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110 Third Avenue
110 Third Avenue
New York, NY 10003
10/5/05

Structural Technical Report 1

Structural Concepts/Structural Existing Conditions Report

Executive Summary:

110 Third Avenue serves as a great addition to the New York skyline with twenty-one stories of residential condominiums. Totaling around 110,000 square feet of living and retail space, the building reaches 227'-6" above grade, with the highest occupied floor at 210'-6". The exterior façade is reminiscent of the repeating patterns found quite often in 1960's post-modern architecture. The spiraling balconies and tapered neck of the building alter the Roheian approach to box skyscrapers slightly to adjust for more modern tastes. The prime downtown location in the heart of Manhattan allows tenants to experience the very best of the city that never sleeps in their own private haven.

This report serves as an introduction to the basic systems present within 110 Third Avenue, the structural concepts behind its design, and the existing conditions of the area. The scope of this structural technical report includes a description of the physical conditions within 110 Third Avenue including information regarding design concepts and loading. It will give an overview of the general floor framing, structural slabs, lateral resisting system, foundation system, bracing elements, expansion joints, and support for the façade of the building. A preliminary analysis of the structural elements of 110 Third Avenue is also included within the report. These analyses include wind and seismic calculations accompanied by schematics, and a spot-check of typical floor framing elements in gravity load areas.

The analyses performed within this report demonstrate proper sizing of the structural system for both gravity loads and lateral loads. One concern, however, did arise regarding the reinforcement in the slab system. The actual design has slightly less reinforcement, but this may be due to different analysis methods. In all lateral load cases, wind force controlled over seismic. Please see the full report and appendix for the full overview analysis of 110 Third Avenue.

1.1 Scope

The scope of this structural technical report includes a description of the physical conditions within 110 Third Avenue including information regarding design concepts and loading. It will give an overview of the general floor framing, structural slabs, lateral resisting system, foundation system, bracing elements, expansion joints, and support for the façade of the building. A preliminary analysis of the structural elements of 110 Third Avenue is also included within the report. These analyses include wind and seismic calculations accompanied by schematics, and a spot-check of typical floor framing elements in gravity load areas.

1.2 Introduction

110 Third Avenue serves as a great addition to the New York skyline with twenty-one stories of residential condominiums. Totaling around 110,000 square feet of living and retail space, the building reaches 227'-6" above grade, with the highest occupied floor at 210'-6". The exterior façade is reminiscent of the repeating patterns found quite often in 1960's post-modern architecture. The spiraling balconies and tapered neck of the building alter the Roheian approach to box skyscrapers slightly to adjust for more modern tastes. The prime downtown location in the heart of Manhattan allows tenants to experience the very best of the city that never sleeps in their own private haven. First floor apartments offer 2 bedrooms, 2.5 baths with living room, kitchen and access to a private recreation room downstairs complete with a private terrace. All tenants have access to an in-house gym located on the cellar level. Floors 2 through 15 have four or five units per floor, and units feature either one or two bedrooms plus bathroom(s), living room, and kitchen. Floors 16 through 21 have only three units with three bedrooms, 2.5 baths, living room, and kitchen.

The structural system of 110 Third Avenue is predominantly cast-in-place concrete. Most floors have 8" CIP slab, but beginning with floor 15 the slab increases to as much as 24" to support cantilevered portions of the building and mechanical equipment on the roof. All slabs and columns have f'_c= 5000 psi. Loads are carried from the two-way slab system to concrete columns ranging from 12x12 to 40x12. The columns are continuous throughout the height of the building except for a few columns that terminate at floor 16 due to a setback in the building perimeter, and a few columns that originate on the drawings at floor 11 due to the reduction of the elevator core to column-sized portions. Footings range from 4'6" square up to 15' x 9'6". The only beams present in the structure are in the basement level and are grade beams extending from perimeter East-face and West-Face footings to the outside wall. Shear walls extend throughout the height of the building and are located mostly on the North and South sides of the building. The roof is a flat slab system that is drained by roof drains nested under pavers to facilitate its use as a rooftop terrace for tenants. Supporting columns are recessed from the façade on average 10", and therefore allow the designer to use non-bearing prefabricated panels.

The exterior walls of 110 Third Ave. consist of a “window wall” system. This system is fixed window units fabricated with flush aluminum panels finished to match the window wall that rests on the slab. Surrounding the windows are glazed aluminum window wall framing. The window units themselves consist of a 1/4” thick nominal aluminum composite panel affixed to the exterior face window-wall unit with conceded fasteners and/or adhesives finished to match the window-wall. Also present is an insulating spandrel panel. On the North and East sides of the building are balconies from floors 8 through 16 and 16 through 21, respectively. Each balcony is cantilevered 5’ from the building face. The roof is concrete slab supporting mechanical equipment, but it also hosts several private terraces and a common terrace for occupants. The roof itself is composed of a layer of fluid applied roofing membrane, drainage panels, 4” polystyrene, adjustable paver pedestals, topped with a layer of precast concrete pavers. Surrounding the living spaces is a 4’-0” high perimeter parapet planter all around the roof.

2.1 Model Codes

The design of 110 Third Avenue is based on the governing building code, which is the Building Code of the City of New York, including latest amendments (“N.Y.C. Code”). The New York building code expands upon the wind and seismic loading requirements that ASCE 07-98 previously laid out. Some requirements are more stringent, but the N.Y.C. code often provides a simplified set loading criteria in the case of wind loading. This simplification can be seen in the comparison charts provided in the appendix.

2.2 Standards

2.2.1 AMERICAN INSTITUTE OF STEEL CONSTRUCTION " SPECIFICATION FOR STRUCTURAL STEEL BUILDINGS - ALLOWABLE STRESS DESIGN AND PLASTIC DESIGN ", JUNE 1, 1989 ("AISC SPECIFICATION"). AS MODIFIED BY SUBCHAPTER 10 ARTICLE 6 OF THE NYC BUILDING CODE.

2.2.2 AMERICAN CONCRETE INSTITUTE " BUILDING CODE REQUIRMENTS FOR STRUCTURAL CONCRETE" ACI 318-99 ("ACI") AS MODIFIED BY SURCHAPTER 10 ARTICLE 5 OF THE N.Y.C. BUILDING CODE.

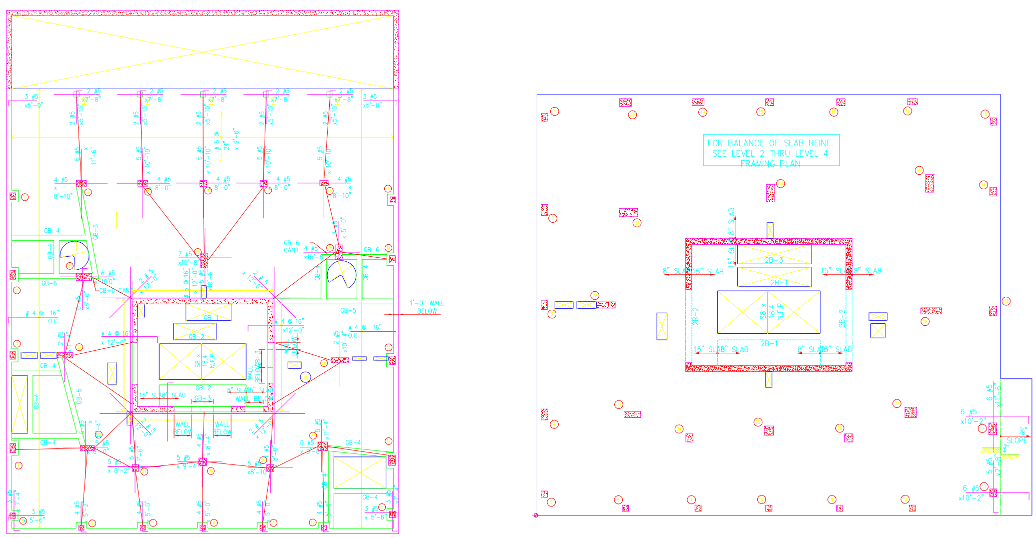
2.2.3 AMERICAN CONCRETE INSTITUTE " BUILDING CODE REQUIRMENTS FOR MASONRY STRUCTURES" ACI 530-99 ("ACI 530") AS MODIFIED BY REFERENCE STANDARD SUBCHAPTER 10 ARTICLE 4 OF THE N.Y.C. BUILDING CODE.

2.2.4 AMERICAN IRON AND STEEL INSTITUTE " SPECIFICATION FOR THE DESIGN OF COLD-FORMED STEEL STRUCTURAL MEMBERS", 1992 ("AISI") AS MODIFIED BY SUBCHAPTER 10 ARTICLE 6 OF THE N.Y.C. BUILDING CODE.

2.2.5 STEEL JOIST INSTITUTE " STANDARD SPECIFICATIONS, LOAD TABLES AND WEIGHT TABLES FOR STEEL JOISTS AND JOIST GIRDERS", 1994 ("SJI") AS MODIFIED BY SUBCHAPTER 10 ARTICLE 6 OF THE N.Y.C. BUILDING CODE.

3.1 Framing Description

110 Third Avenue is completely a flat plate system with columns roughly sorted into a 7x5 element bay. The building extends 68' in the North-South direction (5 columns) and 75' in the East-West direction (7 columns). A flat plate system supports the loads placed on the building and directly transfers the loading to the columns. No drop panels assist in the distribution of weight or add to the building's resistance to punching shear. A central shear wall system centered around the elevator core provides lateral stability and resistance to wind and seismic loading.



Ground Floor Framing Plan and Plan for levels 5 through 10

3.1.1 Loads

3.1.1.1 Gravity Loads

Floor	Partition	Ceiling & Mech.	Floor Finish	Live	Total Imposed
Lobby	-	5	40	100	145
Apartment	12	-	5	40	65
Roof	-	5	25	30	60
Retail	-	5	15	100	120
Storage	-	5	-	100	105
Stairs	-	-	-	100	100
Private Roof Terrace	-	-	65	60	200
Public Roof Terrace	-	-	65	100	200
Mechanical	-	25	40	150	215
Gym	-	5	15	100	215
Courtyard	-	-	65	60	215

Design weight of floor framing is 8” thick concrete flat plate slab at 100 PSF (S-001)

3.1.1.2 Lateral Loads

A static lateral force procedure as per NYC building code reference standard RS 9-6 was performed using a 3-dimensional model in the Etabs software program. However, the model will reach substantial completion and be presented in a later report. Please see the Excel analysis and lateral check done by hand for lateral loading until a later date.

- 3.1.1.2.1 Wind Load Criteria- NYC Building Code
  - 3.1.1.2.1.1 Building height less than 100’-0” – 20 psf
  - 3.1.1.2.1.2 Building height greater than 100’-0” but less than 300’-0” – 25 psf
  - 3.1.1.2.1.3 Building height greater than 300’-0” and less than 500’-0” – 30 psf
- 3.1.1.2.2 Wind Load Criteria- ASCE7-02: See calculations in appendix and under wind load analysis, N-S and E-W for values.
- 3.1.1.2.3 Seismic Design Criteria
  - 3.1.1.2.3.1 I= 1.0
  - 3.1.1.2.3.2 Z= .15 (New York City)
  - 3.1.1.2.3.3 S1= 1.0
  - 3.1.1.2.3.4 R_w= 8 (Building Frame System Concrete Shear Wall)

4.1 Description of Structural System

110 Third Avenue is a great example of economic residential design in an urban setting. The design of the structural system is nearly uniform throughout the height of the building, changing mildly at the 16th floor to accommodate a small setback in overall width of the building. The placement of the main lateral resisting elements around the elevator core saves precious exterior wall space for windows and a curtain wall that are aesthetically beneficial. The foundation is quite typical, but the placement of the columns in irregular-shaped bays shows the designers consideration for well placed structural elements throughout the building. Each apartment space revolves around the architects intent for the flow of the building and individual units, and the placement of columns caters to these needs. Odd placement of columns creates and interesting challenge for analysis and analytical methods, such as the use of RAM, often applied to flat plate concrete buildings.

4.1.1 Foundation

The foundation structure of 110 Third Avenue consists mainly of footings occurring at regular intervals underneath the columns. There is also a perimeter wall footing that ranges from 2’-0” to 9’-8” in width. The footings range from 4’-6” square to 9’-6” x 15’-0” to 11’-0” x 12’-6”, and there also are also grade beams connecting East and West face foundations with the exterior. These grade beams are 18x24 with 3 #11 top and bottom continuous reinforcement. The bottom of footings bear on gravely sand (NYC classification 7-65 and 6-65) with a minimum allowable bearing capacity of 4 tons per square foot. Also note that overturning moment in the foundation will be examined in a later report to insure lateral system does work.

4.1.2 Framing

The framing of 110 Third Avenue is an economical approach to mid-rise residential facilities. It consists of an inner core of shear walls around the elevator and stairwell that resists lateral loads, and a column layout setback from the perimeter to allow for a lightweight, prefabricated aluminum and glass panel to serve as the exterior façade. In addition, a flat plate slab provides support against gravity loads and transfers weight directly to the columns. This may leave the building vulnerable to punching shear, and this aspect of the building will be evaluated in the future. The columns are irregularly sized, and a pattern really doesn’t develop in their sizing except around the perimeter where a regular grid is present. Column sizes range from 12” x 12” to 40” x 12” and are spaced at intervals that suit the needs of the architecture of the apartment. All columns are 5000 psi concrete

4.1.3 Slabs

A typical flat plate slab system serves the entirety of 110 Third Avenue, with a typical slab thickness of 8”. Slab size increases around the elevator core to 15”, and increases to

24” near the elevator core on the roof level to support mechanical equipment. Slabs are continued, in portions of each floor, past the perimeter to form balconies. The balconies have a ¾” step down from the 8” slab that makes up the entire interior space, and are therefore 7 ¼ in. thick. The flat plate slab is a great approach to a mid-rise residential tower because it saves on formwork and labor costs. All slabs are 5000 psi concrete

4.1.4 Shear Walls

Shear walls serve as the sole lateral load resisting system, and are located around the elevator core (see lateral load check for schematic). They are continuous from floor 2 to the roof, and on the ground floor and first floor they are supported by additional length and reinforcement. The shear walls present a uniform lateral resisting behavior and make 110 Third Avenue a consistent, simple building to analyze.

5.1 Load Computations

The load computations that follow were derived from ASCE7-02 Chapters 6 and 9 for wind analysis and seismic analysis, respectively. After completing both analyses, floor shear was controlled by wind loading in every case. The results from these computations was applied in the simplified lateral element check to determine if the shear wall system, the sole lateral force resisting system, provided enough resistive support.

5.1.1 Wind

Wind analysis for each direction was performed using an Excel spreadsheet after determining preliminary constant values. Please see the appendix for basis of values as well as comparison charts showing the differences between the NYC code and ASCE7-02. Also note that diagrams showing lateral wind forces, including windward and leeward pressures, are included in the appendix.

5.1.1.1 N-S Analysis:

PROJECT NAME: 110 Third Avenue
DCE JOB No.: Project No.

GUST EFFECT FACTOR FOR FLEXIBLE BUILDINGS (ANSI / ASCE 7-98)

	Y - Dir	
Building Properties		
Roof Height h	210.00	
Width B	75.00	
Length L	68.00	
Freq n_1	0.167	
Damping ratio β	0.02	
Flexible Response Factors		
Peak Response Factors		
Background g_Q	3.4	
Wind g_v	3.4	
Resonant g_R	3.738	$g_R = \sqrt{2 \ln(3600 n_1)} + 0.577 / \sqrt{2 \ln(3600 n_1)}$
Intensity of Turbulence ($I_{\bar{z}}$)		
c	0.3	from T6-4
$\bar{z}$	126.00	$\bar{z}$ = 0.6 h; but > z_{min} from table T6-4
$I_{\bar{z}}$	0.240	$I_{\bar{z}} = c(\bar{z}/33)^{1/6}$
Integral Length Scale of Turbulence ($L_{\bar{z}}$)		
ℓ (ft)	320	from T6-4
$\bar{\varepsilon}$	0.333333	from T6-4
$L_{\bar{z}}$	500.15	$L_{\bar{z}} = \ell(\bar{z}/33)^{\bar{\varepsilon}}$
Background Response		
Q	0.833	$Q = \sqrt{1 / (1 + 0.63 ((B + h)) / L_z)^{0.63})}$
Mean Hourly Speed at Height z ($\bar{V}_{\bar{z}}$)		
$\bar{\alpha}$	1/4	from T6-4
$\bar{b}$	0.45	from T6-4
V (mph)	105.00	
$\bar{V}_{\bar{z}}$ (ft/s)	96.872	$\bar{V}_{\bar{z}} = \bar{b} (\bar{z}/33)^{\bar{\alpha}} V (88/60)$
Resonant Response Factor		
N_1	0.861	$N_1 = n_1 L_{\bar{z}} / \bar{V}_{\bar{z}}$
R_n	0.142	$R_n = \dfrac{7.47 N_1}{(1+10.3N_1)^{5/3}}$
η_h	1.662	$\eta_h = 4.6 n_1 h / \bar{V}_{\bar{z}}$
η_B	0.594	$\eta_B = 4.6 n_1 B / \bar{V}_{\bar{z}}$
η_L	1.802	$\eta_L = 15.4 n_1 L / \bar{V}_{\bar{z}}$
R_h	0.427	$R = 1/\eta - ((1-e^{-2\eta}) / 2\eta^2)$
R_B	0.699	
R_L	0.405	
R	1.234	$R = \sqrt{(1/\beta) R_n R_h R_B (0.53 + 0.47 R_L)}$
Gust Effect Factor		
Gf	**1.24**	$Gf = 0.925 \left(\dfrac{1 + 1.7 I_z \sqrt{g_Q^2 Q^2 + g_R^2 R^2}}{1 + 1.7 g_v I_z} \right)$

PROJECT NAME: 110 Third Avenue
DCE JOB No.: Project No.

WIND DIRECTION: NORTH-SOUTH (Y-DIR) **# Stories:** 21

WIND SPEED:	105.00 MPH	**L :**	68.000 ft	**FREQ n_1:**	0.1667 Hz	**Ground to**	
EXP. CAT:	B	**B :**	75.000 ft	**ALPHA=**	7	**Base h:**	0.000 ft
IMPORT. FACTOR:	1.15	**Mean Roof h :**	210.00 ft	**Zg (ft)=**	1200 ft		
DIREC. FACT. Kd:	0.85	**Kh =**	1.222	**G=**	0.8	**Wind Load**	
TOPOG. FACT Kzt:	1.00 (see sht. Kzt)	**L/B =**	0.907	**Gf=**	1.243	**to be applied**	
$0.00256\ K_d\ K_{zt}\ V^2\ I$ =	27.59 psf	**Cp (wind):**	0.8			**at Yo:**	0.000 ft
		Cp (leew):	-0.50				

WIND FORCE CALCULATION PER ASCE7-02 - MAIN WIND FORCE RESISTING SYSTEM

LEVEL	FLOOR I.D.	FL TO FL HEIGHT (ft)	TRIB. WIDTH (ft)	Exp Area Yo_i (ft)	FLOOR ELEV (ft)	EXPOSED ELEV (ft)	Kz	WIND PRESS. (psf)	WIND FORCE (Kips)	FLOOR SHEAR (Kips)	FLOOR MOMENT (Kip-ft)	Case 1 Mz (Kip-ft)	Case 2 Mz (Kip-ft)	
21	21	11.000	75.000	0.000	207.33	207.33	1.217	54.35	22.4	22.4	246.6	0.0	52.5	-52.5
20	20	9.667	75.000	0.000	196.33	196.33	1.198	53.83	41.7	64.1	866.6	0.0	97.8	-97.8
19	19	9.667	75.000	0.000	186.67	186.67	1.181	53.36	38.7	102.8	1,860.6	0.0	90.7	-90.7
18	18	9.667	75.000	0.000	177.00	177.00	1.163	52.87	38.3	141.2	3,225.1	0.0	89.8	-89.8
17	17	9.667	75.000	0.000	167.33	167.33	1.145	52.36	38.0	179.1	4,956.6	0.0	89.0	-89.0
16	16	9.667	75.000	0.000	157.67	157.67	1.126	51.83	37.6	216.7	7,051.3	0.0	88.1	-88.1
15	15	9.667	75.000	0.000	148.00	148.00	1.105	51.28	37.2	253.9	9,505.5	0.0	87.1	-87.1
14	14	9.667	75.000	0.000	138.33	138.33	1.084	50.70	36.8	290.6	12,315.0	0.0	86.1	-86.1
13	13	9.667	75.000	0.000	128.67	128.67	1.062	50.09	36.3	327.0	15,475.5	0.0	85.1	-85.1
12	12	9.667	75.000	0.000	119.00	119.00	1.039	49.45	35.9	362.8	18,982.6	0.0	84.0	-84.0
11	11	9.667	75.000	0.000	109.33	109.33	1.014	48.77	35.4	398.2	22,831.5	0.0	82.9	-82.9
10	10	9.667	75.000	0.000	99.67	99.67	0.987	48.04	34.8	433.0	27,017.0	0.0	81.6	-81.6
9	9	9.667	75.000	0.000	90.00	90.00	0.959	47.26	34.3	467.3	31,533.8	0.0	80.3	-80.3
8	8	9.667	75.000	0.000	80.33	80.33	0.928	46.42	33.7	500.9	36,376.0	0.0	78.9	-78.9
7	7	9.667	75.000	0.000	70.67	70.67	0.895	45.51	33.0	533.9	41,537.0	0.0	77.3	-77.3
6	6	9.667	75.000	0.000	61.00	61.00	0.858	44.50	32.3	566.2	47,009.9	0.0	75.6	-75.6
5	5	9.667	75.000	0.000	51.33	51.33	0.817	43.36	31.4	597.6	52,786.7	0.0	73.7	-73.7
4	4	9.667	75.000	0.000	41.67	41.67	0.770	42.07	30.5	628.1	58,858.3	0.0	71.5	-71.5
3	3	10.000	75.000	0.000	32.00	32.00	0.714	40.53	29.9	658.0	65,438.2	0.0	70.1	-70.1
2	2	10.000	75.000	0.000	22.00	22.00	0.641	38.54	28.9	686.9	72,307.1	0.0	67.7	-67.7
1	1	12.000	75.000	0.000	12.00	12.00	0.575	36.72	30.3	717.2	80,913.4	0.0	71.0	-71.0

TRIB HEIGHT		NYC BLDG CODE			GOVERNING VALUES	
TOP	BOT	WIND PRESS. (psf)	WIND FORCE (Kips)	FLOOR SHEAR (Kips)	FLOOR SHEAR (Kips)	FLOOR MOMENT (Kip-ft)
0.000	5.500	25.0	10.3	10.3	22.4	246.6
5.500	4.833	25.0	19.4	29.7	64.1	866.6
4.833	4.833	25.0	18.1	47.8	102.8	1,860.6
4.833	4.833	25.0	18.1	65.9	141.2	3,225.1
4.833	4.833	25.0	18.1	84.1	179.1	4,956.6
4.833	4.833	25.0	18.1	102.2	216.7	7,051.3
4.833	4.833	25.0	18.1	120.3	253.9	9,505.5
4.833	4.833	25.0	18.1	138.4	290.6	12,315.0
4.833	4.833	25.0	18.1	156.6	327.0	15,475.5
4.833	4.833	25.0	18.1	174.7	362.8	18,982.6
4.833	4.833	25.0	18.1	192.8	398.2	22,831.5
4.833	4.833	20.0	14.5	207.3	433.0	27,017.0
4.833	4.833	20.0	14.5	221.8	467.3	31,533.8
4.833	4.833	20.0	14.5	236.3	500.9	36,376.0
4.833	4.833	20.0	14.5	250.8	533.9	41,537.0
4.833	4.833	20.0	14.5	265.3	566.2	47,009.9
4.833	4.833	20.0	14.5	279.8	597.6	52,786.7
4.833	4.833	20.0	14.5	294.3	628.1	58,858.3
4.833	5.000	20.0	14.7	309.1	658.0	65,438.2
5.000	5.000	20.0	15.0	324.1	686.9	72,307.1
5.000	6.000	20.0	16.5	340.6	717.2	80,913.4
		0.0	0.0			

Note: This figure is a continuation of the first one; the 21st floor is listed first down to the 1st floor

5.1.1.2 E-W Analysis

PROJECT NAME: 110 Third Avenue
DCE JOB No.: Project No.

GUST EFFECT FACTOR FOR FLEXIBLE BUILDINGS (ANSI / ASCE 7-98)

	X - Dir	
Building Properties		
Roof Height h	210.00	
Width B	68.00	
Length L	75.00	
Freq n_1	0.853	
Damping ratio β	0.02	
Flexible Response Factors		
Peak Response Factors		
Background g_Q	3.4	
Wind g_v	3.4	
Resonant g_R	4.151	$g_R = \sqrt{2 \ln(3600 n_1)} + 0.577/\sqrt{2 \ln(3600 n_1)}$
Intensity of Turbulence ($I_{\bar{z}}$)		
$\bar{c}$	0.3	from T6-4
$\bar{z}$	126.00	$\bar{z}$ = 0.6 h; but > z_{min} from table T6-4
$I_{\bar{z}}$	0.240	$I_{\bar{z}} = c(\bar{z}/33)^{1/6}$
Integral Length Scale of Turbulence ($L_{\bar{z}}$)		
l (ft)	320	from T6-4
$\bar{\varepsilon}$	0.333333	from T6-4
$L_{\bar{z}}$	500.15	$L_{\bar{z}} = l(\bar{z}/33)^{\varepsilon}$
Background Response		
Q	0.835	$Q = \sqrt{1 / (1 + 0.63 ((B + h)) / L_z)^{0.63})}$
Mean Hourly Speed at Height z ($\bar{V}_{\bar{z}}$)		
$\bar{\alpha}$	1/4	from T6-4
$\bar{b}$	0.45	from T6-4
V (mph)	105.00	
$\bar{V}_{\bar{z}}$ (ft/s)	96.872	$\bar{V}_{\bar{z}} = \bar{b} (\bar{z}/33)^{\alpha} V (88/60)$
Resonant Response Factor		
N_1	4.404	$N_1 = n_1 L_{\bar{z}} / \bar{V}_{\bar{z}}$
R_n	0.055	$R_n = \dfrac{7.47 N_1}{(1+10.3N_1)^{5/3}}$
η_h	8.506	$\eta_h = 4.6 n_1 h / \bar{V}_{\bar{z}}$
η_B	2.754	$\eta_B = 4.6 n_1 B / \bar{V}_{\bar{z}}$
η_L	10.170	$\eta_L = 15.4 n_1 L / \bar{V}_{\bar{z}}$
R_h	0.111	$R = 1/\eta - ((1-e^{-2\eta}) / 2\eta^2)$
R_B	0.297	
R_L	0.093	
R	0.228	$R = \sqrt{(1/\beta) R_n R_h R_B (0.53 + 0.47 R_L)}$
Gust Effect Factor		
Gf	**0.86**	$Gf = 0.925 \left(\dfrac{1 + 1.7 I_z \sqrt{g_Q^2 Q^2 + g_R^2 R^2}}{1 + 1.7 g_v I_z} \right)$

PROJECT NAME: 110 Third Avenue
DCE JOB No.: Project No.

WIND DIRECTION: EAST-WEST (X-DIR) **# Stories:** 21

WIND SPEED:	105.00 MPH	**L :**	75.000 ft	**FREQ n_1:**	0.8530 Hz	**Ground to**	
EXP. CAT:	B	**B :**	68.000 ft	**ALPHA=**	7	**Base h:**	0.000 ft
IMPORT. FACTOR:	1.15	**Mean Roof h :**	210.00 ft	**Zg (ft)=**	1200 ft		
DIREC. FACT. Kd:	0.85	**Kh =**	1.222	**G=**	0.8	**Wind Load**	
TOPOG. FACT Kzt:	1.00 (see sht. Kzt)	**L/B =**	1.103	**Gf=**	0.860	**to be applied**	
$0.00256\ K_d\ K_{zt}\ V^2\ I$ =	27.59 psf	**Cp (wind):**	0.8			**at Yo:**	0.000 ft
		Cp (leew):	-0.48				

WIND FORCE CALCULATION PER ASCE7-02 - MAIN WIND FORCE RESISTING SYSTEM

LEVEL	FLOOR I.D.	FL TO FL HEIGHT (ft)	TRIB. WIDTH (ft)	Exp Area Yo_i (ft)	FLOOR ELEV (ft)	EXPOSED ELEV (ft)	Kz	WIND PRESS. (psf)	WIND FORCE (Kips)	FLOOR SHEAR (Kips)	FLOOR MOMENT (Kip-ft)	Case 1 Mz (Kip-ft)	Case 2 Mz (Kip-ft)	
21	21	11.000	68.000	0.000	207.33	207.33	1.217	37.02	13.8	13.8	152.3	0.0	29.4	-29.4
20	20	9.667	68.000	0.000	196.33	196.33	1.198	36.66	25.8	39.6	535.1	0.0	54.7	-54.7
19	19	9.667	68.000	0.000	186.67	186.67	1.181	36.33	23.9	63.5	1,148.8	0.0	50.7	-50.7
18	18	9.667	68.000	0.000	177.00	177.00	1.163	36.00	23.7	87.1	1,991.3	0.0	50.3	-50.3
17	17	9.667	68.000	0.000	167.33	167.33	1.145	35.64	23.4	110.6	3,060.2	0.0	49.8	-49.8
16	16	9.667	68.000	0.000	157.67	157.67	1.126	35.28	23.2	133.8	4,353.2	0.0	49.3	-49.3
15	15	9.667	68.000	0.000	148.00	148.00	1.105	34.89	22.9	156.7	5,868.0	0.0	48.7	-48.7
14	14	9.667	68.000	0.000	138.33	138.33	1.084	34.49	22.7	179.4	7,602.0	0.0	48.2	-48.2
13	13	9.667	68.000	0.000	128.67	128.67	1.062	34.07	22.4	201.8	9,552.5	0.0	47.6	-47.6
12	12	9.667	68.000	0.000	119.00	119.00	1.039	33.63	22.1	223.9	11,716.6	0.0	47.0	-47.0
11	11	9.667	68.000	0.000	109.33	109.33	1.014	33.15	21.8	245.7	14,091.4	0.0	46.3	-46.3
10	10	9.667	68.000	0.000	99.67	99.67	0.987	32.65	21.5	267.1	16,673.7	0.0	45.6	-45.6
9	9	9.667	68.000	0.000	90.00	90.00	0.959	32.11	21.1	288.2	19,460.1	0.0	44.9	-44.9
8	8	9.667	68.000	0.000	80.33	80.33	0.928	31.53	20.7	309.0	22,446.8	0.0	44.0	-44.0
7	7	9.667	68.000	0.000	70.67	70.67	0.895	30.90	20.3	329.3	25,629.8	0.0	43.2	-43.2
6	6	9.667	68.000	0.000	61.00	61.00	0.858	30.20	19.9	349.1	29,004.7	0.0	42.2	-42.2
5	5	9.667	68.000	0.000	51.33	51.33	0.817	29.41	19.3	368.5	32,566.5	0.0	41.1	-41.1
4	4	9.667	68.000	0.000	41.67	41.67	0.770	28.52	18.7	387.2	36,309.5	0.0	39.8	-39.8
3	3	10.000	68.000	0.000	32.00	32.00	0.714	27.45	18.4	405.6	40,365.2	0.0	39.0	-39.0
2	2	10.000	68.000	0.000	22.00	22.00	0.641	26.08	17.7	423.3	44,598.2	0.0	37.7	-37.7
1	1	12.000	68.000	0.000	12.00	12.00	0.575	24.82	18.6	441.9	49,900.6	0.0	39.4	-39.4

TRIB HEIGHT		NYC BLDG CODE			GOVERNING VALUES	
TOP	BOT	WIND PRESS. (psf)	WIND FORCE (Kips)	FLOOR SHEAR (Kips)	FLOOR SHEAR (Kips)	FLOOR MOMENT (Kip-ft)
0.000	5.500	25.0	9.4	9.4	13.8	152.3
5.500	4.833	25.0	17.6	26.9	39.6	535.1
4.833	4.833	25.0	16.4	43.3	63.5	1,148.8
4.833	4.833	25.0	16.4	59.8	87.1	1,991.3
4.833	4.833	25.0	16.4	76.2	110.6	3,060.2
4.833	4.833	25.0	16.4	92.6	133.8	4,353.2
4.833	4.833	25.0	16.4	109.1	156.7	5,868.0
4.833	4.833	25.0	16.4	125.5	179.4	7,602.0
4.833	4.833	25.0	16.4	141.9	201.8	9,552.5
4.833	4.833	25.0	16.4	158.4	223.9	11,716.6
4.833	4.833	25.0	16.4	174.8	245.7	14,091.4
4.833	4.833	20.0	13.1	188.0	267.1	16,673.7
4.833	4.833	20.0	13.1	201.1	288.2	19,460.1
4.833	4.833	20.0	13.1	214.3	309.0	22,446.8
4.833	4.833	20.0	13.1	227.4	329.3	25,629.8
4.833	4.833	20.0	13.1	240.5	349.1	29,004.7
4.833	4.833	20.0	13.1	253.7	368.5	32,566.5
4.833	4.833	20.0	13.1	266.8	387.2	36,309.5
4.833	5.000	20.0	13.4	280.2	405.6	40,365.2
5.000	5.000	20.0	13.6	293.8	423.3	44,598.2
5.000	6.000	20.0	15.0	308.8	441.9	49,900.6

Note: This figure is a continuation of the first one; the 21st floor is listed first down to the 1st floor

5.1.2 Seismic

Basis for seismic values stems from ASCE7-02 Chapter 9, but also from the geotechnical report provided by Langan geotechnical engineers. Please see below for their evaluation of the site.

Seismic Evaluation

Seismic site coefficients are based on the type and thickness of subsurface materials on which the foundations bear. The soil profile S-types range from S_o for buildings supported directly on hard rock to S_4 for buildings underlain by thick deposits of very loose or soft bearing strata. For the 110 Third Avenue project, shallow foundations bearing on the natural gravelly sand would have a S_1 soil profile, characterized by compact sands (7-65 and 6-65) or soft rock (Class 4-65) where the soil depth is less than 100 ft. A corresponding site coefficient of 1.0 is assigned to this profile. New York City is within Seismic Zone 2A, with an effective zero-period acceleration of 0.15g.

1 SEISMIC LOADING

- Seismic Use Group:

  Occupancy category : III

  seismic use group : II (Table 9.1.3 ASCE 07-02)

- Importance Factor : $I = 1.25$ (Table 9.1.4)

- Site classification : D (see geotechnical report)

  $\bar{V}_s$ = 600 + 1200 ft/s

  $\bar{N}$ = 15 to 50

  $\bar{S}_u$ = 1000 to 2000 psf (50 to 100 kPa)

- Accelerations from Maps

  $S_s = .40$ (Fig. 9.4.1.1a)

  $S_1 = .094$ (Fig. 9.4.1.1b)

- Adjust for site class

  Fa: (Table 9.4.1.2.4a) pg. 129

  $F_a = 1.6 - (1.6 - 1.4)\left(\frac{.4 - .25}{.5 - .25}\right) = 1.48$

  $F_v = 2.4$ (Table 9.4.1.2.4b) pg. 130

  $S_{MS} = F_a S_s = (1.48)(.4) = .592$

  $S_{M1} = F_v S_1 = (2.4)(.094) = .2256$

- Design spectral response acceleration parameters:

  $S_{DS} = \frac{2}{3}(S_{MS}) = \frac{2}{3}(.592) = .395$

  $S_{D1} = \frac{2}{3}(S_{M1}) = \frac{2}{3}(.2256) = .1504$

- Seismic Design Category

  Table 9.4.2.1a: SDC C pg. 131

  Table 9.4.2.1b: SDC C pg. 132

2

Use Equivalent Lateral Force Analysis 9.5.5

- permitted as per Table 9.5.2.5.1, pg. 140

• Seismic Base Shear: $V = C_s W$

Loads: W see spreadsheet

• seismic response coefficient: C_s

R = 5.5, ordinary reinforced concrete shear walls (Table 9.5.2.2)

I = 1.25 as above

See spreadsheet for rest of calcs.

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS

Ceiling & Mechanical	5	
Floor Finish	25	
Roof Dead Loads:	30	
Snow Load:	0	
Lobby	45	
Apartment	17	
Retail	20	
Roof Terrace	65	
Mechanical	65	
Floor Dead Loads:	65	max
Exterior Wall Load:	15	
Seismic Use Group:	II	
Site Classification:	D	
Occupancy Category	III	
I	1.25	
City	Scranton	
S_s	0.4	
S1	0.094	
F_a	1.48	
F_v	2.4	
S_{MS}	0.592	
S_{M1}	0.2256	
S_{DS}	0.394667	
S_{D1}	0.1504	
SDC	C	
B	75	
L	68	
Wroof	178.74	
Wfloors	382.98	
W	7838.34	
# of Stories	21	
Story Height (ft.)	10	avg.
h_n	210	
R	5.5	Table 9.5.2.2 p.133-135
Structure Type (N-S)	All other structural systems	
Structure Type (E-W)	All other structural systems	
Ct (N-S)	0.02	
x (N-S)	0.75	
T (N-S)	1.103302	
Ct (E-W)	0.02	
x (E-W)	0.75	
T (E-W)	1.103302	
Cs	0.089697	
Cs max (N-S)	0.030981	
Controlling Cs (N-S)	0.030981	
Cs max (E-W)	0.030981	
Controlling Cs (E-W)	0.030981	
Cs min	0.021707	
V (N-S)	242.8426	
V(E-W)	242.8426	
k (N-S)	1.301651	
k (E-W)	1.301651	

Table 9.1.3

	I	II	III
I	X		
II	X		
III		X	
IV			X

Table 9.1.4

Seismic Use Group		I
I		1
II		1.25
III		1.5

Occupancy Category (Table 1.1)	
I	Temporary and storage facilities
II	All buildings not listed as I, III, and IV
III	Substantial hazard to human life in the event of a failure (300 or more people congregate)
IV	Essential facilities (hospitals, emergency shelters, fire stations)

Structure Type	Ct	x
Moment resisting frames of steel where frames resist 100 % of seismic	0.028	0.8
Moment resisting frames of Concrete where frames resist 100 % of seismic	0.016	0.9
Eccentrically braced steel frames	0.03	0.75
All other structural systems	0.02	0.75

N-S

T	k
<=0.5	1
.5-2.5	1.301651078
>=2.5	2

E-W

T	k
<=0.5	1
.5-2.5	1.301651078
>=2.5	2

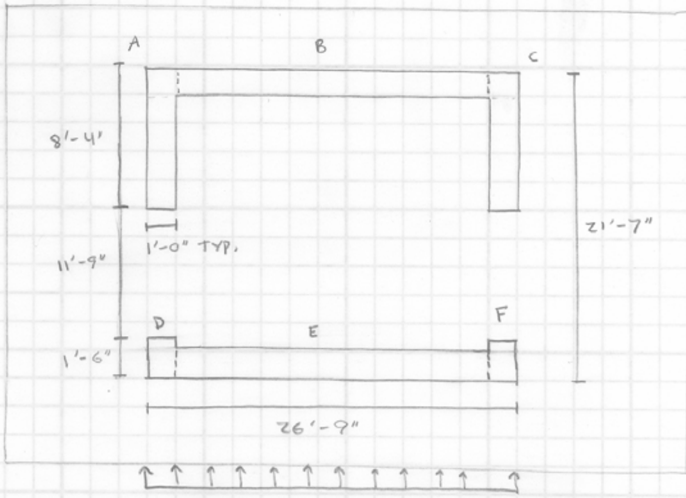
Level	w_x	h_x	wxhx^k (N-S)	wxhx^k (E-W)	Cvx (N-S)	Cvx (E-W)	Fx (N-S)	Fx (E-W)
21(roof)	178.74	210	188339.3215	188339.3215	0.054091	0.054091	13.13557	13.13556806
20	382.98	200	378716.5365	378716.5365	0.108767	0.108767	26.41327	26.41326728
19	382.98	190	354256.7839	354256.7839	0.101742	0.101742	24.70734	24.70734235
18	382.98	180	330182.4471	330182.4471	0.094828	0.094828	23.0283	23.02829792
17	382.98	170	306508.3692	306508.3692	0.088029	0.088029	21.37717	21.3771692
16	382.98	160	283250.8657	283250.8657	0.081349	0.081349	19.75509	19.75509413
15	382.98	150	260427.9712	260427.9712	0.074795	0.074795	18.16333	18.16333048
14	382.98	140	238059.7458	238059.7458	0.068371	0.068371	16.60328	16.60327736
13	382.98	130	216168.6637	216168.6637	0.062083	0.062083	15.0765	15.07650219
12	382.98	120	194780.1091	194780.1091	0.055941	0.055941	13.58478	13.58477539
11	382.98	110	173923.0263	173923.0263	0.049951	0.049951	12.13012	12.13011564
10	382.98	100	153630.7853	153630.7853	0.044123	0.044123	10.71485	10.7148503
9	382.98	90	133942.3652	133942.3652	0.038468	0.038468	9.341698	9.341697951
8	382.98	80	114904.0212	114904.0212	0.033	0.033	8.013885	8.013884612
7	382.98	70	96571.71573	96571.71573	0.027735	0.027735	6.735313	6.735313339
6	382.98	60	79014.8257	79014.8257	0.022693	0.022693	5.510823	5.510822765
5	382.98	50	62322.122	62322.122	0.017899	0.017899	4.346604	4.346604142
4	382.98	40	46612.15793	46612.15793	0.013387	0.013387	3.250926	3.250925871
3	382.98	30	32053.2867	32053.2867	0.009206	0.009206	2.23553	2.235529604
2	382.98	20	18908.76616	18908.76616	0.005431	0.005431	1.318776	1.318776041
1	382.98	10	7670.561788	7670.561788	0.002203	0.002203	0.534977	0.5349769
					1	1	242.8426	242.8425535

5.1.3 Simplified Check of Lateral Element

Distribution of Lateral Loads by Rigidity – N-S Direction

Assume that distribution by rigidity will apply to 110 Third Avenue for simplicity. 110 Third Avenue does not comply with the stipulation of being less than seven stories, but has a rigid diaphragm and uniform lateral resisting behavior.

- Analyze shear wall plan for level 19, N-S direction:



NOT TO SCALE

h = 9'-8"
= 9.67'

Step 1: Determine center of mass

@ center of shear wall system

Step 2:

$\left(h/L\right)_A = \left(\frac{9.67'}{8.33'}\right) = 1.16$ Intermediate wall $\left(K = \frac{Et}{4(h/L)^3 + 3(h/L)}\right)$

$\left(h/L\right)_B = \left(\frac{9.67'}{24.75'}\right) = .391$ " "

$\left(h/L\right)_C = \left(\frac{9.67}{8.33}\right) = 1.16$ " "

$\left(h/L\right)_D = \left(\frac{9.67}{1.5}\right) = 6.45$ Tall wall $\left(k = \frac{3EI}{h^3}\right)$

$\left(h/L\right)_E = \left(\frac{9.67}{24.75}\right) = .391$ Intermediate wall

$\left(h/L\right)_F = \left(\frac{9.67}{1.5}\right) = 6.45$ Tall wall

2

$$K_A = \frac{Et}{4\left(h/L\right)^3 + 2.78\left(h/L\right)} = \frac{1}{4(1.16)^3 + 2.78(1.16)} = .10561$$

$$K_B = \frac{1}{4(.391)^3 + 2.78(.391)} = .754$$

$$K_C = .10561$$

$$K_D = \frac{3EI}{h^3} = \frac{3\left(b h_s^3/12\right)}{h^3} = \frac{3\left((1')(1.5')^3/12\right)}{(9.67)^3} = 9.33\times10^{-4}$$

$$K_E = .754$$

$$K_F = 9.33\times10^{-4}$$

Step 3: Determine Center of Rigidity

$x_A = x_D = 0$ $y_B = 21'$

$x_C = x_F = 26'$ $y_E = 0'$

$$x_{CR} = \frac{\Sigma K_i x_i}{\Sigma K_i} = \frac{(K_C \cdot x_C) + (K_F \cdot x_F)}{\Sigma K_i} = \frac{(.10561 \cdot 26') + (9.33\times10^{-4} \cdot 26')}{(.10561)2 + (9.33\times10^{-4})2}$$

$$= \frac{2.77}{.213} = 13'$$

$y_{CR} = 10.5'$ by inspection

Step 4: Determine Eccentricities

$e_x = 0$
$e_y = 0$
} No accidental Torsion

Step 5: Determine Torsional Moment

$M_t = P_y \cdot e_x + P_x \cdot e_y = 0$ No torsional moment

3

Step 6: Develop coordinate system w/ origin at CR
Not necessary

Step 7: Determine polar moment of inertia

$$J = \Sigma(k_i d_i^2) = 0$$

Step 8: Determine direct shear in each frame/wall in x-direction

Assume: Analyze for Floor 19

Floor Shear, N-S = 102.8 kips = P

No lateral force in x-direction

Step 9: direct shear in y-dir.

$$F_{A_{DIRECT}} = F_{C_{DIRECT}} = \frac{K_A}{\Sigma k_i} P_x = \frac{.10561}{(.10561)2 + 9.33\times10^{-4}(2)} (102.8\ k) = 50.95\ k$$

$$F_{D_{DIRECT}} = F_{F_{DIRECT}} = \frac{9.33\times10^{-4}}{(.10561)2 + 9.33\times10^{-4}(2)} (102.8) = .45\ k$$

Step 10: Torsional Shear

No torsional Shear

Final Total Shears in each wall:

F_A : 50.95 k

F_B : 0

F_C : 50.95 k

F_D : .45 k

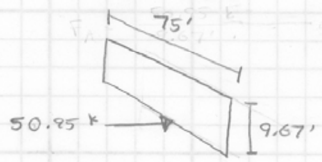
F_E : 0

F_F : .45 k

Lateral Check

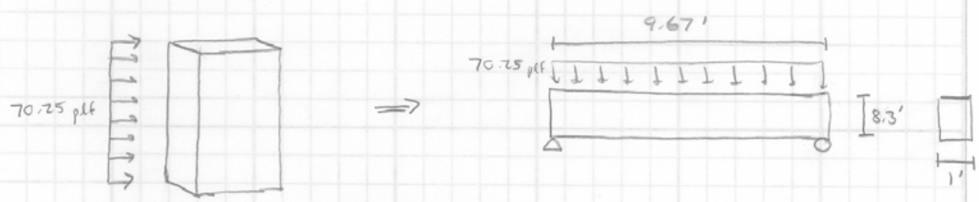
- Check wall A (see Lateral distribution for wall label) at floor 19 for N-S wind loading

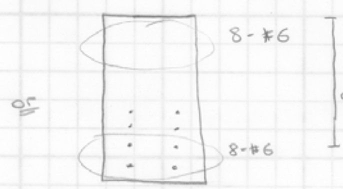
$F_A = 50.95$ k



$W = \frac{50.95 \text{ k}}{9.67' \cdot 75'} = 70.25$ plf

Wall A





$A_s = 8(.44) = 3.52 \text{ in}^2$

$\phi = 3/4 = .75$

$a = \frac{A_s f_y}{.85 f'_c b} = \frac{(3.52)(60)}{.85(5)(12)} = 4.14''$

$d = (8.33')(12 \text{ in/ft}) - 1.5 - .5 - .75 - 1.5 - .75 - \frac{1.5}{2} = 94.3$ (cover, stirrup, ϕ)

$\phi M_n = .9\left[A_s f_y \left(d - \frac{a}{2}\right)\right] = .9\left[3.52 \text{ in}^2 (60)\left(94.3 - \frac{4.14}{2}\right)\right]$

$\phi M_n = 17{,}520.8$

2 Lateral Check

$$V_u \leq \phi V_n$$

• $V_u = 50.95\ k$

• $V_c = \frac{1}{2}(2)\sqrt{f'_c}\ b_w d = \sqrt{5000\ psi}\,(12'')(94.3'') = 80.02\ k$

$\phi V_n = \phi V_c$ (no reinforcement for this direction, only flexural reinforcement)

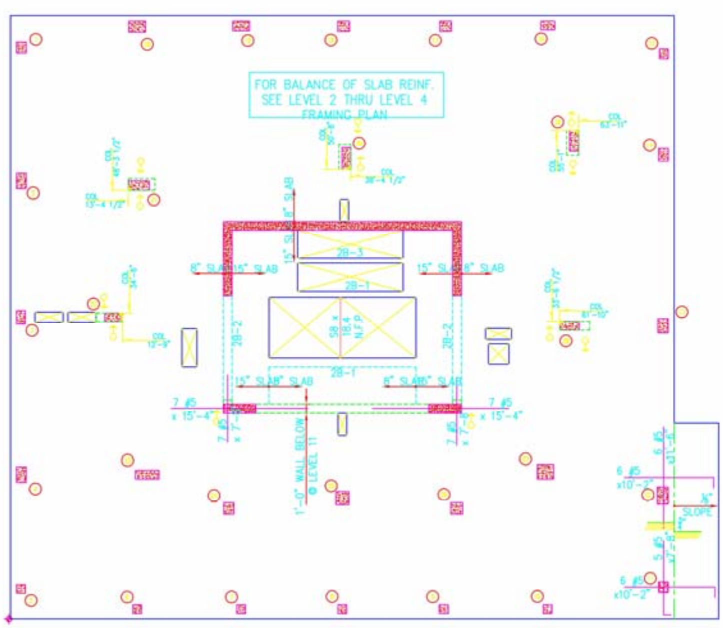
$\phi V_n = .75(80.02) = 60\ k$

$V_u = 50.95 \leq \phi V_n = 60.01$

OK in shear

• will check flexure at a later date

6.1 Gravity Load Check



LEVEL 11 THRU 15 FRAMING PLAN

SCALE $\frac{1}{8}$" = 1'-0"

A spot check of slab sizing and reinforcement was performed on a typical column strip located anywhere from the 11th through 15th floor between columns 27 and 28 to determine whether the concrete slab had enough flexural capacity to support live and dead loads. Analyzed in the long span direction, it was found that the slab met minimum thickness requirements but did not meet minimum reinforcement requirements. From ACI, the required minimum thickness of the slab was 6", but designers of 110 Third Avenue used an 8" slab. This prevents the necessity of analyzing of deflections due to the large margin of increase in slab depth. However, the reinforcing of the two way slab, #4 @ 16" on center top and bottom, proved to be insufficient reinforcing based on the direct design method. After calculating the overall static moment and distributing to the column strip at the interior support and midspan, the midspan passed but reinforcing at the interior support did not. Not only did the reinforcing not meet minimum steel requirements ($.0018A_g$), but a moment of 6.3 'k overshadowed the 4.3 'k provided by the specified reinforcement. The direct design method demonstrated the use of #4 @ 8" at the interior supports and #4 @ 12" at the midspan was appropriate. Equivalent frame analysis may produce a different moment distribution where #4 @ 16" may be satisfactory reinforcement. The direct design method showed that the specified reinforcement came close to satisfying requirements, but fell slightly short. Direct design, however, requires a high degree of uniformity between span lengths and a minimal column offset, both of which are nearly violated by 110 Third Avenue's column layout. In future reports, the use of equivalent frame analysis will be used to address the concerns found in this spot check of the reinforcing in the slab system. See Appendix for calculations.

Appendix

Live Load reduction (ASCE 07-02, 4.8)

$$L = L_o \left(.25 + \frac{15}{\sqrt{K_{LL} A_T}} \right)$$

where $A_T \approx 15 \times 18' = 270'$ SF

Table 4-2 ∴ $K_{LL} = 1$

$K_{LL} A_T = (1)(270) = 270 < 400$

∴ cannot use LL reduction

Snow loading: $p_f = .7 C_e C_t I p_g$ (7.3)

Ground snow load: $p_g = 23\ \text{lb}/\text{ft}^2$ (Fig. 7-1)

Exposure Factor: $C_e = 1.0$ (Table 7-2)

Thermal Factor: $C_t = 1.0$ (Table 7-3)

Importance Factor: $I = 1.1$ (Table 7-4)

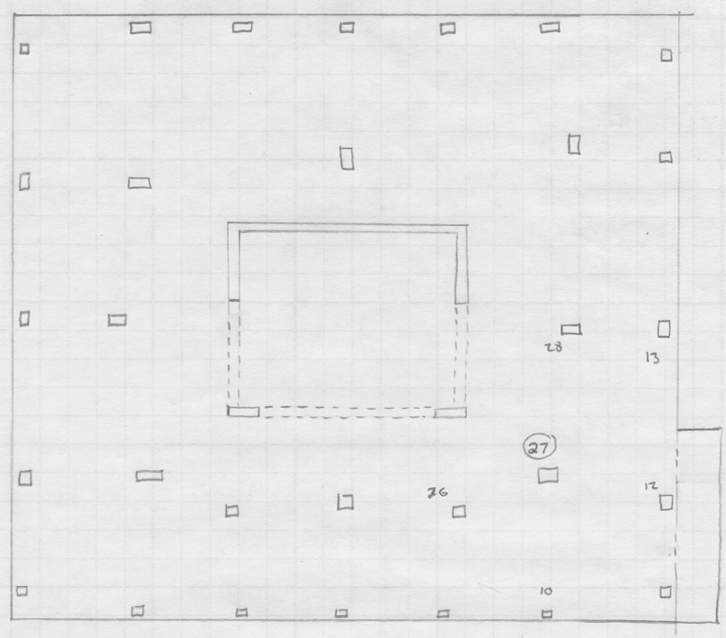
$p_f = .7(1)(1)(1.1)(23\ \text{lb}/\text{ft}^2)$
$= 17.71$ psf

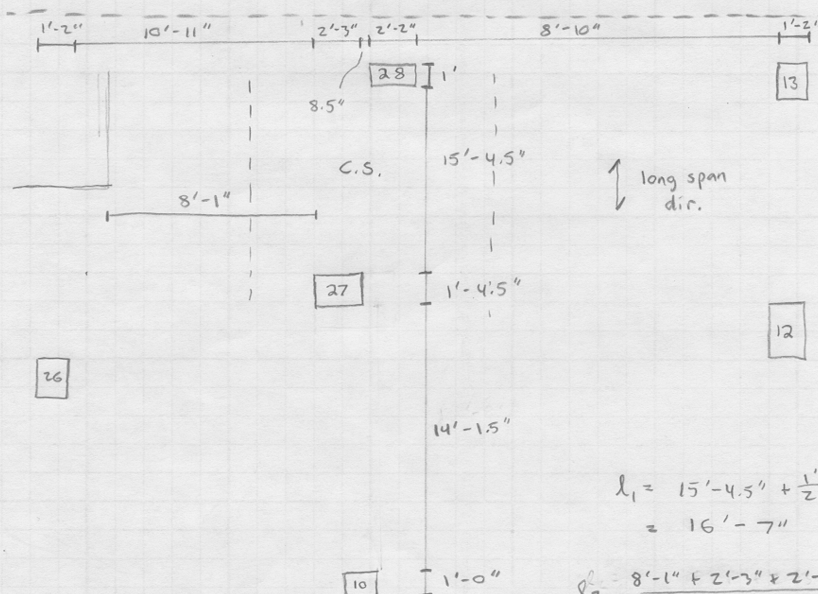
Min. snow load $= (20\ \text{psf})I = 20(1.1) = 22$ psf

Snow load < 30 psf ∴ do not include in seismic loading (9.5.3)

1 SPOT CHECK

Level 11 thru 15 Framing plan





$$l_1 = 15'\text{-}4.5" + \frac{1'}{2} + \frac{1'\text{-}4.5"}{2}$$

$$= 16'\text{-}7"$$

$$l_2 = \frac{8'\text{-}1" + 2'\text{-}3" + 2'\text{-}3" + 8'\text{-}10" + 1'\text{[illegible]}}{2}$$

$$l_2 = \frac{22.5'}{2} = 11'\text{-}3"$$

$$\beta = \frac{16'\text{-}7"}{11'\text{-}3"} = 1.47$$

2

Two-way slab:

- $\frac{1}{2} \ell_{c.s.} = \frac{1}{4}\left(8'-1'' + 2'-3'' + \frac{2'-2''}{2}\right) \approx 2'-10''$ Left half C.S.
- $\frac{1}{2} \ell_{c.s.} = \frac{1}{4}\left(8'-10'' + \frac{2'-2''}{2} + \frac{1'-2''}{2}\right) \approx 2'-8''$ Right half C.S.

  Total C.S = 2'-10" + 2'-8" = 5'-6"

- min. thickness for flat plate, interior span
  - T. 9.5 c in ACI : $\frac{\ell_n}{33} = \frac{15'-4.5''}{33} = \boxed{5.6''}$
  - $.2 \le \frac{\alpha_{f_1} \ell_2^2}{\alpha_{f_2} \ell_1^2} \le 5.0$

$$.2 \le \frac{(11.25')^2}{(16.6')^2} \le 5.0$$

$$.2 \le \alpha_{fm} = .46 \le 5.0 \quad \underline{OK} \quad (\text{ACI } 13.6.1.6)$$

$$h_{min} = \frac{\ell_n\left(.8 + \frac{f_y}{200{,}000}\right)}{36 + 5\beta(\alpha_{fm} - .2)}$$

$$h_{min} = \frac{(15'-4.5'')\left(.8 + \frac{60{,}000}{200{,}000}\right)}{36 + 5(1.47)(.46 - .2)} = \frac{16.9125}{37.911}$$

$$h_{min} = .446' = \boxed{5.4''} \quad (\text{ACI } 9.5.3.3)$$

Use 8" slab to be conservative

- Loads

  Self-weight : $(150\text{ pcf})(8'')\left(\frac{1}{12}\right) = 100$ psf
  Dead load : 25 psf (Dwg. S-001)
  Live load : 40 psf (Dwg. S-001)

$$w_u = 1.2(100 + 25) + 1.6(40) = 214 \text{ psf}$$

- Static Moment

$$M_o = \frac{w_u \ell_2 \ell_n^2}{8} = \frac{(.214)(11.25')(15.375)^2}{8} = 71.14\ 'k$$

3

- Moment distribution to column strip: $\alpha_{f1} \ell_2/\ell_1 = (0)\left(\frac{11.25}{16.58}\right) = 0$

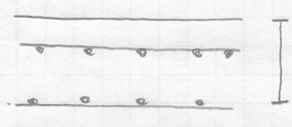
  - Column strip at interior support (-) = $M_o(.65)(.75)$
    (ACI 13.6.3.2 and 13.6.4.1)
    $= (71.14)(.65)(.75) = 34.68$ 'k

  - Column strip at midspan (+) = $M_o(.35)(.60)$
    (ACI 13.6.3.2 and 13.6.4.4)
    $= (71.14)(.35)(.60) = 14.94$ 'k

- min. reinforcing

  $.0018\,A_g = .0018(8'')(12''/ft) = .1728 \ in^2/ft$

  $As_{min} = \frac{M_{n\,req'd}}{f_y(d-\frac{a}{2})}$ use #4 @ 12" min. reinforcement for $A \leq .2 \ in^2/ft$



$d = 8'' - .75''$ cover $- .5''$ reinf. $- \frac{.5''}{2}$ reinf.
$= 6.5''$

$a = \frac{A_s f_y}{.85 f'_c b} = \frac{(.2 \ in^2/ft)(60 \ ksi)}{.85(5 \ ksi)(12 \ in/ft)} = .235$ in.
(5 ksi ← Dwg. 001)

$\phi M_n = .9\left[.2 \ in^2/ft \ (60 \ ksi)\left(6.5 - \frac{.235}{2}\right)\right]$

$= 68.63 \ \frac{in \cdot k}{ft} = 5.74$ 'k/ft.

$As_{min} = \frac{M_n \ req'd}{f_y(d - a/2)} = \frac{68.63/.9}{60(6.5 - \frac{.235}{2})} = .199 \ in^2$

- Moment per foot of width:

  C.S. width = 5'-6"

  At interior support : $\frac{34.68 \text{ 'k}}{5.5'} = 6.3$ 'k

  At midspan : $\frac{14.94 \text{ 'k}}{5.5'} = 2.7$ 'k

4

- At interior support, try #4 @ 8"

$\phi M_n = \frac{12"}{8"}(5.74\text{'k/ft}) = 8.61\text{'k}$

$\phi M_n = 8.61 > M_u = 6.3\text{'k}$

∴ OK

use #4 @ 8"

- At midspan, use #4 @12"

min support is sufficient

$\phi M_n = 5.74\text{'k} > 2.7\text{'k} = M_u$

∴ OK

use #4 @ 12"

Designers of 110 Third ave. used:

- 8" slab
- #4@16" everywhere

$\phi M_n = 5.74\text{'k}\left(\frac{12}{16}\right) = 4.3\text{'k} > 2.7\text{'k}$ for midspan

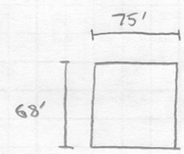
$< 6.3\text{'k}$ at interior support

FAILS

* Note: Equivalent frame analysis may produce a different moment distribution, and #4@16" may be satisfactory reinforcement. Direct design method requires a high degree of uniformity between span lengths and a minimal column offset, both of which are nearly violated by 110 Third Avenue's column layout.

WIND LOAD

ASCE 07-02 , Ch. 6.5.3



1. Basic wind speed $V = 105$ mph

wind directionality: $K_d = .85$

↕ N-S: B = 75'
L = 68'

↔ E-W: B = 68'
L = 75'

2. Table 1-1 , Category III

Table 6-1 , $I = 1.15$

3. Exposure Category

6.5.6.2 Surface Roughness B

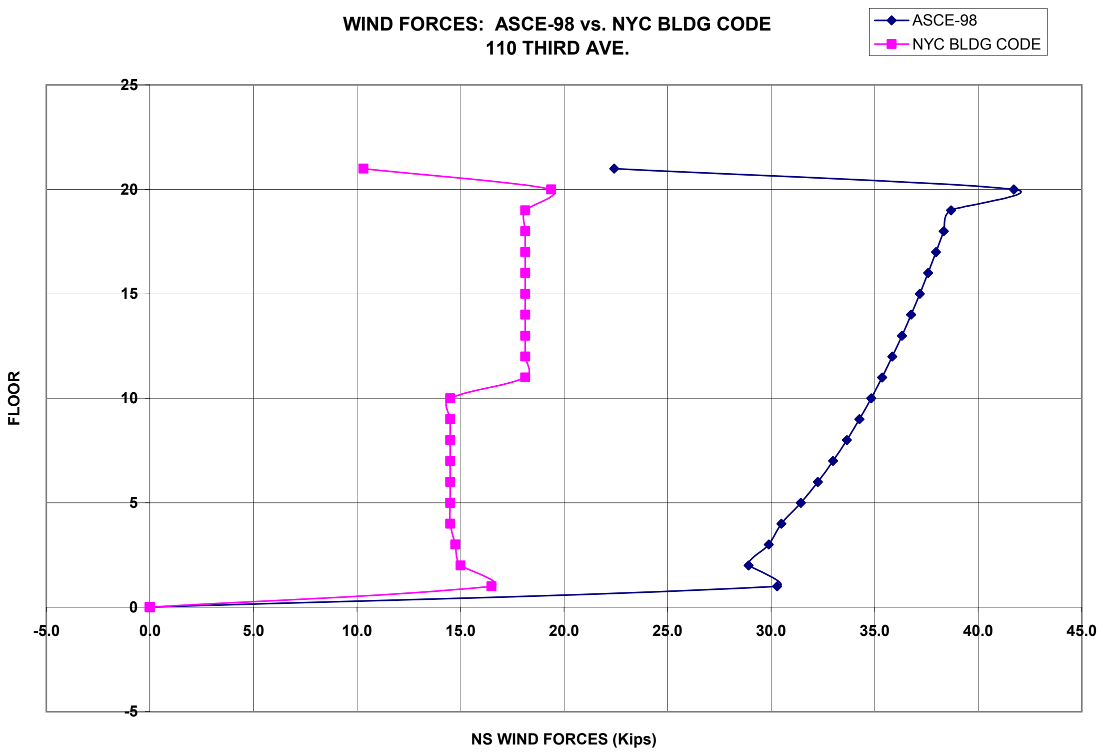
K_z - Table 6-3

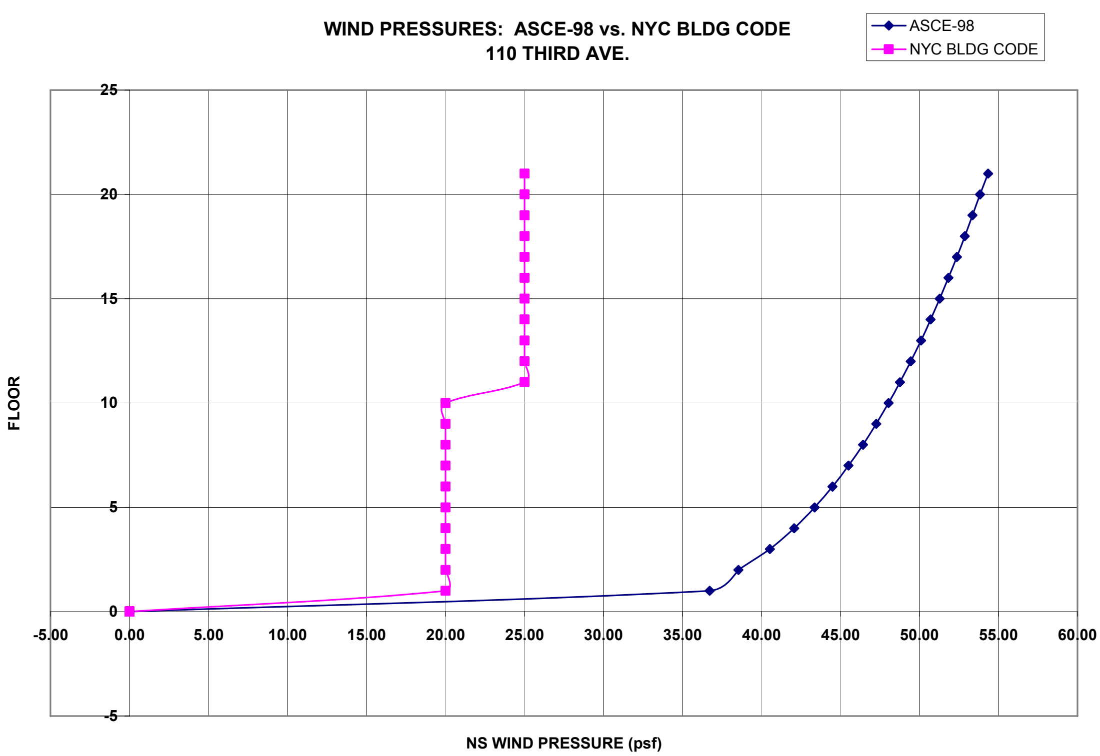
4. $K_{zt} = 1.0$

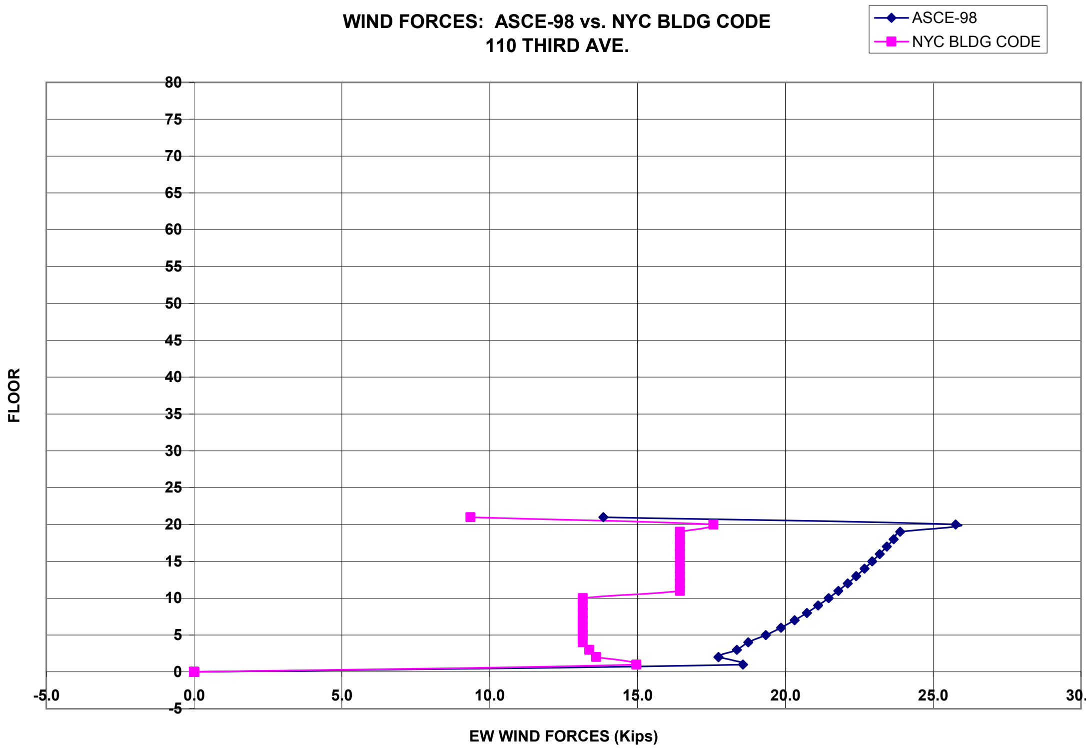
5. Gust Factor - see spreadsheet

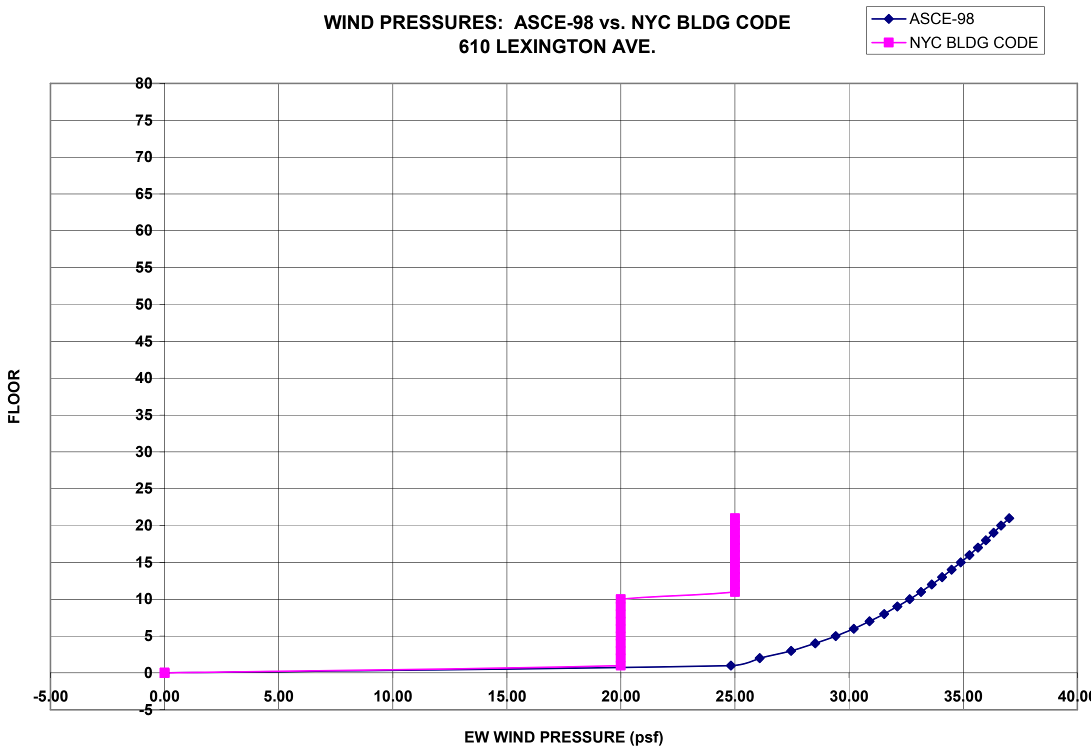
Estimate frequency:

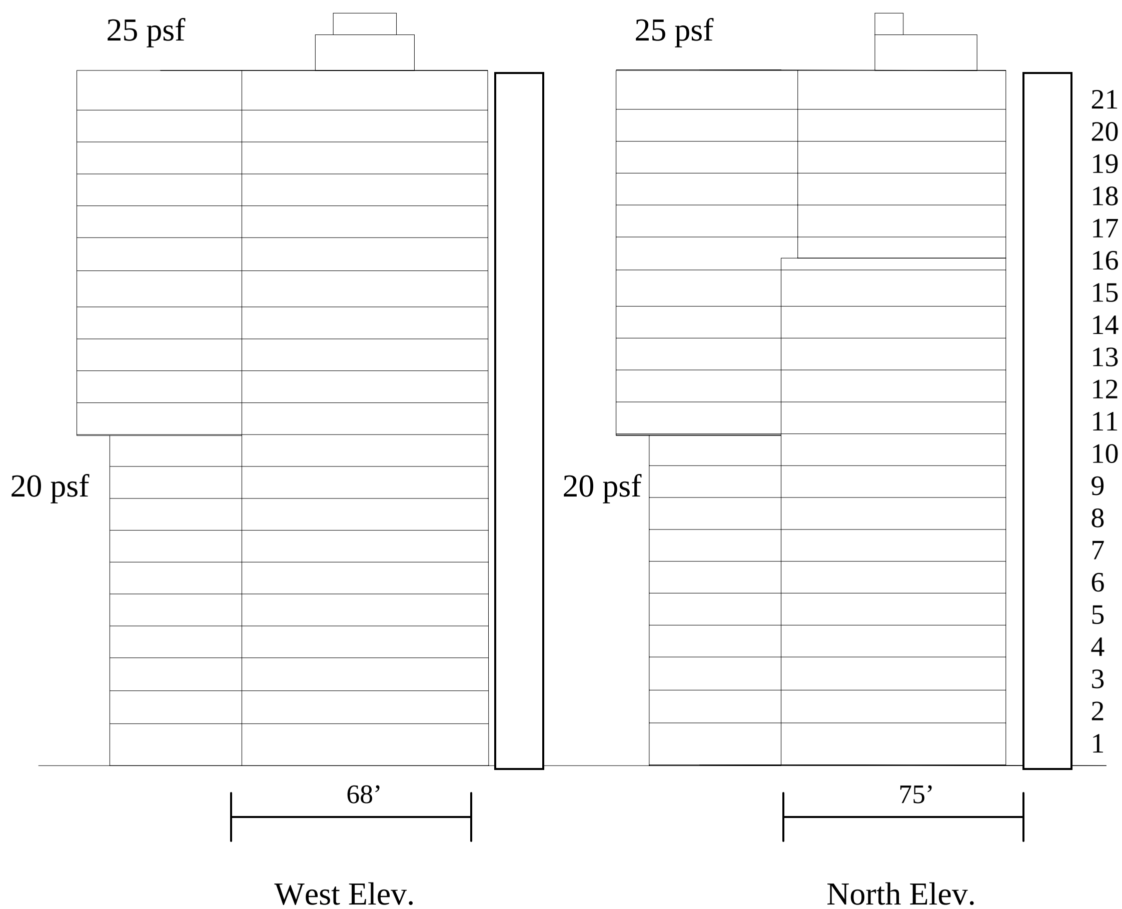
$$f = n_1 = \frac{1}{C_t h^{.75}} = \frac{1}{.02\,(227.5)^{.75}} = .853$$

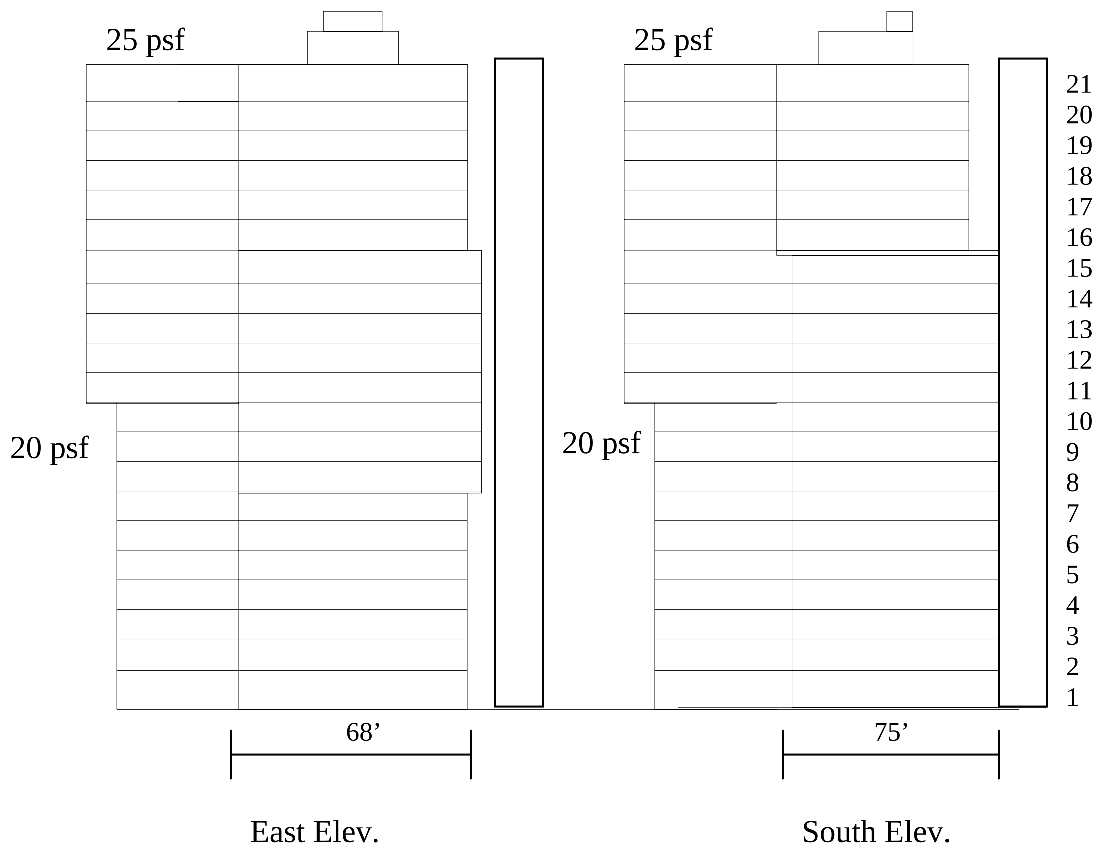

WIND FORCES: ASCE-98 vs. NYC BLDG CODE
110 THIRD AVE.
ASCE-98
NYC BLDG CODE
FLOOR
NS WIND FORCES (Kips)
25
20
15
10
5
0
-5
-5.0
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0


WIND PRESSURES: ASCE-98 vs. NYC BLDG CODE
110 THIRD AVE.
ASCE-98
NYC BLDG CODE
FLOOR
NS WIND PRESSURE (psf)
25
20
15
10
5
0
-5
-5.00
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
55.00
60.00


WIND FORCES: ASCE-98 vs. NYC BLDG CODE
110 THIRD AVE.
ASCE-98
NYC BLDG CODE
FLOOR
EW WIND FORCES (Kips)
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
-5
-5.0
0.0
5.0
10.0
15.0
20.0
25.0
30.0


WIND PRESSURES: ASCE-98 vs. NYC BLDG CODE
610 LEXINGTON AVE.
ASCE-98
NYC BLDG CODE
FLOOR
EW WIND PRESSURE (psf)
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
-5
-5.00
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00


25 psf
25 psf
21
20
19
18
17
16
15
14
13
12
11
10
20 psf
20 psf
9
8
7
6
5
4
3
2
1
68’
75’
West Elev.
North Elev.



25 psf
25 psf
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
20 psf
20 psf
68’
75’
East Elev.
South Elev.