## Letter of Transmittal

September 26, 2014

Ali Said
Structural Thesis Advisor
The Pennsylvania State University
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Dear Doctor Said,

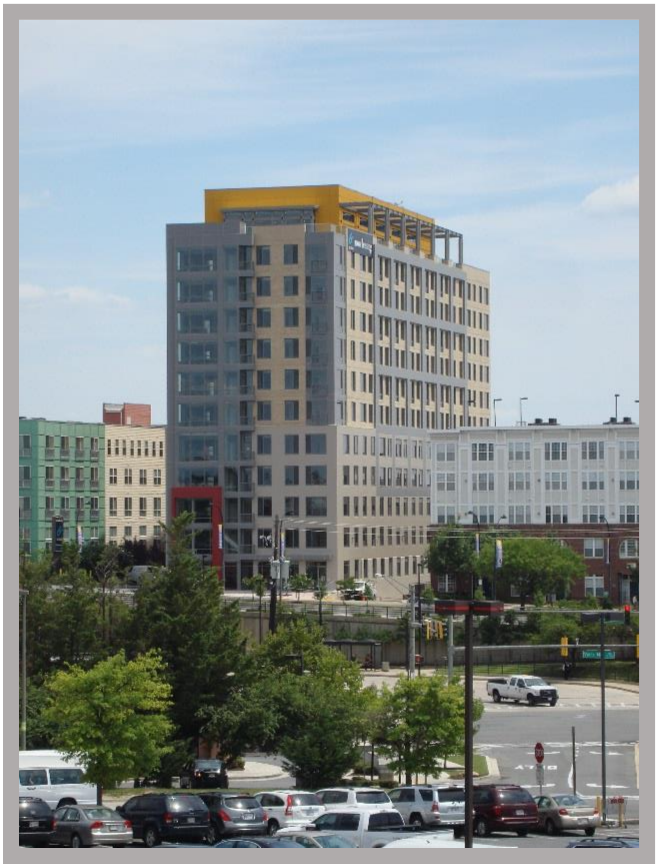
The following technical report fulfills the second Technical Report assigned by the structural faculty for senior thesis.

Technical Report 2 includes a structural analysis of the loads on 11141 Georgia Ave in Wheaton, MD. Included is a list of codes and documents used to compile this report. The analysis includes roof loads, snow loads and drifts, floor loads, exterior wall loads, wind pressures, and seismic story forces.

Thank you for your time in reviewing this report. I look forward to hearing your feedback and discussing it with you.

Sincerely,
Samantha deVries

Enclosed: Technical Report 2



# 11141 Georgia Avenue

Located in Wheaton, MD

**Technical Report 2**

Samantha deVries

Structural Option

Advisor: Ali Said

September 26, 2014

## Table of Contents

## Executive Summary

11141 Georgia Avenue, located in Wheaton, MD, is a 1960's concrete office building on which a 7-story steel addition was completed in August 2014 for $20 million. The building is a high rise apartment building with one and two bedroom studios, a rooftop terrace and penthouse, and is conveniently located next to the metro station.

The Foundations are spread footings with piers and a foundation retaining wall where the building steps from the lowest basement level to the next. Modifications were required to the foundations and slab on grade only where a new elevator pit was added and the old pit was removed.

The structure of the original building is reinforced concrete with typical two-way concrete slab bays that are approximately 22' by 21'. Again, the slabs in the original building only required modifications where new stairwells and elevators were added and the original ones were removed. The addition's structure is framed in structural steel with rolled W-shapes for the columns, girders, and beams, and composites joists for the bays in the floors and on the roof. Each floor has metal deck with a concrete topping.

The lateral system consists of concrete moment frames in the original structure, and steel moment frames in the new structure. Some columns were expanded for additional stiffness to resist an increase in lateral loads due to an increased building height.

There are many joints and connections that involved tying the new columns, beams, and other structural elements into the original building through drilling a hole to embed and grout rebar, anchors, or other connections.

The loads used in the structural design on the project all followed IBC 2009, which allows the use of ASCE 7-05. Due to a change in building use which allows a smaller reduced live load, the removal of the original penthouse, and the use of steel rather than concrete for the addition, the total loads reaching the foundations were close to the original 1960's design loads.

## Purpose

The Purpose of this report is to identify and quantify the structural design loads used in the design of the building 11141 Georgia Avenue located in Wheaton, MD.

The report will identify all building codes, specifications, and other relevant documents used in the design loads of the building. A code analysis was completed using thesis documents to provide a site-specific and building-specific determination of the design loads to be used in the design of the building. Gravity, wind, and seismic loads will be determined and summarized in this report. Because the loads determined will be used for further evaluation of the existing design, codes used for the original design have been used. Redesigns in the spring semester may include an update to a more current code.

# 11141 Georgia Avenue: High Rise Residential Apartments Located in: Wheaton, MD

### Building Statistics

Full Height: 158 Feet
Number of Stories: 14
Size: 158,000 Square Feet
Cost: $44 Million (for the addition)
Dates of Construction: February 2013 - August 2014
Project Delivery Method: Contractor at Risk

### Project Team

Owner: ML Wheaton, LLC c/o Lower Enterprises
General Contractor and CM: Whiting-Turner
Architect: Bonstra Haresign Architects, LLP
Structural Engineer: Rathgeber/Goss Associates
Mechanical Engineer: Brothers Ductwork HVAC, Inc.
Plumbing Engineer: KNI Engineering, Inc.
Lighting Design: Gilmore Lighting Design
Acoustics: Polysonics Acoustics &Technology Consultants

### Structural Systems

The original building was a concrete moment frame building with concrete floor slabs. The foundations include some retaining walls and spread footings.

The new addition was built in steel with a moment frame lateral system to minimize the amount of load added to the existing building's columns and foundations. The floors of the addition are steel deck with a concrete topping.

Due to a change in the building's occupancy type, design loads for the new addition were similar to the original design gravity loads. Therefore, modifications to accommodate the addition were relatively minimal.

The original portion of the building required several modifications to accommodate a new architectural layout.

### Architecture

The original building was a 5 story office building with 2 basement levels constructed in the 1960's. A 7 story addition converted it into a high rise apartment building with one and two bedroom studios.

### Construction

Construction of the addition required a renovation of the original structure as well. Once the foundations were underpinned properly, construction of the addition occurred simultaneously with the retrofit work.

### Mechanical

Cooling occurs using rooftop chiller condensing units (1 unit for each apartment). All units have occupant operable windows. Heating occurs through the use of electrical heaters and heat pumps.

### Electrical/Lighting

The apartments have recessed lighting, and lobbies have pendant and wall mounted fixtures. There are 2 Main Power Distributers, each fed from a transformer, one with 1400 KVA, the other is 1750 KVA.

Samantha deVries: Structural Option
Advisor: Ali Said

Project Sponsor: Rathgeger/Goss Associates
https://www.engr.psu.edu/ae/thesis/portfolios/2015/sjd5225/deVries_AE_Thesis/Home.html

## Site Plan and Location of Building

11141 Georgia Ave is Located in Wheaton Maryland near the Wheaton Metro Station. To the west of the site is a mainly commercial zone, while to the east is a residential zone. The site itself is combined commercial-residential. Figures 1 and 2 below illustrate the building's location.


Figure 1: Building Location on Site, Courtesy of Bonstra Haresign Architects

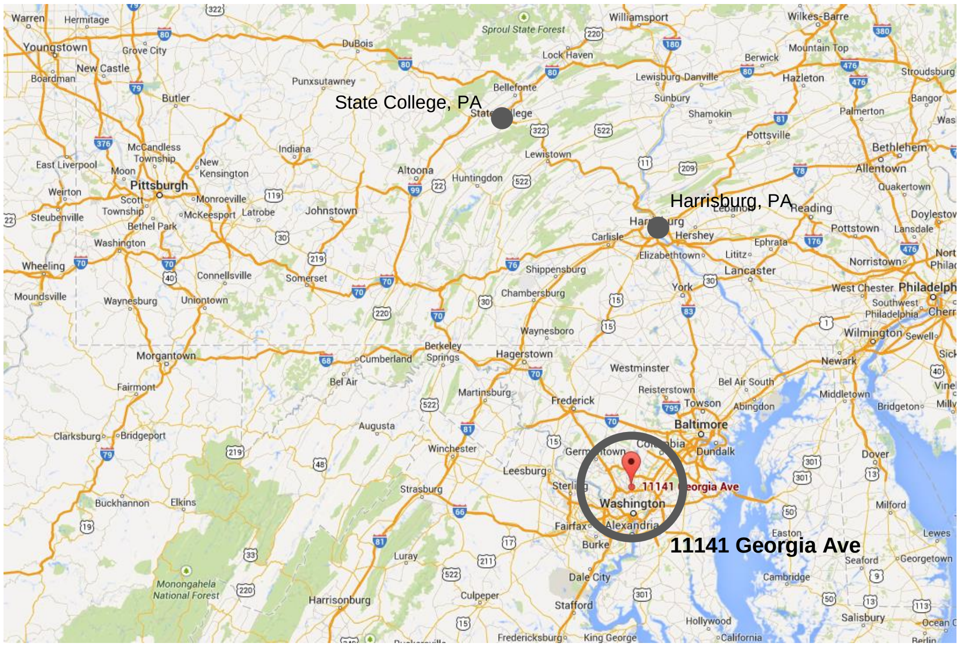



Figure 2: Map showing building location relative to State College and Harrisburg

## Documents used during preparation of report

The following is a list of the structural codes used on the project. The codes used in the original 1962 drawings were not available. The codes used on the new addition to and renovation of the original building will be the referenced codes in this and future technical. The following codes will be used to determine current loads on the structure.

**International Code Council**

International Building Code 2009

**American Society of Civil Engineers**

ASCE 7-05: Minimum Design Loads for Buildings and Other Structures

**Vulcraft Deck Catalog**

**Previous Course Notes**

## Roof Loads

The roof loads calculation includes the roof dead loads, roof live loads, and snow loads. The loads calculated will also be compared to the loads used in the design of the building. Figure 3 and 4 below shows the layers of roofing considered in the dead load calculations.

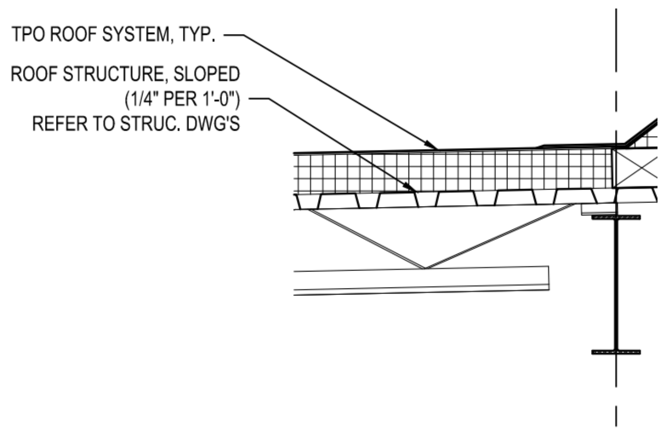



Figure 3: Section through penthouse roof. From 1/A4.09

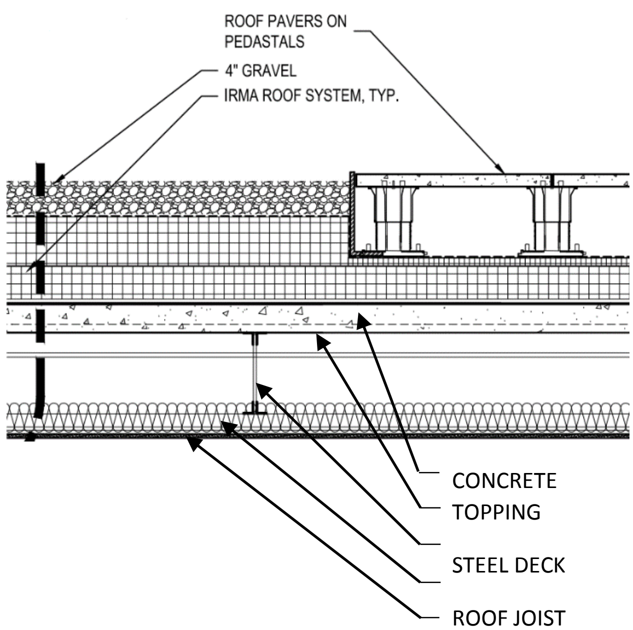



Figure 4: Section through roof at the 12th floor terrace level. From 3/A4.09.

Note: IRMA (Inverted Roof Membrane Assembly) roof system includes a membrane layer and rigid insulation

Tech Report 2 | Roof Loads | Samantha deVries

**Roof Dead Load**

Penthouse Roof:

| | Load (psf) |
|---|---|
| Joist/Beam Allowance | 10 |
| Roof Decking | 10 |
| Roofing System | 7 |
| | 27 psf |

12th Floor Terrace:

| | |
|---|---|
| Concrete / Deck | 37 |
| Joist / Beam Allowance | 10 |
| 4" rigid insulation | 3 |
| Drop Ceiling | 5 |
| MEP | 15 |
| Sprinklers | 3 |
| Pavers or Tiles | 25 |
| | 98 psf |

**Roof Live Load**

Penthouse Roof:

Code minimum is 20 psf
(Table 4-1: Ordinary flat roofs)

Use 30 psf (value used in design)

12th Floor Terrace:

Table 4-1: Roofs used for assemby purposes

Use 100 psf (same as design value)

* Note: drawings indicate that snow load must be used instead as the live load where it is the larger value

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ASCE 7-05 : Chapter 7

Section 7.3 : Flat Roof Snow Loads

$p_f = 0.7 C_e C_t I p_g$

$p_g = 25$ psf (Figure 7-1)

$C_e = 0.9$ (Table 7-2) Terrain Category B
Roof Fully Exposed

$C_t = 1.0$ (Table 7-3)

$I = 1.0$ (Table 7-4) Use w/ importance Category II

$p_f = 0.7(0.9)(1.0)(1.0)(25) = 15.8$ psf

min. where $p_g > 20$ psf
$p_f = 20(I) = 20(1.0)$

$\boxed{p_f = 20 \text{ psf}}$ (Design snow load = 20 psf) < 30 psf LL on Penthouse Roof

Snow Drift Section 7.7: Drifts on Lower Roofs

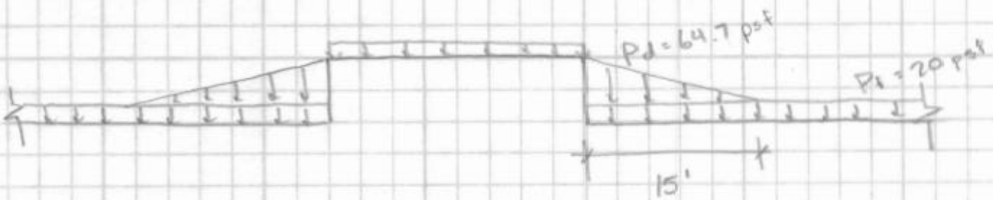
$\gamma = 0.13 p_g + 14 = 0.13(25) + 14 = 17.25$
$h_b = p_s / \gamma = 15.8 / 17.25 = 0.916$
$h_c = 15' \rightarrow h_c / h_b = 16.4 > 0.2$ (must calc. drift)

$l_{upper\ roof} = 128'$ $l_{lower\ roof} = 40'$

leeward drift (Fig. 7-9 w/ 128')
$h_d = 3.75' \rightarrow$ use larger value
windward drift (Fig. 7-9 w/ 40')
$h_d = 2.0'$

$h_d < h_c = 15$, so $w = 4h_d = 4(3.75) = 15'$

$p_d = h_d \gamma = 3.75(17.25) = \boxed{64.7 \text{ psf}}$ < 100 psf LL on level 12



## Floor Loads

The floor load calculations will include both the dead and live loads for both the original concrete floors and the new addition's floors. Figure 5 below shows a section through a typical concrete slab in the original building, and figure 6 shows a section through a typical floor of the addition.

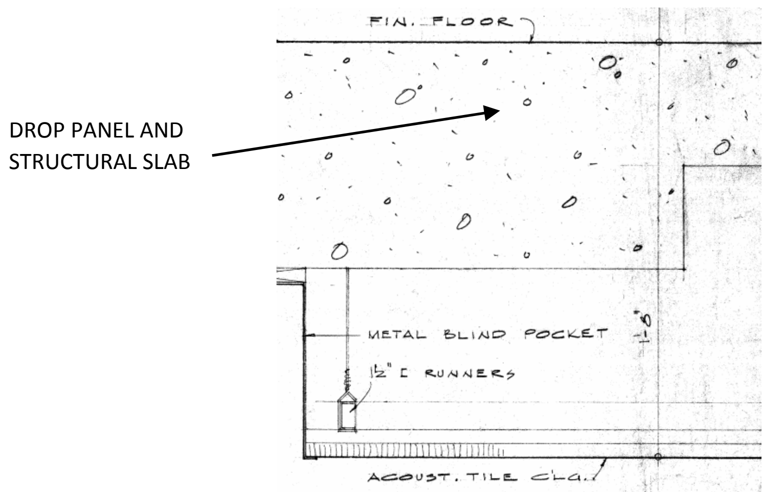



Figure 5: Section through typical floor in existing building. From A.12: Window & Wall Sections

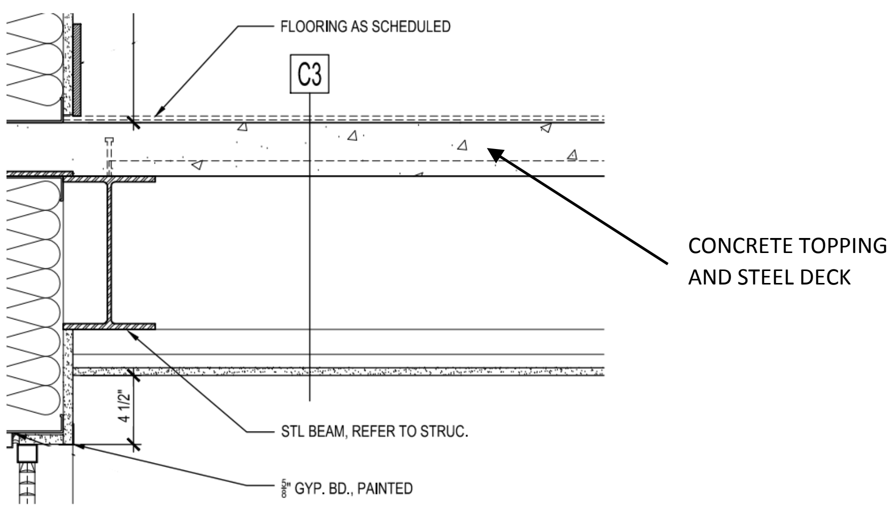



Figure 6: Section through typical floor in addition. From 10/A4.20

Tech Report 2 | Floor Loads | Samantha deVries

## Floor Dead Loads

### Concrete Floor

| Concrete Floor | Load (psf) |
|---|---|
| Drop Ceiling | 5 |
| MEP | 15 |
| Sprinklers | 3 |
| Concrete 6 1/2" | 81.25 |
| or 8" x 150 pcf | 100 |

6 1/2" slab : 105 psf
8" slab : 123 psf

### Steel Framed Floors

| Steel Framed Floors | Load (psf) |
|---|---|
| Ceiling | 5 |
| MEP | 15 |
| Sprinklers | 3 |
| Beam / Joist Allowance | 15 |
| Concrete / Deck | 37 |

75 psf

## Floor Live Loads

| Area | Code Min. (psf) | Design Value |
|---|---|---|
| Residential | 40 | 40 |
| Lobbies / Stairs / Exits | 100 | 100 |
| Penthouse Floor | 100 | 100 |
| Lobby Floor | 100 | 100 |
| Corridors above 1st Floor | 40 | 40 |
| 12th Floor Corridors | 40 | 100 |
| Parking | 40 | 40 |

Note: Residential Areas also receive a 20 psf partition Allowance

## Perimeter and Exterior Wall Loads

The exterior wall load calculations will produce a line load around the perimeter of the building for the original façade and the new façades. Figure 7 is a typical section through the exterior wall in the original building, and figure 8 is a section through a typical exterior wall in the addition.

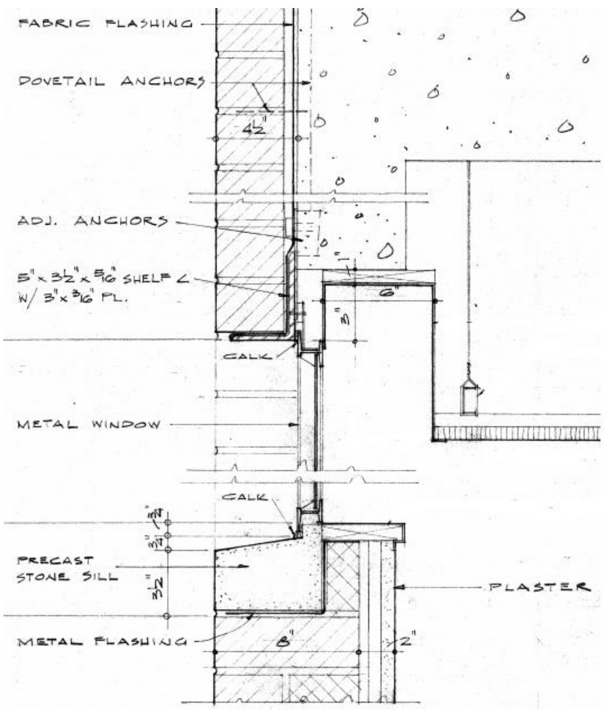



Figure 7: Section through typical exterior wall in existing building. From A.12: Window & Wall Sections

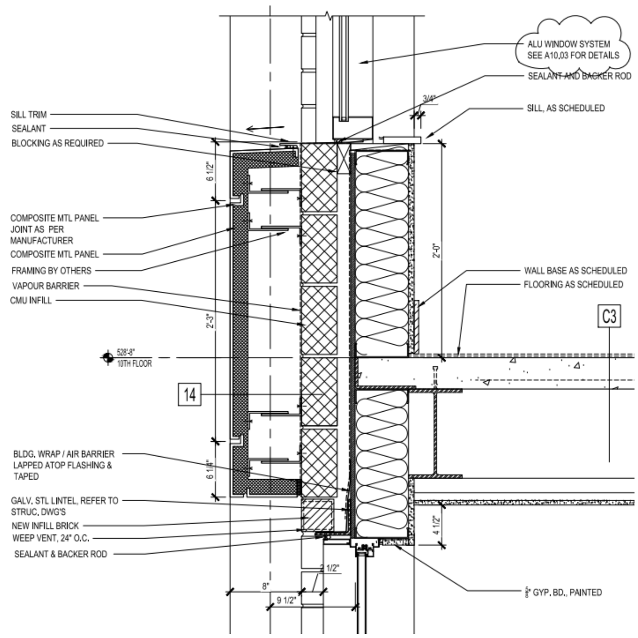



Figure 8: Section through typical exterior wall in addition. From 4A.21.

## Wall Load Path

The exterior façade components, such as the brick or metal panels, rest on a steel angle at each level, and the gypsum board and insulation rests on the framed interior wall, which is attached to the brick or CMU. Therefore, the exterior wall loads acts as a line load at each floor slab around the perimeter of the building. The load on the slab edge is then carried by the slab to the exterior columns, which then carry the load down to the foundations, followed by the soil.

Tech Report 2 | Exterior Wall Loads | Samantha deVries

Typical Existing Building Wall Dead Load:

Applied as a line load at the edge of the slab

8" Brick Layer (assume hard brick)

130 pcf × 8/12 = 87 psf × 11' typ. = 957 plf

3/4" layer gypsum board

50 pcf × 0.75/12 × 11' = 34.4 plf

Total = 992 plf

Typical Addition Wall Dead Load:

Composite Metal Panel

5 psf × 11' = 55 plf

CMU Infill (or Brick facade w/out metal panel)

29 psf (CMU) ×11' or 38 psf (brick medium weight) ×11'

319 plf 418 plf

Water Membrane

2 psf × 11' = 22 plf

3/4" gypsum board = 34.4 plf

Fibrous glass insulation

1.1 psf × 11 = 12.1 plf

Total: at metal panels = 443 plf

at brick faces = 487 plf

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Non-Typical Dead Loads

Floors & Roofs:

At 3/4" drop panels (7' x 7') existing building

3/4" x 150 pcf = **9 psf**

Existing Building Perimeter Beams

12" x 150 pcf x 12" width (avg.) = **150 plf**

16" depth = **200 plf**

18" = **225 plf**

24" = **300 plf**

30" = **375 plf**

(Note: there is a large variety of perimeter beam sizes, so this is a sample to provide a range of additional load)

## Wind Loads

The following section includes wind load calculations for 11141 Georgia Ave according to ASCE 7-05: Section 6 using Method 2. Excel was utilized to program the equations for increased efficiency while working through the calculations. The spreadsheets are shown first for wind in the direction perpendicular to the building, followed by wind parallel to the building. Included at the end of the section are diagrams showing the wind loads acting on the building.

## Wind Load Calculations: Wind Parallel to Building

**ASCE 7-05, Chapter 6.5: Method 2 - Analytical Procedure**

**Design Procedure from Section 6.5.3**

Blue boxes are input boxes, all else are determined by equations

| **Building Information** | | |
|---|---|---|
| | B | 60 |
| | L | 214 |
| | h | 153 |
| | z bar | 145 |

| | **Variable** | **Value** | **Units** | **Comments** |
|---|---|---|---|---|
| **1. Determine Basic Wind Speed and Directonality Factor** | | | | |
| Basic Wind Speed | V | 90 | mph | (Fig. 6-1) |
| Directionality Factor | $k_d$ | 0.85 | | (Table 6-4) |
| **2. Determine Importance Factor** | | | | |
| Occupancy Category | | II | | (Table 1-1) |
| Importance Factor | I | 1 | | (Table 6-1) |

**3 & 9. Exposure Category, Velocity Pressure Exposure Coefficient, and Velocity Pressure**

Exposure Category B — From Structural Drawings

Velocity Pressure Exposure Coefficient

Note: Use exposure B, case 2 for MWFRS

Values determined by Interpolation

| Height (ft) | $K_z$ | $q_z$ or $q_h$ |
|---|---|---|
| 8 | 0.570 | 11.82 |
| 19 | 0.618 | 12.81 |
| 30 | 0.700 | 14.52 |
| 41 | 0.765 | 15.86 |
| 51 | 0.814 | 16.88 |
| 61 | 0.854 | 17.71 |
| 73 | 0.902 | 18.70 |
| 83 | 0.940 | 19.49 |
| 94 | 0.972 | 20.16 |
| 104 | 1.000 | 20.74 |
| 114 | 1.025 | 21.25 |
| 125 | 1.053 | 21.84 |
| 136 | 1.080 | 22.39 |
| 140 | 1.090 | 22.60 |
| 153 | 1.116 | 23.14 |
| 158 | 1.126 | 23.35 |

**4. Determine Topographic Factor**

| | | | |
|---|---|---|---|
| Topographic Factor | $K_z$ | 1 | Value used by structural engineering firm |

**5. Determine Gust Effect Factor**

The following is based on a flexible building (Section 6.5.8.2)

Input Variables

| | | |
|---|---|---|
| b bar | 0.45 | (Table 6-1) |
| α bar | 0.25 | (Table 6-1) |
| ϵ bar | 0.33 | (Table 6-1) |
| l | 320.00 | (Table 6-1) |
| c | 0.30 | (Table 6-1) |
| β | 1.50 | (C6.5.8) |

Output Variables

| | | | |
|---|---|---|---|
| $n_1$ | 0.49 | | |
| $N_1$ | 2.987 | $R_n$ | 0.070 |
| $\eta_h$ | 4.012 | $R_h$ | 0.218 |
| $\eta_B$ | 1.573 | $R_B$ | 0.442 |
| $\eta_L$ | 18.785 | $R_L$ | 0.052 |
| $I_{z\ bar}$ | 0.23 | $g_q$ | 3.40 |
| $L_{z\ bar}$ | 524.125 | $g_r$ | 4.02 |
| $V\ bar_{z\ bar}$ | 86.000 | $g_v$ | 3.40 |
| Q | 0.86 | | |
| R | 0.05 | | |

Gust Effect Factor $G_f$ 0.85

**6. Determine the Enclosure Classification**

Building is considered enclosed (Section 6.5.9)

**7. Determine the Internal Pressure Coefficient**

| | | |
|---|---|---|
| $Gc_{pi}$ | 0.18 | (Figure 6-5) |
| or | -0.18 | |

**8. Determine External Pressure Coefficients**

| | | | | |
|---|---|---|---|---|
| Windward Wall | $C_p$ | 0.8 | (Figure 6-6) | use with $q_z$ |
| Leeward Wall | $C_p$ | -0.222 | (Figure 6-6) | use with $q_h$ |
| Side Wall | $C_p$ | -0.7 | (Figure 6-6) | use with $q_h$ |
| Roof (0' to 76.5') | $C_p$ | -1.07 | (Figure 6-6) | |
| Roof (76.5' to 158') | $C_p$ | -0.78 | (Figure 6-6) | |
| Roof (158' to 213') | $C_p$ | -0.58 | (Figure 6-6) | |

| Wind Pressure Chart (Wind Parallel to Building) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Location** | **z(ft)** | **$q_z$ or $q_h$** | **$C_p$** | **$G_f$** | **$Gc_{pi}$** | **$q_iGC_{pi}$ (psf)** | **Net Pressure (psf)** | |
| | | | | | | | **$q_zG_fC_p$-$q_i$(+$GC_{pi}$)** | **$q_zG_fC_p$-$q_i$(-$GC_{pi}$)** |
| **Windward** | 8 | 11.82 | 0.8 | 0.85 | 0.18 | 2.13 | 5.92 | **10.17** |
| | 19 | 12.81 | 0.8 | 0.85 | 0.18 | 2.31 | 6.41 | **11.03** |
| | 30 | 14.52 | 0.8 | 0.85 | 0.18 | 2.61 | 7.27 | **12.49** |
| | 41 | 15.86 | 0.8 | 0.85 | 0.18 | 2.86 | 7.94 | **13.65** |
| | 51 | 16.88 | 0.8 | 0.85 | 0.18 | 3.04 | 8.45 | **14.53** |
| | 61 | 17.71 | 0.8 | 0.85 | 0.18 | 3.19 | 8.86 | **15.24** |
| | 73 | 18.70 | 0.8 | 0.85 | 0.18 | 3.37 | 9.36 | **16.10** |
| | 83 | 19.49 | 0.8 | 0.85 | 0.18 | 3.51 | 9.76 | **16.77** |
| | 94 | 20.16 | 0.8 | 0.85 | 0.18 | 3.63 | 10.09 | **17.34** |
| | 104 | 20.74 | 0.8 | 0.85 | 0.18 | 3.73 | 10.38 | **17.84** |
| | 114 | 21.25 | 0.8 | 0.85 | 0.18 | 3.83 | 10.64 | **18.29** |
| | 125 | 21.84 | 0.8 | 0.85 | 0.18 | 3.93 | 10.93 | **18.79** |
| | 136 | 22.39 | 0.8 | 0.85 | 0.18 | 4.03 | 11.21 | **19.27** |
| | 153 | 23.14 | 0.8 | 0.85 | 0.18 | 4.17 | 11.58 | **19.91** |
| **Leeward** | All | 23.35 | -0.22 | 0.85 | 0.18 | 4.20 | **-8.61** | -0.21 |
| **Side** | All | 23.35 | -0.7 | 0.85 | 0.18 | 4.20 | **-18.11** | -9.70 |
| **Roof (0' to 76.5')** | 153 | 23.35 | -1.07 | 0.85 | 0.18 | 4.20 | **-25.46** | -17.05 |
| **Roof (76.5' to 158')** | 153 | 23.35 | -0.78 | 0.85 | 0.18 | 4.20 | **-19.70** | -11.29 |
| **Roof (158' to 213')** | 153 | 23.35 | -0.58 | 0.85 | 0.18 | 4.20 | **-15.72** | -7.32 |
| **Low Parapet WW** | 140 | 22.60 | | | 1.5 | 33.90 | | **33.90** |
| **Low Parapet LW** | 140 | 22.60 | | | -1.0 | -22.60 | | **-22.60** |
| **High Parapet WW** | 158 | 23.35 | | | 1.5 | 35.02 | | **35.02** |
| **High Parapet LW** | 158 | 23.35 | | | -1.0 | -23.35 | | **-23.35** |

## Wind Load Calculations: Wind Perpendicular to Building

**ASCE 7-05, Chapter 6.5: Method 2 - Analytical Procedure**

**Design Procedure from Section 6.5.3**

Blue boxes are input boxes, all else are determined by equations

| | | |
|---|---|---|
| **Building Information** | B | 214 |
| | L | 60 |
| | h | 153 |
| | z bar | 145 |

| | Variable | Value | Units | Comments |
|---|---|---|---|---|
| **1. Determine Basic Wind Speed and Directonality Factor** | | | | |
| Basic Wind Speed | V | 90 | mph | (Fig. 6-1) |
| Directionality Factor | $k_d$ | 0.85 | | (Table 6-4) |
| **2. Determine Importance Factor** | | | | |
| Occupancy Category | | II | | (Table 1-1) |
| Importance Factor | I | 1 | | (Table 6-1) |
| **3 & 9. Exposure Category, Velocity Pressure Exposure Coefficient, and Velocity Pressure** | | | | |
| Exposure Category | | B | | From Structural Drawings |
| Velocity Pressure Exposure Coefficient | | | | |

Note: Use exposure B, case 2 for MWFRS

Values determined by Interpolation

| Height (ft) | $K_z$ | $q_z$ or $q_h$ |
|---|---|---|
| 8 | 0.570 | 11.82 |
| 19 | 0.618 | 12.81 |
| 30 | 0.700 | 14.52 |
| 41 | 0.765 | 15.86 |
| 51 | 0.814 | 16.88 |
| 61 | 0.854 | 17.71 |
| 73 | 0.902 | 18.70 |
| 83 | 0.940 | 19.49 |
| 94 | 0.972 | 20.16 |
| 104 | 1.000 | 20.74 |
| 114 | 1.025 | 21.25 |
| 125 | 1.053 | 21.84 |
| 136 | 1.080 | 22.39 |
| 140 | 1.090 | 22.60 |
| 153 | 1.116 | 23.14 |
| 158 | 1.126 | 23.35 |

| | Variable | Value | Units | Comments |
|---|---|---|---|---|
| **4. Determine Topographic Factor** | | | | |
| Topographic Factor | $K_z$ | 1 | | Value used by structural engineering firm |

**5. Determine Gust Effect Factor**

The following is based on a flexible building (Section 6.5.8.2)

Input Variables

| | | |
|---|---|---|
| b bar | 0.45 | (Table 6-1) |
| α bar | 0.25 | (Table 6-1) |
| ϵ bar | 0.33 | (Table 6-1) |
| l | 320.00 | (Table 6-1) |
| c | 0.30 | (Table 6-1) |
| β | 1.50 | (C6.5.8) |

Output Variables

| | | | |
|---|---|---|---|
| $n_1$ | 0.49 | | |
| $N_1$ | 2.987 | $R_n$ | 0.070 |
| $\eta_h$ | 4.012 | $R_h$ | 0.218 |
| $\eta_B$ | 5.611 | $R_B$ | 0.162 |
| $\eta_L$ | 5.267 | $R_L$ | 0.172 |
| $I_{z\ bar}$ | 0.23 | $g_q$ | 3.40 |
| $L_{z\ bar}$ | 524.125 | $g_r$ | 4.02 |
| $V\ bar_{z\ bar}$ | 86.000 | $g_v$ | 3.40 |
| Q | 0.82 | | |
| R | 0.03 | | |

Gust Effect Factor $G_f$ 0.83

**6. Determine the Enclosure Classification**

Building is considered enclosed (Section 6.5.9)

**7. Determine the Internal Pressure Coefficient**

| | | |
|---|---|---|
| $GC_{pi}$ | 0.18 | (Figure 6-5) |
| or | -0.18 | |

**8. Determine External Pressure Coefficients**

| | | | | |
|---|---|---|---|---|
| Windward Wall | $C_p$ | 0.8 | (Figure 6-6) | use with $q_z$ |
| Leeward Wall | $C_p$ | -0.5 | (Figure 6-6) | use with $q_h$ |
| Side Wall | $C_p$ | -0.7 | (Figure 6-6) | use with $q_h$ |
| Roof (0' to 60') | $C_p$ | -0.9 | (Figure 6-6) | |

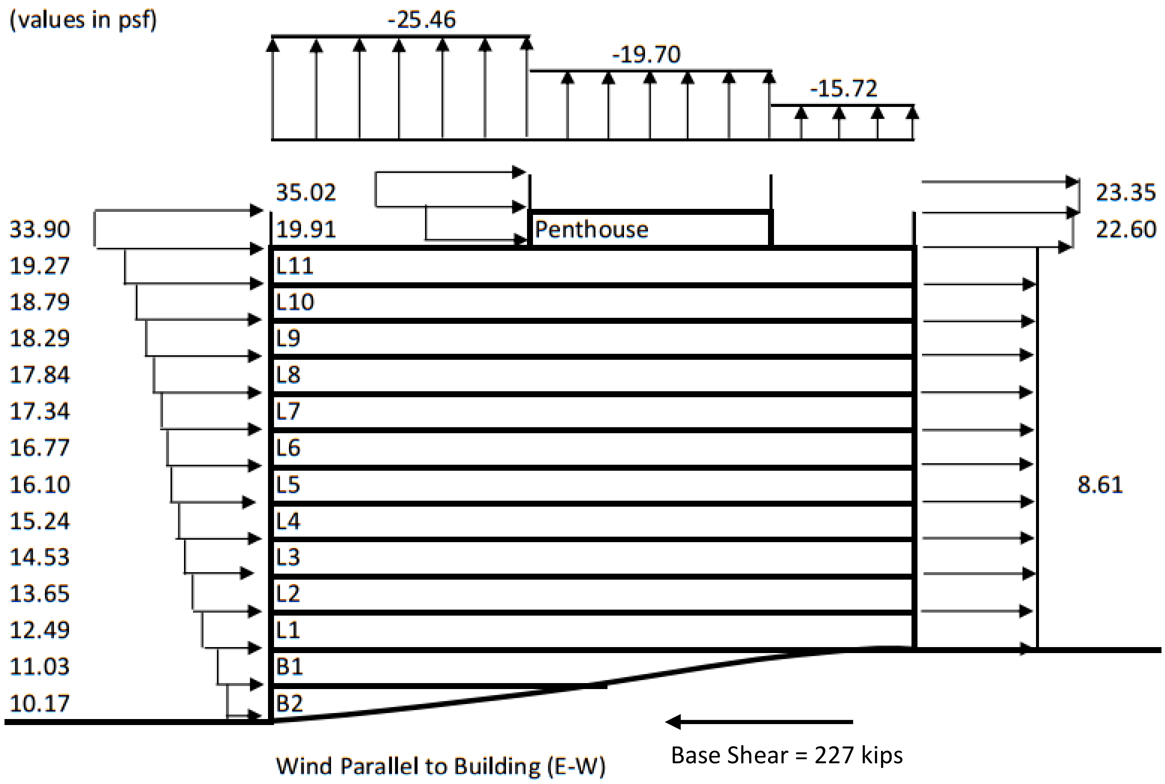
| Wind Pressure Chart (Wind Perpendicular to Building) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Location** | **z(ft)** | **$q_z$ or $q_h$** | **$C_p$** | **$G_f$** | **$Gc_{pi}$** | **$q_iGC_{pi}$ (psf)** | **Net Pressure (psf)** | |
| | | | | | | | **$q_zG_fC_p$-$q_i$(+$GC_{pi}$)** | **$q_zG_fC_p$-$q_i$(-$GC_{pi}$)** |
| **Windward** | 8 | 11.82 | 0.8 | 0.83 | 0.18 | 2.13 | 5.70 | **9.95** |
| | 19 | 12.81 | 0.8 | 0.83 | 0.18 | 2.31 | 6.17 | **10.79** |
| | 30 | 14.52 | 0.8 | 0.83 | 0.18 | 2.61 | 6.99 | **12.22** |
| | 41 | 15.86 | 0.8 | 0.83 | 0.18 | 2.86 | 7.64 | **13.35** |
| | 51 | 16.88 | 0.8 | 0.83 | 0.18 | 3.04 | 8.13 | **14.21** |
| | 61 | 17.71 | 0.8 | 0.83 | 0.18 | 3.19 | 8.53 | **14.91** |
| | 73 | 18.70 | 0.8 | 0.83 | 0.18 | 3.37 | 9.01 | **15.75** |
| | 83 | 19.49 | 0.8 | 0.83 | 0.18 | 3.51 | 9.39 | **16.41** |
| | 94 | 20.16 | 0.8 | 0.83 | 0.18 | 3.63 | 9.71 | **16.97** |
| | 104 | 20.74 | 0.8 | 0.83 | 0.18 | 3.73 | 9.99 | **17.46** |
| | 114 | 21.25 | 0.8 | 0.83 | 0.18 | 3.83 | 10.24 | **17.89** |
| | 125 | 21.84 | 0.8 | 0.83 | 0.18 | 3.93 | 10.52 | **18.38** |
| | 136 | 22.39 | 0.8 | 0.83 | 0.18 | 4.03 | 10.79 | **18.85** |
| | 153 | 23.14 | 0.8 | 0.83 | 0.18 | 4.17 | 11.15 | **19.48** |
| **Leeward** | All | 23.35 | -0.5 | 0.83 | 0.18 | 4.20 | **-13.86** | -5.46 |
| **Side** | All | 23.35 | -0.7 | 0.83 | 0.18 | 4.20 | **-17.72** | -9.32 |
| **Roof (0' to 60')** | 153 | 23.35 | -0.9 | 0.83 | 0.18 | 4.20 | **-21.59** | -13.18 |
| **Low Parapet WW** | 140 | 22.60 | | | 1.5 | 33.90 | | **33.90** |
| **High Parapet WW** | 158 | 23.35 | | | 1.5 | 35.02 | | **35.02** |
| **High Parapet LW** | 158 | 23.35 | | | -1.0 | -23.35 | | **-23.35** |

## Base Shear Calculations

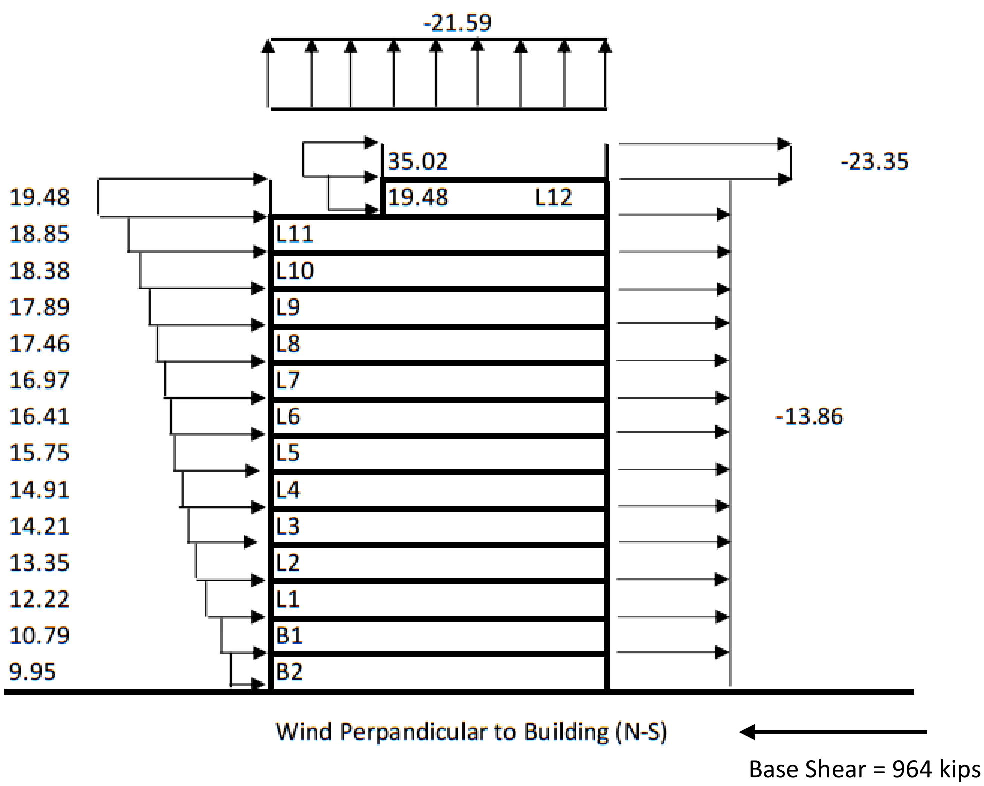
To calculate the base shear for both wind directions, the story height was multiplied by the pressure at that level and by the width of the building perpendicular to the wind direction. These products were summed up, including pressure from both the windward and leeward sides of the building, to find the total base shear in both orthogonal directions.

| Level | Floor Ht. | Story Ht. * Net Pressure | |
|---|---|---|---|
| | | Perpendicular | Parallel |
| **B2** | 8 | 79.6 | 81.4 |
| **B1** | 11 | 118.7 | 121.3 |
| **L1** | 11 | 134.4 | 137.4 |
| **L2** | 11 | 146.9 | 150.2 |
| **L3** | 10 | 142.1 | 145.3 |
| **L4** | 10 | 149.1 | 152.4 |
| **L5** | 12 | 189.0 | 193.1 |
| **L6** | 10 | 164.1 | 167.7 |
| **L7** | 11 | 186.6 | 190.8 |
| **L8** | 10 | 174.6 | 178.4 |
| **L9** | 10 | 178.9 | 182.9 |
| **L10** | 11 | 202.2 | 206.7 |
| **L11** | 11 | 207.4 | 212.0 |
| **L12** | 17 | 331.2 | 338.5 |
| **Base Shear (kips)** | | 963.9 | 226.6 |

**Wind Diagrams**
(values in psf)




Wind Parallel to Building (E-W)




Wind Perpandicular to Building (N-S)

## Seismic Loads

The following section includes seismic load calculations for 11141 Georgia Ave according to ASCE 7-05: Chapter 11 and 12.

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## Seismic Load Calculations

ASCE 7-05, Chapter 12: Seismic Design Requirements for Building Structures

1. Exemptions (11.1.2)

   Building not exempt

2. Site Class (11.4.2)

   C (from structural documents)

   11.4.1 (Fig. 22-1 to 22-6)

   $S_s = 0.155\,g$
   $S_1 = 0.050\,g$ (from structural documents)

   11.4.3 Adjust for site class:

   Table 11.4-1, $S_s < 0.25$, $F_a = 1.2$
   Table 11.4-2, $S_1 \le 0.1$, $F_v = 1.7$

   Eqn 11.4-1 $S_{MS} = F_a S_s = 1.2(0.155) = 0.186\,g$
   Eqn 11.4-2 $S_{M1} = F_v S_1 = 1.7(0.050) = 0.085\,g$

   11.4.4 Design Parameters:

   Eqn. 11.4-3, $S_{DS} = \frac{2}{3} S_{MS} = (2/3)(0.186) = \underline{0.124\,g}$
   Eqn. 11.4-4, $S_{D1} = \frac{2}{3} S_{M1} = (2/3)(0.085) = \underline{0.057\,g}$

3. Seismic Design Category (11.6)

   Table 11.6-1 $S_{DS} < 0.167 \rightarrow A$
   Table 11.6-2 $S_{D1} < 0.067 \rightarrow A$ ∴ **SDC A**

4. Select Analysis Procedure (use 11.7)

   Eq. 11.7-1 $F_x = 0.01 w_x$

5. Calculate effective total seismic weight (W)

   Roof: DL + 20% SL
   Floors: DL

   $W_{RF}$ = (penthouse) = $(125')(46')(27 + 0.2(20)) + 2(125 + 46')(38)(5')$
   = 178,250 + 49,020
   = $\underline{228{,}000 \text{ lbs}}$

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$W_{ST\,FL} = (60')(214')(75\text{ psf}) + 2(60+214)(490\text{ plf})$
$= 963{,}000 + 268{,}520$
$= 1{,}232{,}000\text{ lbs}$

$W_{CONC\,FL} = (60')(214')(105\text{ psf}) + 2(60+214)(992)$
6½" typ.
$= 1{,}348{,}200 + 543{,}616$
$= 1{,}892{,}000\text{ lbs}$

Total Load =

$W = W_{RF} + 6(W_{ST\,FL}) + 7(W_{CONC\,FL})$
$= 228\text{ k} + 6(1{,}232\text{ k}) + 7(1{,}892\text{ k})$
$W = 20{,}864\text{ k}$

6. Other Factors

Basic Seismic Force-Resisting System: Ordinary Concrete Moment Frames and Steel Moment Frames

Response Modification Factor, R = 3 (Table 12.2-1)

7. Calculate Seismic Base Shear (V)

Eqn. 12.8-1 $V = C_s W$

$C_s = S_{DS} / \left(\frac{R}{I}\right)$ Eq. 12.8-2

$= 0.124 / (3/1) = 0.042$

$V = 0.042(20{,}864) = \boxed{876\text{ k}}$

$T_a = 0.1N = 0.1(14) = 1.4\text{ s}$ (Eqn. 12.8-8)

$T_L = 5.5\text{ s}$ (Fig. 22-2)

$C_s$ need not exceed $\dfrac{S_{D1} T_L}{T^2 (R/I)} = 0.116 > 0.042$ ✓

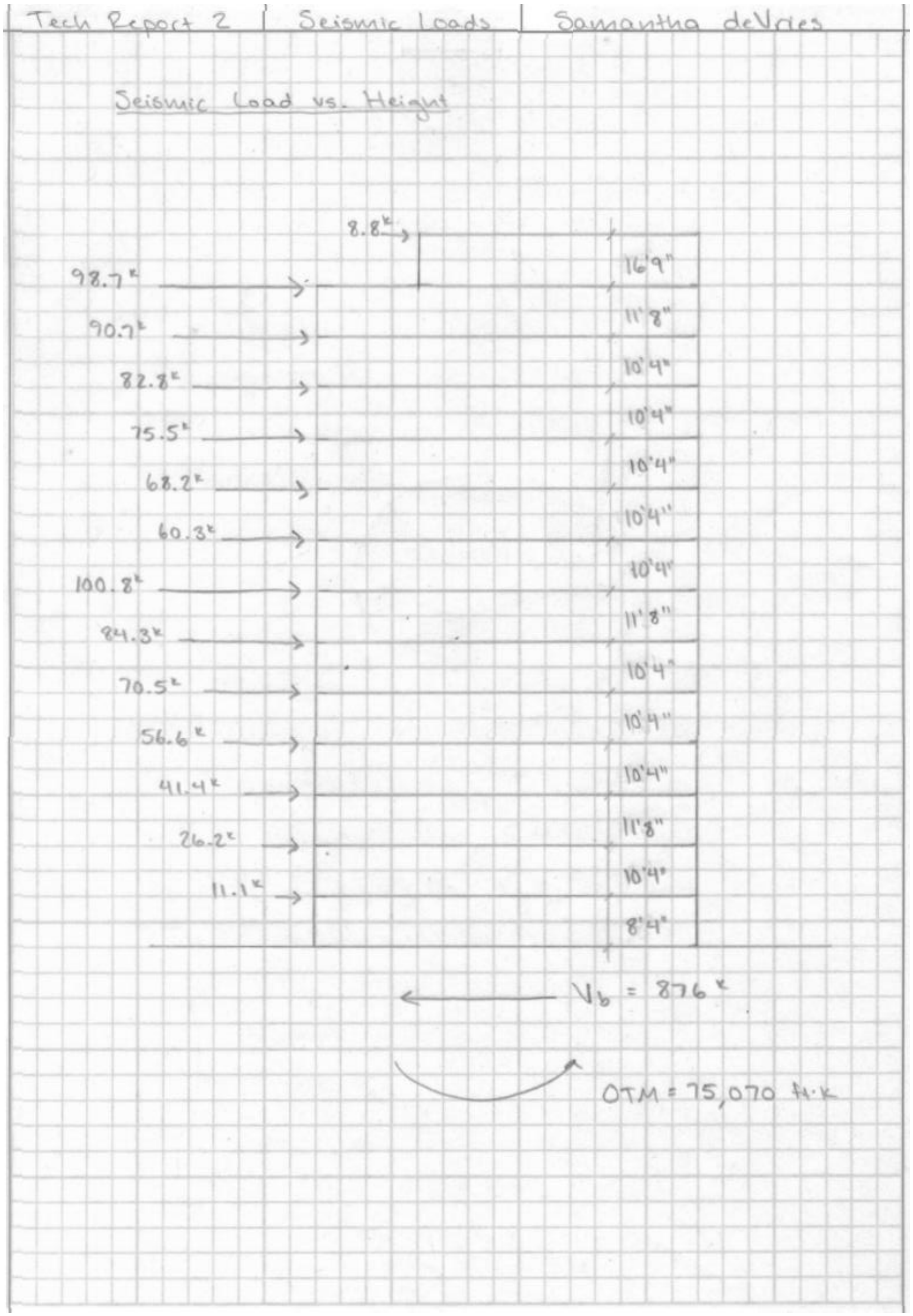
8. Vertical Distribution of Seismic Forces ($F_x$)

$F_x = C_{vx} V = \dfrac{w_x h_x^k}{\sum w_i h_i^k} V$

$k = 1.5$ (using linear interpolation)

9. Determine Seismic Design Story Shear ($V_x$) 12.8.4

| Level | $h_x$ (ft) | $w_x$ (k) | $w_x h_x^k$ | $C_{vx}$ | $F_x$ (k) | $V_x$ (k) | hx * Fx (ft*k) |
|---|---|---|---|---|---|---|---|
| **Penthouse** | 153 | 228 | 526737 | 0.010 | 8.8 | 8.8 | 1353 |
| **12** | 136 | 1232 | 5881051 | 0.113 | 98.7 | 107.6 | 13426 |
| **11** | 125 | 1232 | 5405378 | 0.104 | 90.7 | 198.3 | 11342 |
| **10** | 114 | 1232 | 4929705 | 0.094 | 82.8 | 281.1 | 9434 |
| **9** | 104 | 1232 | 4497275 | 0.086 | 75.5 | 356.6 | 7851 |
| **8** | 94 | 1232 | 4064844 | 0.078 | 68.2 | 424.8 | 6414 |
| **7** | 83 | 1232 | 3589171 | 0.069 | 60.3 | 485.0 | 5001 |
| **6** | 73 | 1892 | 6007649 | 0.115 | 100.8 | 585.9 | 7362 |
| **5** | 61 | 1892 | 5020090 | 0.096 | 84.3 | 670.2 | 5141 |
| **4** | 51 | 1892 | 4197125 | 0.080 | 70.5 | 740.6 | 3593 |
| **3** | 41 | 1892 | 3374159 | 0.065 | 56.6 | 797.3 | 2322 |
| **2** | 30 | 1892 | 2468897 | 0.047 | 41.4 | 838.7 | 1243 |
| **1** | 19 | 1892 | 1563635 | 0.030 | 26.2 | 864.9 | 499 |
| **B1** | 8 | 1892 | 658373 | 0.013 | 11.1 | 876.0 | 88 |
| **Sum** | | 20864 | 52184088 | 1.000 | 876.0 | | **75070** |
| | | | | | | | **=OTM** |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Seismic Load vs. Height
8.8k
98.7k
90.7k
82.8k
75.5k
68.2k
60.3k
100.8k
84.3k
70.5k
56.6k
41.4k
26.2k
11.1k
16'9"
11'8"
10'4"
10'4"
10'4"
10'4"
10'4"
11'8"
10'4"
10'4"
10'4"
11'8"
10'4"
8'4"
Vb = 876k
OTM = 75,070 ft·k

## Appendix

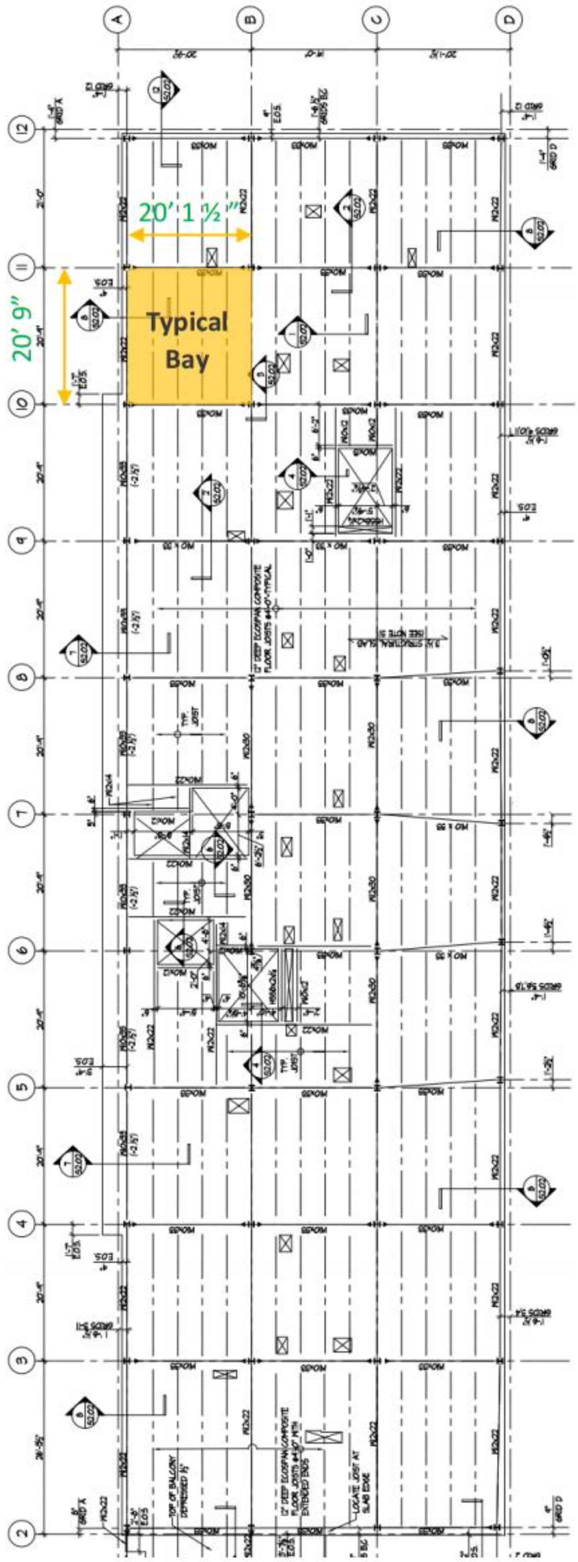


Figure 9: Typical Floor Plan in Addition, S1.07

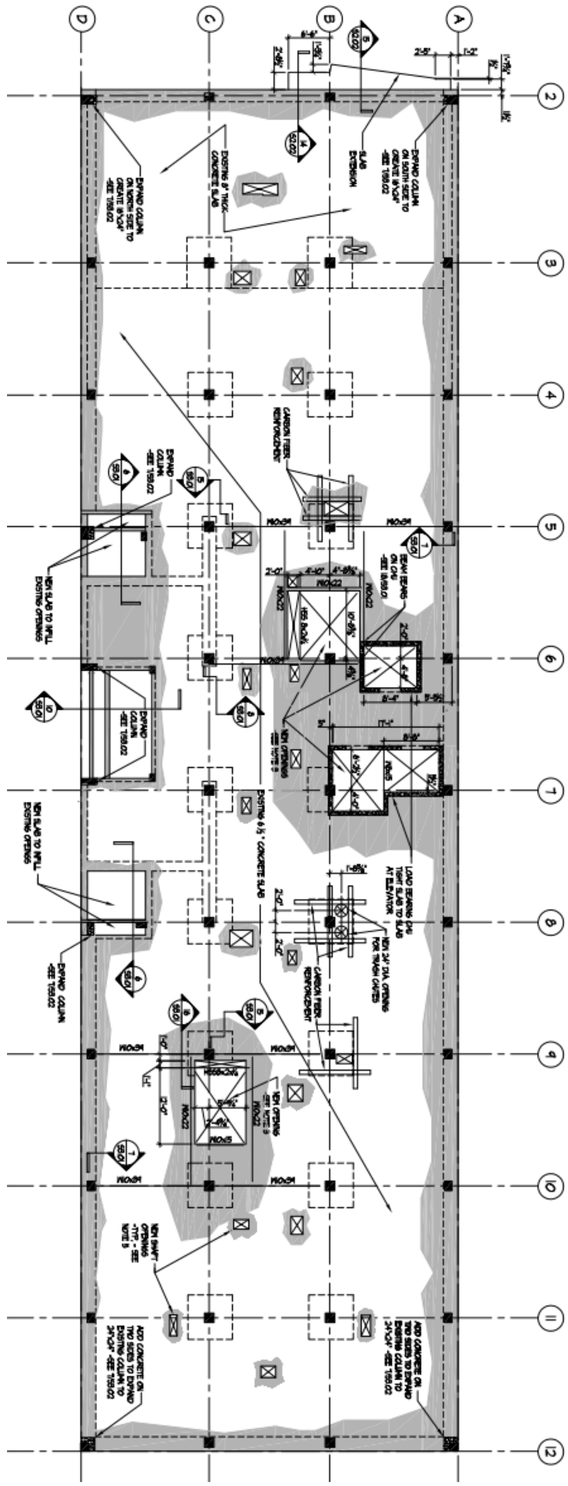

Figure 10: Typical Floor Plan in Original Building, S1.04

Note: Building Drawing sets and images pulled from those sets which appear in this report are courtesy of Rathgeber Goss Association and Bonstra Haresign Architects.