Overlook Towers

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Technical Assignment 1

October 5, 2006

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Executive Summary:

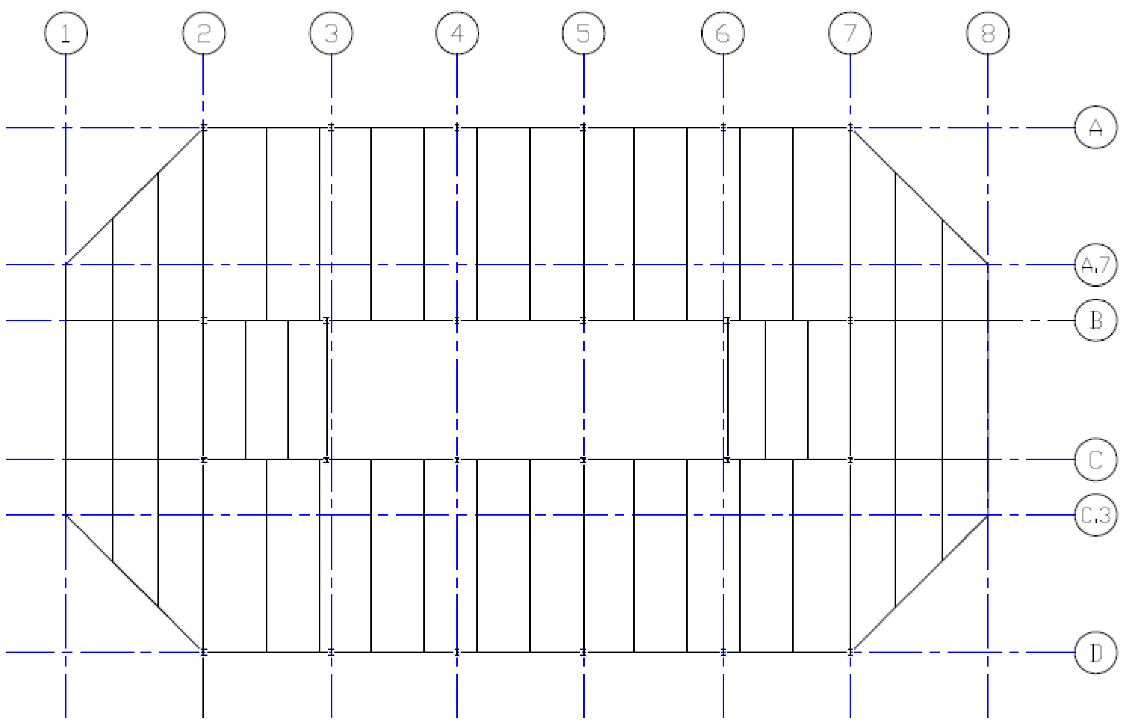
This assignment takes a look at the structural system of Overlook Towers. This nine story office building is one of three buildings in the complex. There are two nine story office buildings and a five story parking deck. The flooring is a lightweight concrete composite deck system which is supported by a steel structure. The exterior of the building is a curtain wall and precast concrete panel system. Wind loads are carried and transferred by a central lateral bracing system.

Wind, seismic and snow loads are calculated in the appendices. These calculations follow the building codes used for designing the structure, IBC 2000. Spot checks are also performed at various places in the building. Included in the spot check is a typical beam and girder check along with lateral loading due to wind forces on a column.

Structural System:

Overlook Towers is a nine story steel office building located just outside of Washington D.C. The superstructure is composed mostly of structural steel with composite deck and slab system. The general layout of each office building is eight bays spaced approximately thirty feet on center in the east-west direction. In the opposite direction are four bays spaced from about fourteen feet through thirty-three feet. The central core of the building is where the major lateral supporting frames are located. These frames contain the elevators and stairways. The roofing system is a series of flat steel trusses supporting a rooftop penthouse, which is where all of the major mechanical equipment is located. The overall dimensions of the building are about 220' by 125'.

Typical Framing Plan:



Building Codes:

The building loads are designed in accordance with the 2000 International Building Code with local adjustments.

Live Loads:	Flat Roof Snow Load – 21 psf
	Ground Snow Load – 30 psf
	Office Load – 100 psf
	Permanent Corridor – 100 psf
	Lobbies/stairs – 100 psf
	Mechanical – 125 psf
	Storage Space – 125 psf
Dead Loads:	Mechanical and Ceiling – 5 psf
	Single-ply roof – 11 psf

Foundation:

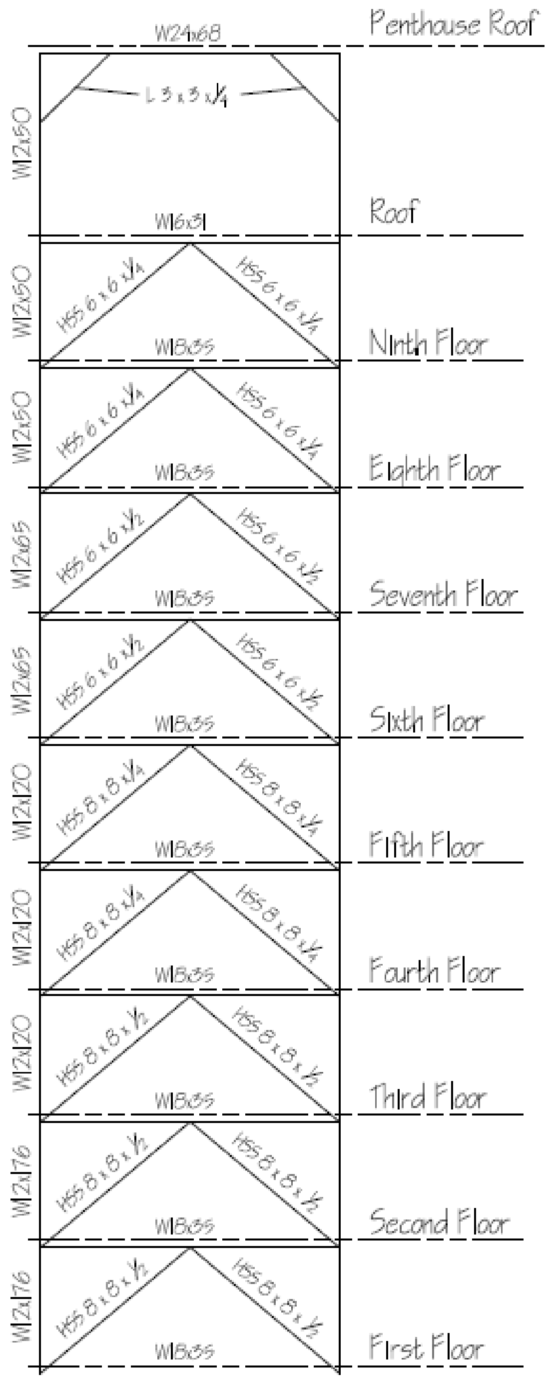
The foundation uses normal weight 3,000 psi concrete for the footings and pilasters and normal weight 4,000 psi concrete for the five inch thick slab on grade. The foundation has been designed for 20,000 psf at a bearing depth of 2'-6". Below the slab is a vapor barrier lying on top of a 4" layer of crushed stones. Expansion joints for the slab are to be at every column line. The steel reinforcing is grade 60 ASTM A 615 bars.

Elevated Floor System:

Elevated floor slabs are made of 6 ¼" thick structural lightweight concrete. The slab is reinforced with 6x6-W1.4 x W1.4 welded wire fabric. Working with the slab is an 18 gauge three inch deep composite steel deck. The slab is designed so that no shoring is required for construction. The concrete is required to have a design strength of 4000 psi after curing. Supporting the decks are ASTM 992 wide flange beams. The typical interior beam size is a W24x55 which has a span of 46'. The beams are spaced at a typical distance of 12'-6". The floors are designed to carry a load of 100 psf for the office space and is also designed for a concentrated load of 2000 pounds on a 2 ½ foot square area.

Columns:

The columns around the exterior of the building have an average spacing of 30 feet. The largest columns stand 40 feet. This size column is used up to the sixth floor where the height changes to about 25 feet. The columns are spliced at a typical height of three feet above the floor slab.



- 1 of 4 Interior Frames

Lateral System:

The lateral system of Overlook Towers is a series of braced frames located in the center of the building. Inside of the frames forms a core of the building where there are four elevator shafts, each leading to the ninth floor.

As you can see in the illustration to the right, the frames consist of W-shapes for the column support and HSS shapes are used for the lateral bracing. This layout is similar in all four of the frame types. Most of the differences from frame to frame is the size of the members.

Appendices:

A. Dead Load Calculations
B. Wind Calculations
C. Snow Load
D. Seismic Load
E. Spot Check

Appendix A – Dead Load

Floor Slab Weight: Lightweight concrete – 112 pcf x 3 ¼" slab = 31.1 psf
18 gauge steel decking – 4 psf
Mechanical & Ceiling – 5 psf
Allowance – 15 psf

Total: 55.1 psf → 60 psf dead load for floor slab alone.

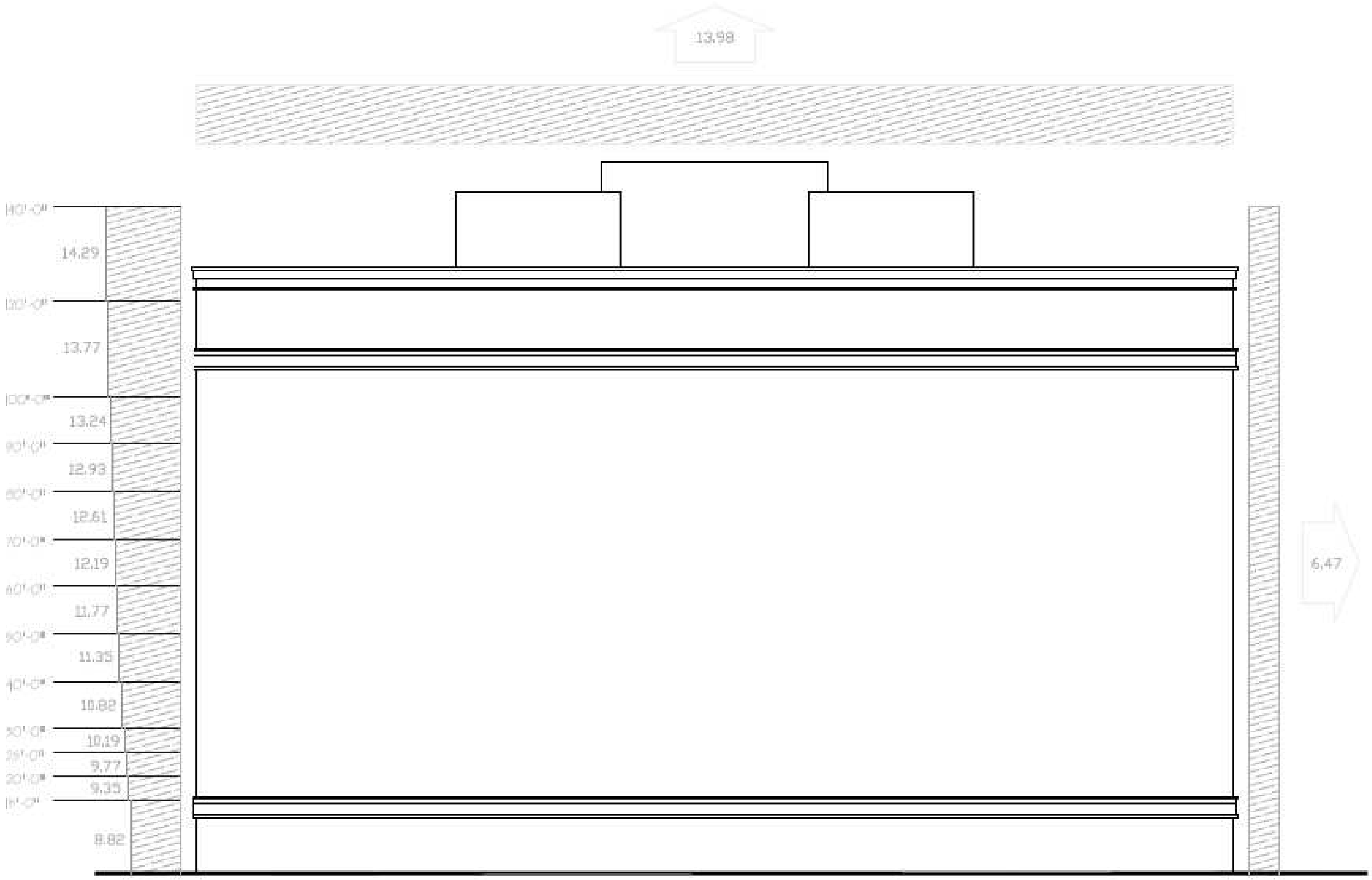
The following calculation takes into account the dead load for the structural system of the building along with some mechanical allowances. Items such as the mechanical equipment and lighting system were omitted because these weights are relatively small compared to the total weight of the building. Also the roof trusses were omitted for the fact that not enough information was available at this time.

Dead Load Calculations					
Second Floor					
Member	Weight (plf)	Length(ft)	Qty/fl.	Floors	**Total**
W21x44	44	30	8	1	**10.56 kip**
W21x44	44	44	4	1	**7.74 kip**
W24x55	55	46	19	1	**48.07 kip**
W24x55	55	30	8	1	**13.20 kip**
W18x35	35	30	25	1	**26.25 kip**
W24x62	62	46	4	1	**11.41 kip**
W18x40	40	30	4	1	**4.80 kip**
W24x68	68	45	4	1	**12.24 kip**
W10x15	15	9.5	4	1	**0.57 kip**
W12x14	14	8	4	1	**0.45 kip**
W21x50	50	32.5	4	1	**6.50 kip**
W16x26	26	13	4	1	**1.35 kip**
				SUM	**143.14 kip**
Floors 3 - 9					
Member	Weight (plf)	Length(ft)	Qty/fl.	Floors	**Total**
W21x44	44	30	10	7	**92.40 kip**
W24x55	55	46	26	7	**460.46 kip**
W24x55	55	30	25	7	**288.75 kip**
W18x35	35	30	14	7	**102.90 kip**
W18x40	40	30	2	7	**16.80 kip**
W16x26	26	13	4	7	**9.46 kip**
W12x14	14	8	4	7	**3.14 kip**
W10x15	15	7.75	4	7	**3.26 kip**
W24x68	68	45	4	7	**85.68 kip**
				SUM	**1,062.85 kip**
Floor Slab					
area(sf)	weight(psf)	Floors			
25000	70	8		**Total**	**14,000 kip**
Columns					
Member	Weight(plf)	Length (ft)	Qty.		**Total**
W12x58	58	40.5	4		**9 kip**
W12x65	65	40.5	4		**11 kip**
W12x96	96	40.5	4		**16 kip**
W12x106	106	40.5	4		**17 kip**
W12x87	87	40.5	8		**28 kip**
W12x136	136	40.5	1		**6 kip**
W12x40	40	27	4		**4 kip**
W12x50	50	27	4		**5 kip**
W12x65	65	27	7		**12 kip**
W12x53	53	27	8		**11 kip**
W12x87	87	27	1		**2 kip**
W12x40	40	24	24		**23 kip**
W12x65	65	37.5	1		**2 kip**
				SUM	**148 kip**
		Total Dead Load:			**15,354 kip**

Appendix B – Wind Load

Basic Wind Speed V = 90 mph Exposure B
Importance Factor I = 1.0

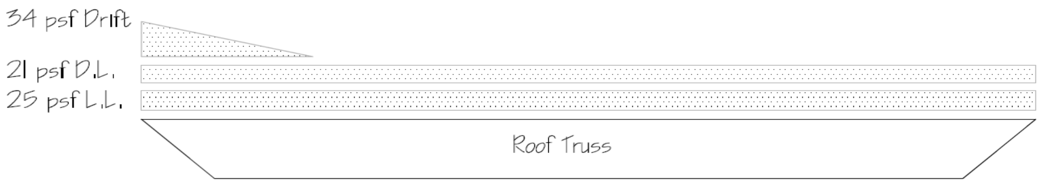
Wall Calculation					
Height	k	q	Windward	Leeward	Net Load
0-15	0.57	10.08	8.82	5.08	13.90
20	0.62	10.96	9.35	5.21	14.56
25	0.66	11.67	9.77	5.32	15.09
30	0.7	12.38	10.19	5.42	15.61
40	0.76	13.44	10.82	5.59	16.41
50	0.81	14.32	11.35	5.72	17.07
60	0.85	15.03	11.77	5.83	17.59
70	0.89	15.74	12.19	5.93	18.12
80	0.93	16.44	12.61	6.04	18.65
90	0.96	16.97	12.93	6.12	19.05
100	0.99	17.50	13.24	6.20	19.44
120	1.04	18.39	13.77	6.34	20.10
140	1.09	19.27	14.29	6.47	20.76



Appendix C – Snow Load

$p_f = 0.7(C_eC_tIp_g) = 0.7(30) = 21$ psf roof load

$C_e = 1.0$ $C_t = 1.0$ $I = 1.0$ $p_g = 30$ psf



Appendix D – Seismic Load

Section 1613.0 IBC 2000

$S_s = 0.20g$		Site Class:	C
$S_1 = 0.08g$		Seismic Use Group:	I
$S_{DS} = 0.16g$		Importance Factor:	1.0
$S_{D1} = 0.09g$		Design Category:	B

Calculations based on the equivalent lateral force method.

$$C_s = \frac{S_{DS}}{R/I} = \frac{0.160}{3.0/1.0} = 0.053$$

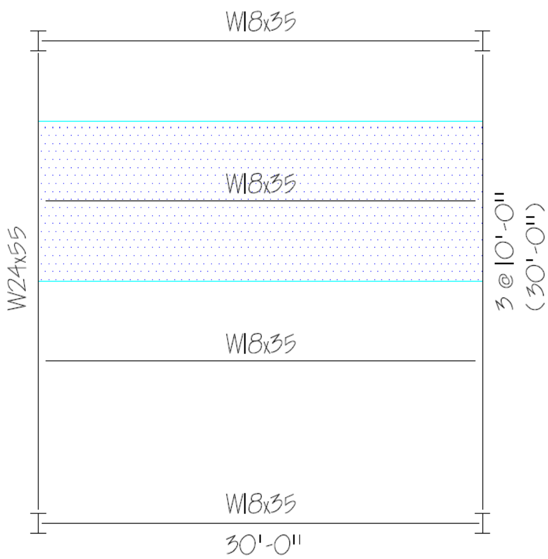
$$C_s > 0.044 S_{DS} I = 0.044(0.16)1.0 = 0.00704$$

$$C_s \le \frac{S_{D1}}{T(R/I)} = \frac{0.09}{0.864(3.0/1.0)} = 0.0347$$

$$\therefore C_s = 0.0347$$

$$V = C_s * W = 0.0347(15{,}354^k) = 533.1^k$$

Appendix E – Spot Checks



Typical Frame Check:

L.L. = 100 psf (office space)
D.L. = 60 psf

Beam: W18x35

$w_u = 1.6(100) + 1.2(60) = 232$ psf

$$M_u = \frac{.232(10)30^2}{8} = 261^{ft\text{-}k}$$

$$V_u = \frac{.232(10)30}{2} = 34.8^{k}$$

Girder: W24x55 (tributary width = 38')

$$M_u = \frac{.232(38)30^2}{8} = 992^{ft\text{-}k}$$

$$V_u = \frac{.232(38)30}{2} = 132^{k}$$

Composite Deck: 18 Ga. 6 ¼" Lightweight Concrete Steel Decking

w_{uL} = 120 psf
f_c' = 4000 psi

From United Steel Deck Catalog: w = 122.5 psf > 120 psf live load.
Max. unshored span – 13.26'

The composite decking is ok. The drawings call for no shoring and the maximum span is 12'-8 ¼", this is also allowable.