706 Madison Avenue | New York, USA

Structural Existing Conditions Report

Structural Assignment 1

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Executive Summary

706 Madison Avenue is a 48,500 square-foot, high-end retail building located on the southwest corner of Madison Avenue and 63rd Street of the upper east side of Manhattan, New York. The building consists of a 3-story existing landmarked building and a five-story horizontal extension on two sides.

The existing landmarked building was built in 1920 and was initially constructed with masonry walls, steel columns, cinder concrete slabs, and marble and brick façades. Back to 1920s, building codes didn't require seismic design for structures. So the old building wasn't designed to resist seismic load; however, the masonry walls and core stairwells in the building have been designed for wind.

The addition took place on March 2015. It is still under construction and scheduled to be done in January 2016. The structural system consists of steel columns, concrete slab with composite metal deck, a mat foundation and moment frames for a lateral load resisting system. However, the addition's lateral load resisting system is independent from the existing building.

The building was designed based on the 2008 New York City Building Code. The exterior of building also needs to meet the historical requirements, which are regulated by Landmark Preservation Commission (LPC).

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[1] Introduction

1.1 Purpose

This report has been written in order to develop a detailed description of the existing structural system in the 706 Madison Avenue. The building's technical information and challenges have been indicated so that readers can learn the foundation of building through the introductory narratives. More detailed structural information of the building has been introduced in the following narratives, which provide a deeper understanding of the existing structural system of the building.

1.2 Scope

In order to fulfill the objective indicated above, the content of this report will focus on the structural aspects, which include an overview of the building, structural framing systems, lateral resisting systems, foundation systems, joint connections, load determination and load paths. In addition, the other aspects that relative to the building will be briefly described in this report, such as the building enclosure/façade, code requirements and the historical requirements.

1.3 General Building Description

706 Madison Avenue consists of a three-story existing landmarked building and a five-story new addition on two sides. The total area of the building is 48,500 square feet. The building was converted from a bank to high-end retail, which includes a sub-cellar floor of storage and mechanical spaces, multiple floors of retail clothing stores, and an outdoor-café roof terrace as shown in the figure below (Figure 1).

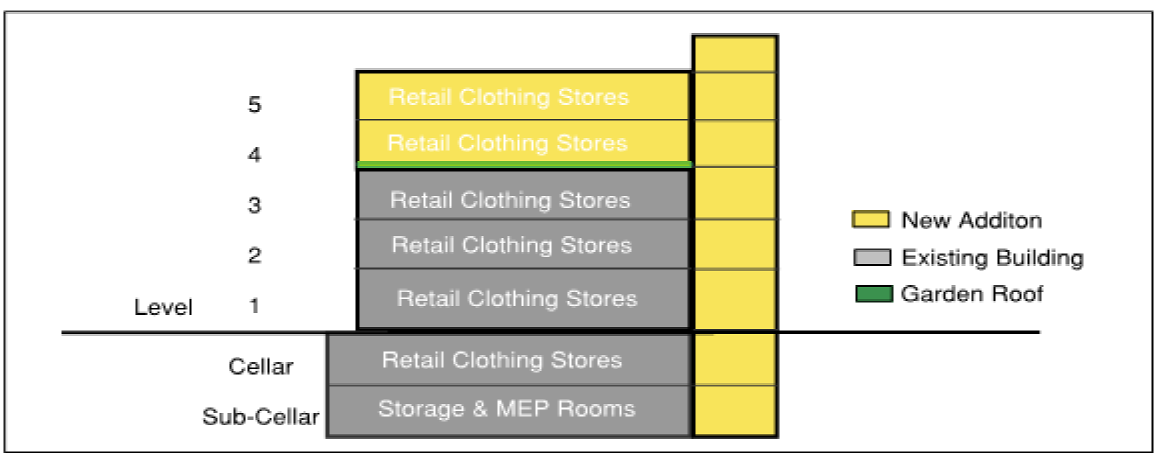

Figure 1 - Building Section from 63 Street

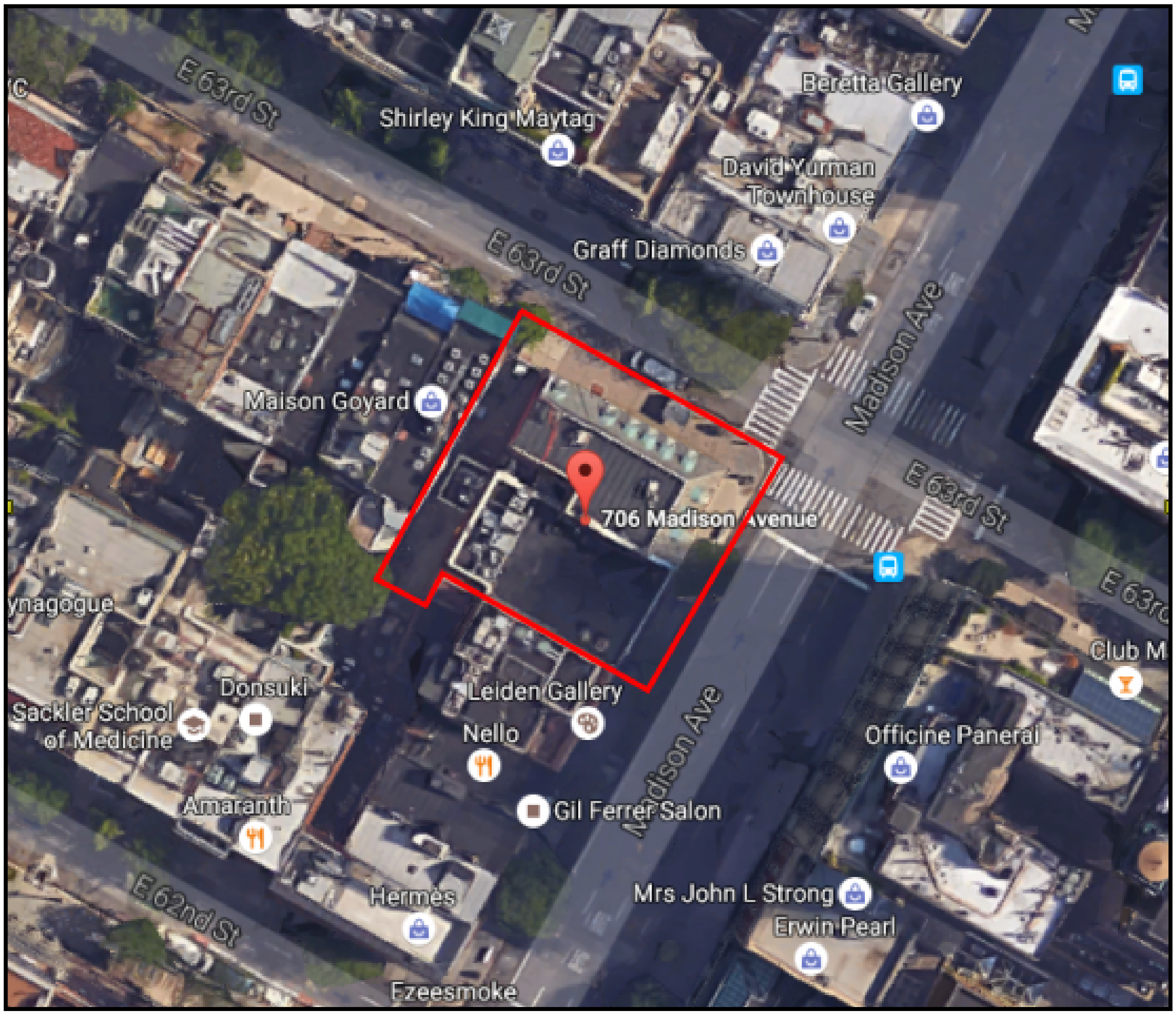

Figure 2 - Building Site [Courtesy of Google Maps]

As shown in the figure above (Figure 2), 706 Madison Avenue is located at the southwest corner of Madison Avenue and East 63rd Street, which is in a historical district at the upper east side of Manhattan, New York. Since the building is in the historical district, the historical requirements for buildings influence the design of this building, especailly in building façade design.

This building has been constructed in March 2015 and will be finished in January 2016. The project delivery method is design-bid-build and the cost of the project will be estimated to be $1000 per square foot without design fees. The building is designed by Page Ayres Cowley Architects and structurally by Simpson Gumpertz & Heger (SGH). JRM construction has been chosen to be the construction management team cooperating with the designers and individual contractors to construct the building on site.

1.4 Structural Framing System Overview

Back to 1920s, the existing landmarked building was built to be a steel frame structure with a structural assembly including beams, columns, cinder concrete slabs, masonry walls and a masonry core. Cinder concrete slab construction became one of the most dominant structural slab systems used from the 1920s to the 1940s. However, unlike the concrete with reinforcement bars, the systems were not really “reinforced concrete” in the conventional sense but actually tensile structures encased in a light weight low strength concrete. The steel-draped wire mesh acted as a tensile system which couldn’t provide enough reinforcement so that the spans were not able to go long. On the lateral design side, the building was built at a time when the old building codes didn’t required any seismic design. The masonry walls and stairwells (core) were designed to resist wind loads.

Comparing with the existing building, the new design of the structural steel framed addition uses the concrete slab with the composite metal deck for the framing systems, the moment frames for the lateral load resisting systems, and mat-slab foundation for the foundation of the building. The addition is structurally independent form the existing building. And the two buildings will be seismically isolated but the space between the two buildings will be open. By this time, a few modifications will take place in the existing building, including slab replacement, removal of some structural columns, addition of transfer girders, and a garden roof. In the following discussions and calculations of this project, I would like to follow the new and renovated structural systems instead of analyzing the old existing structural systems.

The design of new addition was challenging due to constrained site conditions. The building has two below-grade stories, with new excavation adjacent to historic townhouses. Because of multiple unforeseen conditions, ncluding tangent-pile wall misalignment, below-grade protrusions at the adjacent buildings, and high ground water, the team needed to re-design the foundations and lateral system of the addition several times as the construction proceeded.

[2] Structural Framing System

In this section, the detailed structural framing systems within the building will be introduced and discussed, including typical bay framing, floor and roof framing, foundation system, columns, lateral load resisting system, and load paths.

2.1 Typical Bay Framing

The typical bay framing in this building is classified into two bay categories: ordinary bay framing in the addition and the renovated bay framing in the existing building as shown in the figures below (Figure 3 & Figure 4). The dimension of the ordinary bay is approximately 29’-0” x 16’-0” and the dimension of the renovated bay is approximately 17’-7” x 19’-7”. Two bays are both constituted by steel beams, steel columns, and the concrete slab with a composite metal deck.

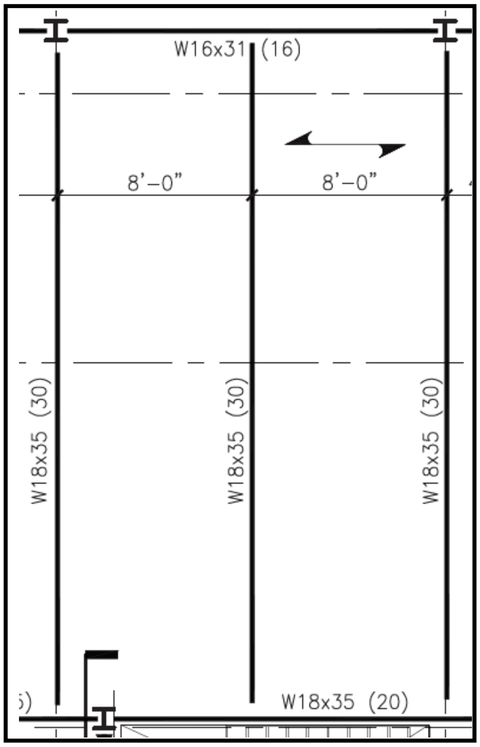

Figure 3 - Ordinary Bay Framing

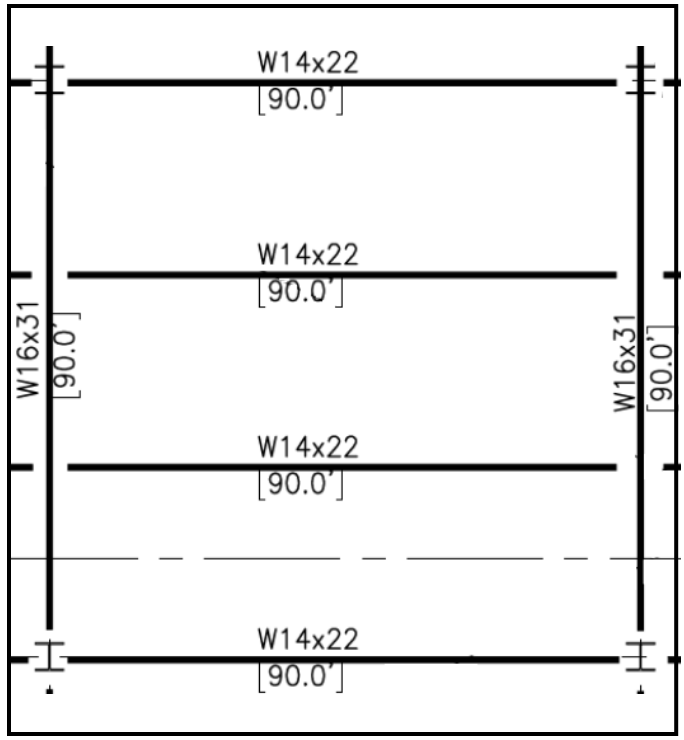

Figure 4 - Renovated Bay Framing

2.2 Floor and Roof Framing

The typical floor and roof framing in the existing building is replaced by a concrete slab with composite metal deck, which is made of by 3 ¼" lightweight concrete over 1 ½"-18GA. metal deck reinforced with welded wire fabric (WWF4x4). The addition adopts the same framing system; however, it uses 3"-16 GA. metal deck instead of using 1 ½"-18GA. metal deck. Furthermore, the headed shear stud is arranged to be 2 studs per foot in order to provide a composite construction for the slab and the steel beams. A typical detail for the reinforcement of the concrete slab is shown below (Figure 5).

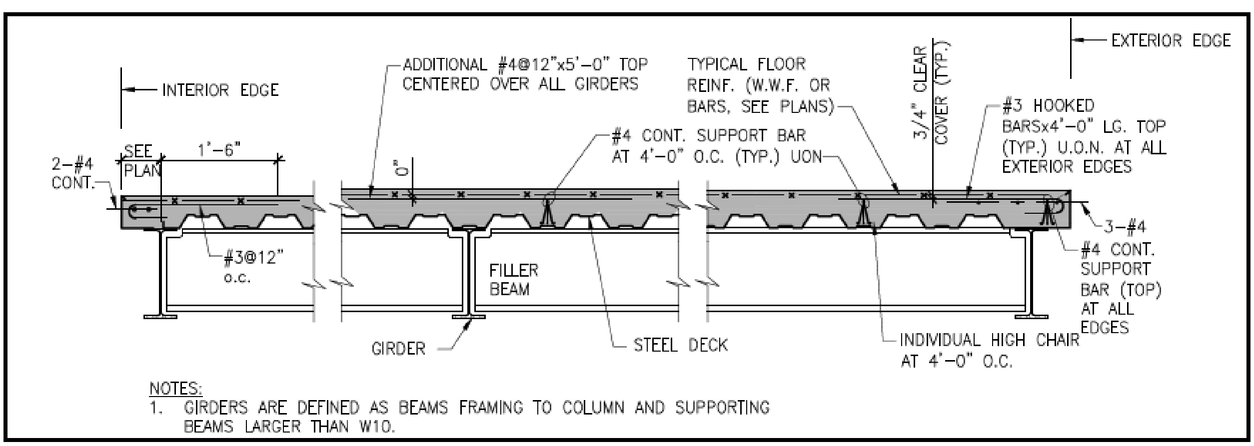

Figure 5 - Typical Floor section

2.3 Foundation System

The foundation system of 706 Madison Avenue is typically the mat foundation, which is comprised of 2'-6" thick mat slab reinforced with steel reinforcements at the top and bottom. Shear reinforcement is also provided around the steel column and base plate above to prevent the foundation from cracking due to shear. The figure below (Figure 5) is a detailed diagram of the reinforcement of the foundation slab as well as the 24" concrete pile wall along the slab step. The minimum reinforcement in slab is at least 0.0018 times the area of the concrete in each direction. The minimum concrete clear cover is 3" at the bottom of the mat slab and 2" at the top of the mat slab.

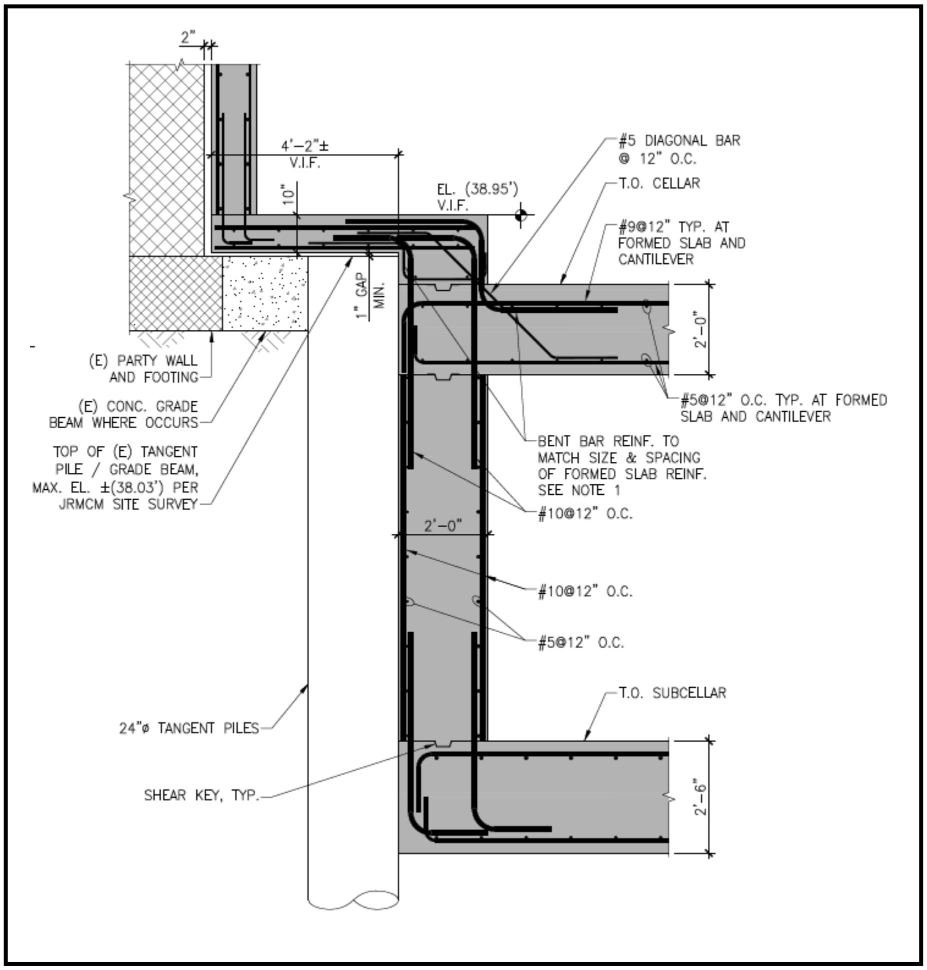

Figure 6 - Slab Step Section

The concrete slab that runs horizontally and vertically through the foundation has a compressive strength of 5000 psi. According to a recommendation given by geotechnical engineers, mat slab is designed for a maximum allowable bearing of 2.5 KSF typically and 4 KSF in the southwest corner of new addition.

2.4 Columns

The structural columns specified in structural framing design of the 706 Madison Ave are mostly W-Shape ASTM A992/A992M steel columns and a small group of HSS ASTM A500 hollow steel columns in the corridor or around stairwells. Most columns from sub-cellar level to cellar level are W10. Column size is in a range between W10 to W14 and the largest size of the column utilized in this building is W14x176.

The columns are typically spliced at the interfaces between the 1st and 2nd floors, 3rd and 4th floors, and 5th floors and roof. Three different splices utilized in column connection design are gravity column splice, gravity column splice with changed nominal depth, and moment frame column splice as shown in the figure (Figure 7). Welding takes place into most of column splice constructions. Moreover, all columns in the foundation will be welded onto the ASTM A36 steel base plate and be connected to the foundation slab through a bunch of anchor rods.

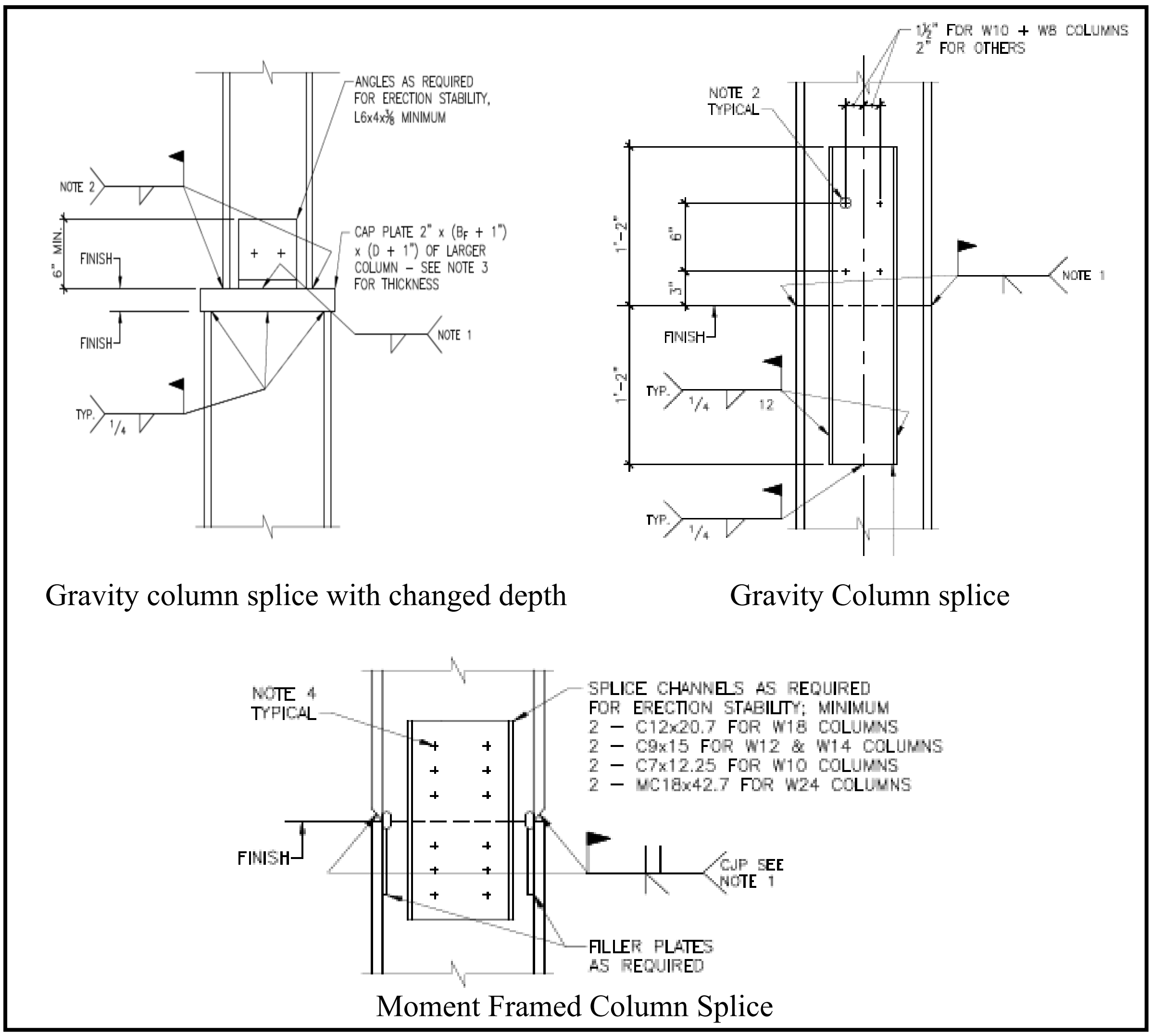

Figure 7 - Typical Column Splices

2.5 Lateral Load Resisting System

As mentioned in section 1.4, the masonry walls and stairwells both serve as the lateral load resisting system for the existing landmarked building. All lateral load resistance and stability of the new addition in the completed structure is provided by ordinary steel moment frames along the perimeter. The new addition is seismically independent from the existing building as a result of 4" seismic gap between the addition and the existing building. This is provided in order to accommodate expansion joint assembly. The moment frames are detailed to include designed lateral connection at the surface of the column and beam as shown in the figure below (Figure 8).

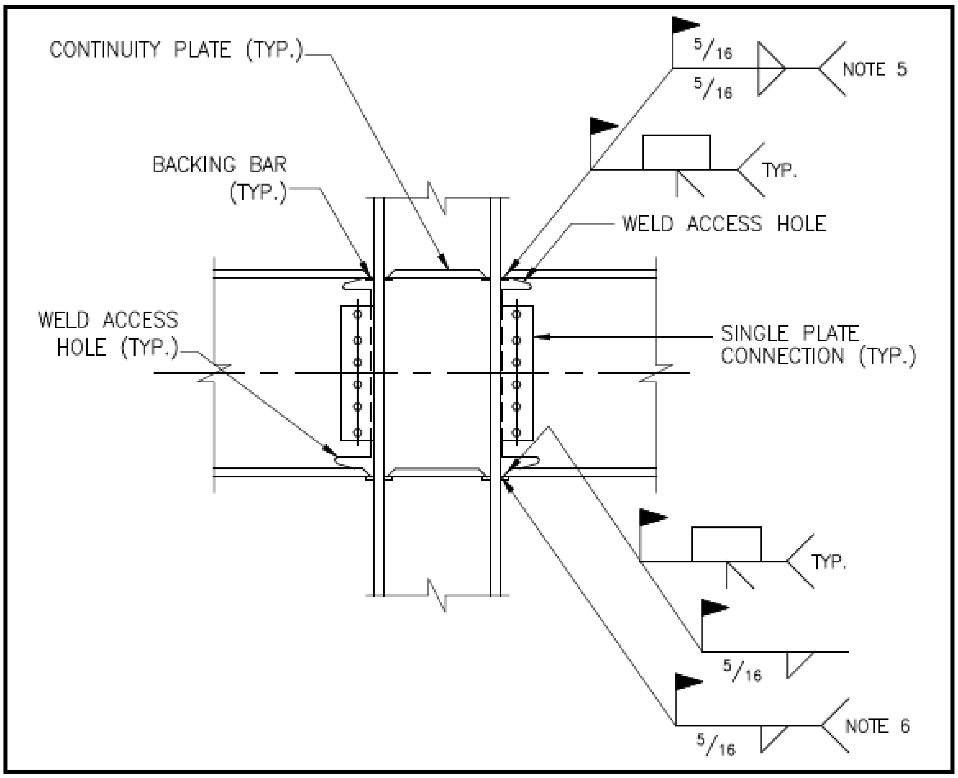

Figure 8 – Ordinary Moment Frame Connection

2.6 Load Paths

In order to determine the load path of the structural design, two load classifications must be considered: gravity and lateral.

The typical gravity loads, including dead, live, snow, and rain will be resisted by the roof or floor diaphragms, transmitted to the steel girders through the joists or framing beams, and transferred to the mat slab through the steel columns. The mat slab then spreads the gravity load out into the ground. The foundation is designed to prevent the slab from cracking and to prevent differential settlement caused by gravity loads.

The typical lateral loads, consisting of wind and seismic, act on the exterior frames of the building first. The composite concrete on metal deck floors serves as a horizontal diaphragm that distributes the lateral wind and seismic forces from exterior frames to the vertical moment frame, which carry the applied lateral loads to the building foundation. The foundation is designed to resist uplift resulting from the overturning moments caused by lateral loads.

[3] Loads

This section focuses on a description of loads that have been used to design 706 Madison Ave and how they were determined per the national codes, standards and design codes.

3.1 Building Codes and Reference Standards

All the building codes, standards and structural design codes used to design 706 Madison Avenue have been listed in the table below (Table 1).

Table 1 – Applicable Codes

Category	Building Codes/Reference Standards
Building Codes	New York City Building Code (NYCBC) 2008
Load Determination	American Concrete of Civil Engineers (ASCE) 7-02
Concrete Design	American Concrete Institute (ACI) 301-306, 315, 347
Steel Design	American Institute of Steel Construction (AISC) 360-05
Seismic Design	American Institute of Steel Construction (AISC) 341-05
Welding Design	American Welding Society (AWS)
Composite Deck	Steel Deck Institute (SDI)

3.2 Dead Load

The design dead loads were determined based on the materials' characteristics and manufacturer's data. The structural drawings describes dead load as "All permanent stationary construction". Therefore, dead loads are determined by the self-weight of the building component.

3.3 Live Load

The following design live loads were determined on the basis of the reference standard ASCE 7-02. The primary design live loads haven been found in structural drawings and listed in the table below (Table 2).

Table 2 – Live Loads

Live Load	Load value
1. Retail - 1st Floor	105 psf
2. Retail - Upper Floors (2nd , 3rd, and 5th floors)	75 psf
3. Public Assembly space (4th floor, including setback roof terrace)	100 psf
4. Stairs and Exists	125 psf
5. Storage (Sub-cellar and Cellar)	600 psf
6. Elevator Machine Room	125 psf

3.4 Snow Loads

Where appropriate, drifting snow loads have been considered in accordance with Section 1608 of the Building Code. The primary design snow load information has been found in the structural drawings and listed in the table below (Table 3).

Table 3 – Snow Loads

Snow Load	Load Value
1. Ground Snow Load, P_g	25 psf
2. Flat Roof Snow Load, P_f	20 psf
3. Snow Exposure Factor, C_e	0.9
4. Snow Load Importance Factor, I_s	1.0
5. Thermal Factor, C_t	1.0

3.5 Wind Loads

The following design wind loads are determined on the basis of the reference standard ASCE 7-02. The primary design wind load information has been found in the structural drawings and listed in the table below (Table 4).

Table 4 – Wind Loads

Wind Load	Load value
1. Basic Wind Speed (3 sec gust), V	98 mph
2. Wind Importance Factor, I_w	1.0
3. Wind Exposure	B
4. Internal Pressure Coefficient	+/-0.18

3.6 Seismic Loads

The following design seismic loads are determined on the basis of the reference standard AISC 341-05. The primary design seismic load information has been found in the structural drawings and listed in the table below (Table 5).

Table 5 – Seismic Loads

Seismic Load	Load Value
1. Seismic Importance Factor, I_E	1.0
2. Spectral Response Acceleration, S_s	0.365
3. Spectral Response Acceleration, S_1	0.071
4. Site Class	D
5. Spectral Response Coefficient, S_{DS}	0.367
6. Spectral Response Coefficient, S_{D1}	0.114
7. Seismic Design Category	C
8. Design Base Shear, V	164,000 Ibs
9. Seismic Response Coefficient, C_s	0.16
10. Response Modification Factor, R	3
11. Seismic Force Resisting System	
a. Ordinary Steel Moment Frames	
b. Ordinary Reinforced Concrete Shear wall	

[4] Joint Details and Connections

Joints and connections are very important components of the building construction because they provide a smooth or flexible place for the building to expand, contract, and move without overstressing the structure and causing cracking problems. This section outlines two different type of joint systems and briefly introduces steel connections.

4.1 Building Expansion Joints

The seismic joint between the new addition and the existing building serves as an expansion joint, which can not only absorb the heat-induced expansion and contraction of concrete slabs or walls, but also provides a space where the concrete slab can move due to the seismic or wind load without overstressing the concrete and causing cracking problems. As shown in the figure below (Figure 9), the 4” seismic joint, formed with soft material, located between two concrete buildings will allow one of the two buildings to move independently from the other during a seismic event without cracking the other building.

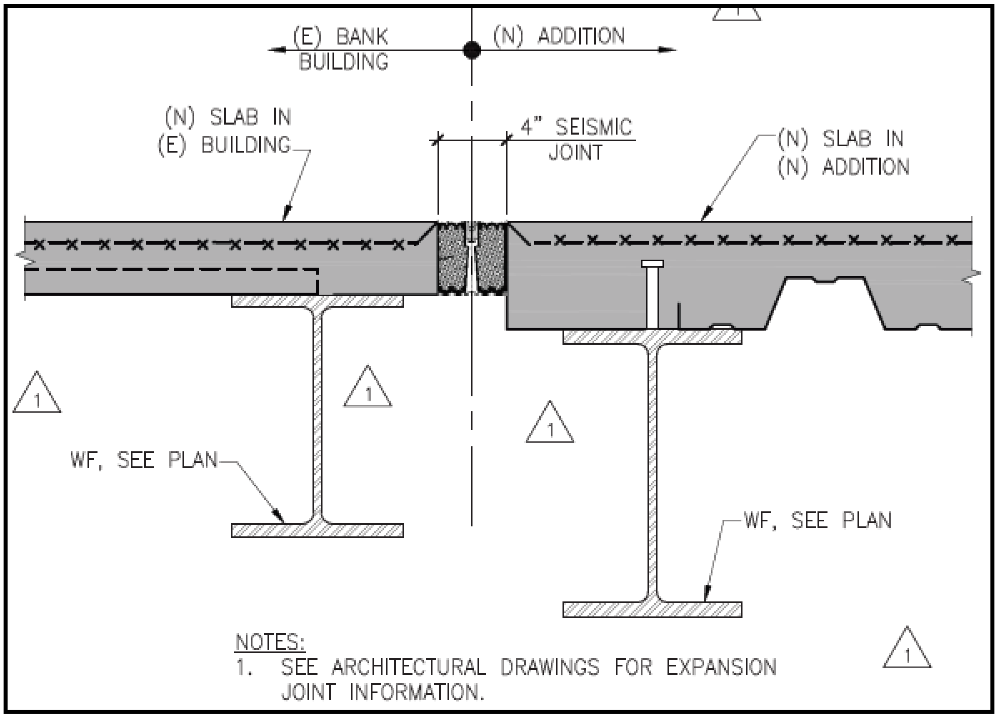

Figure 9 – Seismic Joint Between Addition and Existing Building

4.2 Construction Joints

As shown in the figure below (Figure 11 & 12), two type of construction joints are utilized to design the connection of 706 Madison Avenue: the horizontal wall construction joint and the vertical construction joint. As shown in the figure below (Figure 11), the CONT. 1x2 or 12" LONG KEY @ 24" acts as a construction joint and is located at predetermined pour stops or where the first pour stops and the second pour will occur. The joint is to help provide continuity between pours to help maintain structural integrity in shear and reduce cracking.

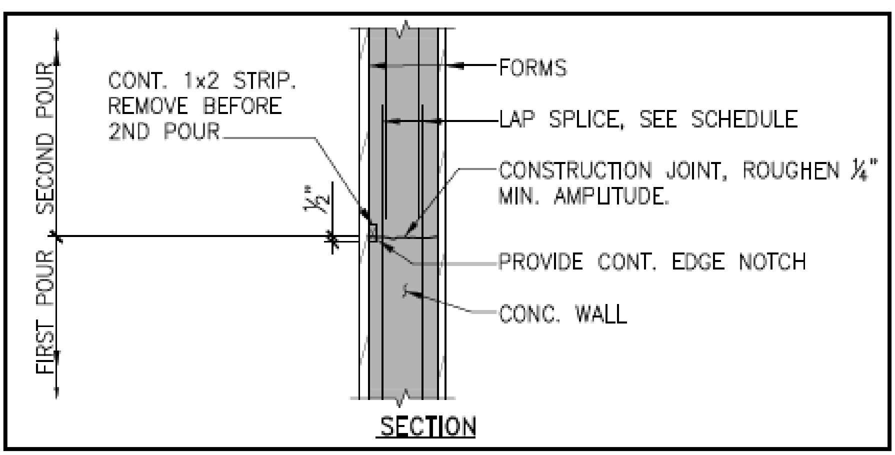

Figure 11 – Horizontal Wall Construction Joint

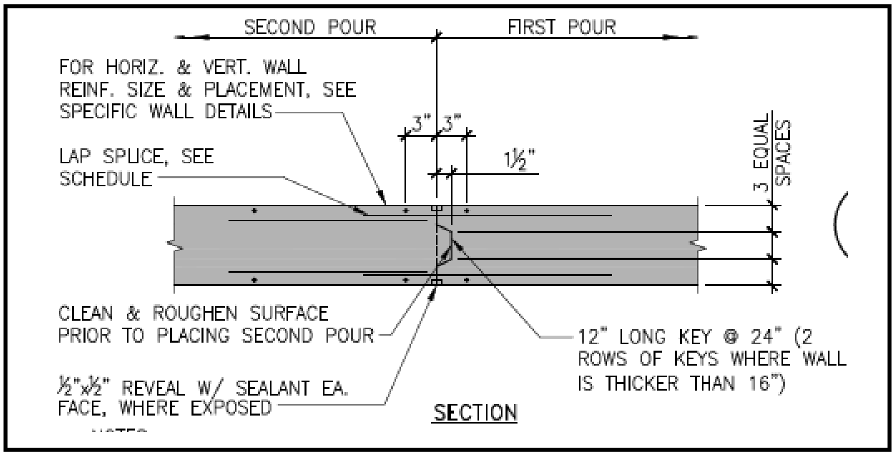

Figure 12 – Vertical Wall Construction Joint

4.3 Steel Connections

The steel connection is the dominant connection type is 706 Madison Ave, which includes the wide flange and beam shear connection, typical beam framing to spandrel Beam connection, beam-to-beam moment connection, wide flange column with web parallel to beam web, wide flange column with web perpendicular to beam web, typical moment frame connection and bolted wide flange brace connection, etc. The figure below (Figure 13) indicates some types of steel connections and details of welding and bolting.

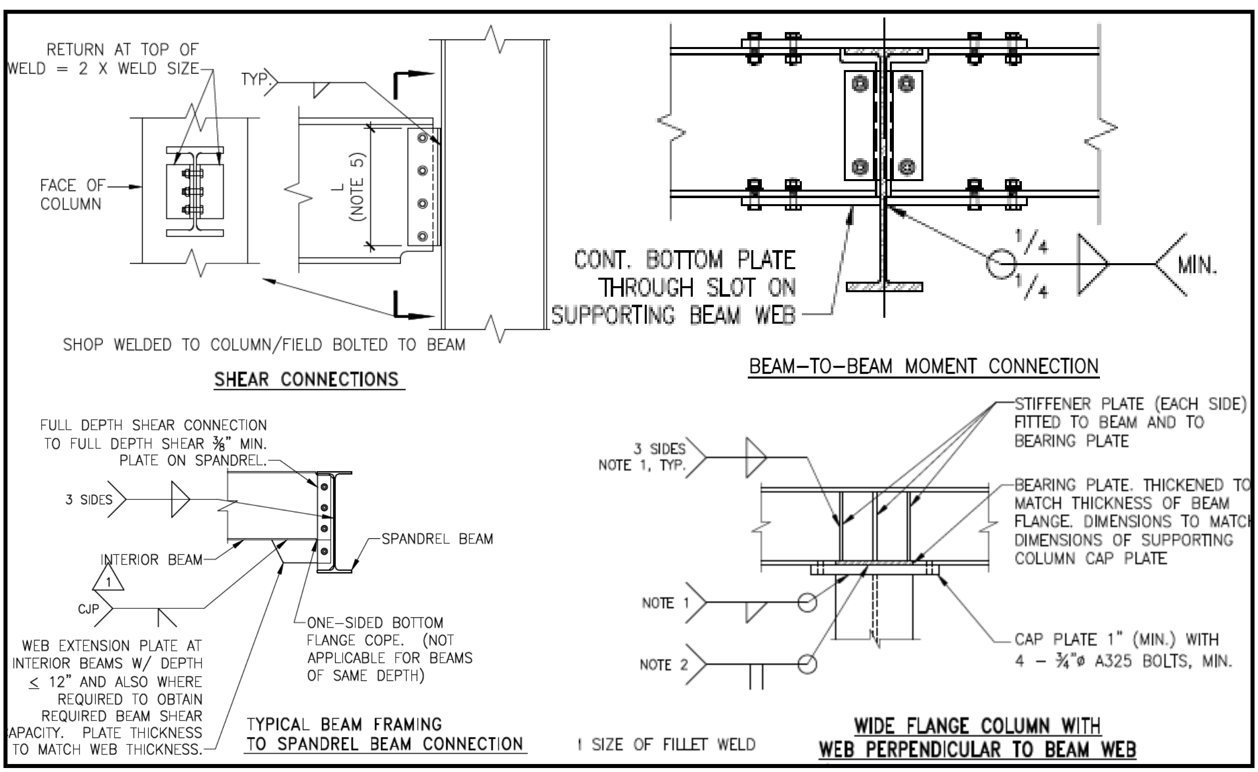

Figure 13 – Steel Connections

[5] Summary

706 Madison Avenue consists of a 3-story existing landmarked building and a 5-story addition with a total size of 48,500 square foot. The building is located in the historical district of New York City, so the future design will also be limited by the historical requirements. The structural system of the building is comprised of steel beams, columns, composite metal deck framing systems, moment frame lateral load resisting systems as well as a mat foundation. The addition's lateral load resisting system is independent from the existing building, so any future calculation for the wind and seismic design will be complicated.

5.1 Conclusion

I have analyzed the existing structural conditions of 706 Madison Avenue from the introduction to the body: structural framing systems, lateral load resisting systems, load determination related building and design code, and joints and connections. From this, I have learned how to study the building with the drawings, specifications and building codes. I have also studied many new building components, including expansion joints, construction joints, transfer girders, and a mat foundation. This initial investigation will give me foresight to know the challenges that I should focus on when I get into the calculation parts of the project.