American Eagle Outfitters
Quantum II Corporate Headquarters

Technical Report #3:
Lateral System Analysis
And Configuration Design

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Executive summary

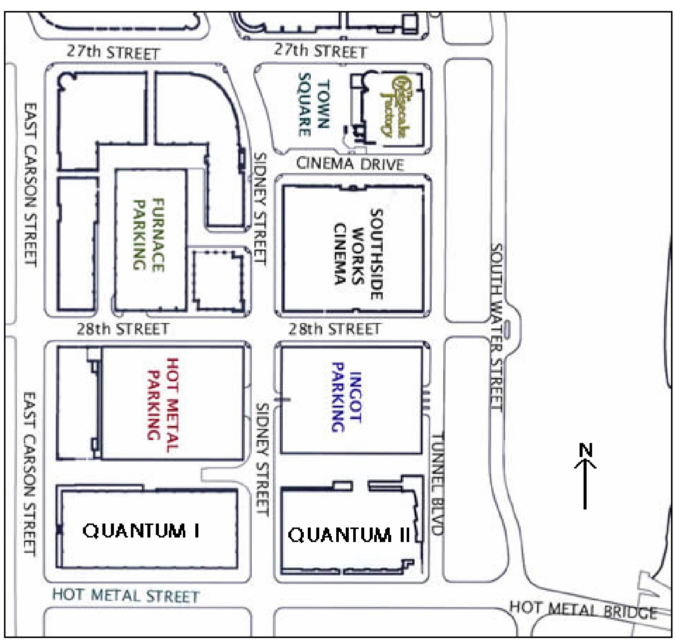
The American Eagle Outfitters Quantum II Corporate Headquarters is a 6 story 186,000 square foot office building located just outside the city of Pittsburgh Pennsylvania in the new multi million dollar Southside Works commercial development. The building is currently in the tenant fit-out phase of construction.

The following report defines the lateral loads experienced by the structure, the controlling load combination, and load distribution. Finally it investigates the design of the structure's lateral resisting system. The existing lateral resisting system is a moment connection frame. The computer analysis program RAM Steel, as well as various hand calculated checks were utilized and performed to evaluate the existing design.

The analysis verifies that the existing design is adequate, except in the RAM calculation of total building drift, which yielded values greater than the conservative industry standard of limiting drift to L/400. This could be credited to an insufficient user proficiency of the RAM Steel program.

Introduction

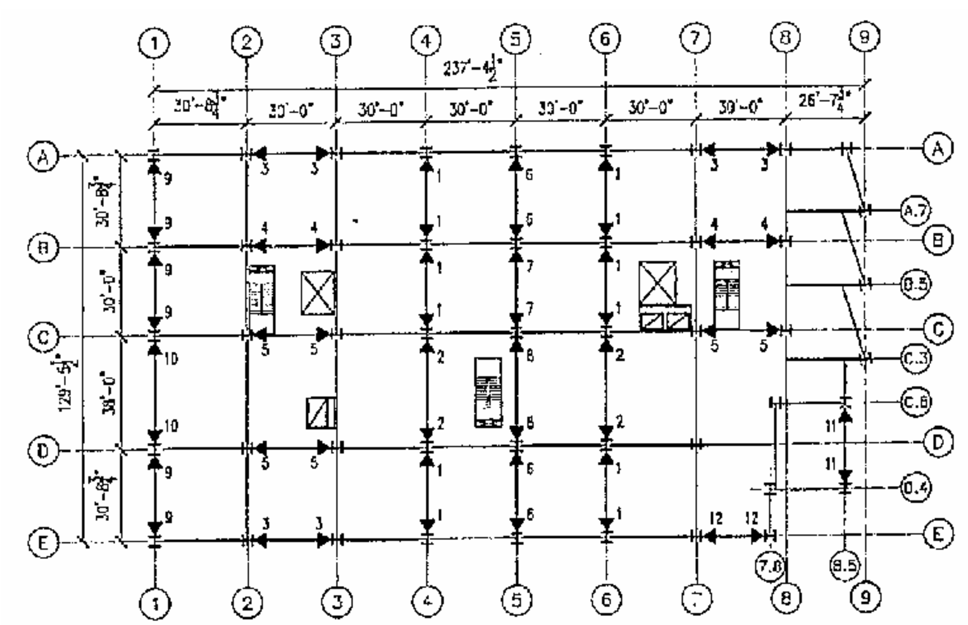
The Quantum II office is located along the Monongahela River at the east end of Pittsburgh's Southside Works commercial development. Currently it is the first building seen when traveling to Pittsburgh's Southside via the Hot Metal Bridge. The structure was designed and built without a tenant and was therefore engineered to maximize open floor space and therefore fit-out flexibility. Having been purchased by the American Eagle Outfitters Corporation the Quantum II office building is currently in the fit-out stage of construction.



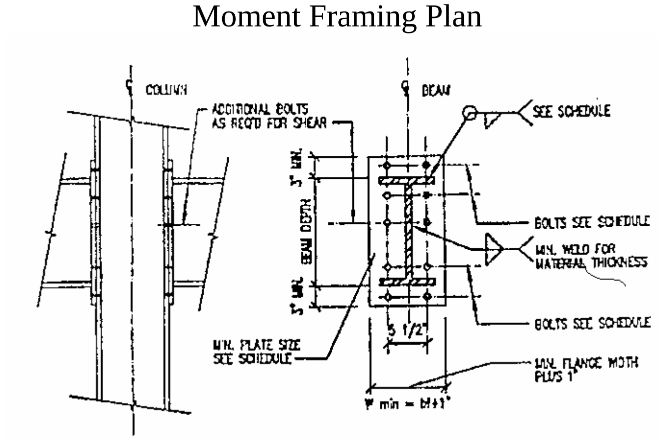
All together the American Eagle Quantum II Corporate Headquarters provides 6 stories and 186,000 square feet of versatile space. Most will be used as office and conference room space with the exception of a cafeteria on the sixth floor and an American Eagle Outfitters store lab on the first. The majority of the structural layout consists of three rows of 30'x30' and one row of 30'x38' bays. The steel members that comprise these bays are of A572 grade steel, that has a yield strength of 50ksi. Each floor acts as a rigid diaphragm that consists of 3" of concrete laid over a 3" 20 gauge steel deck. The foundation is a series of 45' auger piles with caps and grade beams.

As stated above Quantum II was designed for maximum adaptability during fit-out. The engineers needed a lateral system that would not obstruct the floor plan the way cross bracing and shear walls do. To achieve this fixed moment connections were utilized. Being that moment connections are less effective than their competition at resisting lateral forces, an extensive amount of the buildings connections had to be fixed. Indeed, nearly every beam column and connection is involved in the lateral system. Below is a diagram of the moment connections. The arrows indicate which direction the moment connection resists lateral loads.

RAM Steel was utilized



Moment Framing Plan



Moment Connection Diagram

Topics investigated in this report include the following:

- Load and Load Cases
- Distribution
- Analysis
- Member Checks
- Conclusion

Loads and Load Cases

All loads and load cases were generated per ASCE7-02. Loads were detailed in Technical Report #1. A summary table is shown below; where as specific calculations and diagrams are shown in the appendix sections A and B.

Level	Seismic (k)	Wind E-W (k)
Roof	167.081	116.87
6	163.609	86.92
5	129.027	84.52
4	95.045	81.99
3	61.855	78.06
2	29.843	74.83
1	0.000	36.66

The Following load combinations were taken from ASCE7-02 and were used to determine critical cases.

- 1.4D
- 1.2D + 1.6L + 0.5S
- 1.2D + 1.6S + L
- 1.2D + 1.6W + L 0.5S
- 1.2D + 1.0E + L + 0.2S
- 0.9D + 1.6W
- 0.9D + 1.0E

Identifying the correct load combination is unclear at first because of the fact that wind controls at the base of the building but seismic controls at the top. However, when comparing 1.6W to 1.0E we see that it will be wind that controls. Therefore that controlling load combination is 1.2D + 1.6W + L 0.5S.

Distribution

In the East–West direction centrally located frames on lines 4, 5, and 6 will carry the majority of the lateral force. The frame on line 1, as is common with edge members, is significantly smaller than the internal frames, using W10s and W12s as opposed to W14s. It will therefore support less of the lateral force. Additionally the frame on line 8.5 is relatively smaller, and relegated to the forces experienced in the building’s elaborate façade as opposed to the building’s core resistance. Similarly, in the North-

South direction the majority of the lateral force will be absorbed by the five internal frames, located on lines B, C and D. Again the frames along the edges, lines A and E, are smaller, W10s instead of W14s, and will resist less load.

Analysis

As stated previously, hand calculated checks and the computer program RAM Steel were used to conduct a Lateral analysis of the structure.

Member Checks

Drift

Building drift is usually relegated to L/400. In this case the allowable drift is 0.41 inches per floor and 2.52 inches for the entire structure. A hand calculation of story drift was performed for the fourth floor. Results of this check are found in the appendix section E and show that the design is adequate. However, drift analysis performed in Ram Steel, the results of which are found in the appendix section C, yielded roof drift values of up to 3 inches.

Overturning

The matter of building overturning must also be addressed. If a structure's weight and width are not enough to resist the moment applied by lateral forces additional loads will be encountered in the foundation design. A check of overturning can be found in the appendix section D. It concludes that the building is sufficient on its own of resisting an overturning moment of 64,980 ft-kips with its own moment of 1,035,031 ft-kips.

Conclusion

This report shows that wind forces control lateral design once appropriately factored for safety under the controlling combination of 1.2D + 1.6W + L 0.5S. Also, that the structure's own weight is sufficient in resisting overturning. Unfortunately, this analysis partially fails to verify the existing design's adequacy to keep total structural drift to within the standard limit of L/400. This shortcoming was experienced in the RAM Steel analysis and was most likely a result of user's ability with the program.

APPENDIX

Appendix A: Wind

CLASS:
DATE:
ASSIGNMENT:
PAGE: ___ of ___

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Wind Load $h > 60'$

T 1.1: Occupancy Category III

T 6.1: $I = 1.15$ (non hurricane Region)

F 6-1: $V_0 = 90$ mph

T 6-4: $k_d = 0.85$

eq. 6.3: $k_{zT} = (1 + k_1 \cdot k_2 k_3)^2 = 1$

$k_h = 0.945$ @ (mean roof height) = 85'

k_z = height @ specific point

eq. 6-15: $q_h = 0.00256\, k_h \cdot k_{zT} \cdot k_d \cdot V^2 \cdot I \; \left(\frac{lb}{ft^2}\right)$

$q_h = 0.00256(0.945)\, 1 \cdot 0.85\, (90\text{mph})^2\, 1.15 =$

$q_h = 19.15462$ psf

$q_z = 0.00256 \cdot k_z \cdot K_{zt} \cdot k_d\, V^2\, I$

$q_z = 0.00256\, k_z \cdot 1 \cdot 0.85\, (90\text{mph})^2\, 1.15 =$

$q_z = 20.26944 \cdot k_z$ psf

Chart q_z's

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Wind Load

T 6-2: (exp. B) $c = 0.3$ $\ell = 320'$ $\bar{\epsilon} = \frac{1}{3.0}$

eq 6-7: $L_{\bar{z}} = \ell \left(\frac{\bar{z}}{33}\right)^{\bar{\epsilon}} = 320 \left(\frac{51}{33}\right)^{\frac{1}{3.0}} = 370$

$\bar{z} = 0.6\,(85') = 51'$

eq 6-6: $Q = \sqrt{1/1 + 0.63\left(\frac{B+h}{L_{\bar{z}}}\right)^{0.63}} = \sqrt{1/1 + 0.63\left(\frac{240' + 85'}{370'}\right)^{0.63}}$

$Q = 0.7954$

eq 6-5: $I_{\bar{z}} = c\left(\frac{33}{\bar{z}}\right)^{\frac{1}{6}} = 0.3\left(\frac{33}{51}\right)^{\frac{1}{6}} = 0.279$

eq 6-4: $G = 0.925\left(\frac{1 + (1.7 \cdot 3.4)\, I_{\bar{z}}\, Q}{1 + (1.7 \cdot 3.4)\, I_{\bar{z}}}\right)$

$G = 0.925\left(\frac{1 + (1.7 \cdot 3.4)\, 0.279 \cdot 0.7954}{1 + (1.7 \cdot 3.4)\, 0.279}\right) = 0.808$

F 6-6: $C_p =$ 0.8 windward
-0.7 side
-0.25 NS leeward $L/B = \frac{240'}{132'}$
-0.5 EW leeward $L/B = \frac{132'}{240'}$

F 6-5: $GC_{pi} = \pm 0.18$ (enclosed building)

eq 6-23: $p = q\,(G \cdot C_p) - q_h\,(GC_{pi})$ $q = q_z$ (windward) $= q_h$ (leeward & side)

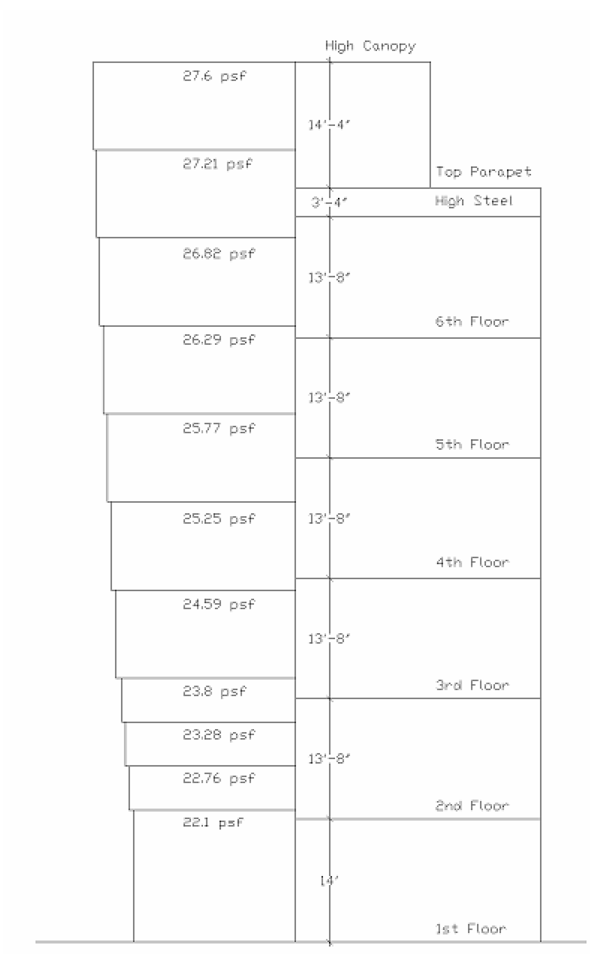
wind $p = q_z(0.808 \cdot 0.8) - 19.15(-0.18)$

side $p = q_z(-0.7 \cdot 0.808) - 19.15(0.18)$

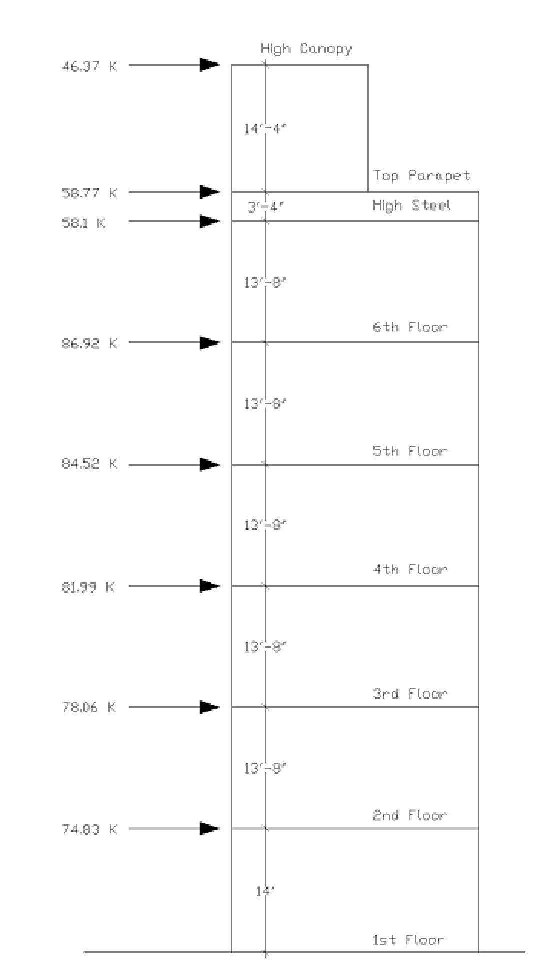
EW lee $p = 19.15(-0.5 \cdot 0.808) - 19.15(0.18)$

NS lee $p = 19.15(-0.25 \cdot 0.808) - 19.15(0.18)$

z (ft)	Kz (T6-3)	qz	P (psf) Windward	P (psf) Side	P (psf) Leeward EastWast	P (psf) Total
0-15	0.57	11.554	10.916	-9.983	-11.186	22.1020
20	0.62	12.567	11.571	-10.556	-11.186	22.7571
25	0.66	13.378	12.095	-11.014	-11.186	23.2812
30	0.70	14.189	12.619	-11.473	-11.186	23.8053
40	0.76	15.405	13.405	-12.161	-11.186	24.5914
50	0.81	16.418	14.061	-12.734	-11.186	25.2466
60	0.85	17.229	14.585	-13.193	-11.186	25.7706
70	0.89	18.040	15.109	-13.651	-11.186	26.2947
80	0.93	18.851	15.633	-14.110	-11.186	26.8188
90	0.96	19.459	16.026	-14.454	-11.186	27.2119
100	0.99	20.067	16.419	-14.798	-11.186	27.6049



Wind Pressure



Wind Force

Appendix B: Seismic

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Seismic Loading

T 9.1.3 : Seismic Use Group II (Occ. Cat. III)

T 9.1.4 : $I = 1.25$ (Seis. Use Grp III)

T 9.4.1.2 : Site Class D

F 9.4.1.1a : $S_S = 0.127$

F 9.4.1.1b : $S_1 = 0.054$

T 9.4.1.2a : $F_a = 1.6$

T 9.4.1.2b : $F_v = 2.4$

eq: 9.4.1.2.4-1 : $F_a \cdot S_s = 1.6 \cdot 0.127 = S_{MS} = 0.203$

eq: 9.4.1.2.4-2 : $F_v \cdot S_1 = 2.4 \cdot 0.054 = S_{M1} = 0.129$

eq: 9.4.1.2.5-1 : $\frac{2}{3} S_{MS} = \frac{2}{3}\, 0.203 = S_{DS} = 0.135$

eq: 9.4.1.2.5-2 : $\frac{2}{3} S_{M1} = \frac{2}{3}\, 0.129 = S_{D1} = 0.086$

T 9.4.2.1a : Seismic Design Cat. A

T 9.4.2.1b : Seismic Design Cat. B

T 9.5.2.2 ; $R = 3.5$ (Steel Moment Frame)

T 9.5.5.3.2 : $C_T = 0.028$ $x = 0.8$ (Steel)

eq 9.5.5.3.2-1 : $T = C_T h_n^{\,x} = 0.028\,(85')^{0.8} = 0.9788$

$$C_S = \frac{S_{DS}}{R/I} = \frac{0.135}{3.5/1.25} = 0.0482 \leftarrow$$

$$C_{S\,max} = \frac{S_{D1}}{T(R/I)} = \frac{0.086}{0.9788\left(\frac{3.5}{1.25}\right)} = 0.0314$$

$$k = 1 + \frac{0.632 - 0.5}{2} = 1.07$$

$$C_{S\,min} = 0.044 \cdot I \cdot S_{DS} = 0.044\,(1.25)\,0.135 = 0.0074$$

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CLASS: ______
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Seismic Loading

TYP Floor Area = 31,000 ft^2
TYP perimeter = 770 ft

Calc. Dead Load of Structure

Exterior wall: 20psf × 13'-8" × 770 ft = 210 k

TYP Floor: (2-6) = 31,000 ft (57+10+5) psf · $\frac{1k}{1000p}$ + 210k = 2442 k

Roof: 31,000 ft^2 · (57+10) psf · $\frac{1k}{1000p}$ = 2077 k

1st floor = (31,000 ft^2 × 4" × $\frac{1'}{12"}$ · 150 pcf) $\frac{1k}{1000p}$ + 210k = 1760 k

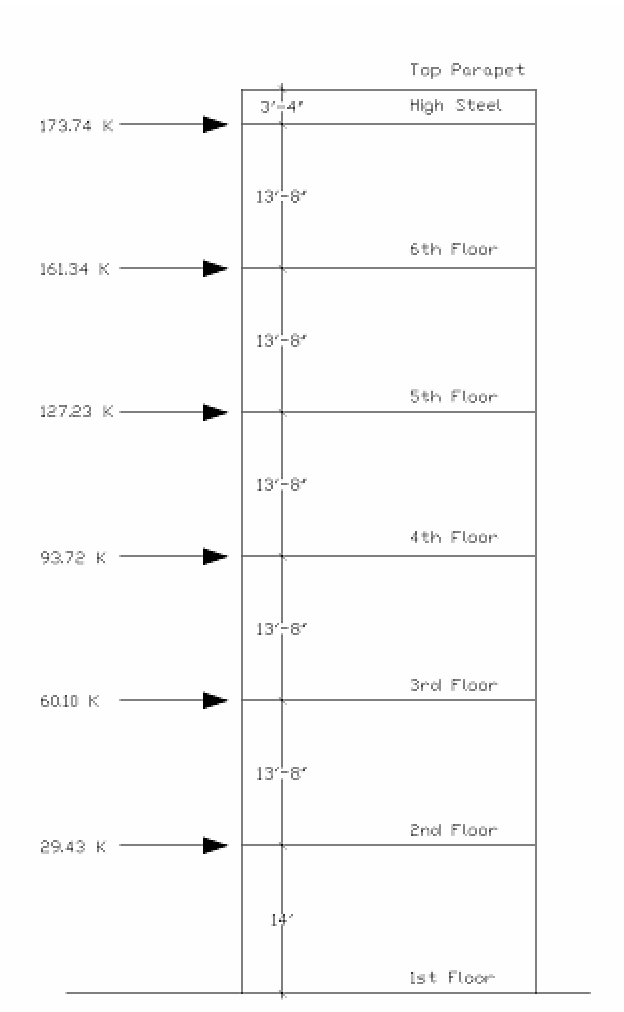
$\Sigma W = 5(2442k) + 2077k + 1760k =$ ~~13,412k~~ 16,047k

~~$V = C_s \cdot W = 0.0482 \cdot 13412k$~~ =

$V = C_s \cdot W = 0.0482 \cdot 16047\,k = 773.46\,k$

Level	Wx (K)	hx (ft)	Wxhx^1.07	Cvx	Fx (K)	Mo (ft-K)
Roof	2077	82.333	397485.39	0.258455	167.081	13756.24
6	2442	68.666	389225.72	0.253084	163.609	11234.35
5	2442	55	306955.86	0.19959	129.027	7096.486
4	2442	41.333	226113.02	0.147024	95.045	3928.504
3	2442	27.666	147153.46	0.095683	61.855	1711.282
2	2442	14	70997.794	0.046164	29.843	417.8089
1	1760	0	0	0	0	0
SUM:			1537931.2	1	**646.46**	**38144.68**

V = 646.46 K



Seismic Force

Appendix C: Drift RAM Output

Drift

RAM Frame v10.0
DataBase: TRUE
Building Code: IBC

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Steel Code: IBC

CRITERIA:

Rigid End Zones:	Ignore Effects
Member Force Output:	At Face of Joint
P-Delta:	No
Diaphragm:	Rigid
Ground Level:	Base

LOAD CASE DEFINITIONS:

D	DeadLoad	RAMUSER
Lp	PosLiveLoad	RAMUSER
Sp	PosRoofLiveLoad	RAMUSER
W1	wind	Wind_IBC03_1_X
W2	wind	Wind_IBC03_1_Y
W3	wind	Wind_IBC03_2_X+E
W4	wind	Wind_IBC03_2_X-E
W5	wind	Wind_IBC03_2_Y+E
W6	wind	Wind_IBC03_2_Y-E
W7	wind	Wind_IBC03_3_X+Y
W8	wind	Wind_IBC03_3_X-Y
W9	wind	Wind_IBC03_4_X+Y_CW
W10	wind	Wind_IBC03_4_X+Y_CCW
W11	wind	Wind_IBC03_4_X-Y_CW
W12	wind	Wind_IBC03_4_X-Y_CCW
E1	Seismic	EQ_IBC03_X_+E_F
E2	Seismic	EQ_IBC03_X_-E_F
E3	Seismic	EQ_IBC03_Y_+E_F
E4	Seismic	EQ_IBC03_Y_-E_F

RESULTS:

Location (ft): (106.218, 81.465)

Story	LdC	Displacement		Story Drift		Drift Ratio	
		X	Y	X	Y	X	Y
		in	in	in	in		
Roof	D	-0.0058	-0.0067	-0.0020	-0.0015	0.0000	0.0000
	Lp	-0.0267	-0.0126	-0.0085	-0.0020	0.0001	0.0000
	Sp	-0.0021	-0.0005	-0.0005	-0.0002	0.0000	0.0000
	W1	1.5809	0.0225	0.0990	0.0020	0.0006	0.0000
	W2	-0.2690	4.1556	-0.0190	0.2599	0.0001	0.0015
	W3	1.2407	-0.0656	0.0776	-0.0050	0.0005	0.0000
	W4	1.1305	0.0995	0.0708	0.0080	0.0004	0.0000
	W5	-0.4197	3.4432	-0.0276	0.2205	0.0002	0.0013
	W6	0.0162	2.7901	-0.0008	0.1693	0.0000	0.0010

Drift

RAM Frame v10.0
DataBase: TRUE
Building Code: IBC

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Steel Code: IBC

Story	LdC	Displacement		Story Drift		Drift Ratio	
	W7	0.9839	3.1336	0.0600	0.1964	0.0004	0.0012
	W8	1.3874	-3.0998	0.0884	-0.1934	0.0005	0.0012
	W9	0.9427	2.0434	0.0576	0.1232	0.0003	0.0007
	W10	0.5331	2.6570	0.0324	0.1714	0.0002	0.0010
	W11	1.2454	-2.6316	0.0789	-0.1691	0.0005	0.0010
	W12	0.8357	-2.0180	0.0537	-0.1210	0.0003	0.0007
	E1	2.3479	-0.0328	0.2578	-0.0033	0.0015	0.0000
	E2	2.2713	0.0821	0.2494	0.0098	0.0015	0.0001
	E3	-0.2366	2.9760	-0.0262	0.3204	0.0002	0.0019
	E4	-0.0965	2.7660	-0.0108	0.2964	0.0001	0.0018
6th	D	-0.0038	-0.0052	-0.0018	-0.0014	0.0000	0.0000
	Lp	-0.0181	-0.0106	-0.0071	-0.0023	0.0000	0.0000
	Sp	-0.0016	-0.0003	-0.0006	-0.0001	0.0000	0.0000
	W1	1.4819	0.0205	0.2146	0.0033	0.0013	0.0000
	W2	-0.2500	3.8957	-0.0363	0.5592	0.0002	0.0033
	W3	1.1631	-0.0607	0.1685	-0.0088	0.0010	0.0001
	W4	1.0597	0.0914	0.1535	0.0139	0.0009	0.0001
	W5	-0.3921	3.2227	-0.0568	0.4642	0.0003	0.0028
	W6	0.0171	2.6208	0.0023	0.3746	0.0000	0.0022
	W7	0.9239	2.9371	0.1337	0.4219	0.0008	0.0025
	W8	1.2990	-2.9063	0.1882	-0.4169	0.0011	0.0025
	W9	0.8851	1.9201	0.1281	0.2743	0.0008	0.0016
	W10	0.5007	2.4856	0.0725	0.3586	0.0004	0.0021
	W11	1.1664	-2.4625	0.1689	-0.3548	0.0010	0.0021
	W12	0.7820	-1.8970	0.1134	-0.2706	0.0007	0.0016
	E1	2.0901	-0.0295	0.4152	-0.0051	0.0025	0.0000
	E2	2.0219	0.0722	0.4017	0.0141	0.0024	0.0001
	E3	-0.2104	2.6556	-0.0405	0.5171	0.0002	0.0031
	E4	-0.0857	2.4696	-0.0157	0.4820	0.0001	0.0029
5th	D	-0.0020	-0.0039	-0.0013	-0.0014	0.0000	0.0000
	Lp	-0.0110	-0.0083	-0.0055	-0.0029	0.0000	0.0000
	Sp	-0.0009	-0.0002	-0.0004	-0.0001	0.0000	0.0000
	W1	1.2673	0.0172	0.2937	0.0049	0.0017	0.0000
	W2	-0.2137	3.3364	-0.0530	0.7933	0.0003	0.0047
	W3	0.9947	-0.0518	0.2305	-0.0136	0.0014	0.0001
	W4	0.9062	0.0776	0.2100	0.0209	0.0013	0.0001
	W5	-0.3353	2.7584	-0.0801	0.6631	0.0005	0.0039
	W6	0.0147	2.2462	0.0006	0.5269	0.0000	0.0031
	W7	0.7901	2.5152	0.1805	0.5986	0.0011	0.0036
	W8	1.1108	-2.4894	0.2600	-0.5913	0.0015	0.0035
	W9	0.7570	1.6458	0.1733	0.3850	0.0010	0.0023
	W10	0.4282	2.1270	0.0974	0.5130	0.0006	0.0031
	W11	0.9975	-2.1077	0.2329	-0.5075	0.0014	0.0030

Drift

RAM Frame v10.0
DataBase: TRUE
Building Code: IBC

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Steel Code: IBC

Story	LdC	Displacement		Story Drift		Drift Ratio	
	W12	0.6686	-1.6265	0.1571	-0.3795	0.0009	0.0023
	E1	1.6749	-0.0244	0.4666	-0.0070	0.0028	0.0000
	E2	1.6202	0.0581	0.4515	0.0180	0.0027	0.0001
	E3	-0.1699	2.1385	-0.0487	0.6064	0.0003	0.0036
	E4	-0.0700	1.9877	-0.0210	0.5607	0.0001	0.0033
4th	D	-0.0007	-0.0025	-0.0008	-0.0012	0.0000	0.0000
	Lp	-0.0054	-0.0054	-0.0037	-0.0025	0.0000	0.0000
	Sp	-0.0005	-0.0001	-0.0003	-0.0001	0.0000	0.0000
	W1	0.9736	0.0123	0.3719	0.0054	0.0022	0.0000
	W2	-0.1607	2.5431	-0.0649	0.9961	0.0004	0.0059
	W3	0.7642	-0.0382	0.2918	-0.0162	0.0017	0.0001
	W4	0.6962	0.0567	0.2660	0.0244	0.0016	0.0001
	W5	-0.2552	2.0954	-0.0998	0.8275	0.0006	0.0049
	W6	0.0142	1.7193	0.0024	0.6667	0.0000	0.0040
	W7	0.6097	1.9166	0.2303	0.7512	0.0014	0.0045
	W8	0.8507	-1.8981	0.3276	-0.7430	0.0019	0.0044
	W9	0.5838	1.2608	0.2207	0.4878	0.0013	0.0029
	W10	0.3307	1.6141	0.1247	0.6389	0.0007	0.0038
	W11	0.7646	-1.6002	0.2937	-0.6328	0.0017	0.0038
	W12	0.5115	-1.2469	0.1977	-0.4817	0.0012	0.0029
	E1	1.2082	-0.0174	0.5091	-0.0077	0.0030	0.0000
	E2	1.1687	0.0401	0.4926	0.0184	0.0029	0.0001
	E3	-0.1212	1.5321	-0.0523	0.6580	0.0003	0.0039
	E4	-0.0490	1.4270	-0.0221	0.6103	0.0001	0.0036
3rd	D	0.0000	-0.0013	-0.0001	-0.0009	0.0000	0.0000
	Lp	-0.0017	-0.0029	-0.0014	-0.0021	0.0000	0.0000
	Sp	-0.0002	-0.0000	-0.0002	-0.0000	0.0000	0.0000
	W1	0.6017	0.0069	0.3671	0.0049	0.0022	0.0000
	W2	-0.0958	1.5470	-0.0635	0.9729	0.0004	0.0058
	W3	0.4724	-0.0220	0.2883	-0.0154	0.0017	0.0001
	W4	0.4302	0.0323	0.2624	0.0227	0.0016	0.0001
	W5	-0.1555	1.2679	-0.0988	0.8051	0.0006	0.0048
	W6	0.0117	1.0527	0.0036	0.6543	0.0000	0.0039
	W7	0.3794	1.1654	0.2277	0.7333	0.0014	0.0044
	W8	0.5231	-1.1551	0.3230	-0.7260	0.0019	0.0043
	W9	0.3631	0.7730	0.2189	0.4792	0.0013	0.0029
	W10	0.2060	0.9751	0.1227	0.6209	0.0007	0.0037
	W11	0.4709	-0.9674	0.2903	-0.6154	0.0017	0.0037
	W12	0.3138	-0.7652	0.1942	-0.4737	0.0012	0.0028
	E1	0.6991	-0.0097	0.4423	-0.0069	0.0026	0.0000
	E2	0.6761	0.0217	0.4277	0.0154	0.0025	0.0001
	E3	-0.0689	0.8742	-0.0461	0.5690	0.0003	0.0034
	E4	-0.0268	0.8167	-0.0194	0.5283	0.0001	0.0031

Drift

RAM Frame v10.0
DataBase: TRUE
Building Code: IBC

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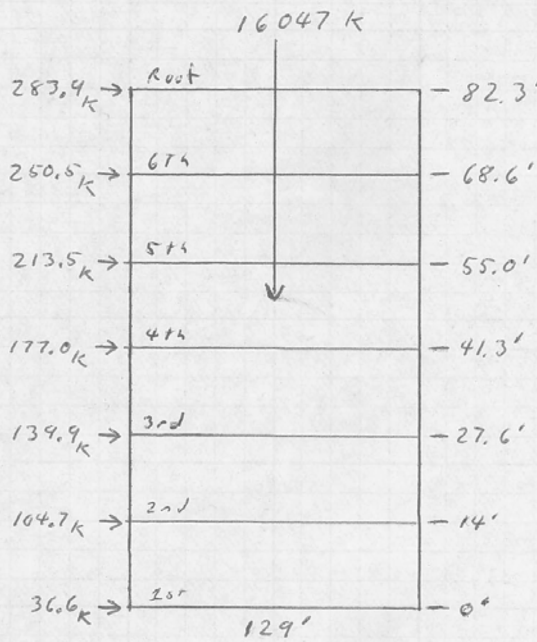
11/21/06 12:05:20
Steel Code: IBC

Story	LdC	Displacement		Story Drift		Drift Ratio	
2nd	D	0.0001	-0.0004	0.0001	-0.0004	0.0000	0.0000
	Lp	-0.0003	-0.0008	-0.0003	-0.0008	0.0000	0.0000
	Sp	-0.0001	-0.0000	-0.0001	-0.0000	0.0000	0.0000
	W1	0.2346	0.0020	0.2346	0.0020	0.0014	0.0000
	W2	-0.0323	0.5741	-0.0323	0.5741	0.0002	0.0034
	W3	0.1841	-0.0066	0.1841	-0.0066	0.0011	0.0000
	W4	0.1677	0.0096	0.1677	0.0096	0.0010	0.0001
	W5	-0.0566	0.4627	-0.0566	0.4627	0.0003	0.0028
	W6	0.0082	0.3984	0.0082	0.3984	0.0000	0.0024
	W7	0.1517	0.4321	0.1517	0.4321	0.0009	0.0026
	W8	0.2001	-0.4290	0.2001	-0.4290	0.0012	0.0026
	W9	0.1442	0.2938	0.1442	0.2938	0.0009	0.0017
	W10	0.0834	0.3543	0.0834	0.3543	0.0005	0.0021
	W11	0.1805	-0.3520	0.1805	-0.3520	0.0011	0.0021
	W12	0.1197	-0.2916	0.1197	-0.2916	0.0007	0.0017
	E1	0.2568	-0.0029	0.2568	-0.0029	0.0015	0.0000
	E2	0.2484	0.0063	0.2484	0.0063	0.0015	0.0000
	E3	-0.0228	0.3051	-0.0228	0.3051	0.0001	0.0018
	E4	-0.0074	0.2884	-0.0074	0.2884	0.0000	0.0017

Appendix D: Overturning

Over-Turning

Level	Height (ft)	Seismic (k)	Wind E-W (k)	Total Lateral (K)	M Over Turning (ft*K)	W Floor (K)
Roof	82.333	167.081	116.87	283.951	23378.5377	2077
6	68.666	163.609	86.92	250.529	17202.8243	2442
5	55.000	129.027	84.52	213.547	11745.0850	2442
4	41.333	95.045	81.99	177.035	7317.3877	2442
3	27.666	61.855	78.06	139.915	3870.8884	2442
2	14.000	29.843	74.83	104.673	1465.4220	2442
1	0.000	0.000	36.66	36.663	0.0000	1760
				Totals	64980.1450	16047

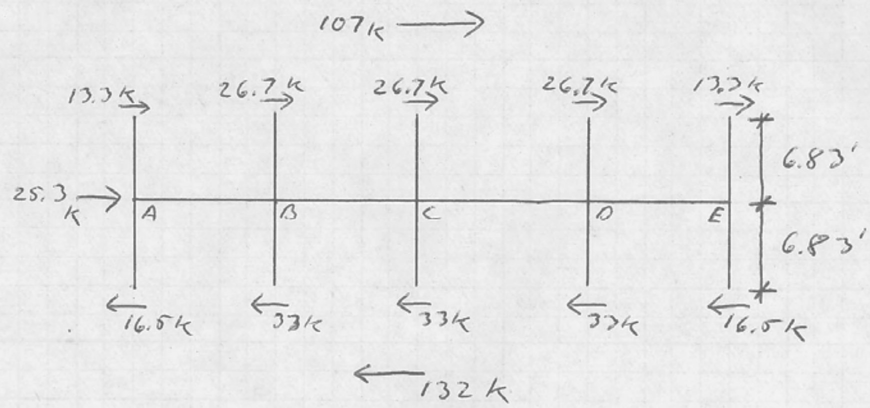


Resisting Moment = 16047k · $\frac{124'}{2}$ = 1035031.5 'k > 64980.1 'k

Building weighs enough to resist over-turning

Appendix E: Story Drift

Portal Method: 4th Floor



$$We = \frac{P\Delta}{2}$$

$$we = \left(\frac{13.3\,\Delta}{2}\right)2 + \left(\frac{26.7\Delta}{2}\right)3 + 25.3\,\frac{1}{6} = 57.56\,\Delta$$

$$W_i = \int \frac{M^2}{2EI}\,dx$$

$$W_i = \int_0^{6.8} \frac{(13.3\,x)^2}{2EI}\,dx \cdot 2 + 2 \cdot \int_0^{6.8} \frac{(26.7\,x)^2}{2EI}\,dx + \int_0^{6.8} \frac{(26.7x)^2}{2EI}$$

$W_i = 0.0018748 + 0.002579 + 0.00116$

$W_i = 0.00561438$

$I_{A,E} = 341$

$I_{B,D} = 999$

$I_C = 1110$

$E = 29000$

$57.56\,\Delta = 0.005614$

$\Delta = 0.00117$ in

$$\frac{h}{400} = \frac{13.667' \cdot \frac{12''}{1'}}{400} = 0.41001\,in$$

$0.41 >> 0.00117 \quad \therefore$ ok