	27.85
6	3427.13	72.00	12090260	0.019723	16.76
5	3427.13	61.75	9016690.8	0.014709	12.50
4	3427.13	51.50	6375032.3	0.010399	8.84
3	3427.13	41.25	4172442.2	0.006806	5.78
2	3452.5	31.00	2435760.2	0.003973	3.38
1	3428.3	10.50	305879.51	0.000499	0.42
		$\Sigma\, w_i h^k_i$ =	613018057	$\Sigma\, F_x$ (k) =	849.73

APPENDIX D

Distribution by Rigidity: West-East Direction

Shear Wall Dimensions (for both Wind Directions)					
Wall	**t (in)**	**L (ft)**	**I (in^4)**	**X_i (ft)**	**Y_i (ft)**
A	16	25	36000000	0.666667	0
B	12	14.5	5268024	0	30.25
C	12	14.5	5268024	0	37.93
D	12	23.1667	21485045	0.666667	0
E	16	9.25	1823508	85.91667	0
F	12	9.25	1367631	114.333	0
G	12	28.42	39665776	0	48.458
H	12	8.93	1230547	143.4167	0
J	9	19.3333	9365328	71.41667	0
K	12	6.08333	389016.4	145.594	0
L	12	6.307	433523.1	0	37.932
M	12	7.47	720286.9	0	65.4322
O	24	19.927	27346358	180.5	0
P	24	14.708	10995997	180.5	0
Q	12	8.8333	1191003	0	72.172
R	12	19.1667	12167063	130.9	0
S	12	8.8333	1191003	0	92.333

	R/E for Each Wall: West - East Direction								
Level	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**J**
6	0.0032	0.00047	0.00047	0.00191	0.00016	0.00012	0.00353	0.00011	0.00083
5	0.00625	0.00091	0.00091	0.00373	0.00032	0.00024	0.00688	0.00021	0.00625
4	0.01176	0.00172	0.00172	0.00702	0.0006	0.00045	0.01296	0.0004	0.01176
3	0.026269	0.003844	0.003844	0.015677	0.001331	0.000998	0.028943	0.000898	0.026269
2	0.078969	0.011556	0.011556	0.047129	0.004	0.003	0.08701	0.002699	0.020544
1	0.066958	0.239411	0.023177	0.017383	0.416097	0.015641	0.066958	0.239411	0.108417

	R/E for Each Wall: West- East Direction (continued)								
Level	**K**	**L**	**M**	**N**	**O**	**P**	**Q**	**R**	**S**
6	3.5E-05	3.9E-05	6.4E-05						
5	0.00162	6.7E-05	7.5E-05						
4	0.00306	0.00013	0.00014						
3	0.006834	0.000284	0.000316						
2	0.000853	0.000951	0.00158	0.059986	0.024121	0.002613	0.026689	0.002613	0.026689
1	0.004945	0.00551	0.009155	0.314822	0.139762	0.015138	0.141067	0.015138	0.141067

	Center of Rigidity: West-East Wind Direction			
Level	**Σk_x =**	**Σk_y =**	**X_{bar} (ft)**	**Y_{bar} (ft)**
6	0.00637	0.00457	17.4895	45.6595
5	0.00638	0.00457	17.4895	45.6595
4	0.01243	0.00891	17.4895	45.6595
3	0.02341	0.01678	17.4895	45.6595
2	0.05229	0.03747	17.4895	45.6595
1	0.29468	0.11788	85.2682	47.2815

Story Forces		Trib H (ft)	Trib W (ft)
F_6 (k) =	71.84	53.72	72.1667
F_5 (k) =	107.73	41	72.1667
F_4 (k) =	104.11	41	72.1667
F_3 (k) =	100.05	41	72.1667
F_2 (k) =	116.41	41	104.417
F_1 (k) =	156.65	51.5	104.417
F_{ground} (k)	73.54	51.5	104.417

Story Shears	
F_6 (k) =	71.84
F_5 (k) =	179.57
F_4 (k) =	283.67
F_3 (k) =	383.73
F_2 (k) =	500.14
F_1 (k) =	656.78
F_{ground} (k)	730.32

	Concentric Forces per Wall: Wind Acting in West-East Direction					
	Wall B		Wall C		Wall G	
Level	**Proportion of R**	**Shear (k)**	**Proportion**	**Shear (k)**	**Proportion**	**Shear (k)**
6	0.073513	5.28	0.073513	5.28	0.553519	39.76
5	0.073513	13.20	0.073513	13.20	0.553519	99.39
4	0.073513	20.85	0.073513	20.85	0.553519	157.02
3	0.073513	28.21	0.073513	28.21	0.553519	212.40
2	0.039215	19.61	0.039215	19.61	0.295269	147.68
1	0.043511	28.58	0.043511	28.58	0.270391	177.59

	Wall L		Wall M	
Level	**Proportion of R**	**Shear (k)**	**Proportion**	**Shear (k)**
6	0.00604963	0.43	0.010051	0.72
5	0.00604963	1.09	0.010051	1.80
4	0.00604963	1.72	0.010051	2.85
3	0.00604963	2.32	0.010051	3.86
2	0.00322712	1.61	0.005362	2.68
1	0.00358068	2.35	0.005949	3.91

	Wall P		Wall R	
Level	**Proportion of R**	**Shear (k)**	**Proportion**	**Shear (k)**
2	0.008866	4.43	0.008865745	4.43
1	0.015061	9.89	0.009837082	6.46

First Level of Floors: Eccentric Shears – West-East Wind Direction					
Wall	**R**	**dx**	**$R*dx^2$**	**$R*dx/\Sigma Rx^2$**	**Torsional Shear (k)**
A	0.3932	87.19	2988.741	0.0036	12.05
B	0.0670	16.86	19.028	0.0001	0.40
C	0.0670	9.18	5.640	0.0001	0.22
D	0.2394	87.19	1819.885	0.0022	7.34
E	0.0232	1.94	0.087	0.0000	0.02
F	0.0174	26.48	12.189	0.0000	0.16
G	0.4161	1.35	0.759	0.0001	0.20
H	0.0156	47.11	34.708	0.0001	0.26
J	0.1084	24.31	64.068	0.0003	0.93
N	0.0049	57.74	16.485	0.0000	0.10
O	0.0055	9.18	0.464	0.0000	0.02
P	0.0092	18.32	3.074	0.0000	0.06
Q	0.3148	92.65	2702.252	0.0031	10.25
R	0.1398	92.65	1199.640	0.0014	4.55
S	0.0151	25.06	9.510	0.0000	0.13

Second Level of Floors: Eccentric Shears					
Wall	**R**	**dx**	**$R*dx^2$**	**$R*dx/\Sigma Rx^2$**	**Torsional Shear (k)**
A	0.0790	87.19	600.280	0.0038	9.25
B	0.0116	16.86	3.284	0.0001	0.26
C	0.0116	9.18	0.973	0.0001	0.14
D	0.0471	87.19	358.251	0.0022	5.52
E	0.0040	1.94	0.015	0.0000	0.01
F	0.0030	26.48	2.104	0.0000	0.11
G	0.0870	1.35	0.159	0.0001	0.16
H	0.0027	47.11	5.990	0.0001	0.17
J	0.0205	24.31	12.140	0.0003	0.67
K	0.0009	57.74	2.845	0.0000	0.01
L	0.0010	9.18	0.080	0.0000	0.00
M	0.0016	18.32	0.531	0.0000	0.01
N	0.0600	92.65	514.887	0.0006	1.44
O	0.0241	92.65	207.037	0.0002	0.58
P	0.0026	25.06	1.641	0.0000	0.02

Third Level of Floors: Eccentric Shears					
Wall	**R**	**dx**	**$R*dx^2$**	**$R*dx/\Sigma Rx^2$**	**Tors. Shear (k)**
A	0.0263	87.19	199.680	0.0070	49.79
B	0.0038	16.86	1.092	0.0002	1.41
C	0.0038	9.18	0.324	0.0001	0.77
D	0.0157	87.19	119.171	0.0042	29.71
E	0.0013	1.94	0.005	0.0000	0.06
F	0.0010	26.48	0.700	0.0001	0.57
G	0.0289	1.35	0.053	0.0001	0.85
H	0.0009	47.11	1.993	0.0001	0.92
J	0.0068	24.31	4.038	0.0005	3.61
K	0.0003	57.74	0.946	1.71912E-06	0.01
L	0.0003	9.18	0.027	3.04435E-07	0.00
M	0.0005	18.32	0.176	1.01019E-06	0.01

Fourth Level of Floors: Eccentric Shears					
Wall	**R**	**dx**	**$R*dx^2$**	**$R*dx/\Sigma Rx^2$**	**Tors. Shear (k)**
A	0.0118	87.19	89.411	0.0070	23.38
B	0.0017	16.86	0.489	0.0002	0.66
C	0.0017	9.18	0.145	0.0001	0.36
D	0.0070	87.19	53.361	0.0042	13.95
E	0.0006	1.94	0.002	0.0000	0.03
F	0.0004	26.48	0.313	0.0001	0.27
G	0.0130	1.35	0.024	0.0001	0.40
H	0.0004	47.11	0.892	0.0001	0.43
J	0.0031	24.31	1.808	0.0005	1.70
K	0.0001	57.74075	0.424	4.99389E-05	0.17
L	0.000142	9.175396	0.012	8.84353E-06	0.03
M	0.000235	18.3248	0.079	2.93449E-05	0.10

Fifth Level of Floors: Eccentric Shears					
Wall	**R**	**dx**	**$R*dx^2$**	**$R*dx/\Sigma Rx^2$**	**Tors. Shear (k)**
A	0.0062	87.19	47.472	0.007	23.3
B	0.0009	16.86	0.26	0.0002	0.66
C	0.0009	9.18	0.077	0.0001	0.36
D	0.0037	87.19	28.332	0.0042	13.91
E	0.0003	1.94	0.001	0	0.03
F	0.0002	26.48	0.166	0.0001	0.27
G	0.0069	1.35	0.013	0.0001	0.4
H	0.0002	47.11	0.474	0.0001	0.43
J	0.0016	24.31	0.96	0.0005	1.69
K	0.0001	57.74	0.225	4.99E-05	0.17
L	0.0001	9.18	0.006	8.84E-06	0.03
M	0.0001	18.32	0.042	2.93E-05	0.1

Sixth Level of Floors: Eccentric Shears					
Wall	**R**	**dx**	**$R*dx^2$**	**$R*dx/\Sigma Rx^2$**	**Tors. Shear (k)**
A	0.0032	87.19	24.348	0.0036	4.78
B	0.0005	16.86	0.133	0.0001	0.14
C	0.0005	9.18	0.039	0.0001	0.07
D	0.0019	87.19	14.531	0.0021	2.85
E	0.0002	1.94	0.001	0.0000	0.01
F	0.0001	26.48	0.085	0.0000	0.06
G	0.0035	1.35	0.006	0.0001	0.08
H	0.0001	47.11	0.243	0.0001	0.09
J	0.0008	24.31	0.492	0.0003	0.35
K	0.0000	57.74	0.115	2.56129E-05	0.03
L	0.0000	9.18	0.003	4.53571E-06	0.01
M	0.0001	18.32	0.022	2.93449E-05	0.04

Torsional Moments	
Level	**ft-kips**
6	1335.725
5	3338.859
4	5274.599
3	7134.966
2	2464.158
1	3350.32

APPENDIX E

Distribution by Rigidity: North-South Direction

Please see Appendix D for Shear Wall dimensions and standard values.

	R/E for Each Wall: North-South Direction								
Level	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**J**
6	0.0032	0.00047	0.00047	0.00191	0.00016	0.00012	0.00353	0.00011	0.00083
5	0.00625	0.00091	0.00091	0.00373	0.00032	0.00024	0.00688	0.00021	0.00162
4	0.01176	0.00172	0.00172	0.00702	0.0006	0.00045	0.01296	0.0004	0.00306
3	0.02627	0.00384	0.00384	0.01568	0.00133	0.001	0.02894	0.0009	0.00683
2	0.07897	0.01156	0.01156	0.04713	0.004	0.003	0.08701	0.0027	0.02054
1	0.39318	0.06696	0.06696	0.23941	0.02318	0.01738	0.4161	0.01564	0.39318

	R/E for Each Wall: North-South Direction (continued)								
Level	**K**	**L**	**M**	**N**	**O**	**P**	**Q**	**R**	**S**
6	3.5E-05	3.9E-05	6.4E-05						
5	6.7E-05	7.5E-05	0.00012						
4	0.00013	0.00014	0.00024						
3	0.00028	0.00032	0.00053						
2	0.00085	0.00095	0.00158	0.05999	0.02412	0.00261	0.02669	0.00261	0.02669
1	0.10842	0.00494	0.00551	0.00916	0.31482	0.13976	0.01514	0.14107	0.01514

	Center of Rigidity: N-S Wind Direction			
Level	**Σk_x =**	**Σk_y =**	**X_{bar} (ft)**	**Y_{bar} (ft)**
6	0.00638	0.00457	17.4895	45.6595
5	0.01243	0.00891	17.4895	45.6595
4	0.02341	0.01678	17.4895	45.6595
3	0.05229	0.03747	17.4895	45.6595
2	0.29468	0.11788	85.2682	47.2815
1	1.53887	0.59495	87.8532	47.1074

Story Forces		**Trib H (ft)**	**Trib W (ft)**
F_6 (k) =	203.54	53.72	172.5
F_5 (k) =	306.10	41	172.5
F_4 (k) =	297.43	41	172.5
F_3 (k) =	287.74	41	172.5
F_2 (k) =	281.05	41	180.75
F_1 (k) =	335.11	51.5	180.75
F_{ground} (k)	159.27	51.5	180.75

Story Shears	
F_6 (k) =	203.54
F_5 (k) =	509.64
F_4 (k) =	807.07
F_3 (k) =	1094.82
F_2 (k) =	1375.87
F_1 (k) =	1710.98
F_{ground} (k)	1870.25

	Concentric Forces per Wall: Wind Acting in N-S Direction					
	Wall A		Wall D		Wall E	
Level	Proportion of R	Shear (k)	Proportion	Shear (k)	Proportion	Shear (k)
6	0.700994	142.68	0.418358	85.15	0.035507	7.23
5	0.700994	357.26	0.418358	213.21	0.035507	18.10
4	0.700994	565.75	0.299815	241.97	0.035507	28.66
3	0.700994	767.46	0.418358	458.03	0.035507	38.87
2	0.669921	921.72	0.399814	550.09	0.033934	46.69
1	0.660853	1130.71	0.402403	688.50	0.038956	66.65

	Wall F		Wall H		Wall J	
Level	Proportion of R	Shear (k)	Proportion	Shear (k)	Proportion	Shear (k)
6	0.02663059	5.42	0.023961	4.88	0.182362	37.12
5	0.02663059	13.57	0.023961	12.21	0.182362	92.94
4	0.02663059	21.49	0.023961	19.34	0.182362	147.18
3	0.02663059	29.16	0.023961	26.23	0.182362	199.65
2	0.02545015	35.02	0.022899	31.51	0.174279	239.78
1	0.02921736	49.99	0.026289	44.98	0.182228	311.79

	Wall K		Wall N		Wall O	
Level	Proportion of R	Shear (k)	Proportion	Shear (k)	Proportion	Shear (k)
6	0.00757495	1.54				
5	0.00757495	3.86				
4	0.00757495	6.11				
3	0.00757495	8.29				
2	0.007239178	9.96	0.508886478	700.16	0.204624	281.54
1	0.008310743	14.22	0.529153438	905.37	0.234913	401.93

	Wall Q		Wall S	
Level	Proportion of R	Shear (k)	Proportion	Shear (k)
2	0.090571	124.61	0.226416039	311.52
1	0.091669	156.84	0.091669343	156.84

First Level of Floors: Eccentric Shears – N-S Wind Direction					
Wall	**R**	**dx**	**$R*dx^2$**	**$R*dx/\Sigma Rx^2$**	**Torsional Shear (k)**
A	0.3932	87.19	2988.741	0.0036	15.51
B	0.0670	16.86	19.028	0.0001	0.51
C	0.0670	9.18	5.640	0.0001	0.28
D	0.2394	87.19	1819.885	0.0022	9.45
E	0.0232	1.94	0.087	0.0000	0.02
F	0.0174	26.48	12.189	0.0000	0.21
G	0.4161	1.35	0.759	0.0001	0.25
H	0.0156	47.11	34.708	0.0001	0.33
J	0.1084	24.31	64.068	0.0003	1.19
K	0.0049	57.74	16.485	0.0000	0.13
L	0.0055	9.18	0.464	0.0000	0.02
M	0.0092	18.32	3.074	0.0000	0.08
N	0.3148	92.65	2702.252	0.0031	13.20
O	0.1398	92.65	1199.640	0.0014	5.86
P	0.0151	25.06	9.510	0.0000	0.17

Second Level of Floors: Eccentric Shears					
Wall	**R**	**dx**	**$R*dx^2$**	**$R*dx/\Sigma Rx^2$**	**Torsional Shear (k)**
A	0.0790	87.19	600.280	0.0038	26.38
B	0.0116	16.86	3.284	0.0001	0.75
C	0.0116	9.18	0.973	0.0001	0.41
D	0.0471	87.19	358.251	0.0022	15.74
E	0.0040	1.94	0.015	0.0000	0.03
F	0.0030	26.48	2.104	0.0000	0.30
G	0.0870	1.35	0.159	0.0001	0.45
H	0.0027	47.11	5.990	0.0001	0.49
J	0.0205	24.31	12.140	0.0003	1.91
K	0.0009	57.74	2.845	0.0000	0.04
L	0.0010	9.18	0.080	0.0000	0.01
M	0.0016	18.32	0.531	0.0000	0.02
N	0.0600	92.65	514.887	0.0006	4.10
O	0.0241	92.65	207.037	0.0002	1.65
P	0.0026	25.06	1.641	0.0000	0.05

Third Level of Floors: Eccentric Shears					
Wall	**R**	**dx**	**$R*dx^2$**	**$R*dx/\Sigma Rx^2$**	**Tors. Shear (k)**
A	0.0263	87.19	199.680	0.0070	525.32
B	0.0038	16.86	1.092	0.0002	14.86
C	0.0038	9.18	0.324	0.0001	8.09
D	0.0157	87.19	119.171	0.0042	313.51
E	0.0013	1.94	0.005	0.0000	0.59
F	0.0010	26.48	0.700	0.0001	6.06
G	0.0289	1.35	0.053	0.0001	8.97
H	0.0009	47.11	1.993	0.0001	9.70
J	0.0068	24.31	4.038	0.0005	38.10
K	0.0003	57.74	0.946	1.71912E-06	0.13
L	0.0003	9.18	0.027	3.04435E-07	0.02
M	0.0005	18.32	0.176	1.01019E-06	0.08

Fourth Level of Floors: Eccentric Shears					
Wall	**R**	**dx**	**$R*dx^2$**	**$R*dx/\Sigma Rx^2$**	**Tors. Shear (k)**
A	0.0118	87.19	89.411	0.0070	30.11
B	0.0017	16.86	0.489	0.0002	0.85
C	0.0017	9.18	0.145	0.0001	0.46
D	0.0070	87.19	53.361	0.0042	17.97
E	0.0006	1.94	0.002	0.0000	0.03
F	0.0004	26.48	0.313	0.0001	0.35
G	0.0130	1.35	0.024	0.0001	0.51
H	0.0004	47.11	0.892	0.0001	0.56
J	0.0031	24.31	1.808	0.0005	2.18
K	0.0001	57.74075	0.424	4.99389E-05	0.22
L	0.000142	9.175396	0.012	8.84353E-06	0.04
M	0.000235	18.3248	0.079	2.93449E-05	0.13

Fifth Level of Floors: Eccentric Shears					
Wall	**R**	**dx**	**$R*dx^2$**	**$R*dx/\Sigma Rx^2$**	**Tors. Shear (k)**
A	0.0062	87.19	47.472	0.0070	244.54
B	0.0009	16.86	0.260	0.0002	6.92
C	0.0009	9.18	0.077	0.0001	3.77
D	0.0037	87.19	28.332	0.0042	145.94
E	0.0003	1.94	0.001	0.0000	0.28
F	0.0002	26.48	0.166	0.0001	2.82
G	0.0069	1.35	0.013	0.0001	4.17
H	0.0002	47.11	0.474	0.0001	4.52
J	0.0016	24.31	0.960	0.0005	17.74
K	0.0001	57.74	0.225	4.99E-05	1.75
L	0.0001	9.18	0.006	8.84E-06	0.31
M	0.0001	18.32	0.042	2.93E-05	1.03

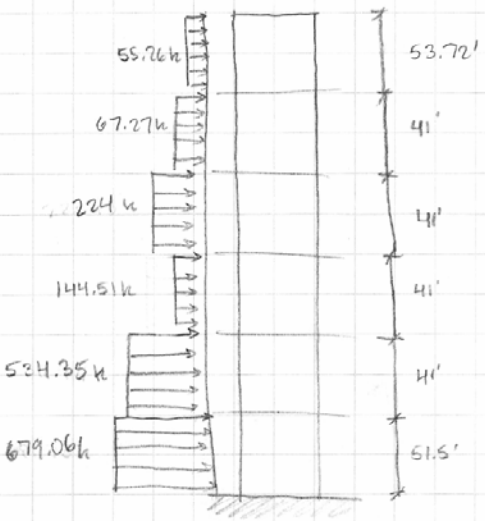
Sixth Level of Floors: Eccentric Shears					
Wall	**R**	**dx**	**$R*dx^2$**	**$R*dx/\Sigma Rx^2$**	**Tors. Shear (k)**
A	0.0032	87.19	24.348	0.0036	50.09
B	0.0005	16.86	0.133	0.0001	1.42
C	0.0005	9.18	0.039	0.0001	0.77
D	0.0019	87.19	14.531	0.0021	29.89
E	0.0002	1.94	0.001	0.0000	0.06
F	0.0001	26.48	0.085	0.0000	0.58
G	0.0035	1.35	0.006	0.0001	0.85
H	0.0001	47.11	0.243	0.0001	0.93
J	0.0008	24.31	0.492	0.0003	3.63
K	0.0000	57.74	0.115	2.56129E-05	0.36
L	0.0000	9.18	0.003	4.53571E-06	0.06
M	0.0001	18.32	0.022	2.93449E-05	0.41

Torsional Moments	
Level	**ft-kips**
6	13995.72
5	35043.15
4	55494.85
3	75280.31
2	7026.321
1	4314.666

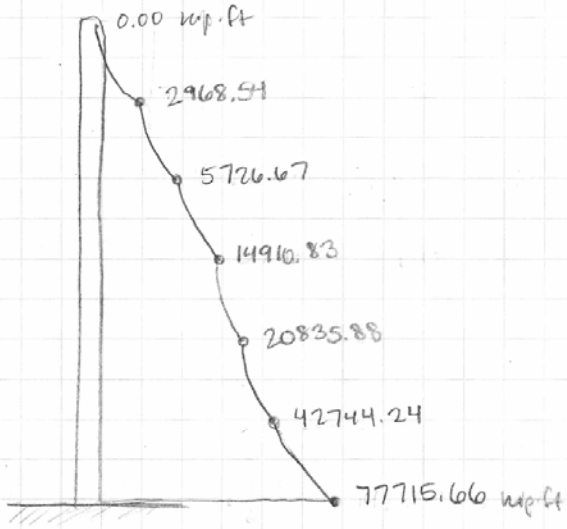
APPENDIX F

Strength Check on Selected Critical Shear Walls

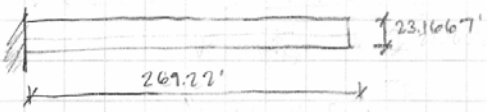
Wall D - North-South Directed Wind



V diagram (determined by Distribution by Rigidity Method)

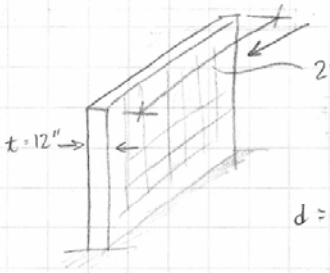


M diagram



Base M = 77715.66 ft·kip for Wall D

M@d = 6982.18 kip·ft



$d = \frac{23.1667'}{2} = 11.58'$

$$\text{Req'd } M_n = \frac{M_u}{\phi} = \frac{77715.66 \text{ kip·ft}}{0.9} = 86530.73 \text{ kip·ft}$$

Actual steel → (22) #11's on lower 15 floors, (vertical)
(22) #9's on 15th - roof

(For simplicity, consider consistent #11's and $f'_c = 6000$ psi)

$$A_s = (22)(1.39 \text{ in}^2) = 30.58 \text{ in}^2$$

$$a = \frac{A_s f_y}{0.85 f'_c b} = \frac{(30.58 \text{ in}^2)(60 \text{ ksi})}{0.85(5 \text{ ksi})(12")} = 35.98"$$

Ductility Check

$d = 11.58' \left(12^{in}/_{ft}\right) = 138.96"$

$\beta_1 = 0.75$ for $f'_c = 6$ ksi

$c = {}^{a}/_{\beta_1} = \frac{35.98"}{0.75} = 48" < 0.375(138.96") = 52.11"$

Use $\Phi = 0.9$

$\Phi M_n = (\Phi) A_s f_y (d - {}^{a}/_{2})$

$= (0.9)(30.58 in^2)(60 ksi)\left(138.96" - \frac{35.98"}{2}\right) = 199760.18 \text{ kip·in}$

$= 16646.68 \text{ kip·ft}$

$\Phi M_n <$ Req'd M_n (Not OK)

Check shear

$V_{max} = 679.06 \text{ kip} = V_u$

$V_c = \frac{1}{2}(2)(\sqrt{f'_c})(b_w)(d) = 129.17 \text{ kip}$

Req'd $V_s = \frac{V_u}{\Phi} + V_c = \frac{679.06k}{0.75} - 129.17k = 776.3 \text{ kip}$

Actual Steel $\longrightarrow$ #4 @ 12" $\longrightarrow A_v = 0.2 in^2$

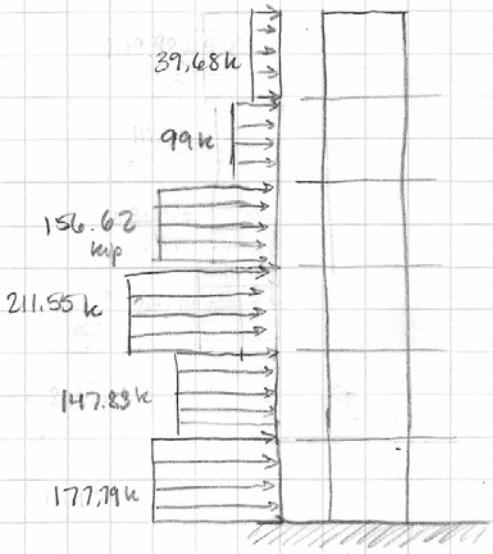
Actual $V_s = A_v f_y ({}^{d}/_{s}) = 4(0.2 in^2)(60 ksi)\left(\frac{138.96"}{12"}\right) = 555.84 \text{ kip}$

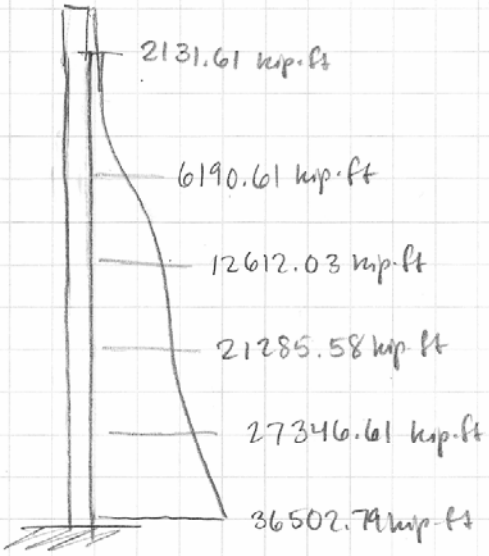
Actual $V_s <$ Req'd V_s (Not OK)

Since neither strength check worked in this case, I believe that there are two factors not accounted for that can aid lateral resistant capacity:

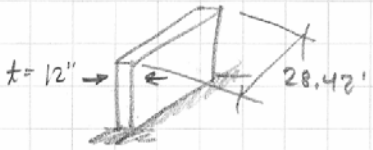
1) Concrete columns (not in scope of this report)
2) The axial load provided by the live and dead loads

Wall G → W-E Directed Wind





V (determined through Dist. by Rigidity)



Base M = 36502.79 ft·kip = M_u

Req'd $M_n = \frac{36502.79 \text{ ft·kip}}{0.9} = 40558.66 \text{ ft·kip}$

Actual steel → #9 @ 12"

$\frac{23.1667'}{1'} \cong 24$ bars

$A_s = 24(1 in^2) = 24 in^2$

$a = \frac{A_s f_y}{0.85 f'_c b} = \frac{(24 in^2)(60 ksi)}{0.85(6 ksi)(12")} = 23.53"$

Ductility check

$d = 28.42'/2 = 14.21'(12 in/ft) = 170.52"$

$c = \frac{23.52"}{0.75} = 31.36" < 0.375(170.52") = 63.95"$

$\Phi M_n = (0.9)(24 in^2)(60 ksi)(170.52" - \frac{63.95"}{2}) = 179554.32 \text{ kip·in}$
$= 14962 \text{ kip·ft}$

Not OK

Check shear

$V_{max} = 211.55 \text{ kip} = V_u$

$V_c = \frac{1}{2}(2)(\sqrt{f'_c})(b_w)(d) = (\sqrt{6000})(12")(170.52") = 158.5 \text{ kip}$

Req'd $V_s = V_u/\phi + V_c = \frac{211.55 \text{ kip}}{0.75} + 158.5 \text{ k} = 440.57 \text{ kip}$

Actual Steel → #4 @ 12" per floor → $A_v = 0.2 \text{in}^2$

Actual $V_s = (4)(0.2 \text{in}^2)(60 \text{ksi})\left(\frac{170.52"}{12"}\right) = 682.08 \text{ kip} > 441 \text{ kip}$

Meets shear requirements

Once again, it appears that the axial loading provided by DL + LL needs to be considered to achieve a comprehensive analysis of lateral resistance in each wall.

APPENDIX G

Story Drift and Shear Wall Drift Calculations

Allowable Story Drift: (BOCA 1996, Table 1610.3.8 – Exposure Group II, "All other buildings")

Allowable Story Drift: $\Delta_a = 0.015(h_{sx})$			
Level	**h_{sx} (ft)**	**Δ_a (ft)**	**Δ_a (in)**
Roof	279.22	4.19	50.26
25	269.22	4.04	48.46
24	259.39	3.89	46.69
23	247.36	3.71	44.52
22	236.00	3.54	42.48
21	225.75	3.39	40.64
20	215.50	3.23	38.79
19	205.25	3.08	36.95
18	195.00	2.93	35.10
17	184.75	2.77	33.26
16	174.50	2.62	31.41
15	164.25	2.46	29.57
14	154.00	2.31	27.72
13	143.75	2.16	25.88
12	133.50	2.00	24.03
11	123.25	1.85	22.19
10	113.00	1.70	20.34
9	102.75	1.54	18.50
8	92.50	1.39	16.65
7	82.25	1.23	14.81
6	72.00	1.08	12.96
5	61.75	0.93	11.12
4	51.50	0.77	9.27
3	41.25	0.62	7.43
2	31.00	0.47	5.58
1	10.50	0.16	1.89

Actual Story Drift Approximations

Using the approximation that the entire building can be treated as a very tall and wide shear wall (since most of the main structural features are reinforced or post-tensioned concrete) and using:

$$\Delta = (Ph^3/3EI) + (2.78Ph/A_{wall}E)$$

The following drift values are based on the story shears provided by the wind loading in the North-South direction:

Level	F (kips)	Elev (ft)	t (ft)	L (ft)	A (ft^2)	I (ft^4)	f'c (psi)	E (k/ft^2)	Δ (in)
Roof	76.99	279.22	172.5	72.1667	12448.76	5402794	5000	598876.7	0.000173
25	75.26	269.22	172.5	72.1667	12448.76	5402794	5000	598876.7	0.000152
24	91.90	259.39	172.5	72.1667	12448.76	5402794	5000	598876.7	0.000166
23	86.04	247.36	172.5	72.1667	12448.76	5402794	5000	598876.7	0.000135
22	77.19	236	172.5	72.1667	12448.76	5402794	5000	598876.7	0.000105
21	76.74	225.75	172.5	72.1667	12448.76	5402794	5000	598876.7	9.15E-05
20	76.02	215.5	172.5	72.1667	12448.76	5402794	5000	598876.7	7.89E-05
19	75.65	205.25	172.5	72.1667	12448.76	5402794	5000	598876.7	6.79E-05
18	75.20	195	172.5	72.1667	12448.76	5402794	5000	598876.7	5.79E-05
17	74.59	184.75	172.5	72.1667	12448.76	5402794	5000	598876.7	4.89E-05
16	74.24	174.5	172.5	72.1667	12448.76	5402794	5000	598876.7	4.1E-05
15	73.62	164.25	172.5	72.1667	12448.76	5402794	5000	598876.7	3.4E-05
14	73.05	154	172.5	72.1667	12448.76	5402794	5000	598876.7	2.78E-05
13	72.43	143.75	172.5	72.1667	12448.76	5402794	5000	598876.7	2.25E-05
12	71.79	133.5	172.5	72.1667	12448.76	5402794	5000	598876.7	1.79E-05
11	70.86	123.25	172.5	72.1667	12448.76	5402794	5000	598876.7	1.39E-05
10	70.20	113	172.5	72.1667	12448.76	5402794	5000	598876.7	1.07E-05
9	69.25	102.75	172.5	72.1667	12448.76	5402794	5000	598876.7	7.96E-06
8	71.73	92.5	180.75	104.4167	18873.31	17147728	6000	656036.6	1.81E-06
7	70.58	82.25	180.75	104.4167	18873.31	17147728	6000	656036.6	1.27E-06
6	69.41	72	180.75	104.4167	18873.31	17147728	6000	656036.6	8.61E-07
5	68.21	61.75	180.75	104.4167	18873.31	17147728	6000	656036.6	5.55E-07
4	66.67	51.5	180.75	104.4167	18873.31	17147728	6000	656036.6	3.34E-07
3	65.07	41.25	180.75	104.4167	18873.31	17147728	6000	656036.6	1.86E-07
2	126.68	31	180.75	104.4167	18873.31	17147728	6000	656036.6	1.85E-07
1	59.93	10.5	180.75	104.4167	18873.31	17147728	6000	656036.6	1.38E-08

For the wind loading in the West-East direction:

Level	F (kips)	Elev (ft)	t (ft)	L (ft)	A (ft2)	I (ft4)	f'c (psi)	E (k/SF)	Δ (in)
Roof	27.25	279.22	72.17	172.50	12448.76	5402793.80	5000.00	598876.73	6.14E-05
25	26.61	269.22	72.17	172.50	12448.76	5402793.80	5000.00	598876.73	5.37E-05
24	32.48	259.39	72.17	172.50	12448.76	5402793.80	5000.00	598876.73	5.87E-05
23	30.37	247.36	72.17	172.50	12448.76	5402793.80	5000.00	598876.73	4.76E-05
22	27.21	236.00	72.17	172.50	12448.76	5402793.80	5000.00	598876.73	3.7E-05
21	27.03	225.75	72.17	172.50	12448.76	5402793.80	5000.00	598876.73	3.22E-05
20	26.73	215.50	72.17	172.50	12448.76	5402793.80	5000.00	598876.73	2.77E-05
19	26.57	205.25	72.17	172.50	12448.76	5402793.80	5000.00	598876.73	2.38E-05
18	26.38	195.00	72.17	172.50	12448.76	5402793.80	5000.00	598876.73	2.03E-05
17	26.12	184.75	72.17	172.50	12448.76	5402793.80	5000.00	598876.73	1.71E-05
16	25.98	174.50	72.17	172.50	12448.76	5402793.80	5000.00	598876.73	1.44E-05
15	25.72	164.25	72.17	172.50	12448.76	5402793.80	5000.00	598876.73	1.19E-05
14	25.48	154.00	72.17	172.50	12448.76	5402793.80	5000.00	598876.73	9.71E-06
13	25.22	143.75	72.17	172.50	12448.76	5402793.80	5000.00	598876.73	7.83E-06
12	24.95	133.50	72.17	172.50	12448.76	5402793.80	5000.00	598876.73	6.22E-06
11	24.57	123.25	72.17	172.50	12448.76	5402793.80	5000.00	598876.73	4.83E-06
10	24.29	113.00	72.17	172.50	12448.76	5402793.80	5000.00	598876.73	3.7E-06
9	23.89	102.75	72.17	172.50	12448.76	5402793.80	5000.00	598876.73	2.75E-06
8	34.09	92.50	104.42	180.75	18873.31	17147727.62	6000.00	656036.59	8.58E-07
7	33.43	82.25	104.42	180.75	18873.31	17147727.62	6000.00	656036.59	6.03E-07
6	32.75	72.00	104.42	180.75	18873.31	17147727.62	6000.00	656036.59	4.06E-07
5.00	32.05	61.75	104.42	180.75	18873.31	17147727.62	6000.00	656036.59	2.61E-07
4.00	31.17	51.50	104.42	180.75	18873.31	17147727.62	6000.00	656036.59	1.56E-07
3.00	30.24	41.25	104.42	180.75	18873.31	17147727.62	6000.00	656036.59	8.62E-08
2.00	58.48	31.00	104.42	180.75	18873.31	17147727.62	6000.00	656036.59	8.55E-08
1.00	27.09	10.50	104.42	180.75	18873.31	17147727.62	6000.00	656036.59	6.25E-09

Shear Wall Deflection Calculations

$$\Delta = (Ph^3/3EI) + (2.78Ph/A_{wall}E)$$

Shear Wall Deflection: First Group of Floors for N-S Wind Direction						
Wall	**t (in)**	**L (ft)**	**A (in^2)**	**I (in^4)**	**P (kips)**	**Delta (in)**
A	16	25	4800	36000000	1115.19	0.623
B	12	14.5	2088	5268024	0.51	0.002
C	12	14.5	2088	5268024	0.28	0.001
D	12	23.1667	3336.005	21485044.7	679.06	0.623
E	16	9.25	1776	1823508	66.63	0.645
F	12	9.25	1332	1367631	50.20	0.648
G	12	28.42	4092.48	39665776.4	0.25	0.000
H	12	8.93	1285.92	1230546.74	45.31	0.649
J	9	19.3333	2087.996	9365327.56	310.60	0.629
K	12	6.08333	875.9995	389016.361	14.35	0.643
L	12	6.307	908.208	433523.088	0.02	0.001
M	12	7.47	1075.68	720286.945	0.08	0.002
N	24	19.927	5738.976	27346358.1	918.57	0.640
O	24	14.708	4235.904	10995996.6	407.79	0.677
P	12	8.8333	1271.995	1191002.52	0.17	0.003
Q	12	19.1667	2760.005	12167063.5	159.59	0.248
R	12	8.8333	1271.995	1191002.52	0.31	0.005
S	12	19.1667	2760.005	12167063.5	160.09	0.249
				Sum of N-S Walls:		6.274
				Sum of W-E Walls:		0.013

Shear Wall Deflection: Second Group of Floors for N-S Wind Direction						
Wall	**t (in)**	**L (ft)**	**A (in^2)**	**I (in^4)**	**P (kips)**	**Delta (in)**
A	16	25	4800	36000000	895.35	0.273
B	12	14.5	2088	5268024	0.75	0.001
C	12	14.5	2088	5268024	0.41	0.001
D	12	23.1667	3336.005	21485044.7	534.35	0.265
E	16	9.25	1776	1823508	46.66	0.231
F	12	9.25	1332	1367631	35.32	0.233
G	12	28.42	4092.48	39665776.4	0.45	0.000
H	12	8.93	1285.92	1230546.74	31.99	0.234
J	9	19.3333	2087.996	9365327.56	237.87	0.256
K	12	6.08333	875.9995	389016.361	10.00	0.227
L	12	6.307	908.208	433523.088	0.01	0.000
M	12	7.47	1075.68	720286.945	0.02	0.000
N	24	19.927	5738.976	27346358.1	704.26	0.261
O	24	14.708	4235.904	10995996.6	283.18	0.244
P	12	8.8333	1271.995	1191002.52	0.05	0.000
Q	12	19.1667	2760.005	12167063.5	125.46	0.103
R	12	8.8333	1271.995	1191002.52	0.09	0.001
S	12	19.1667	2760.005	12167063.5	312.52	0.258
				Sum of N-S Walls:		2.585
				Sum of W-E Walls:		0.004

Shear Wall Deflection: Third Group of Floors for N-S Wind Direction						
Wall	**t (in)**	**L (ft)**	**A (in^2)**	**I (in^4)**	**P (kips)**	**Delta (in)**
A	16	25	4800	36000000	242.14	0.081
B	12	14.5	2088	5268024	14.86	0.029
C	12	14.5	2088	5268024	8.09	0.016
D	12	23.1667	3336.005	21485044.7	144.51	0.078
E	16	9.25	1776	1823508	39.47	0.214
F	12	9.25	1332	1367631	35.22	0.254
G	12	28.42	4092.48	39665776.4	8.97	0.003
H	12	8.93	1285.92	1230546.74	35.94	0.288
J	9	19.3333	2087.996	9365327.56	237.76	0.280
K	12	6.08333	875.9995	389016.361	8.42	0.210
L	12	6.307	908.208	433523.088	0.02	0.001
M	12	7.47	1075.68	720286.945	0.08	0.001
				Sum of N-S Walls:		1.405
				Sum of W-E Walls:		0.050

Shear Wall Deflection: Fourth Group of Floors for N-S Wind Direction						
Wall	**t (in)**	**L (ft)**	**A (in^2)**	**I (in^4)**	**P (kips)**	**Delta (in)**
A	16	25	4800	36000000	535.65	0.179
B	12	14.5	2088	5268024	0.85	0.002
C	12	14.5	2088	5268024	0.46	0.001
D	12	23.1667	3336.005	21485044.7	224.00	0.122
E	16	9.25	1776	1823508	28.69	0.156
F	12	9.25	1332	1367631	21.84	0.158
G	12	28.42	4092.48	39665776.4	0.51	0.000
H	12	8.93	1285.92	1230546.74	19.89	0.159
J	9	19.3333	2087.996	9365327.56	149.36	0.176
K	12	6.08333	875.9995	389016.361	6.33	0.158
L	12	6.307	908.208	433523.088	0.04	0.001
M	12	7.47	1075.68	720286.945	0.13	0.002
				Sum of N-S Walls:		1.107
				Sum of W-E Walls:		0.005

Shear Wall Deflection: Fifth Group of Floors for N-S Wind Direction						
Wall	**t (in)**	**L (ft)**	**A (in^2)**	**I (in^4)**	**P (kips)**	**Delta (in)**
A	16	25	4800	36000000	112.72	0.038
B	12	14.5	2088	5268024	6.92	0.014
C	12	14.5	2088	5268024	3.77	0.007
D	12	23.1667	3336.005	21485044.7	67.27	0.037
E	16	9.25	1776	1823508	18.37	0.100
F	12	9.25	1332	1367631	16.39	0.118
G	12	28.42	4092.48	39665776.4	4.17	0.001
H	12	8.93	1285.92	1230546.74	16.73	0.134
J	9	19.3333	2087.996	9365327.56	110.68	0.130
K	12	6.08333	875.9995	389016.361	5.61	0.140
L	12	6.307	908.208	433523.088	0.31	0.007
M	12	7.47	1075.68	720286.945	1.03	0.014
				Sum of N-S Walls:		0.696
				Sum of W-E Walls:		0.043

Shear Wall Deflection: Sixth Group of Floors for N-S Wind Direction						
Wall	**t (in)**	**L (ft)**	**A (in^2)**	**I (in^4)**	**P (kips)**	**Delta (in)**
A	16	25	4800	36000000	92.59	0.064
B	12	14.5	2088	5268024	1.42	0.006
C	12	14.5	2088	5268024	0.77	0.003
D	12	23.1667	3336.005	21485044.7	55.26	0.062
E	16	9.25	1776	1823508	7.28	0.088
F	12	9.25	1332	1367631	6.00	0.096
G	12	28.42	4092.48	39665776.4	0.85	0.001
H	12	8.93	1285.92	1230546.74	5.80	0.103
J	9	19.3333	2087.996	9365327.56	40.75	0.102
K	12	6.08333	875.9995	389016.361	1.90	0.106
L	12	6.307	908.208	433523.088	0.06	0.003
M	12	7.47	1075.68	720286.945	0.41	0.012
				Sum of N-S Walls:		0.620
				Sum of W-E Walls:		0.026

APPENDIX H

Overturning Moments

Based on Controlling Case: N-S Wind			
Level	**F (kips)**	**Elev (ft)**	**M (kip-ft)**
Roof	76.99	279.22	21497.67
25	75.26	269.22	20261.76
24	91.90	259.39	23837.14
23	86.04	247.36	21283.05
22	77.19	236.00	18216.21
21	76.74	225.75	17323.84
20	76.02	215.50	16382.7
19	75.65	205.25	15527.32
18	75.20	195.00	14663.08
17	74.59	184.75	13780.05
16	74.24	174.50	12955.49
15	73.62	164.25	12092.5
14	73.05	154.00	11249.54
13	72.43	143.75	10412.19
12	71.79	133.50	9583.761
11	70.86	123.25	8733.449
10	70.20	113.00	7932.576
9	69.25	102.75	7115.731
8	71.73	92.50	6635.326
7	70.58	82.25	5805.454
6	69.41	72.00	4997.342
5	68.21	61.75	4211.767
4	66.67	51.50	3433.753
3	65.07	41.25	2684.328
2	126.68	31.00	3926.951
1	59.93	10.50	629.2253
Total Overturning M (kip-ft) =			295172.2

$T_{overturning} = C_{overturning}$ = Moment/Span = (295,172.2 kip/ft)/(182.72 ft) = 1633.041 kip
C_{weight} = (Weight/2) = (54470 kips)/2 = 27235 kips

Since $C_{weight} > C_{overturning}$, the weight of the building eliminates chance of overturning