Appendix A

Structural Depth Appendix
(with Commentary)

Columbia University Northwest Science Building

Broadway & 120th Street, New York, NY

This Structural Depth Appendix Section will provide commentary along with some of the tables, graphs, images, and figures. The commentary is intended to give the reader a better understanding of the process in which the lateral system was analyzed and redesigned.

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WIND CALCS: (MIAMI, FL)

- IS THE BUILDING ENCLOSED? – YES
- IS THE BLD. LOW-RISE? – NO
  - $n_1 = 100/226 = 0.4425 < 1$ (FLEXIBLE)
  - BASIC WIND SPEED (V) FOR MIAMI, FL. 150 MPH

- $K_d = 0.85$
- $I = 1.15$
- $K_{zt} = 1.0$
- EXPOSURE CATEGORY C
- $G = 0.85$

- FOR ALL OTHER CALCULATIONS ON WIND
  → SEE WIND SPREADSHEETS, TABLES, + FIGURES

The following tables provide excel spreadsheet calculations for determining the wind forces acting upon the building in Miami, FL. These calculations conclude with story forces, story shear, and overturning moment values.

Table 4A: Wind North-South Direction

Level	Height (Feet)	Tributary Area (Feet)	K_z	$q_z = 0.00256K_zK_{zt}K_dV^2I$	K_h	$q_h = 0.00256K_hK_{zt}K_dV^2I$
Roof (15)	226.00	4.67	1.50	84.87	1.50	84.87
14M	216.67	9.34	1.49	84.12	1.50	84.87
14	207.33	9.59	1.48	83.34	1.50	84.87
13M	197.50	9.36	1.46	82.49	1.50	84.87
13	188.63	9.34	1.45	81.70	1.50	84.87
12M	178.83	9.33	1.43	80.79	1.50	84.87
12	169.97	9.33	1.42	79.93	1.50	84.87
11M	160.17	9.34	1.40	78.93	1.50	84.87
11	151.30	9.34	1.38	77.99	1.50	84.87
10M	141.50	9.84	1.36	76.90	1.50	84.87
10	132.63	9.84	1.34	75.86	1.50	84.87
9M	122.83	9.33	1.32	74.64	1.50	84.87
9	113.97	8.83	1.30	73.48	1.50	84.87
8M	104.17	8.84	1.28	72.10	1.50	84.87
8	95.30	9.34	1.25	70.76	1.50	84.87
7M	85.50	9.33	1.22	69.16	1.50	84.87
7	76.64	9.54	1.20	67.59	1.50	84.87
6M	66.42	9.45	1.16	65.58	1.50	84.87
6	57.75	10.09	1.13	63.68	1.50	84.87
5	46.25	11.25	1.08	60.77	1.50	84.87
4	35.25	11.88	1.02	57.39	1.50	84.87
3	22.50	11.88	0.92	52.22	1.50	84.87
2	11.50	11.25	0.85	47.94	1.50	84.87
Ground (1)	0.00	0	0.85	48.01	1.50	84.87

Table 4B: Wind North-South Direction Continued

Level	Windward (psf)	Leeward (psf)	Total (psf)	Story Force (kips)	Story Shear (kips)	Overturning Moment (ft-kips)
Roof (15)	82.63	33.13	115.76	32.71	32.71	0.00
14M	82.03	33.13	115.16	65.08	97.78	305.15
14	81.42	33.13	114.55	66.46	164.24	1218.42
13M	80.74	33.13	113.87	64.48	228.73	2832.91
13	80.11	33.13	113.24	63.99	292.72	4861.70
12M	79.39	33.13	112.52	63.51	356.23	7730.32
12	78.71	33.13	111.84	63.13	419.36	10886.51
11M	77.92	33.13	111.05	62.75	482.11	14996.21
11	77.17	33.13	110.30	62.33	544.44	19272.51
10M	76.31	33.13	109.44	65.15	609.59	24607.99
10	75.48	33.13	108.61	64.66	674.24	30015.02
9M	74.51	33.13	107.64	60.76	735.01	36622.61
9	73.59	33.13	106.72	57.01	792.02	43134.76
8M	72.49	33.13	105.63	56.49	848.51	50896.52
8	71.43	33.13	104.56	59.09	907.59	58422.77
7M	70.16	33.13	103.29	58.31	965.90	67317.17
7	68.91	33.13	102.04	58.90	1024.80	75875.03
6M	67.32	33.13	100.45	57.43	1082.23	86348.44
6	65.81	33.13	98.94	60.40	1142.63	95731.34
5	63.50	33.13	96.63	65.77	1208.40	108871.54
4	60.82	33.13	93.95	67.53	1275.93	122163.92
3	56.72	33.13	89.85	64.58	1340.50	138431.98
2	53.33	33.13	86.46	58.84	1399.35	153177.51
Ground (1)	53.38	33.13	86.51	0.00	**1399.35**	**169270.00**

Table 5A: Wind East-West Direction

Level	Height (Feet)	Tributary Area (Feet)	K_z	$q_z = 0.00256K_zK_{zt}K_dV^2I$	K_h	$q_h = 0.00256K_hK_{zt}K_dV^2I$
Roof (15)	226.00	4.67	1.50	84.87	1.50	84.87
14M	216.67	9.34	1.49	84.12	1.50	84.87
14	207.33	9.59	1.48	83.34	1.50	84.87
13M	197.50	9.36	1.46	82.49	1.50	84.87
13	188.63	9.34	1.45	81.70	1.50	84.87
12M	178.83	9.33	1.43	80.79	1.50	84.87
12	169.97	9.33	1.42	79.93	1.50	84.87
11M	160.17	9.34	1.40	78.93	1.50	84.87
11	151.30	9.34	1.38	77.99	1.50	84.87
10M	141.50	9.84	1.36	76.90	1.50	84.87
10	132.63	9.84	1.34	75.86	1.50	84.87
9M	122.83	9.33	1.32	74.64	1.50	84.87
9	113.97	8.83	1.30	73.48	1.50	84.87
8M	104.17	8.84	1.28	72.10	1.50	84.87
8	95.30	9.34	1.25	70.76	1.50	84.87
7M	85.50	9.33	1.22	69.16	1.50	84.87
7	76.64	9.54	1.20	67.59	1.50	84.87
6M	66.42	9.45	1.16	65.58	1.50	84.87
6	57.75	10.09	1.13	63.68	1.50	84.87
5	46.25	11.25	1.08	60.77	1.50	84.87
4	35.25	11.88	1.02	57.39	1.50	84.87
3	22.50	11.88	0.92	52.22	1.50	84.87
2	11.50	11.25	0.80	45.34	1.50	84.87
Ground (1)	0.00	0	0.80	45.18	1.50	84.87

Table 5B: Wind East-West Direction Continued

Windward (psf)	Leeward (psf)	Total (psf)	Story Force (kips)	Story Shear (kips)	Overturning Moment (ft-kips)
82.63	54.95	137.58	126.41	126.41	0.00
82.03	54.95	136.99	251.73	378.14	1179.42
81.42	54.95	136.37	257.30	635.45	4711.27
80.74	54.95	135.70	249.89	885.34	10957.71
80.11	54.95	135.07	248.20	1133.54	18810.69
79.39	54.95	134.34	246.61	1380.15	29919.42
78.71	54.95	133.66	245.36	1625.51	42147.56
77.92	54.95	132.87	244.17	1869.68	58077.53
77.17	54.95	132.12	242.80	2112.47	74661.56
76.31	54.95	131.26	254.12	2366.59	95363.80
75.48	54.95	130.43	252.52	2619.11	116355.47
74.51	54.95	129.47	237.66	2856.77	142022.75
73.59	54.95	128.54	223.31	3080.08	167333.72
72.49	54.95	127.45	221.66	3301.75	197518.52
71.43	54.95	126.38	232.25	3534.00	226805.01
70.16	54.95	125.12	229.67	3763.67	261438.18
68.91	54.95	123.87	232.50	3996.17	294784.30
67.32	54.95	122.27	227.34	4223.51	335625.14
65.81	54.95	120.76	239.74	4463.25	372242.98
63.50	54.95	118.46	262.20	4725.45	423570.41
60.82	54.95	115.78	270.61	4996.06	475550.35
56.72	54.95	111.67	261.01	5257.08	539250.17
51.26	54.95	106.21	235.08	5492.16	597078.00
51.13	54.95	106.09	0.00	**5492.16**	**660237.85**

Table 6: Un-factored Story Forces for ETABS Deflection Wind Analysis

X-Direction Story Forces (kips)			Y-Direction Story Forces (kips)		
Level			**Level**		
Roof (15)	126.41	252.28	**Roof (15)**	32.71	65.24
14M	251.73		**14M**	65.08	
14	257.30	508.12	**14**	66.46	131.24
13M	249.89		**13M**	64.48	
13	248.20	496.45	**13**	63.99	127.99
12M	246.61		**12M**	63.51	
12	245.36	490.74	**12**	63.13	126.26
11M	244.17		**11M**	62.75	
11	242.80	491.94	**11**	62.33	126.28
10M	254.12		**10M**	65.15	
10	252.52	498.41	**10**	64.66	127.61
9M	237.66		**9M**	60.76	
9	223.31	452.97	**9**	57.01	115.64
8M	221.66		**8M**	56.49	
8	232.25	457.92	**8**	59.09	116.48
7M	229.67		**7M**	58.31	
7	232.50	461.01	**7**	58.90	116.77
6M	227.34		**6M**	57.43	
6	239.74	353.41	**6**	60.40	89.11
5	262.20	262.20	**5**	65.77	65.77
4	270.61	270.61	**4**	67.53	67.53
3	261.01	261.01	**3**	64.58	64.58
2	235.08	235.08	**2**	58.84	58.84

Before the calculated wind forces are inputted into ETABS and analyzed, the author wanted to make sure the structure's lateral system was modeled accurately using ETABS software. An accurate modeled structure will consist of the proper connections, mass, member sizes, member properties, and geometric inputs. The structure is very complex, and it is suspected by the author that it will not be modeled 100% accurate. However, to confirm the validity of the model, the main period of the building will be checked. Below shows the comparison of an estimated code calculation yielding 1.75 seconds, and the ETABS analysis yielding 2.11 seconds. These values are relatively close to one another, ensuring the author that the ETABS model inputs are accurate enough for this thesis study.

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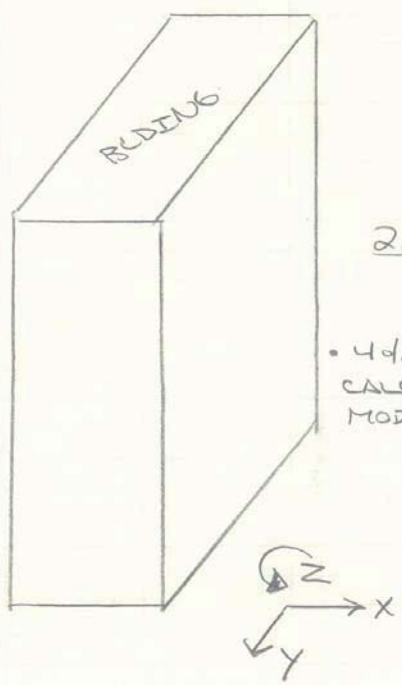
CALCULATION OF PERIOD FOR BLD: (EX. LAT)

$T_a = C_t h_n^x = (0.03)226^{0.75} = 1.75\,sec$

COMPARE TO ETABS MODEL:



$T_x = 2.11\,sec$

$T_y = 1.25\,sec$

$T_z = 1.06\,sec$

$\frac{2.11+1.25}{2} = 1.68\,sec$

- 4% DIFFERENCE BETWEEN CALCULATED PERIOD + ETABS MODEL
  ↳ ∴ OKAY!

– NEEDED TO GET ACCURATE + PRECISE PERIODS SO ETABS MODEL IS CORRECT FOR WIND ANALYSIS (FOR FUTURE DISTRIBUTION OF LATERAL FORCES.

Table 9: East-West Direction – Wind Serviceability Checks (Existing Design)

Grid 1 Wind (Servicability Checks)		
STORY	**DISP-X (IN)**	**STORY DRIFT (IN)**
LEVEL 15	14.09	0.16
LEVEL 14M	14.06	
LEVEL 14	13.93	
LEVEL 13M	13.58	0.49
LEVEL 13	13.09	
LEVEL 12M	12.41	0.69
LEVEL 12	11.72	
LEVEL 11M	10.88	0.80
LEVEL 11	10.08	
LEVEL 10M	9.19	0.59
LEVEL 10	8.61	
LEVEL 9M	8.33	0.37
LEVEL 9	7.96	
LEVEL 8M	7.08	0.94
LEVEL 8	6.14	
LEVEL 7M	5.12	0.84
LEVEL 7	4.28	
LEVEL 6M	3.46	0.61
LEVEL 6	2.84	
LEVEL 5	2.15	0.37
LEVEL 4	1.78	
LEVEL 3	1.08	0.65
LEVEL 2	0.43	

Grid 2 Wind (Servicability Checks)		
STORY	**DISP-X (IN)**	**STORY DRIFT (IN)**
LEVEL 15	14.04	0.18
LEVEL 14M	14.01	
LEVEL 14	13.86	
LEVEL 13M	13.49	0.48
LEVEL 13	13.01	
LEVEL 12M	12.37	0.67
LEVEL 12	11.70	
LEVEL 11M	10.87	0.80
LEVEL 11	10.07	
LEVEL 10M	9.20	0.57
LEVEL 10	8.63	
LEVEL 9M	8.32	0.36
LEVEL 9	7.96	
LEVEL 8M	7.12	0.96
LEVEL 8	6.16	
LEVEL 7M	5.16	0.79
LEVEL 7	4.37	
LEVEL 6M	3.57	0.62
LEVEL 6	2.95	
LEVEL 5	2.24	0.43
LEVEL 4	1.81	
LEVEL 3	1.08	0.67
LEVEL 2	0.41	

Grid 3 Wind (Servicability Checks)		
STORY	**DISP-X (IN)**	**STORY DRIFT (IN)**
LEVEL 15	14.00	0.20
LEVEL 14M	13.95	
LEVEL 14	13.80	
LEVEL 13M	13.42	0.48
LEVEL 13	12.94	
LEVEL 12M	12.32	0.65
LEVEL 12	11.67	
LEVEL 11M	10.84	0.78
LEVEL 11	10.06	
LEVEL 10M	9.22	0.56
LEVEL 10	8.66	
LEVEL 9M	8.34	0.37
LEVEL 9	7.97	
LEVEL 8M	7.12	0.93
LEVEL 8	6.19	
LEVEL 7M	5.23	0.76
LEVEL 7	4.47	
LEVEL 6M	3.68	0.62
LEVEL 6	3.06	
LEVEL 5	2.33	0.49
LEVEL 4	1.84	
LEVEL 3	1.09	0.69
LEVEL 2	0.40	

Grid 4 Wind (Servicability Checks)		
STORY	**DISP-X (IN)**	**STORY DRIFT (IN)**
LEVEL 15	13.96	0.23
LEVEL 14M	13.89	
LEVEL 14	13.73	
LEVEL 13M	13.34	0.48
LEVEL 13	12.86	
LEVEL 12M	12.27	0.62
LEVEL 12	11.65	
LEVEL 11M	10.83	0.78
LEVEL 11	10.05	
LEVEL 10M	9.23	0.55
LEVEL 10	8.68	
LEVEL 9M	8.36	0.38
LEVEL 9	7.98	
LEVEL 8M	7.13	0.92
LEVEL 8	6.21	
LEVEL 7M	5.29	0.73
LEVEL 7	4.56	
LEVEL 6M	3.79	0.62
LEVEL 6	3.17	
LEVEL 5	2.42	0.55
LEVEL 4	1.87	
LEVEL 3	1.09	0.71
LEVEL 2	0.38	

Grid 10 Wind (Servicability Checks)		
STORY	**DISP-X (IN)**	**STORY DRIFT (IN)**
LEVEL 15	13.68	0.37
LEVEL 14M	13.54	
LEVEL 14	13.31	
LEVEL 13M	12.85	0.45
LEVEL 13	12.40	
LEVEL 12M	11.98	0.46
LEVEL 12	11.52	
LEVEL 11M	10.73	0.74
LEVEL 11	9.99	
LEVEL 10M	9.32	0.47
LEVEL 10	8.85	
LEVEL 9M	8.46	0.44
LEVEL 9	8.02	
LEVEL 8M	7.16	0.80
LEVEL 8	6.36	
LEVEL 7M	5.70	0.54
LEVEL 7	5.16	
LEVEL 6M	4.46	0.62
LEVEL 6	3.84	
LEVEL 5	2.96	0.90
LEVEL 4	2.06	
LEVEL 3	1.18	0.75
LEVEL 2	0.43	

Above is ETABS analysis output data for drift and story drift checks. This output data was obtained by loading the lateral system in the East-West direction using unfactored loads (for serviceability checks). As shown above the existing design is deflecting a great amount due to the increase wind loads of Miami, FL. This occurrence is similar to the North-South direction existing analysis. (Table can be found on the following page.)

Table 10: North-South Direction – Wind Serviceability Checks (Existing Design)

Grid A Wind (Servicability Checks)		
STORY	DISP-Y (IN)	STORY DRIFT (IN)
LEVEL 15	2.16	
LEVEL 14M	2.14	0.03
LEVEL 14	2.13	
LEVEL 13M	2.25	0.17
LEVEL 13	2.08	
LEVEL 12M	1.94	0.16
LEVEL 12	1.78	
LEVEL 11M	1.61	0.11
LEVEL 11	1.50	
LEVEL 10M	1.37	0.14
LEVEL 10	1.23	
LEVEL 9M	1.14	0.07
LEVEL 9	1.07	
LEVEL 8M	0.95	0.09
LEVEL 8	0.86	
LEVEL 7M	0.73	0.11
LEVEL 7	0.62	
LEVEL 6M	0.59	0.03
LEVEL 6	0.56	
LEVEL 5	0.49	0.02
LEVEL 4	0.47	
LEVEL 3	0.31	0.14
LEVEL 2	0.17	

Grid C Wind (Servicability Checks)		
STORY	DISP-Y (IN)	STORY DRIFT (IN)
LEVEL 15	1.99	
LEVEL 14M	2.04	0.05
LEVEL 14	2.04	
LEVEL 13M	1.99	0.14
LEVEL 13	1.85	
LEVEL 12M	1.79	0.07
LEVEL 12	1.72	
LEVEL 11M	1.61	0.15
LEVEL 11	1.46	
LEVEL 10M	1.40	0.04
LEVEL 10	1.36	
LEVEL 9M	1.25	-0.02
LEVEL 9	1.27	
LEVEL 8M	1.08	0.08
LEVEL 8	1.00	
LEVEL 7M	0.92	0.05
LEVEL 7	0.87	
LEVEL 6M	0.86	0.03
LEVEL 6	0.83	
LEVEL 5	0.72	0.17
LEVEL 4	0.55	
LEVEL 3	0.33	0.18
LEVEL 2	0.15	

Grid D Wind (Servicability Checks)		
STORY	DISP-Y (IN)	STORY DRIFT (IN)
LEVEL 15	1.92	
LEVEL 14M	1.96	0.01
LEVEL 14	1.93	
LEVEL 13M	1.86	0.12
LEVEL 13	1.74	
LEVEL 12M	1.70	0.08
LEVEL 12	1.62	
LEVEL 11M	1.52	0.07
LEVEL 11	1.45	
LEVEL 10M	1.34	0.06
LEVEL 10	1.28	
LEVEL 9M	1.16	0.13
LEVEL 9	1.03	
LEVEL 8M	0.98	0.03
LEVEL 8	0.95	
LEVEL 7M	0.96	0.01
LEVEL 7	0.95	
LEVEL 6M	0.94	0.02
LEVEL 6	0.92	
LEVEL 5	0.82	0.22
LEVEL 4	0.60	
LEVEL 3	0.34	0.18
LEVEL 2	0.16	

Table 14: East-West Direction – Wind Serviceability Checks (Redesign System)

Grid 1 Wind (Servicability Checks)		
STORY	DISP-X (IN)	STORY DRIFT (IN)
LEVEL 15	6.76	
LEVEL 14M	6.61	0.16
LEVEL 14	6.60	
LEVEL 13M	6.47	0.28
LEVEL 13	6.19	
LEVEL 12M	5.78	0.14
LEVEL 12	5.64	
LEVEL 11M	5.10	0.33
LEVEL 11	4.77	
LEVEL 10M	4.42	0.45
LEVEL 10	3.97	
LEVEL 9M	3.65	0.14
LEVEL 9	3.51	
LEVEL 8M	2.93	0.37
LEVEL 8	2.56	
LEVEL 7M	2.26	0.31
LEVEL 7	1.95	
LEVEL 6M	1.59	0.32
LEVEL 6	1.27	
LEVEL 5	0.87	0.24
LEVEL 4	0.63	
LEVEL 3	0.38	0.25
LEVEL 2	0.13	

Grid 2 Wind (Servicability Checks)		
STORY	DISP-X (IN)	STORY DRIFT (IN)
LEVEL 15	6.75	
LEVEL 14M	6.72	0.14
LEVEL 14	6.61	
LEVEL 13M	6.43	0.23
LEVEL 13	6.20	
LEVEL 12M	5.91	0.29
LEVEL 12	5.62	
LEVEL 11M	5.22	0.36
LEVEL 11	4.86	
LEVEL 10M	4.36	0.36
LEVEL 10	4.00	
LEVEL 9M	3.74	0.24
LEVEL 9	3.50	
LEVEL 8M	3.05	0.46
LEVEL 8	2.59	
LEVEL 7M	2.26	0.29
LEVEL 7	1.97	
LEVEL 6M	1.63	0.35
LEVEL 6	1.28	
LEVEL 5	0.89	0.23
LEVEL 4	0.66	
LEVEL 3	0.36	0.22
LEVEL 2	0.14	

Grid 3 Wind (Servicability Checks)		
STORY	DISP-X (IN)	STORY DRIFT (IN)
LEVEL 15	6.77	
LEVEL 14M	6.71	0.15
LEVEL 14	6.62	
LEVEL 13M	6.44	0.23
LEVEL 13	6.21	
LEVEL 12M	5.90	0.32
LEVEL 12	5.58	
LEVEL 11M	5.18	0.37
LEVEL 11	4.81	
LEVEL 10M	4.33	0.34
LEVEL 10	3.99	
LEVEL 9M	3.74	0.26
LEVEL 9	3.48	
LEVEL 8M	3.06	0.43
LEVEL 8	2.63	
LEVEL 7M	2.25	0.27
LEVEL 7	1.98	
LEVEL 6M	1.60	0.28
LEVEL 6	1.32	
LEVEL 5	0.92	0.28
LEVEL 4	0.64	
LEVEL 3	0.35	0.21
LEVEL 2	0.14	

Grid 4 Wind (Servicability Checks)		
STORY	DISP-X (IN)	STORY DRIFT (IN)
LEVEL 15	6.76	
LEVEL 14M	6.71	0.13
LEVEL 14	6.63	
LEVEL 13M	6.46	0.24
LEVEL 13	6.22	
LEVEL 12M	5.91	0.33
LEVEL 12	5.58	
LEVEL 11M	5.13	0.40
LEVEL 11	4.73	
LEVEL 10M	4.30	0.32
LEVEL 10	3.98	
LEVEL 9M	3.70	0.28
LEVEL 9	3.42	
LEVEL 8M	2.97	0.41
LEVEL 8	2.56	
LEVEL 7M	2.24	0.27
LEVEL 7	1.97	
LEVEL 6M	1.61	0.31
LEVEL 6	1.30	
LEVEL 5	0.90	0.26
LEVEL 4	0.64	
LEVEL 3	0.35	0.21
LEVEL 2	0.14	

Grid 10 Wind (Servicability Checks)		
STORY	DISP-X (IN)	STORY DRIFT (IN)
LEVEL 15	6.77	
LEVEL 14M	6.75	0.18
LEVEL 14	6.59	
LEVEL 13M	6.47	0.21
LEVEL 13	6.26	
LEVEL 12M	5.71	0.35
LEVEL 12	5.36	
LEVEL 11M	4.89	0.23
LEVEL 11	4.66	
LEVEL 10M	4.34	0.32
LEVEL 10	4.02	
LEVEL 9M	3.61	0.30
LEVEL 9	3.31	
LEVEL 8M	2.86	0.30
LEVEL 8	2.56	
LEVEL 7M	2.26	0.28
LEVEL 7	1.98	
LEVEL 6M	1.63	0.29
LEVEL 6	1.34	
LEVEL 5	0.95	0.27
LEVEL 4	0.68	
LEVEL 3	0.36	0.21
LEVEL 2	0.15	

Above is ETABS analysis output data for drift and story drift checks. This output data was obtained by loading the lateral system in the East-West direction using unfactored loads (for serviceability checks). As shown above the redesign lateral system now meets serviceability requirements under Miami, FL wind loading. This holds true for the North-South direction redesigned system analysis. (Table can be found on following page.)

Table 15: North-South Direction – Wind Serviceability Checks (Redesigned System)

Grid A Wind (Servicability Checks)		
STORY	**DISP-Y (IN)**	**STORY DRIFT (IN)**
LEVEL 15	1.20	0.04
LEVEL 14M	1.18	
LEVEL 14	1.16	
LEVEL 13M	1.14	0.02
LEVEL 13	1.12	
LEVEL 12M	1.09	0.02
LEVEL 12	1.07	
LEVEL 11M	1.01	0.05
LEVEL 11	0.96	
LEVEL 10M	0.91	0.05
LEVEL 10	0.86	
LEVEL 9M	0.80	0.04
LEVEL 9	0.76	
LEVEL 8M	0.71	0.03
LEVEL 8	0.68	
LEVEL 7M	0.64	0.03
LEVEL 7	0.61	
LEVEL 6M	0.60	0.02
LEVEL 6	0.58	
LEVEL 5	0.47	0.06
LEVEL 4	0.41	
LEVEL 3	0.25	0.14
LEVEL 2	0.11	

Grid C Wind (Servicability Checks)		
STORY	**DISP-Y (IN)**	**STORY DRIFT (IN)**
LEVEL 15	1.18	0.03
LEVEL 14M	1.16	
LEVEL 14	1.15	
LEVEL 13M	1.12	0.02
LEVEL 13	1.10	
LEVEL 12M	1.07	0.02
LEVEL 12	1.05	
LEVEL 11M	0.99	0.05
LEVEL 11	0.94	
LEVEL 10M	0.89	0.05
LEVEL 10	0.84	
LEVEL 9M	0.79	0.05
LEVEL 9	0.74	
LEVEL 8M	0.70	0.03
LEVEL 8	0.67	
LEVEL 7M	0.63	0.02
LEVEL 7	0.61	
LEVEL 6M	0.60	0.02
LEVEL 6	0.58	
LEVEL 5	0.49	0.11
LEVEL 4	0.38	
LEVEL 3	0.28	0.17
LEVEL 2	0.11	

Grid D Wind (Servicability Checks)		
STORY	**DISP-Y (IN)**	**STORY DRIFT (IN)**
LEVEL 15	1.18	0.04
LEVEL 14M	1.16	
LEVEL 14	1.14	
LEVEL 13M	1.11	0.10
LEVEL 13	1.01	
LEVEL 12M	0.99	0.01
LEVEL 12	0.98	
LEVEL 11M	0.97	0.04
LEVEL 11	0.93	
LEVEL 10M	0.88	0.05
LEVEL 10	0.83	
LEVEL 9M	0.78	0.04
LEVEL 9	0.74	
LEVEL 8M	0.69	0.02
LEVEL 8	0.67	
LEVEL 7M	0.63	0.03
LEVEL 7	0.60	
LEVEL 6M	0.58	0.07
LEVEL 6	0.51	
LEVEL 5	0.43	0.10
LEVEL 4	0.33	
LEVEL 3	0.25	0.14
LEVEL 2	0.11	

A strength check of the existing structure for Miami, FL wind forces is provided below. This strength check yields a failed member. This failure is one example of several occurrences throughout the existing lateral system.

1/30/10

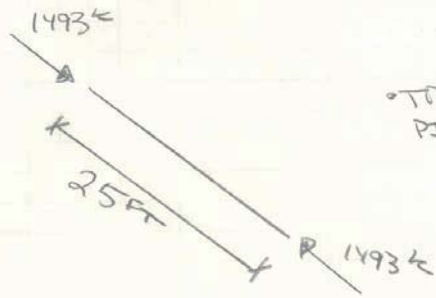
STRENGTH CHECK

• EXISTING LATERAL SYSTEM – MAIMI, FL

– BRACED FRAME BETWEEN LEVELS 8 & 9.

→ ETABS CALCULATED AXIAL FORCE FOR MEMBER (W14x90) → 1493K

CHECK AXIAL CAPACITY OF THIS W14x90 MEMBER:



• $P_u = 1493^k$

• TREAT BRACE AS PIN-PIN COLUMN

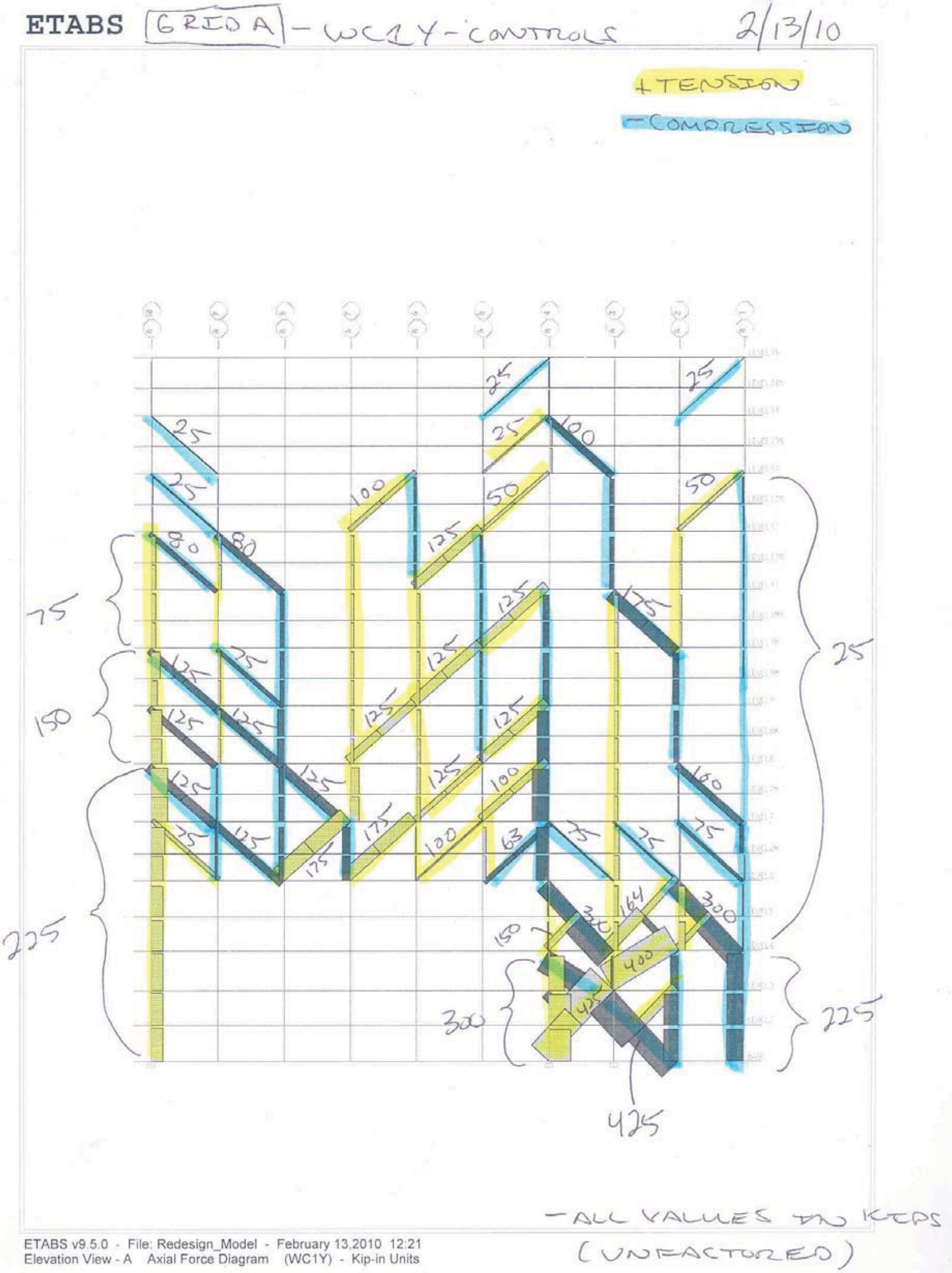
$P_u = 1493^k$

$\phi P_n = 765^k$ (24FT)
$\phi P_n = 708^k$ (26FT)
BOTH < 1493^k

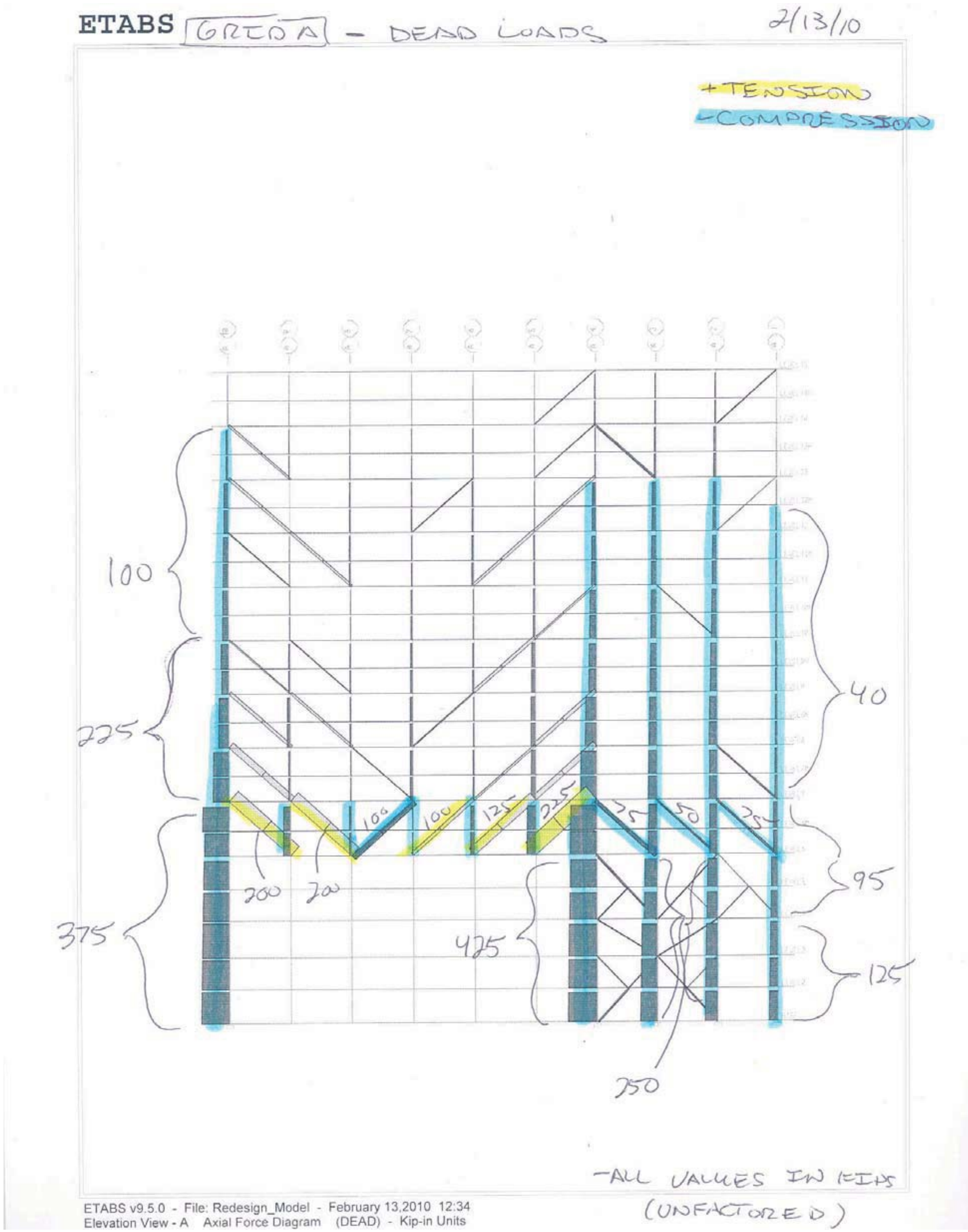
∴ W14x90 BRACE MEMBER IS NO GOOD FOR STRENGTH REQUIREMENT.

– NOTE: AUTHOR SUSPECTS MANY BRACED MEMBERS IN EAST-WEST LAT. SYSTEM TO FAIL STRENGTH REQ. → WILL BE CONSIDERED DURING REDESIGN.

Below is an ETABS printout of axial forces in Grid A for its controlling wind force case. These members were checked by the author and redesign appropriately if a larger section was needed for tension or compression requirements.



Below is an ETABS printout of mainly compressive forces in Grid A. Grid A is in the North-South direction of the lateral system. Grids A, C, & D have lateral members that are loaded under both wind and dead load forces. Combinations of these forces are analyzed to check the design of column and brace frame members.



Below is example hand calculation checks performed for Grid A.

GRID CHECKS | GRID A | 2/13/10

CHECK TRUSS BRACING:

COMBO 1.2D+1.6W+1.0L:

CHECK BRACE BETWEEN 5-4 / LEVEL 6.

1.2[225] + 1.6[175] + 1.0[225] = 800k COMP.

W14X550 — $\phi_c P_n$ = 4560k
LENGTH → 30FT

(OKAY)

CHECK COLUMNS:

LINE 4 – LEVEL 2

1.2(425) + 1.0(425) + 300(1.6) = 1415k

24 FT LONG → (OKAY!)
W14X730

CHECK BRACE: LEVEL 1-3 (BETWEEN LINES 4-5)

1.6(425) + 1.2(75) + 1.0(75) = 900k

W14X90 — $\phi_c P_n$ = 596k
LENGTH 30FT

NEED LARGER SECTION.

(W14X145) → OKAY

MODIFY OTHER BRACING ACCORDINGLY.

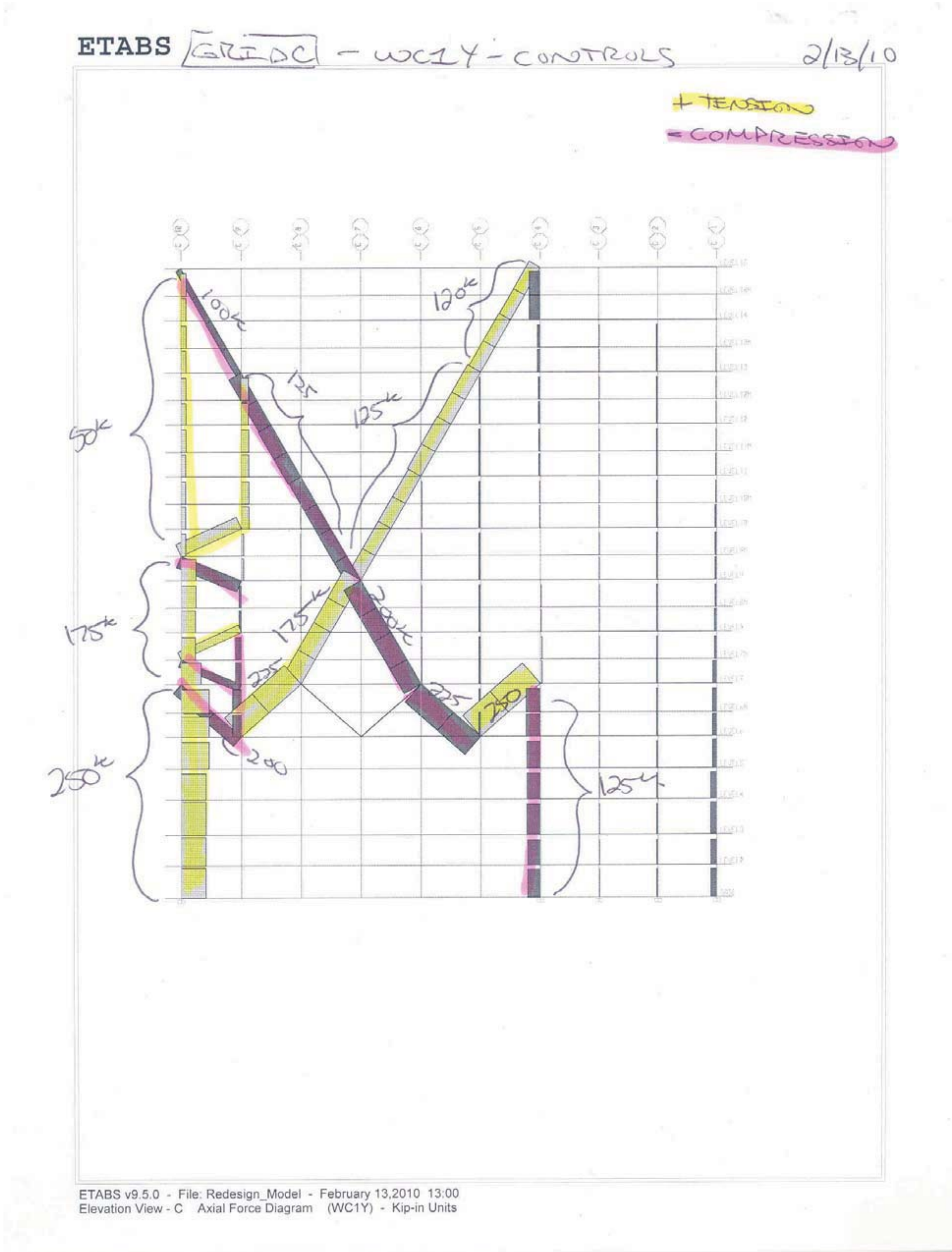
CHECK LONG EXT. COLUMN

W14X730 (LENGTH = 50FT) — $\phi_c P_n$ = 2970k

1.2(375) + 1.0(375) + 225(1.6) = 1100k

(FOS > 2 → OKAY)

Analysis and preliminary design of Grid C followed the same process as shown previously for Grid A.



GRID CHECKS | GRID C | 2/13/10

CHECK LONG EXTERIOR COLUMN:

50FT LONG
W14x730 $\phi_c P_n = 2970^k$

$1.6(250) + 1.2(450) + 1.0(450) = 1400^k$

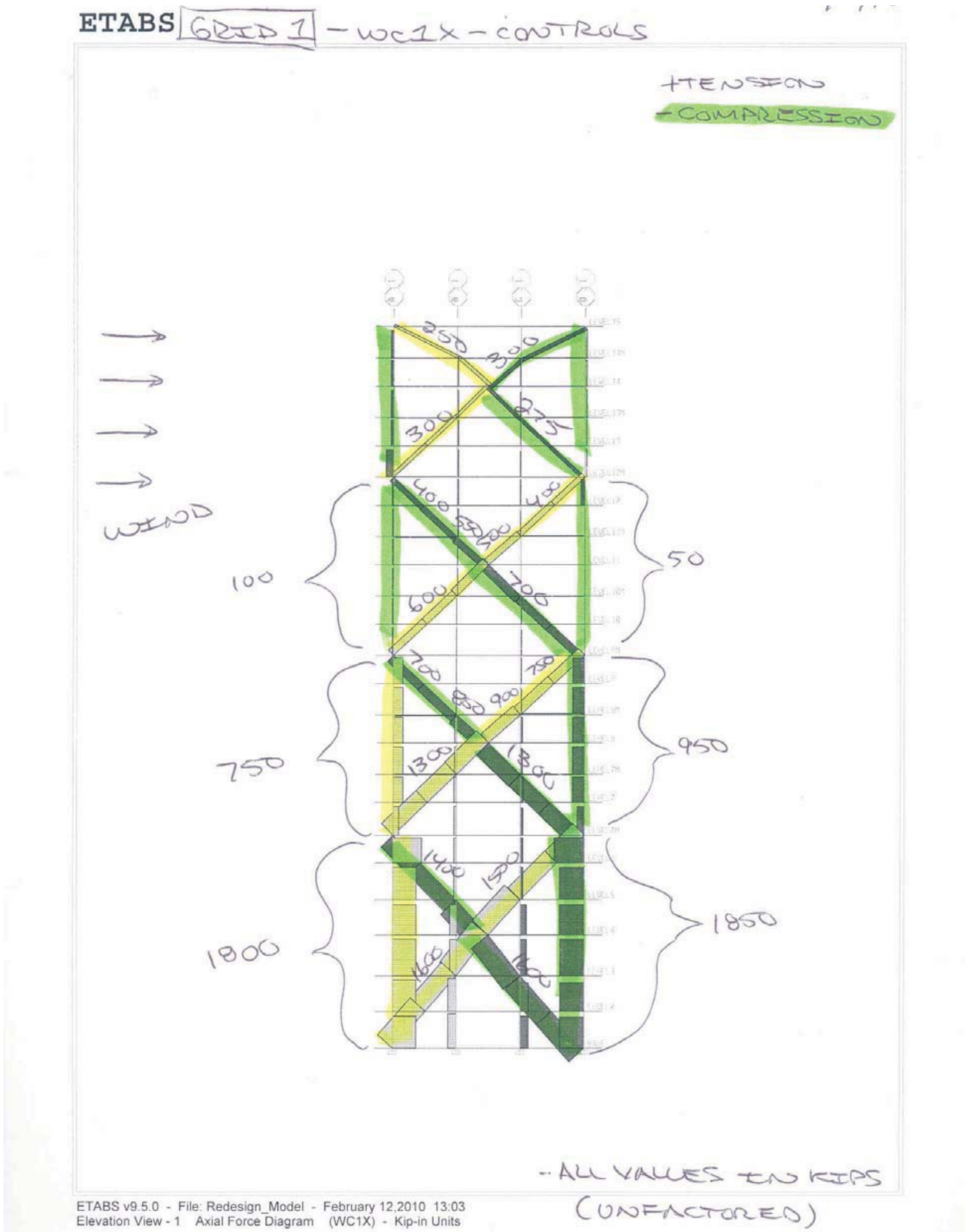
$FOS = \frac{2970}{1400} = 2 \rightarrow$ (OKAY)

CHECK TRUSS BRACING:

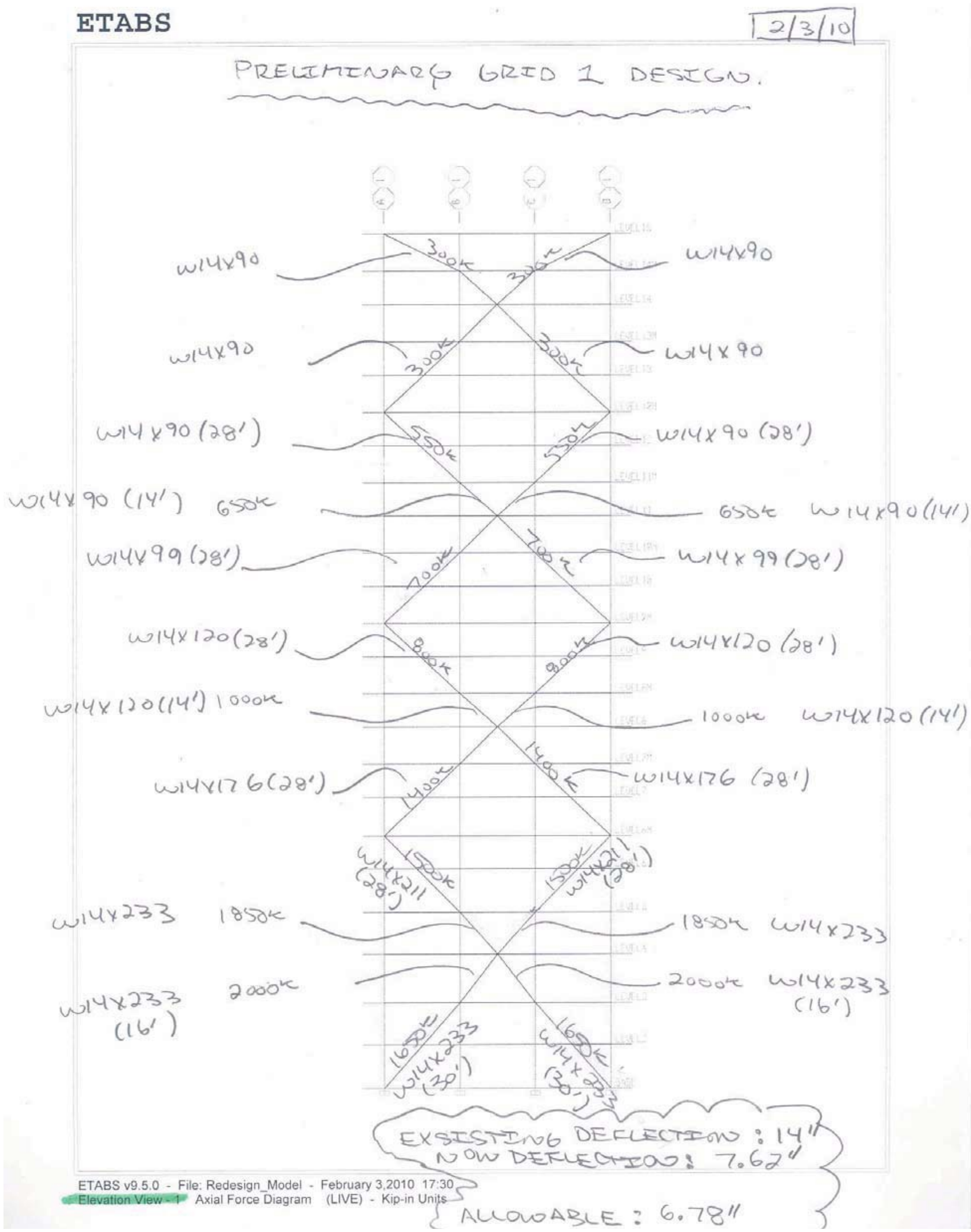
$1.6(250) + 1.2(300) + 1.0(300) = 1100^k$

W14x730^k → (OKAY!)

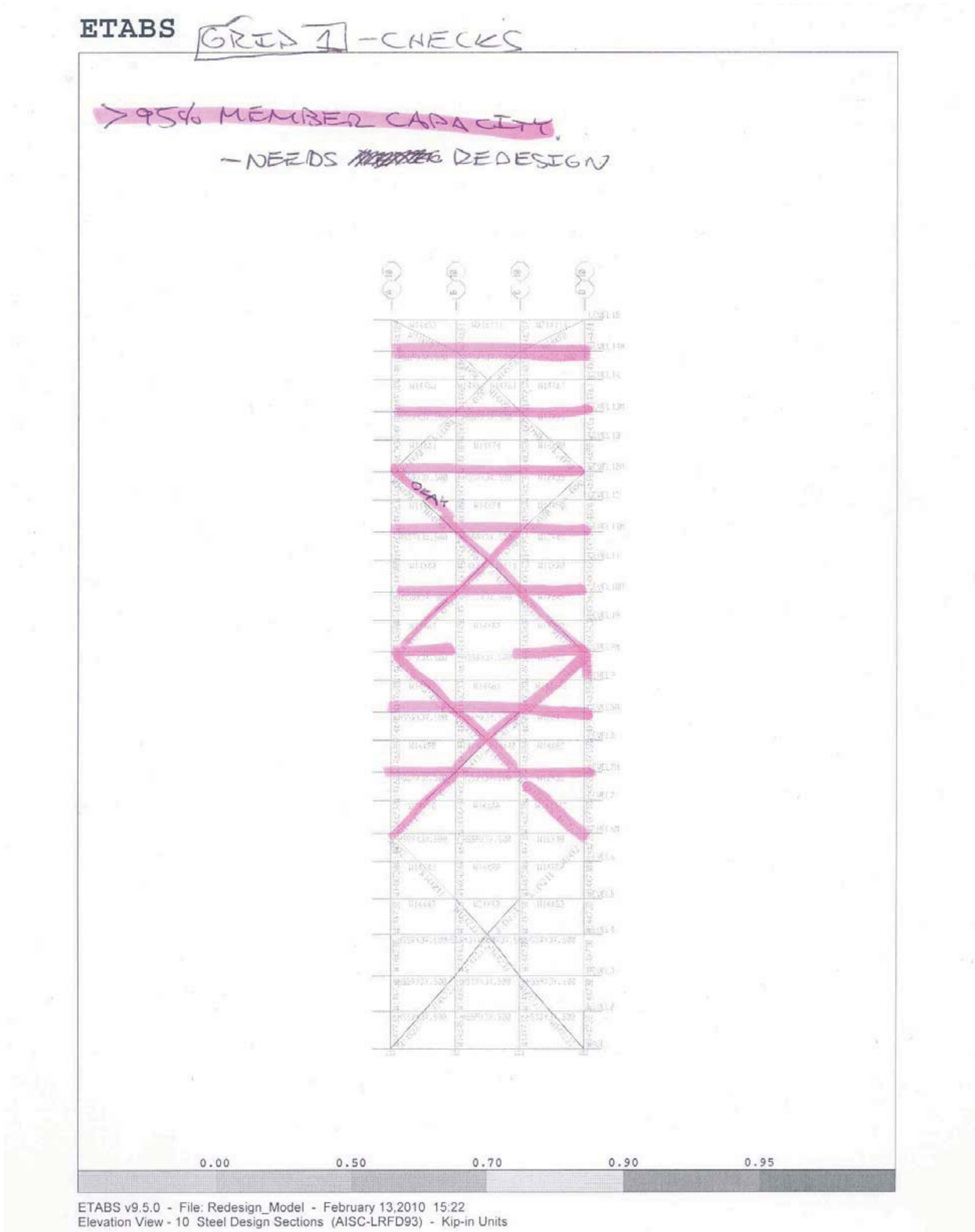
The East-West direction preliminary design came next. This redesign was extensive and did not just involve checking existing member's sizes, which was performed in the North-South direction grids.



Below is a preliminary design of Grid 1 bracing members. The members were treated as concentric (axial loaded) members. Member sizes were chosen appropriately using the LRFD (Load & Resistance Factor Design) manual.



After member changes were performed, the ETABS model was analyzed, once again. Members that did not meet capacity demands were noted and redesign appropriately. This process continued until a sufficient design was attainable.



Additional hand calculated checks (Grid 1) were performed to provide validity of the ETABS analysis.

GRID CHECKS | GRID 1 | 2/11/10 | 2

CHECK 1.2D + 1.6W + 1.0L COLUMNS:

LEVEL 5 EXTERIOR COLUMNS:

$1.2(200^k) + 1.6(1850) + 1.0(200) = 3400^k$

$3400 \leq \phi_c P_n$ (2120) — COLUMN [W14X176] LENGTH 12FT

↳ NO GOOD BUMP UP TO W14X426 ($\phi P_n = 5190^k$)

↓ MODIFY COLUMNS ACCORDINGLY.

FACTOR OF SAFETY:

$\frac{4510}{3400} = 1.52 > 1.5$ (OKAY)

CHECK 0.9D + 1.6L:

LEVEL 5 COLUMN

$1.6(1800) - 0.9(200) = 2700^k$ (TENSION)

↑ TENSION

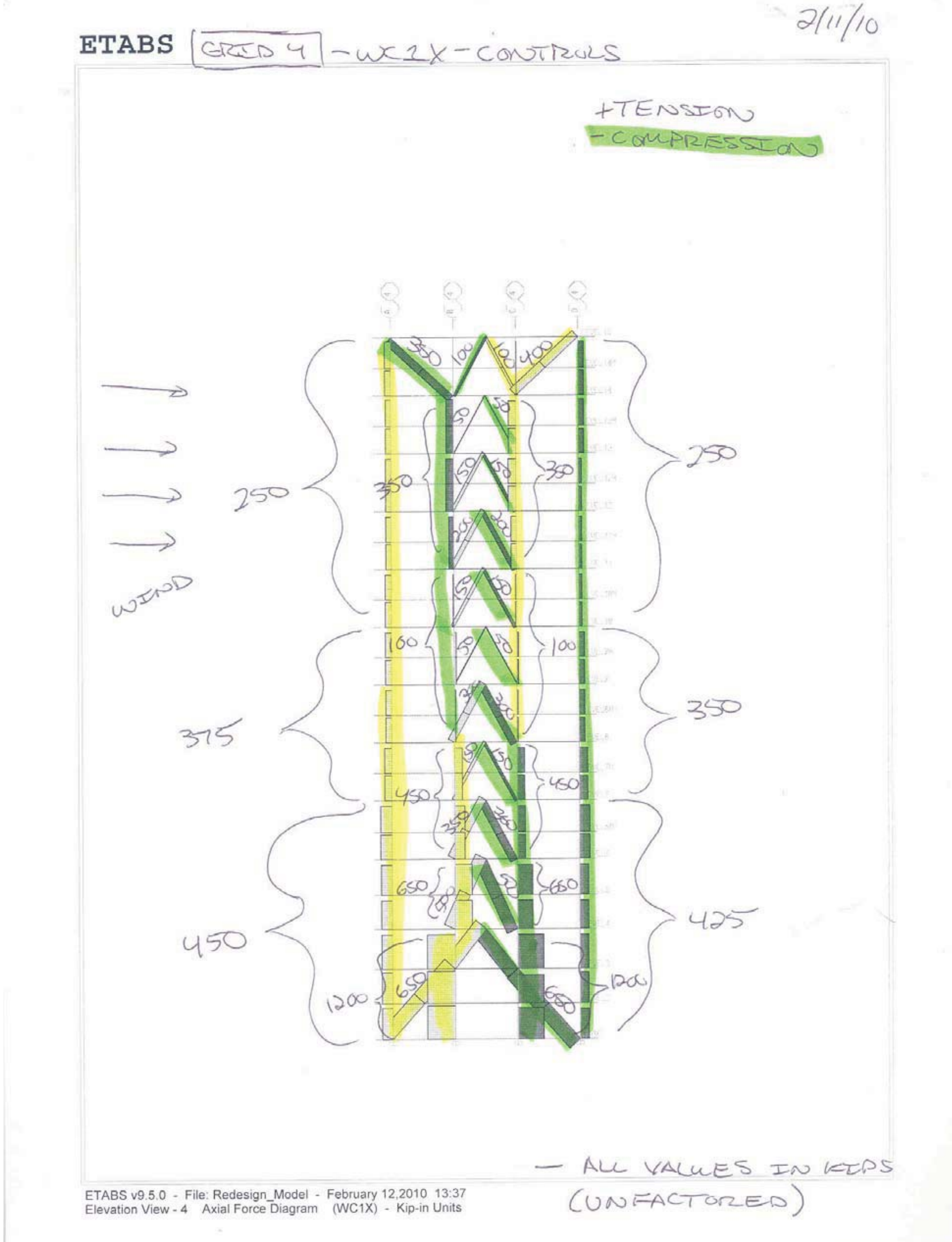
$\phi_c P_n = 5630^k$ [W14X426]

$2700 \leq \phi_t P_n$ → (OKAY)

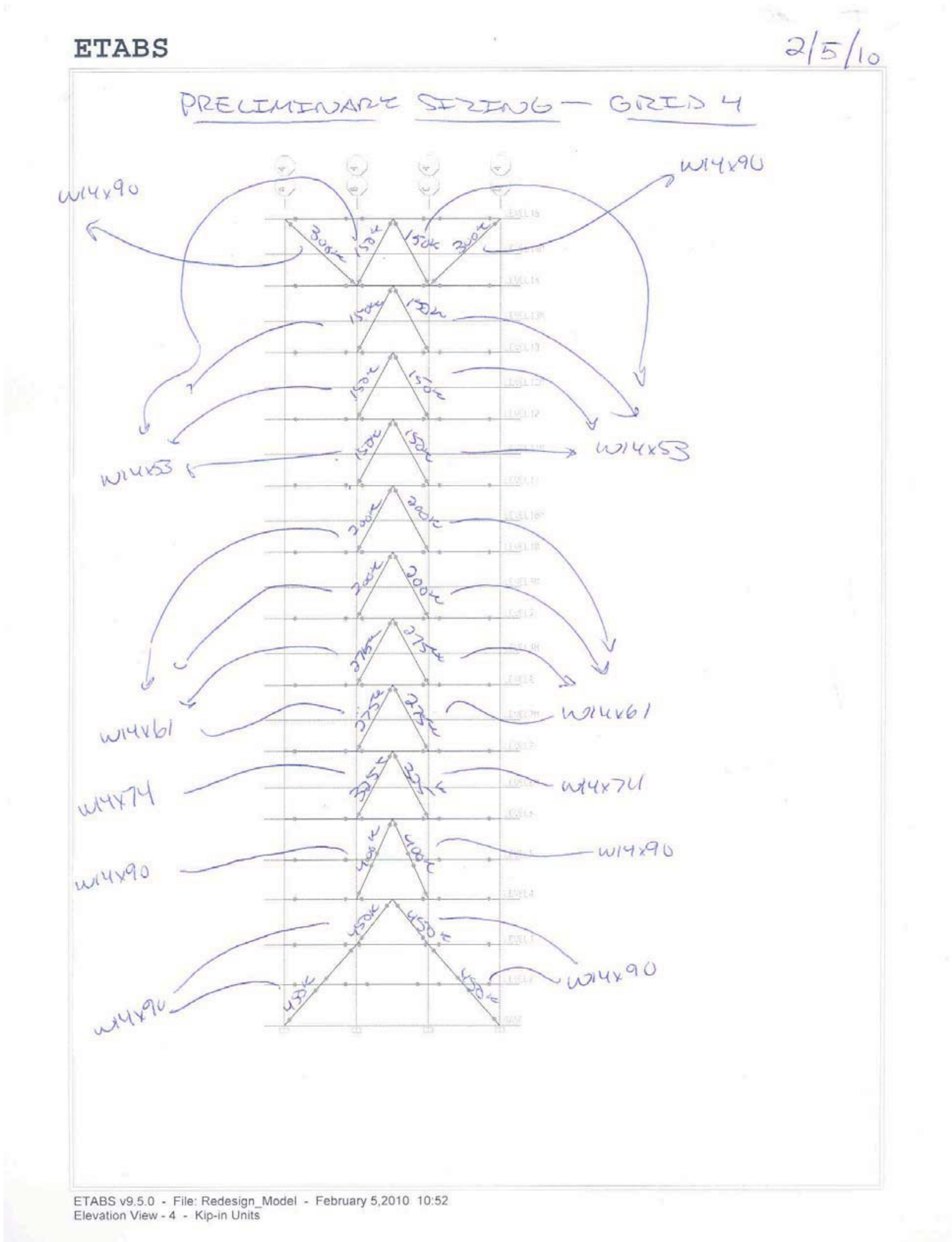
FACTOR OF SAFETY:

$\frac{5630}{2700} = 2.1$ → (OKAY)

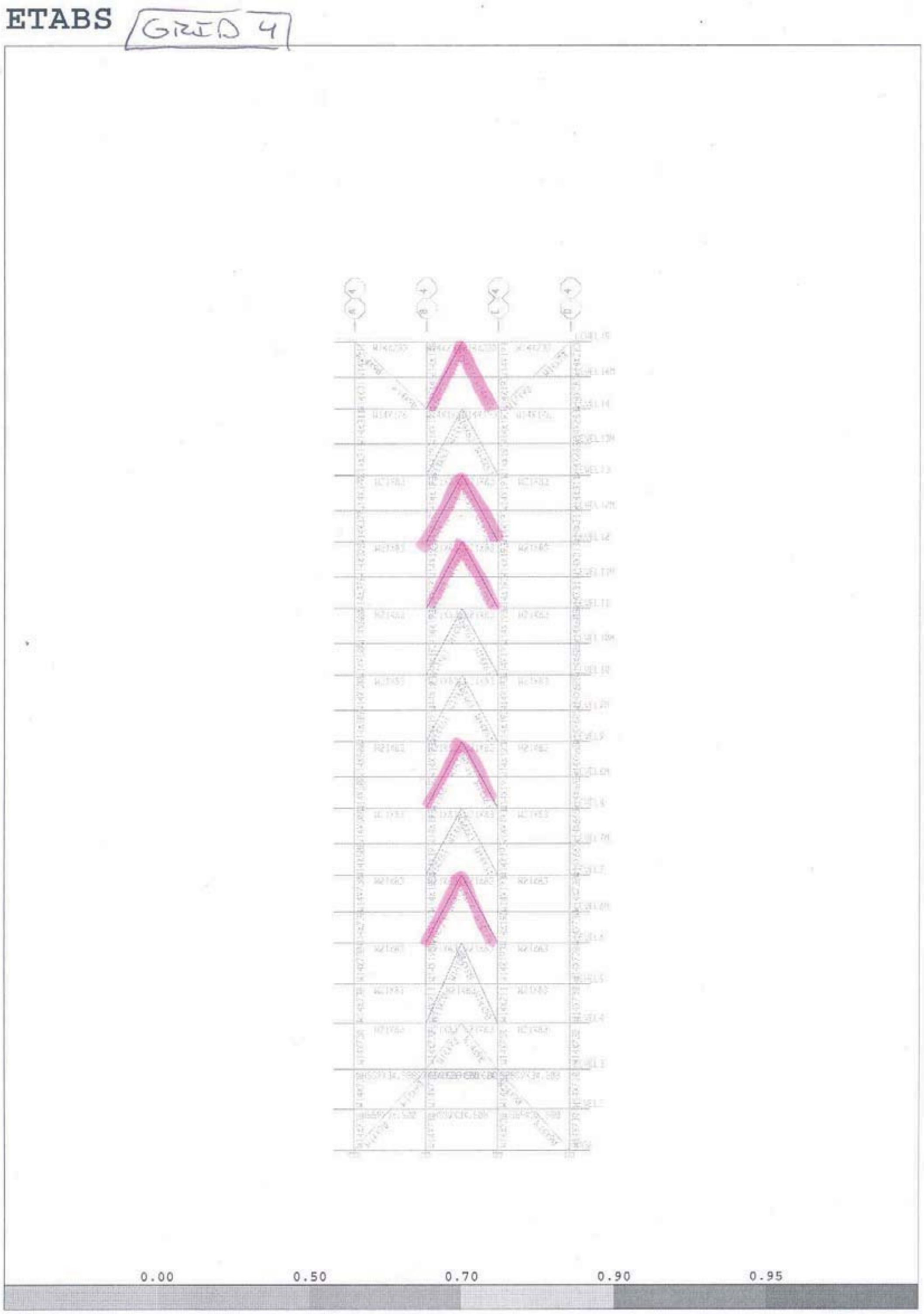
Analysis and redesign of Grid 4 followed similarly to Grid 1. Take notice that Grid 4 is an interior grid and therefore contains one bay chevron bracing to fulfill architectural spatial needs.



Preliminary sizing of Grid 4 members is shown below.



Capacity check of Grid 4 is shown below. Highlighted members did not meet capacity demands and were redesigned once again.



ETABS v9.5.0 - File: Redesign_Model - February 13,2010 15:22
Elevation View - 4 Steel Design Sections (AISC-LRFD93) - Kip-in Units

Hand calculated checks of Grid 4 redesign is shown below and on the following page.

GRID CHECKS | GRID 4 - INT | 2/11/10

CHECK 1.2D + 1.6W + 1.0L COLUMNS:

INTERIOR COLUMNS

LEVEL 5

$1.2(225) + 1.6(650) + 1.0(225) = 1535^k$

$\phi_c P_n = 2120^k$ [W14x176] LENGTH 12FT

$1535^k \leq 2120^k$

OKAY → BUMP UP SO FOS ≥ 1.5

- USE W14x193 ($\phi_c P_n = 2330$) → ADJUST OTHER COLUMNS ACCORDINGLY.

FOS = 1.52 > 1.5 (OKAY)

LEVEL 5 - INTERIOR COLUMN:

CHECK 0.9D + 1.6W:

$-0.9(225) + 1.6(650) = 850^k$ (TENS)

W14x193 → $\phi_t P_n = 2560^k$ → (OKAY.)

FOS > 1.5 → (OKAY)

GRID CHECKS | GRID 4 - EXT | 2/11/10

CHECK 1.2D + 1.6W + 1.0L COLUMNS:

EXT. COL - LEVEL 5

$1.2(400) + 1.6(425) + 1.0(400) = 1560^K$

W14x730
LENGTH 12FT → $\phi_c P_n = 9030^k$ → OKAY!

FOS > 1.5 → OKAY

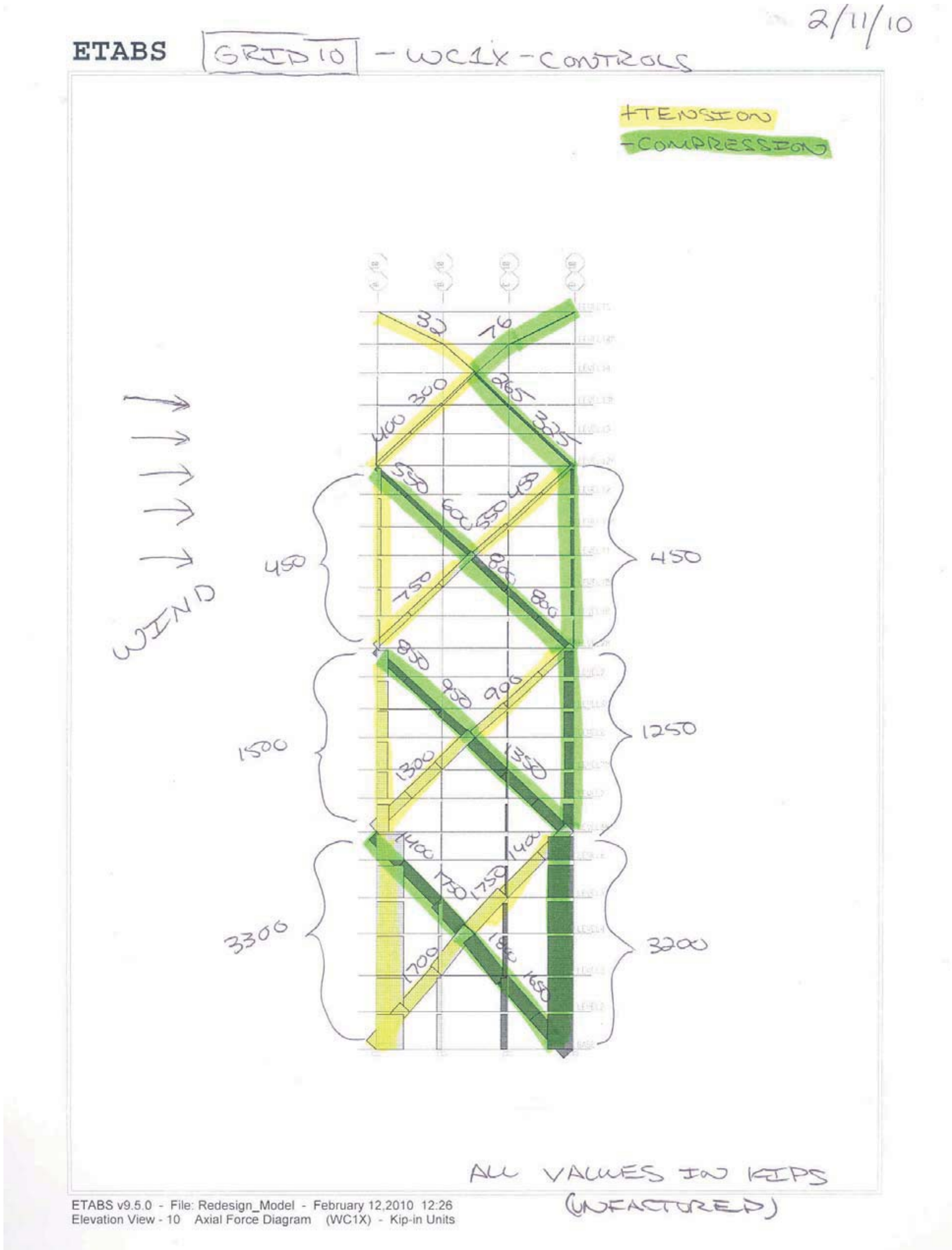
EXT COL - LEVEL 5

CHECK 0.9D + 1.6W

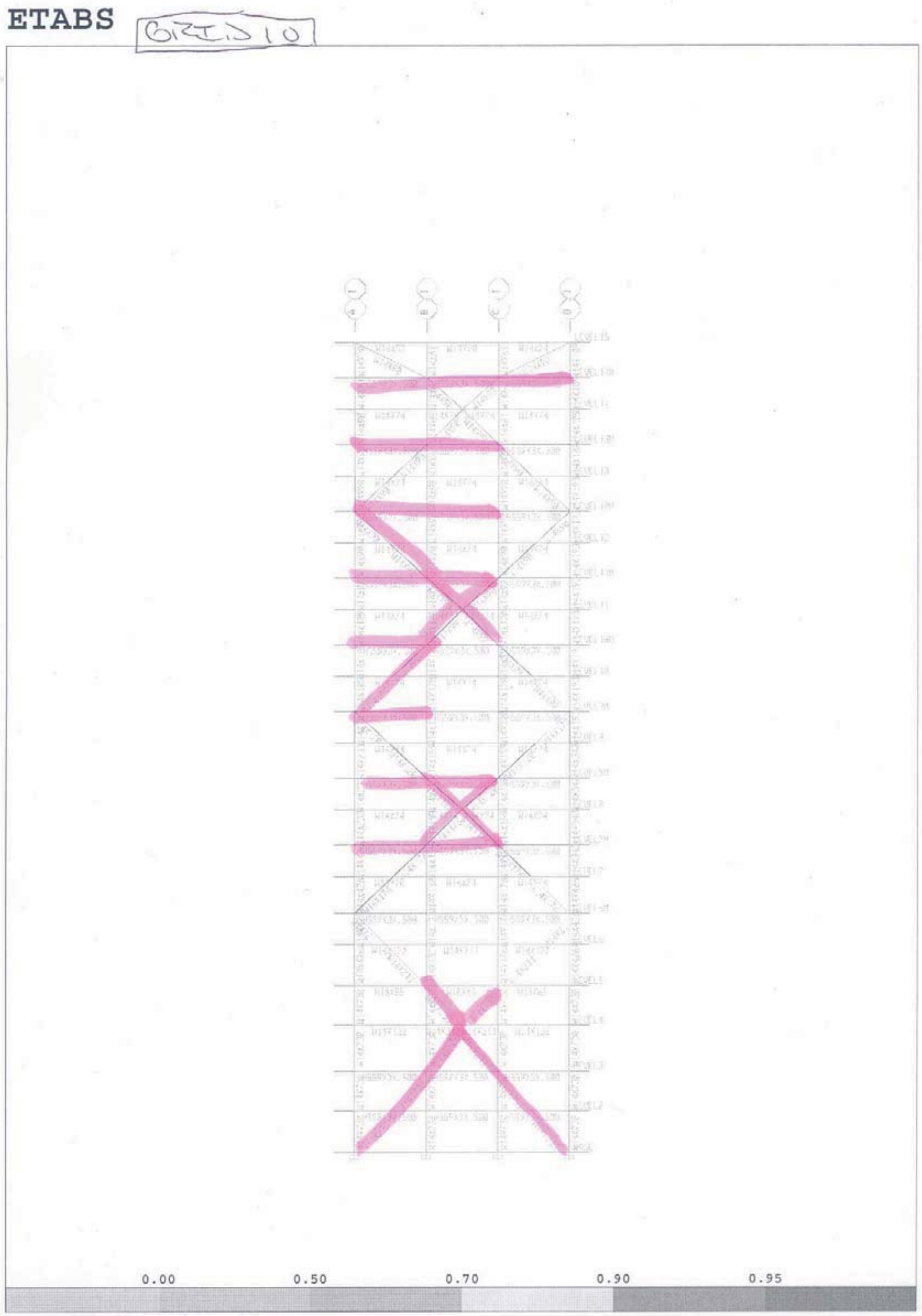
$-0.9(350) + 1.6(450) = 405^k \leq \phi_t P_n$ → OKAY

FOS ≥ 1.5 → OKAY

Analysis and redesign of Grid 10 followed similarly to Grids 1 & 4.



Capacity check of Grid 10 is shown below. Highlighted members did not meet capacity demands and were redesigned once again.



ETABS v9.5.0 - File: Redesign_Model - February 13,2010 15:22
Elevation View - 1 Steel Design Sections (AISC-LRFD93) - Kip-in Units

Hand calculated checks of Grid 10 redesign is shown below.

GRID CHECKS | GRID 10 | 2/11/10 | 1

CHECK 1.2D + 1.6W + 1.0L COLUMNS:

LEVEL 5 EXTERIOR COLUMN:

$1.2(350^k) + 1.6(3200^k) + 1.0(350^k) = 5900^k$

- ASSUME LIVE LOAD IS EQUAL TO DL ON COLUMN

$5900 \le \phi_c P_n$ COLUMN IS W14X730
LENGTH 12^{FT}

$\phi_c P_n = 9030^k \rightarrow$ (OKAY!)

FACTOR OF SAFETY:

$\frac{9030}{5900} = 1.53 > 1.5$ (OKAY)

CHECK 0.9D + 1.6L

LEVEL 5 COLUMN

$1.6(3300^k) - 0.9(350) = 4965^k$ (TENSION)
↑
TENSION

$\phi_t P_n = 9680$ W14X730

$4965 \le \phi_t P_n \rightarrow$ (OKAY!)

FACTOR OF SAFETY:

9685/4965 = 1.95 > 1.5 (OKAY)

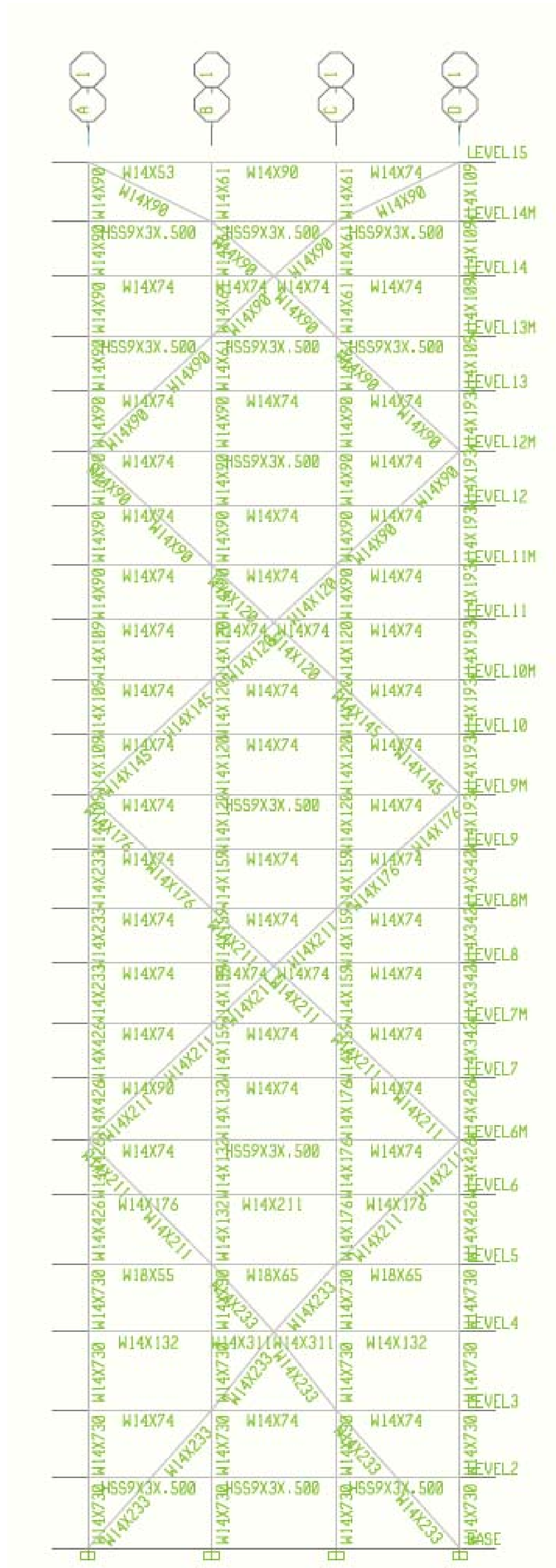
Finalized Member Sizes:

The following pages provide images of all the participating grids of the redesigned lateral system. These images provide finalized member sizes for each grid. Please note that these member sizes were determined through a repetitive analysis process, which is explained in the following paragraph.

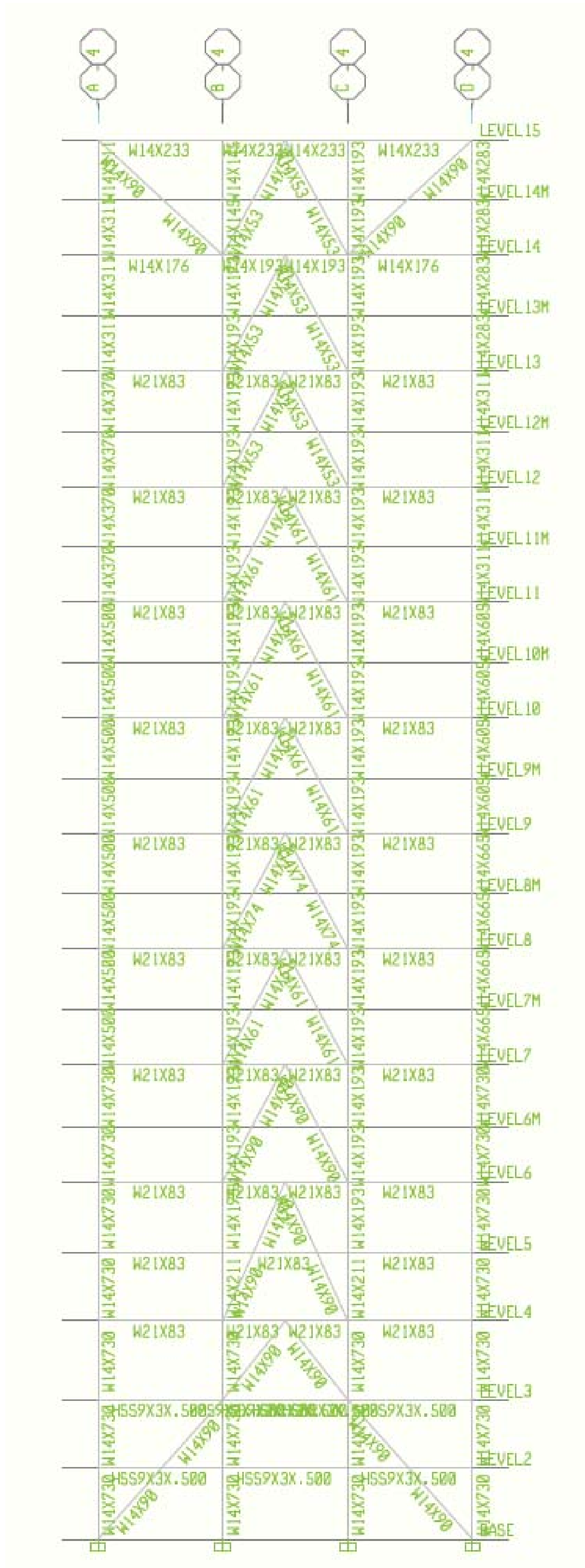
This process utilized ETABS software to analyze each grid under its governing wind case. Forces and stresses were found using the calculated wind forces and ETABS analysis. From these forces and stresses, member sizes could be chosen appropriately. When several member sizes were designed, the stiffness of a participating grid would change relative to the entire lateral system. This would cause a redistribution of lateral forces to each grid. This is why the lateral system was designed using a repetitive process, until distribution of lateral forces to grids remained relatively constant.

The finalized grid designs of the lateral system were obtained only after each passed drift, story drift, and strength requirements.

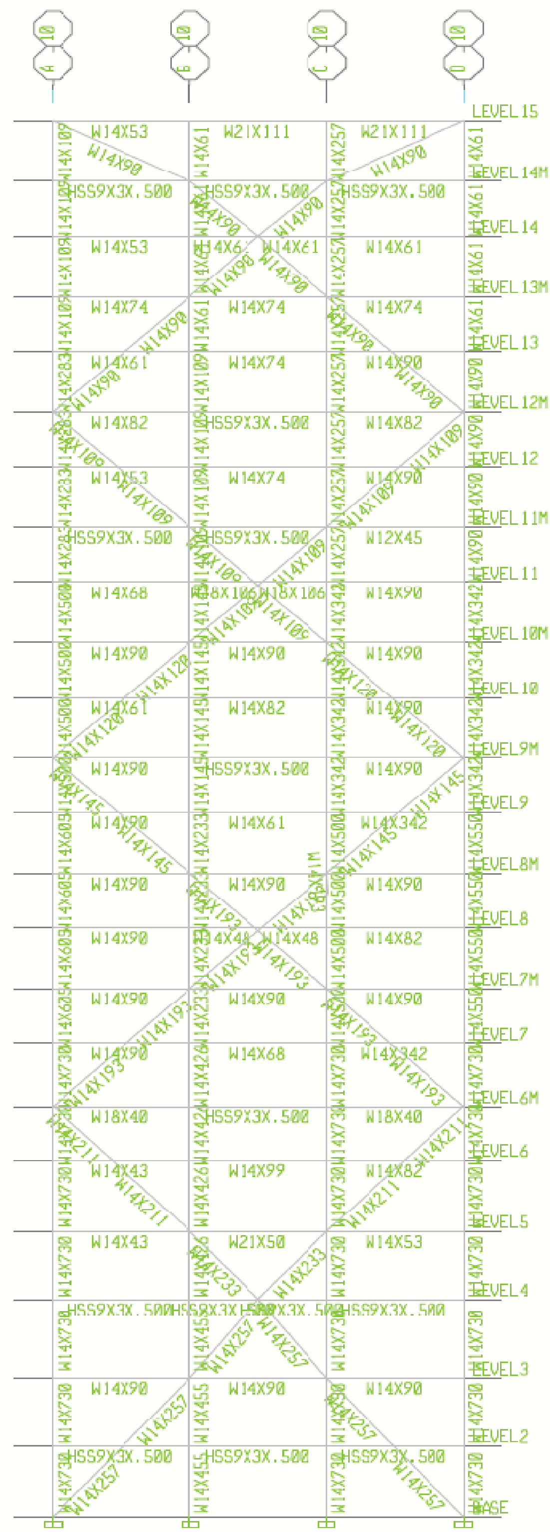
Grid 1 – Finalized Member Sizes



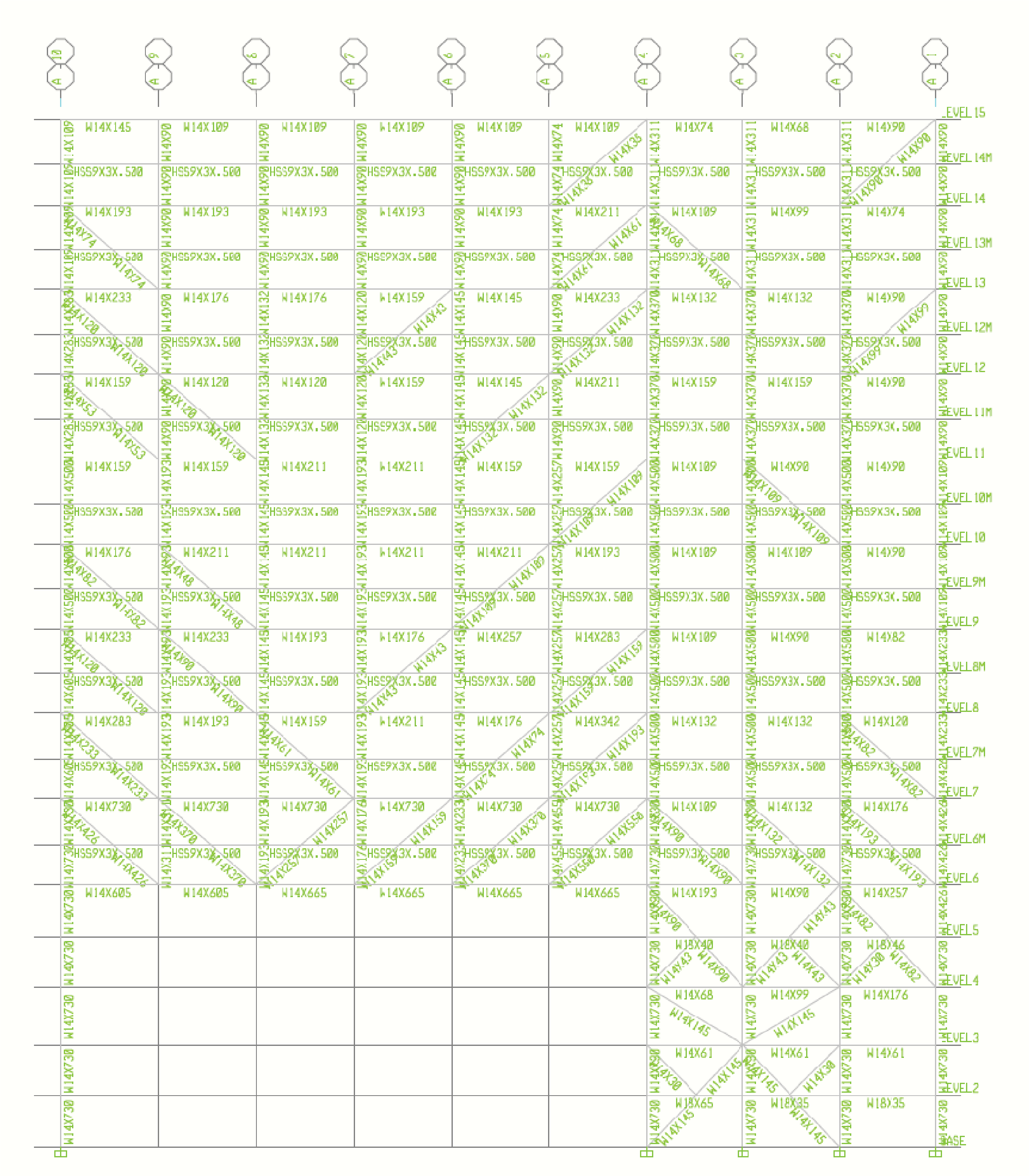
Grid 4 – Finalized Member Sizes



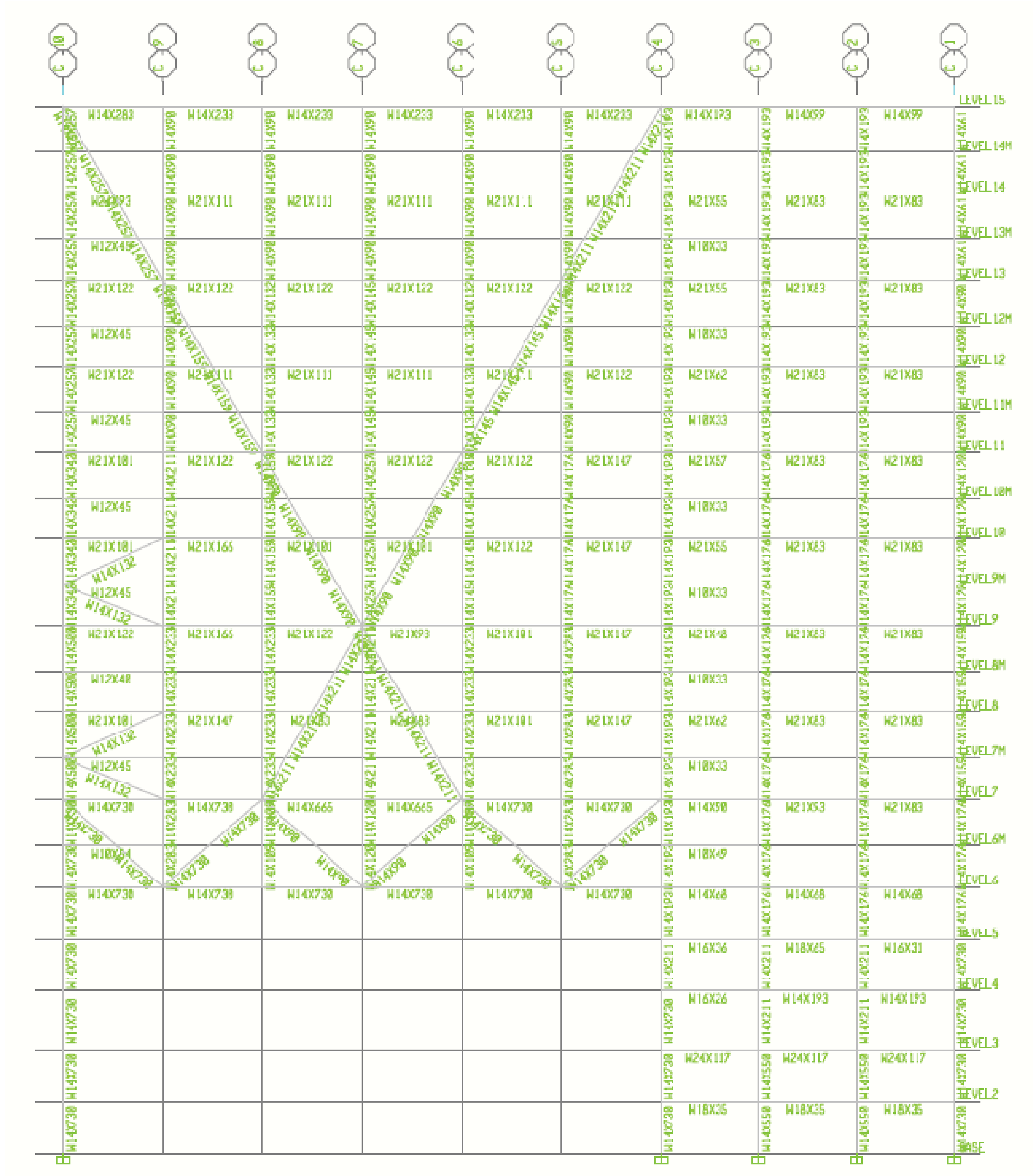
Grid 10 – Finalized Member Sizes



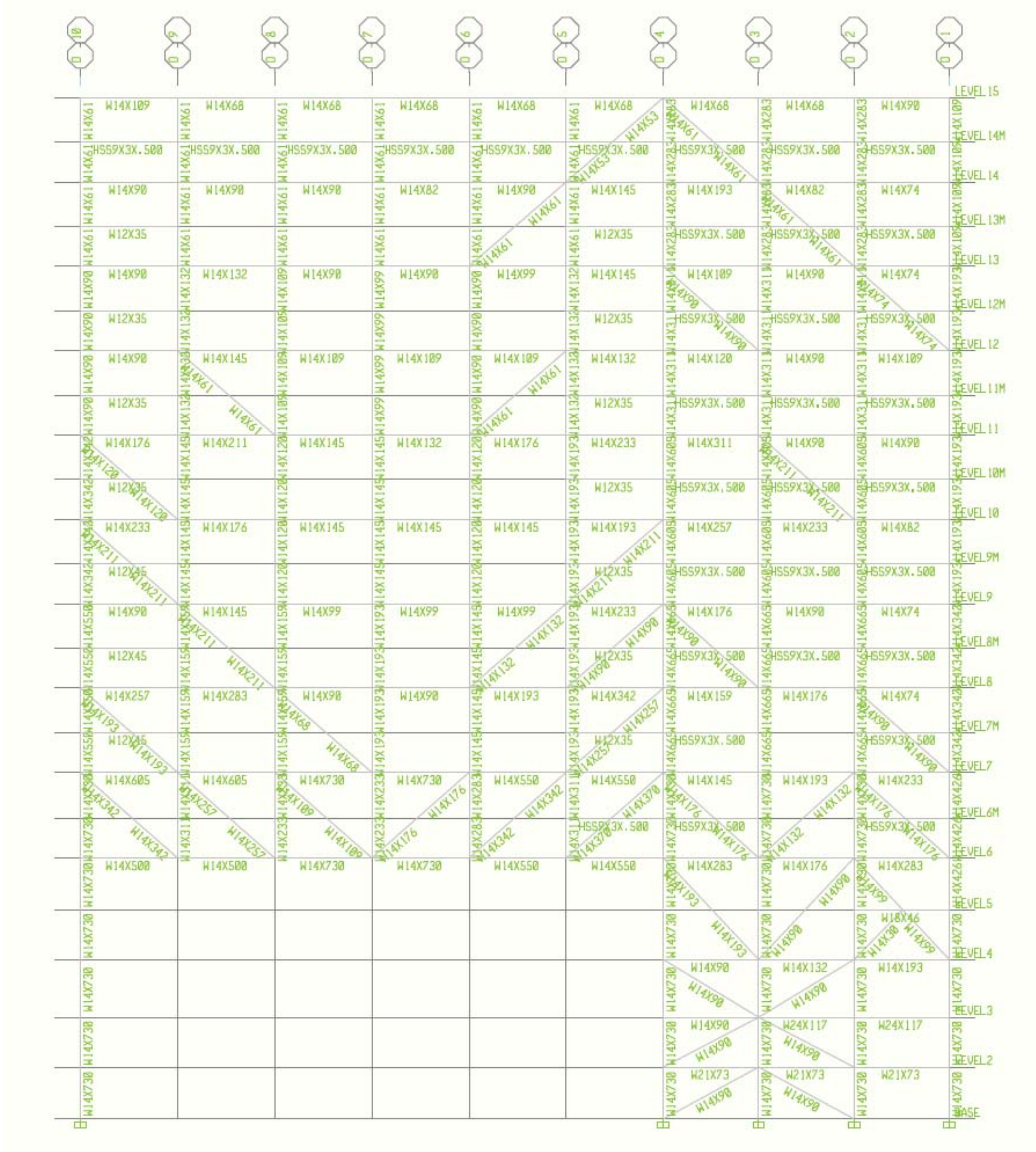
Grid A – Finalized Member Sizes



Grid C – Finalized Member Sizes



Grid D – Finalized Member Sizes



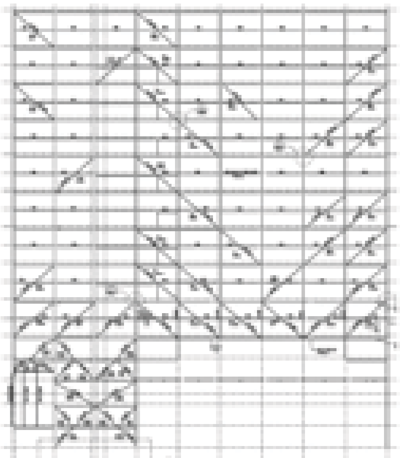
Appendix B

Existing Plans, Elevations, & Sections

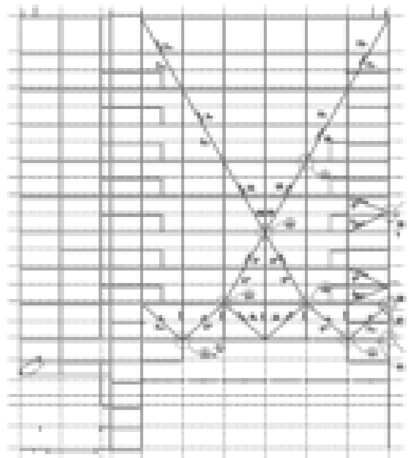
Columbia University Northwest Science Building

Broadway & 120th Street, New York, NY

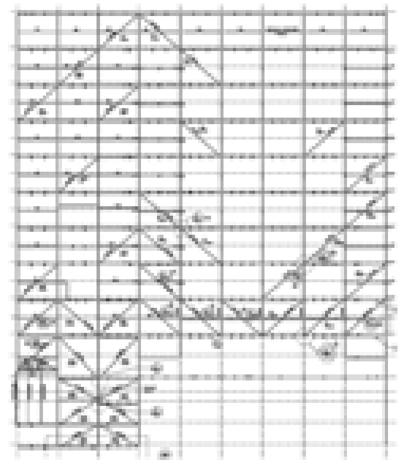
Lateral System Frame Elevations



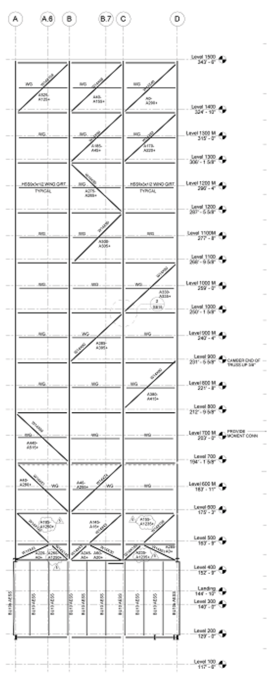
Grid A



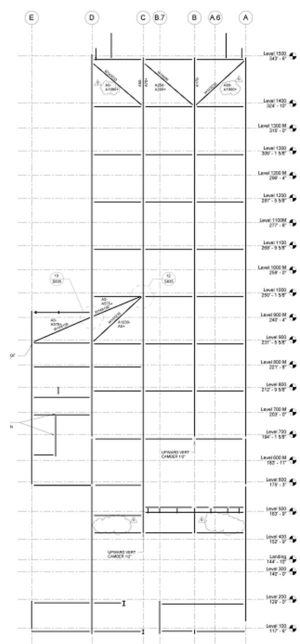
Grid C



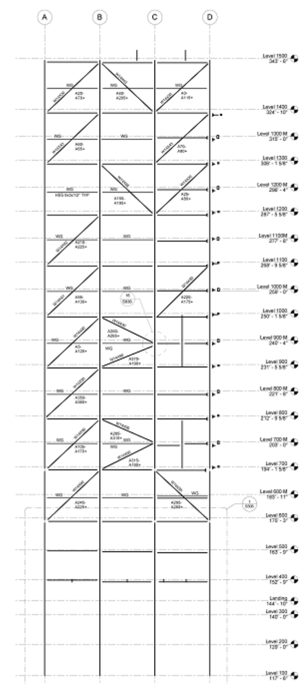
Grid D



GRID 1

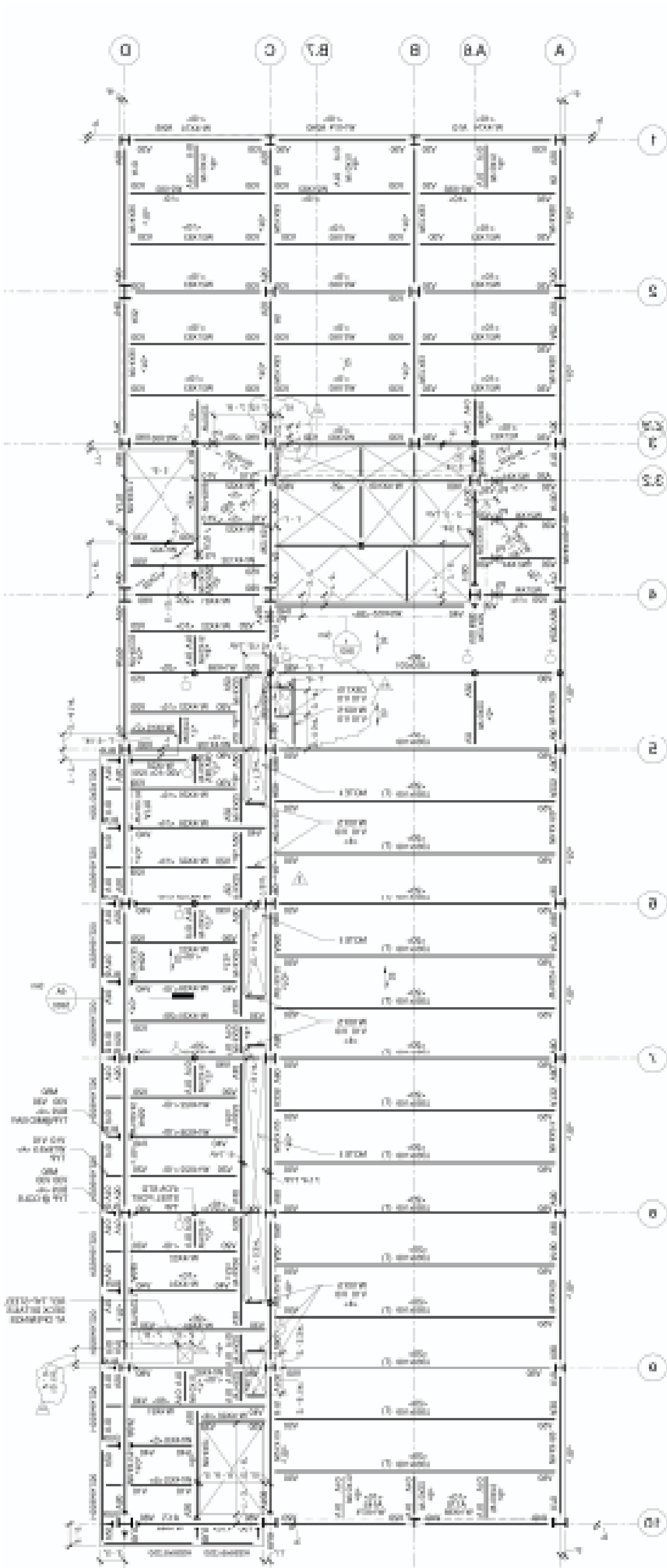


GRIDS 2-4

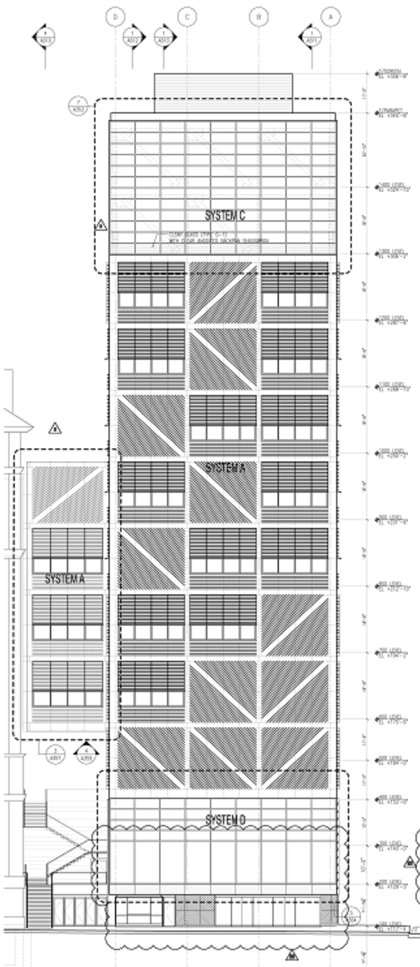


GRID 10

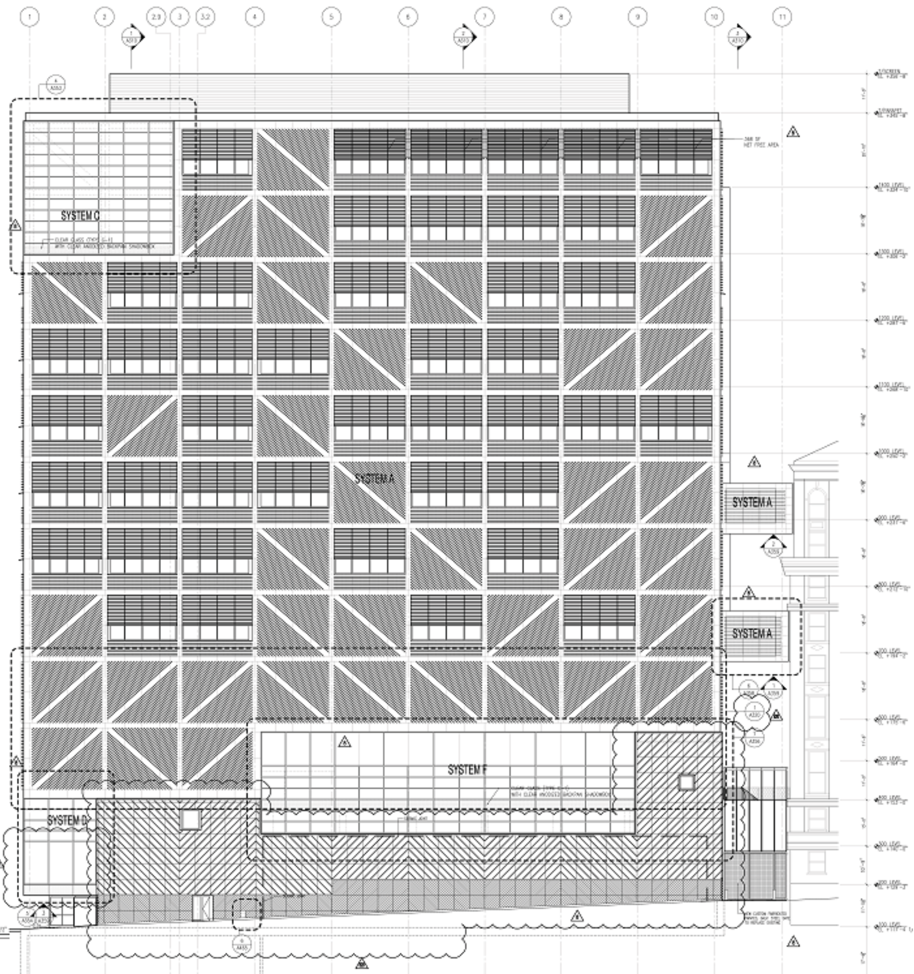
Typical Floor Plan



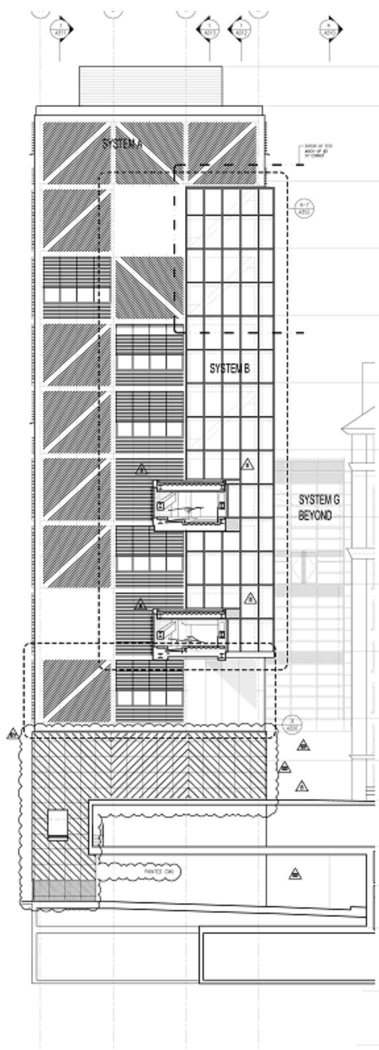
North Building Elevation



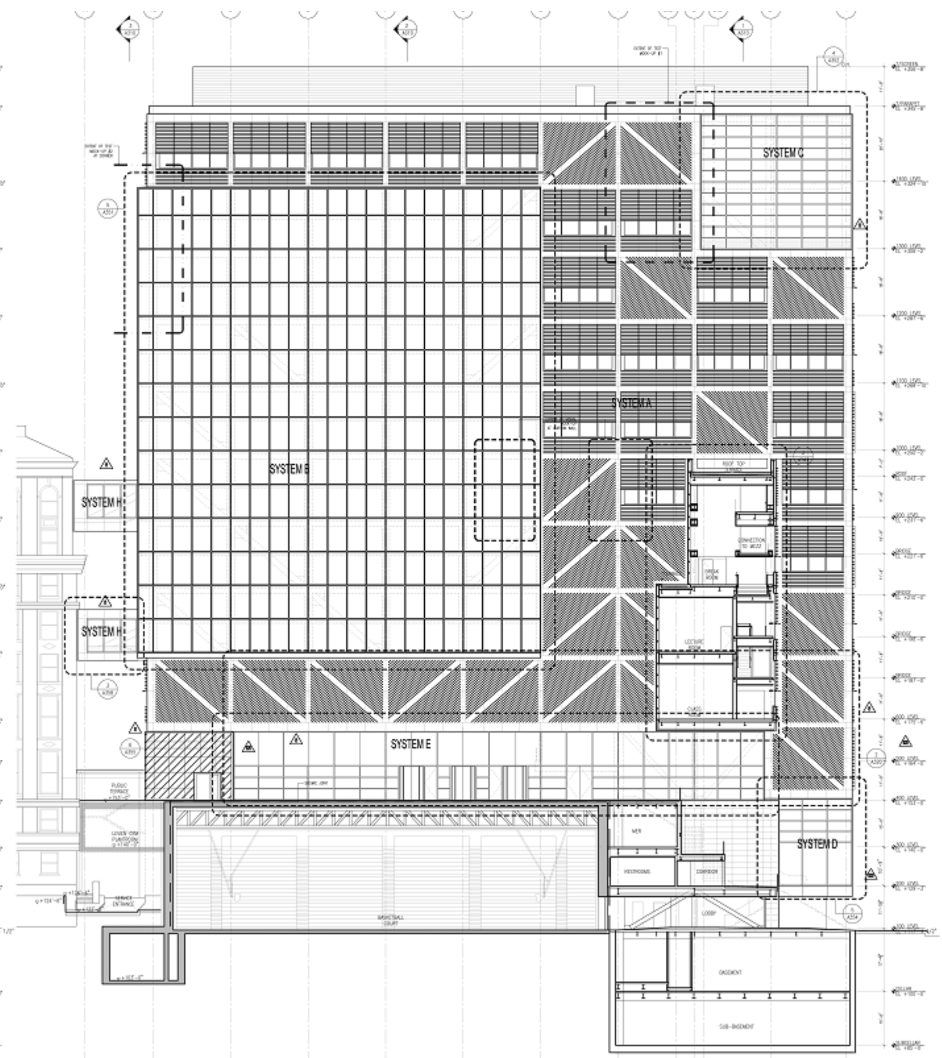
West Building Elevation



South *Building Elevation*

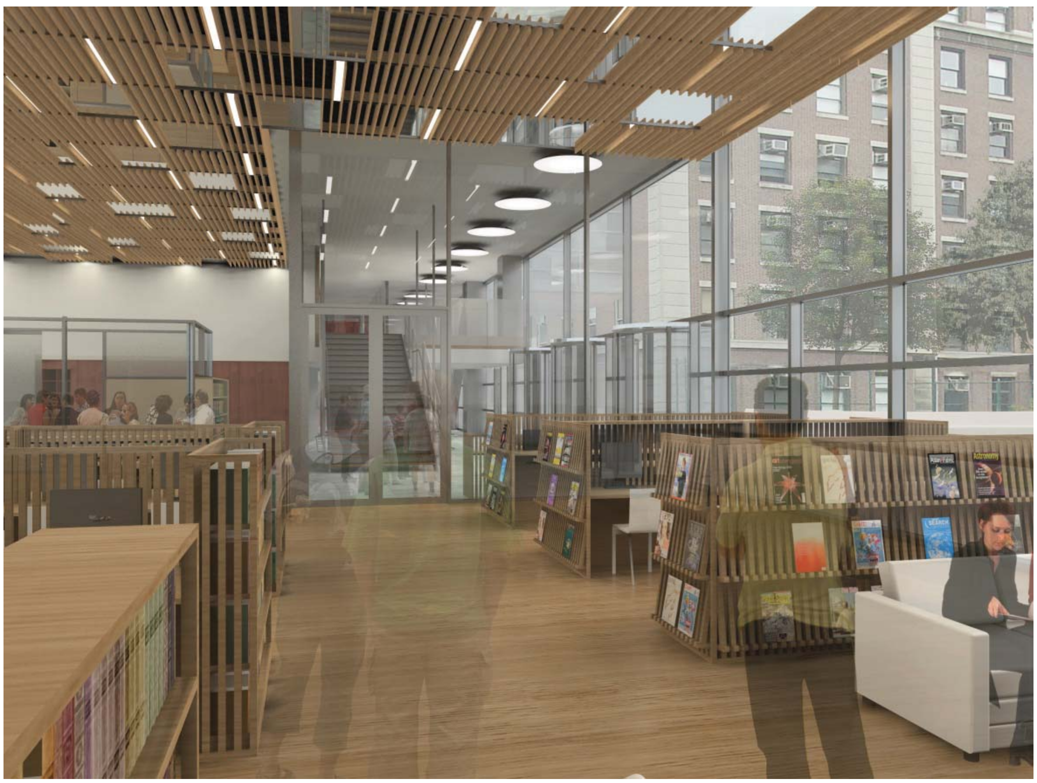


East Building Elevation



Appendix C

Cost Analyses Calculations & Data



Columbia University Northwest Science Building

Broadway & 120th Street, New York, NY

The following two pages provide a cost analysis for the Building Enclosure Breadth's Study. This study was able to reduce the insulation layer of the building enclosure from 4" to 2.5".

RS MEANS 1

NEW YORK, NY

INSULATION → 4" FOAM GLASS

BARE MATERIAL → \$0.50 FOR 4" / PER SF

SQUARE FT OF CURTAIN WALL ON BLD:

- WEST ELEVATION:
  - GROSS → 194 × 226 = 43,844 FT²
  - GLAZING → 30(40) + (20)(100) = 3,200 FT²
  - A_NET = 40,600 FT²
- NORTH ELEVATION:
  - GROSS → 226 × 84 = 18984 FT²
  - GLAZING → 60(45) + 60(30) = 4,500 FT²
  - A_NET = 14,400 FT²
- SOUTH ELEVATION:
  - GROSS = 18984 FT²
  - GLAZING → 23(105) = 2415 FT²
  - A_NET = 16,500 FT²
- EAST ELEVATION:
  - GROSS = 43,844 FT²
  - GLAZING → 105(105) = 11,025 FT²
  - A_NET = 32,800 FT²

A TOTAL CURTAIN WALL = 104,300 FT²

RS MEANS 2

NEW YORK, NY

4" FOAMGLASS INSUL. $\frac{\$3.88}{SQFT} \cdot \frac{104{,}300\ SQFT}{1}$

$= \$404{,}684 \longrightarrow \$404{,}700$ BARE MATERIAL

NYC LOCATION FACTOR

$(1.31)(404{,}700) = \$530{,}150$ (BASE BARE MATERIAL COST)

MIAMI, FL

2.5" FOAMGLASS INSUL. $\frac{\$2.62}{SQFT} \cdot \frac{104{,}300\ SQFT}{1}$

$= \$273{,}300$ BARE MATERIAL

MIAMI LOCATION FACTOR.

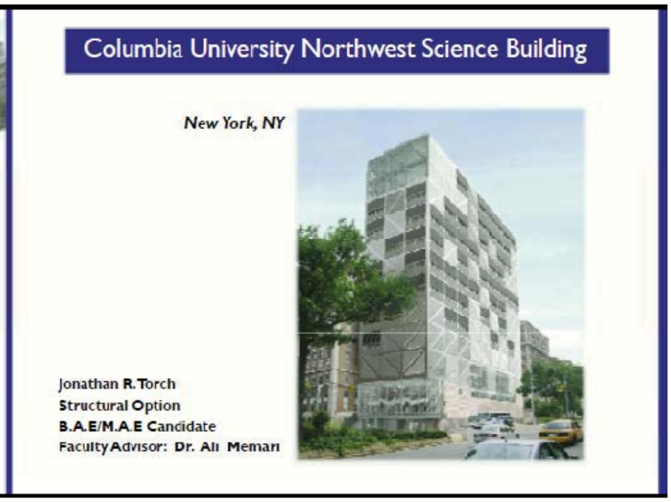
$(1.26)(273{,}200) = \$344{,}250$ (BASE BARE MATERIAL COST)

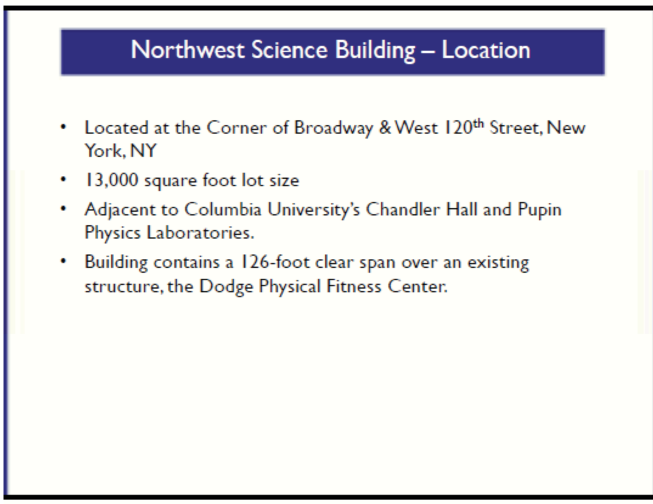
Appendix D

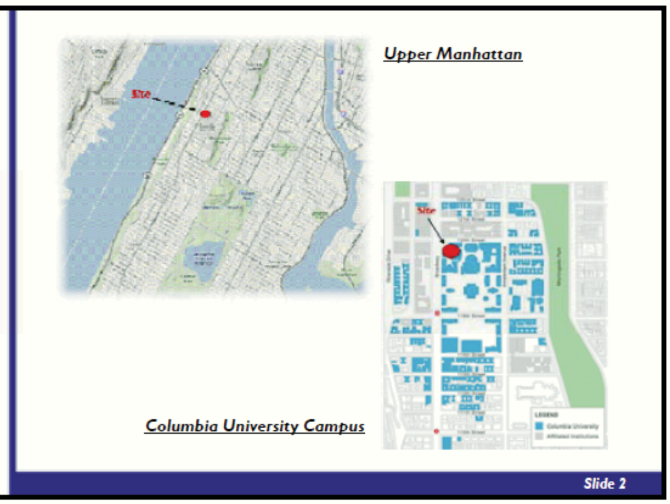
Thesis Presentation Slides

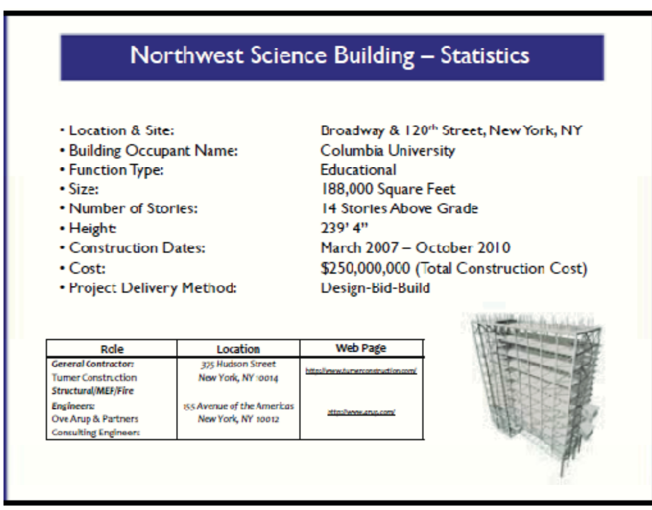
Columbia University Northwest Science Building

Broadway & 120th Street, New York, NY

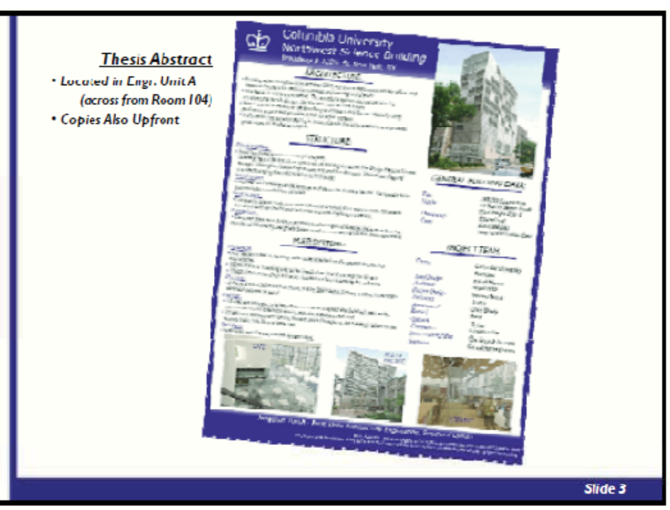








Role	Location	Web Page
General Contractor: Turner Construction	375 Hudson Street New York, NY 10014	http://www.turnerconstruction.com/
Structural/MEP/Fire Engineers: Ove Arup & Partners	155 Avenue of the Americas New York, NY 10012	http://www.arup.com/
Consulting Engineers:		



Northwest Science Building – Statistics

Architecture

- Building when completed in October 2010 will house:
  - Classrooms
  - Faculty Offices
  - Research Facilities for Chemistry, Biology, Engineering, and Physics

Structure

- Composite Steel Frame Design
  - Concrete Slab & Metal Decking Shear Studded to Beam Members
- All Columns are W14's
- Castellated Beams (Cellular Beams) are used for Larger Clear Spans of Laboratory Spaces.
- Lateral System Contains the following:
  - Horizontal HSS Shaped Girt Members
  - Concentric Braced Frames (Wide Flanges)

Thesis Abstract

- *Located in Engr. Unit A (across from Room 104)*
- *Copies Also Upfront*

Slide 4

Thesis Proposal

Structural Depth

- Calculation of Wind Forces for Miami, FL
- Analyze Existing Lateral System for Miami, FL
- Redesign and Analyze Lateral System

Building Enclosure Breadth

- Perform R-value, Condensation, and Air Leakage Analyses
- Modify Curtain Wall for Miami, FL

Architectural Breadth

- Research Miami, FL Architecture
- Redesign Exterior Architecture for Miami, FL

***Relocation of Building** – New York, NY to Miami, FL*

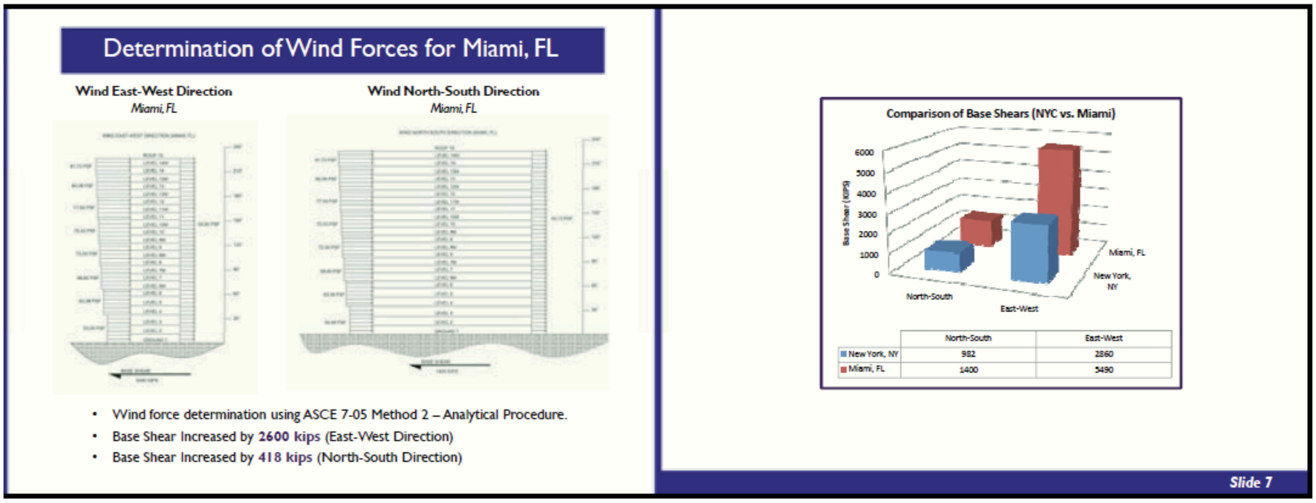
Slide 5

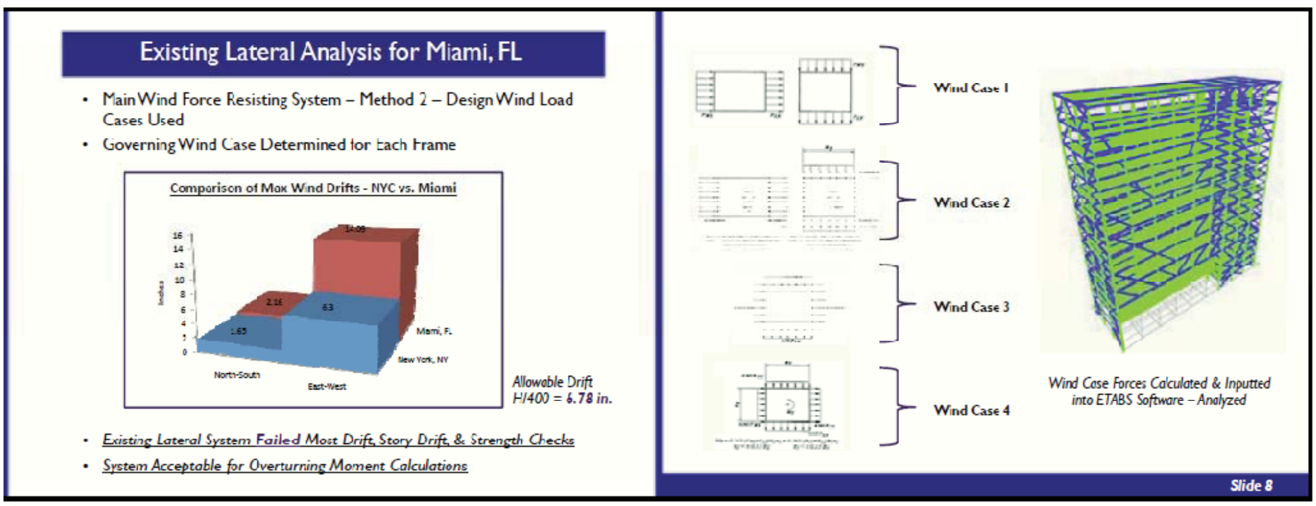
Thesis – Goals

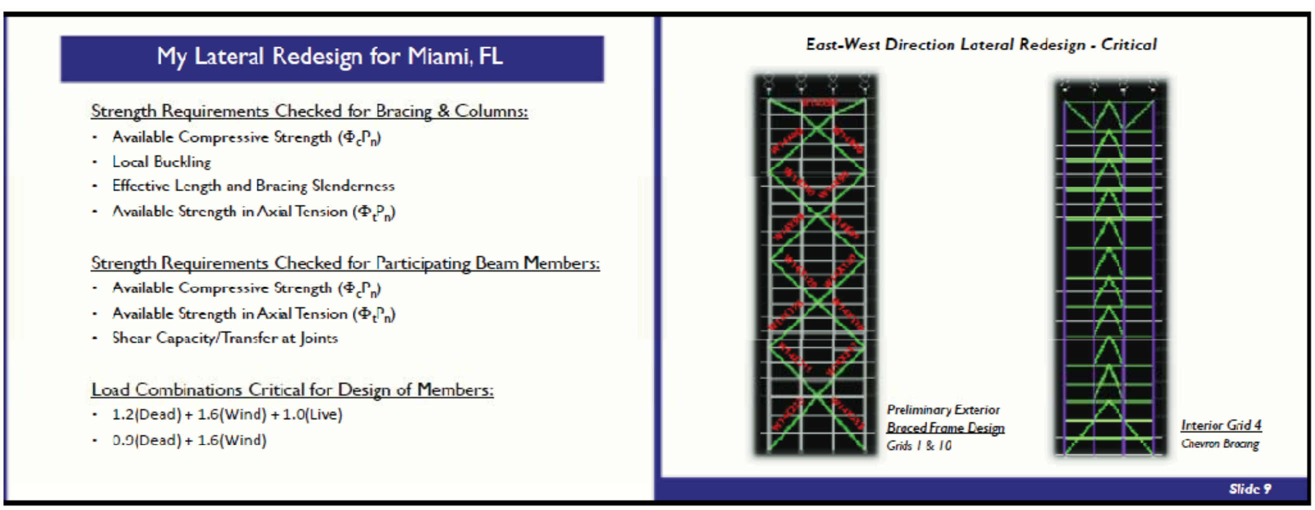
Goals – Based on Relocation of Building to Miami, FL

- Redesign building's lateral system to meet code requirements.
- Provide analysis of lateral system through means of ETABS and hand calculations.
- Research, analyze, and modify building enclosure appropriately for water condensation and heat transmission concerns.
- Redesign exterior architecture of building.

Slide 6


Determination of Wind Forces for Miami, FL
Wind East-West Direction
Miami, FL
Wind North-South Direction
Miami, FL
Wind force determination using ASCE 7-05 Method 2 – Analytical Procedure.
Base Shear Increased by 2600 kips (East-West Direction)
Base Shear Increased by 418 kips (North-South Direction)
Comparison of Base Shears (NYC vs. Miami)
Base Shear (KIPS)
6000
5000
4000
3000
2000
1000
0
North-South
East-West
Miami, FL
New York, NY
North-South | East-West
New York, NY | 982 | 2860
Miami, FL | 1400 | 5490
Slide 7

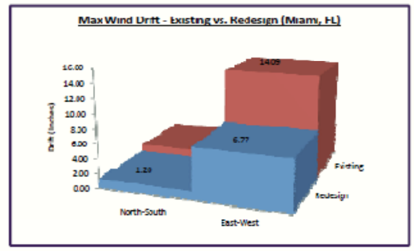

Existing Lateral Analysis for Miami, FL
Main Wind Force Resisting System – Method 2 – Design Wind Load Cases Used
Governing Wind Case Determined for Each Frame
Comparison of Max Wind Drifts - NYC vs. Miami
Inches
16
14
12
10
8
6
4
2
0
14.05
2.16
6.3
1.65
North-South
East-West
Miami, FL
New York, NY
Allowable Drift
H/400 = 6.78 in.
Existing Lateral System Failed Most Drift, Story Drift, & Strength Checks
System Acceptable for Overturning Moment Calculations
Wind Case 1
Wind Case 2
Wind Case 3
Wind Case 4
Wind Case Forces Calculated & Inputted into ETABS Software – Analyzed
Slide 8


My Lateral Redesign for Miami, FL
Strength Requirements Checked for Bracing & Columns:
Available Compressive Strength ($\Phi_c P_n$)
Local Buckling
Effective Length and Bracing Slenderness
Available Strength in Axial Tension ($\Phi_t P_n$)
Strength Requirements Checked for Participating Beam Members:
Available Compressive Strength ($\Phi_c P_n$)
Available Strength in Axial Tension ($\Phi_t P_n$)
Shear Capacity/Transfer at Joints
Load Combinations Critical for Design of Members:
1.2(Dead) + 1.6(Wind) + 1.0(Live)
0.9(Dead) + 1.6(Wind)
East-West Direction Lateral Redesign - Critical
Preliminary Exterior
Braced Frame Design
Grids 1 & 10
Interior Grid 4
Chevron Bracing
Slide 9

My Lateral Redesign for Miami, FL

- Existing Building Drift (Miami, FL) 14.09 Inches *(East West Direction)*
- Redesigned Building Drift (Miami, FL) – **6.77 Inches** *(East-West Direction)*
- Existing Building Drift (Miami, FL) – **2.16 Inches** *(North-South Direction)*
- Redesigned Building Drift (Miami, FL) – **1.20 Inches** *(North-South Direction)*
- North-South Direction Lateral System Redesign
  - Not as critical as East-West Direction
  - Larger member sections provided where needed. (small occurrence)

- ***Redesigned Lateral System Meets Drift, Story Drift, & Strength Requirements***
- ***Redesign Acceptable for Overturning Moment Calculations***



Allowable Drift
H/400 = 6.78 in.

Slide 10

My Lateral Redesign for Miami, FL

Lateral Steel Tonage:

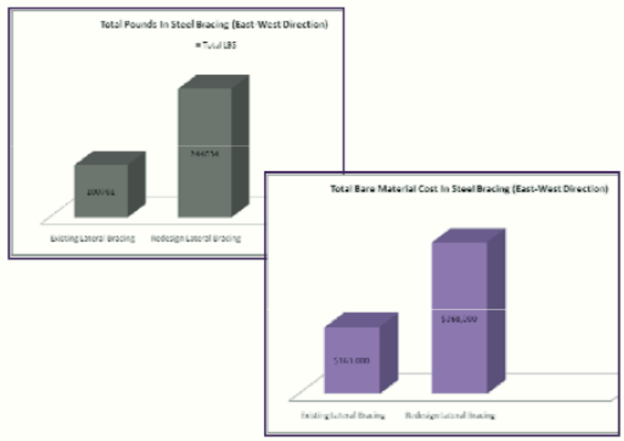
- Existing Lateral Bracing – **50.38 Tons** *(East-West Direction)*
- Redesigned Lateral Bracing– **122.32 Tons** *(East-West Direction)*

*Increase of **72 Tons***

Bare Material Costs:

- Existing Lateral Bracing – **$163,000** *(East-West Direction)*
- Redesigned Lateral Bracing– **$368,000** *(East-West Direction)*

*Increase of **$205,000***



Slide 11

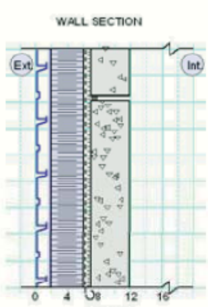
Building Enclosure Breadth

Building Enclosure Breadth Goals

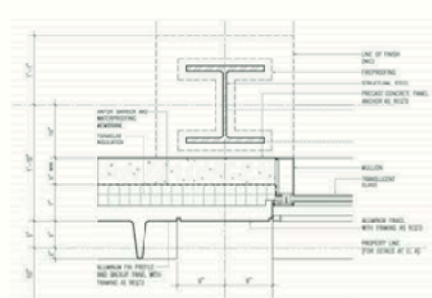
- Perform R-value, condensation, and air leakage analyses of curtain wall system for Miami, FL.
- Design for ASHRAE climate recommendations.
- Perform bare material cost analysis

Wall Section

- Aluminum Cladding
- Cavity (1/2")
- Foamglass Insulation
- Vapor & Air Barriers
- 5 Inch Precast Face Seal



Existing Building Enclosure System - Detail



Slide 12

Building Enclosure Breadth

R-Value Analysis

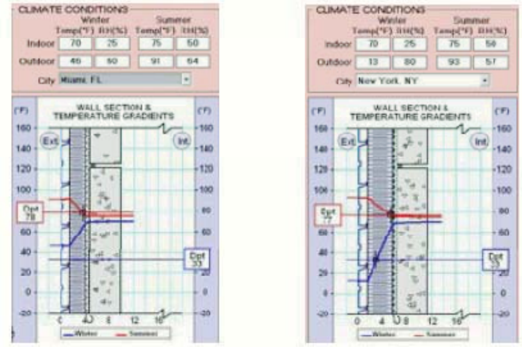
- Decrease in insulation layer (due to Miami's warmer climate)
- R-Value of Existing Wall System (21.23)
- R Value of Redesign Wall System (13.53)

Condensation Analysis

- Decrease in insulation layer checked for condensation concerns.
- Dew points occur on outside of water vapor barrier – ***ACCEPTABLE***

Redesign Wall Section
2.5" Rigid Insulation

Existing Wall Section
4" Rigid Insulation



Building Enclosure Analysis and Images above made possible with I I.A.M. Toolbox Software

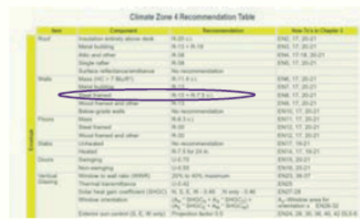
Slide 13

Building Enclosure Breadth

ASHRAE R-Value Recommendations

- Climate Zone 4 (New York, NY)
  - Walls R-Value of 22.5
- Climate Zone 1 (Miami, FL)
  - Walls R-Value of 13.5

- R-Value Provided in Wall Redesign is 13.53 - ***ACCEPTABLE***



ASHRAE Climate Zone 4
New York, NY

ASHRAE Climate Zone 1
Miami, FL

Slide 14

Building Enclosure Breadth

Air Leakage Analysis – *(New York, NY versus Miami, FL)*

- Small difference in energy loss due to air leakage during the summer.
- Large difference in energy loss due to air leakage during the winter.
- 184,000,000 BTUs/Year Difference (New York, NY Greater Energy Loss)
- Equivalent too burning approximately 200,000 gallons of natural gas.
- Analysis supports reduction in insulation layer for Miami, FL.

Bare Material Cost Analysis – *(RS Means)*

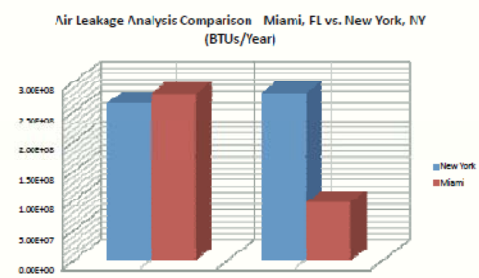
- **$185,900** bare material cost **savings** due to reduction in insulation layer.

Building Enclosure Breadth Conclusions:

- The existing wall system with a modification in the insulation layer (4" to 2.5" thick) will be acceptable for Miami, FL.

Air Leakage Analysis Comparison - Miami, FL vs. New York, NY
All Values in BTUs per Year

	Summer	Winter
New York	2.63E+08	2.80E+08
Miami	2.78E+08	9.56E+07
Difference	1.50E+07	1.84E+08

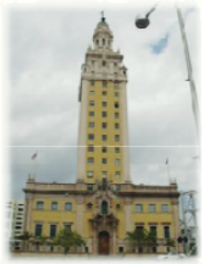


Slide 15

Architectural Breadth

Architectural Breadth Goal

- Redesign building exterior appearance to be representative of Miami architectural culture.
  - Mediterranean Revival Style
  - Art Deco Style
  - Streamline Modern Style



Freedom Tower – Miami, FL
Mediterranean Revival Style

Park Central Hotel – Miami, FL
Art Deco Style

US Bacardi Headquarters – Miami, FL
Streamline Modern Style

Slide 16

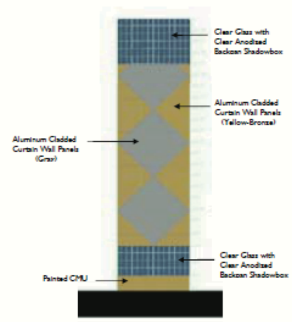
Architectural Breadth

Proposed Architecture – North Façade

- Aluminum Cladding Coloring (Yellow-Bronze & Gray)
  - Diamond Color Pattern Exemplifies Lateral Exterior Frame
  - Color Cladding Represents Art Deco Style Architecture

Park Central Hotel – Miami, FL
Art Deco Style

North Façade Redesign



Existing North Facade

Slide 17

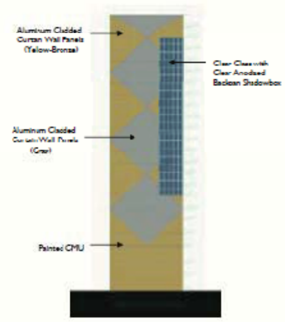
Architectural Breadth

Proposed Architecture – South Façade

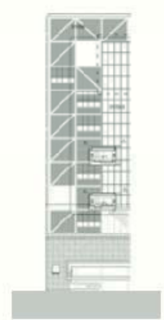
- Aluminum Cladding Coloring (Yellow-Bronze & Gray)
  - Diamond Color Pattern Exemplifies Lateral Exterior Frame
  - Color Cladding Represents Art Deco Style Architecture

Park Central Hotel – Miami, FL
Art Deco Style

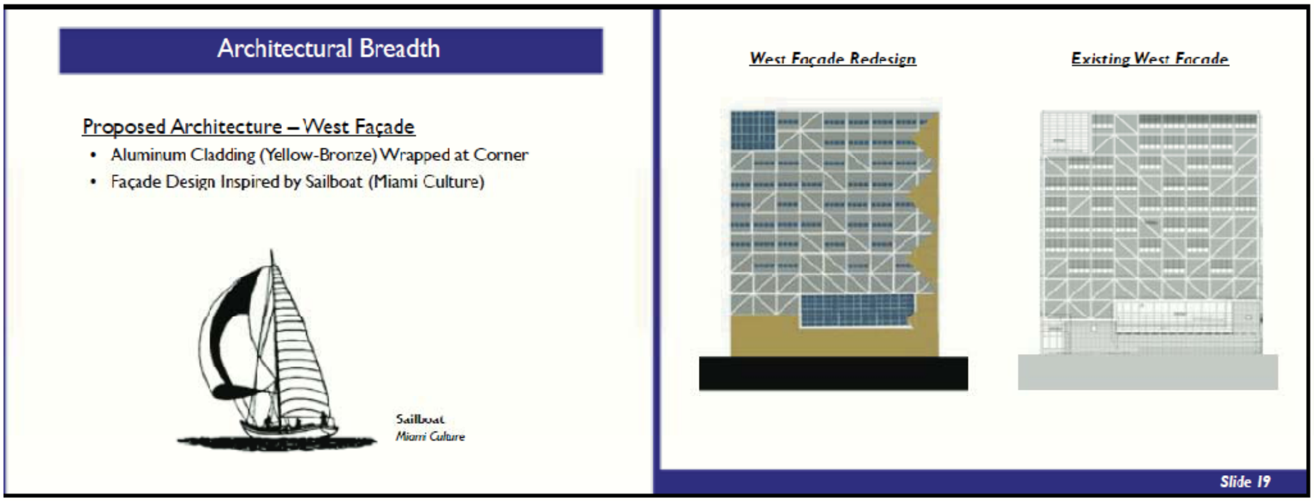
South Façade Redesign

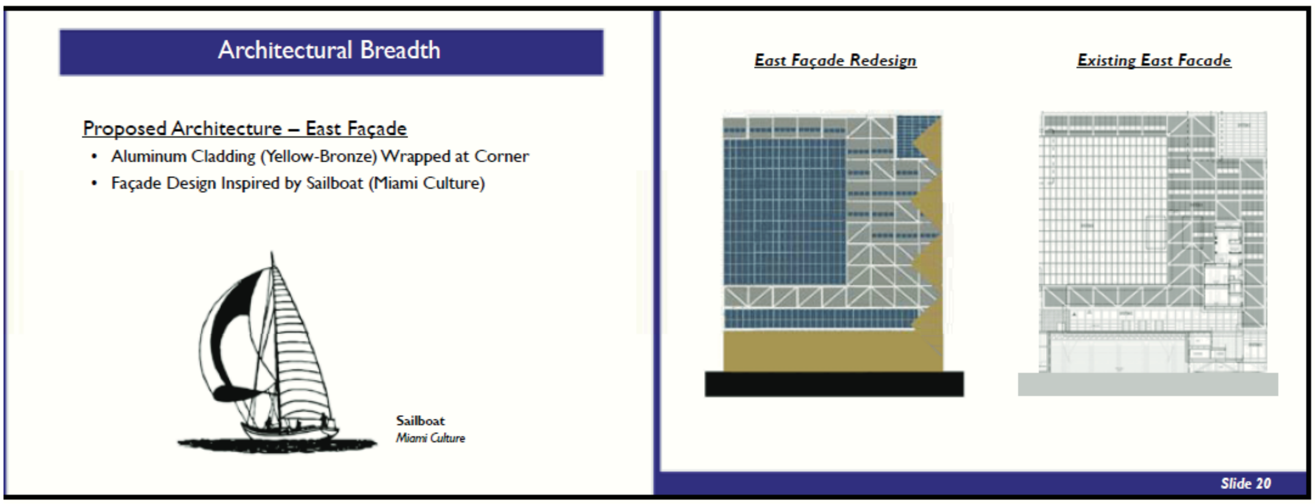


Existing South Facade

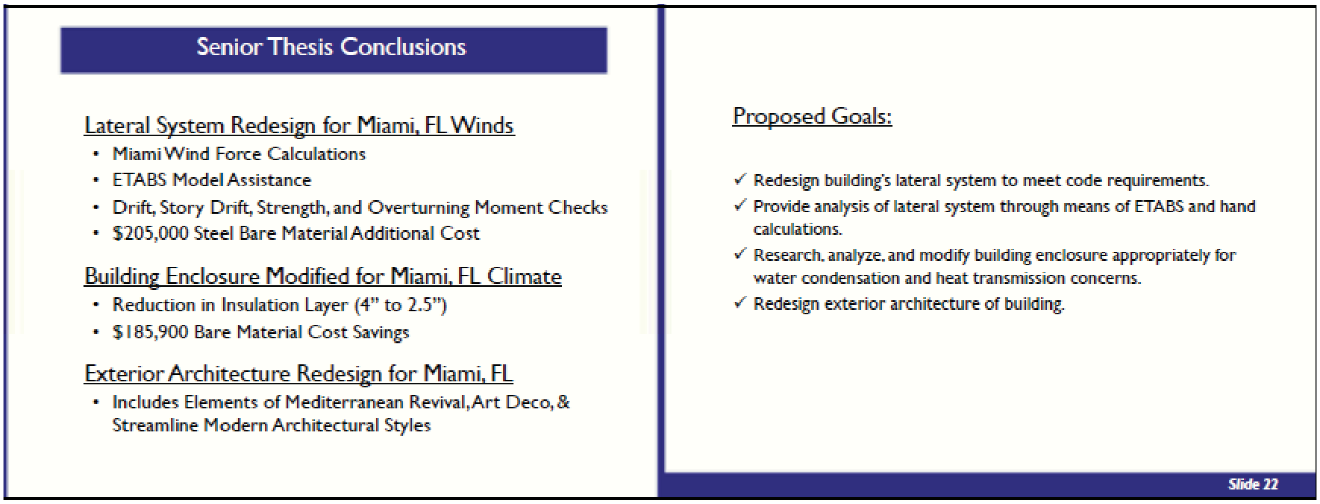


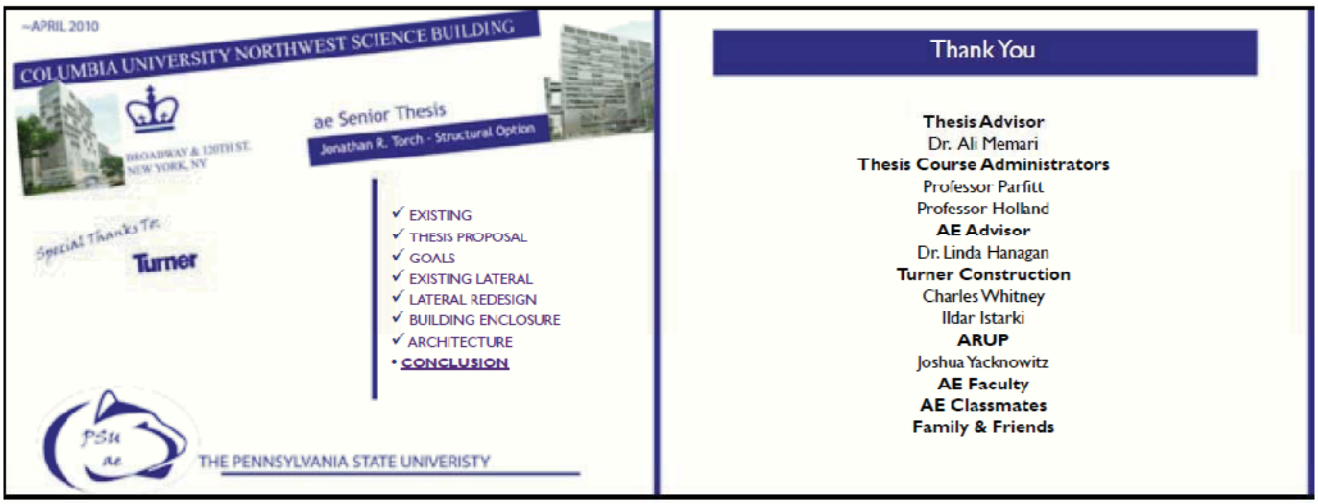
Slide 18


Architectural Breadth
Proposed Architecture – West Façade
• Aluminum Cladding (Yellow-Bronze) Wrapped at Corner
• Façade Design Inspired by Sailboat (Miami Culture)
Sailboat
Miami Culture
West Façade Redesign
Existing West Façade
Slide 19


Architectural Breadth
Proposed Architecture – East Façade
• Aluminum Cladding (Yellow-Bronze) Wrapped at Corner
• Façade Design Inspired by Sailboat (Miami Culture)
Sailboat
Miami Culture
East Façade Redesign
Existing East Façade
Slide 20


Architectural Breadth
Architectural Breadth Conclusions
• Design Incorporates Mix of Miami Modern Architectural Styles
o Mediterranean Revival
o Art Deco
o Streamline Modern
3D North-East Image
3D South-West Image
Slide 21


Senior Thesis Conclusions
Lateral System Redesign for Miami, FL Winds
• Miami Wind Force Calculations
• ETABS Model Assistance
• Drift, Story Drift, Strength, and Overturning Moment Checks
• $205,000 Steel Bare Material Additional Cost
Building Enclosure Modified for Miami, FL Climate
• Reduction in Insulation Layer (4" to 2.5")
• $185,900 Bare Material Cost Savings
Exterior Architecture Redesign for Miami, FL
• Includes Elements of Mediterranean Revival, Art Deco, & Streamline Modern Architectural Styles
Proposed Goals:
✓ Redesign building's lateral system to meet code requirements.
✓ Provide analysis of lateral system through means of ETABS and hand calculations.
✓ Research, analyze, and modify building enclosure appropriately for water condensation and heat transmission concerns.
✓ Redesign exterior architecture of building.
Slide 22


~APRIL 2010
COLUMBIA UNIVERSITY NORTHWEST SCIENCE BUILDING
ae Senior Thesis
Jonathan R. Torch - Structural Option
BROADWAY & 120TH ST.
NEW YORK, NY
Special Thanks To:
Turner
✓ EXISTING
✓ THESIS PROPOSAL
✓ GOALS
✓ EXISTING LATERAL
✓ LATERAL REDESIGN
✓ BUILDING ENCLOSURE
✓ ARCHITECTURE
• CONCLUSION
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THE PENNSYLVANIA STATE UNIVERISTY
Thank You
Thesis Advisor
Dr. Ali Memari
Thesis Course Administrators
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Charles Whitney
Ildar Istarki
ARUP
Joshua Yacknowitz
AE Faculty
AE Classmates
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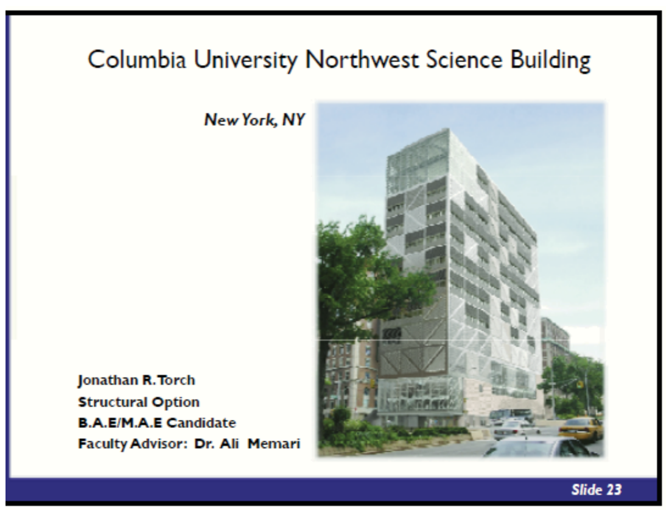
Columbia University Northwest Science Building
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Structural Option
B.A.E/M.A.E Candidate
Faculty Advisor: Dr. Ali Memari
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