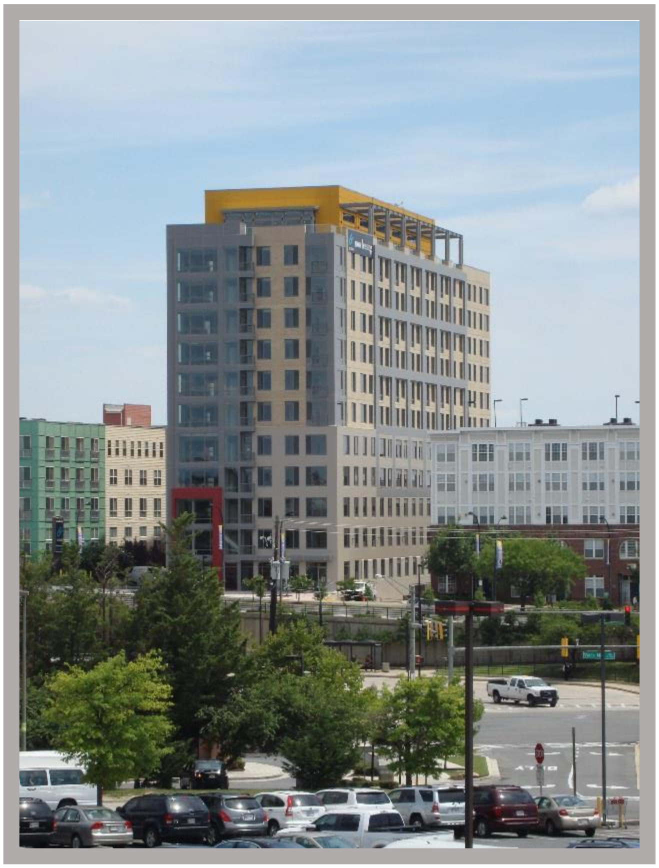


11141 Georgia Avenue

Located in Wheaton, MD

Technical Report 1

Samantha deVries

Structural Option

Advisor: Ali Said

September 12, 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 explore the structural concepts and existing conditions of 11141 Georgia Avenue located in Wheaton, MD.

This report will include an overview of the building and its structural components, including typical floor framing, structural slabs, a description of the lateral force resisting system, foundation system, typical connections and joints at new and existing structural components, and other items. This report will also describe how the primary structural components work together as a system, and will be a reference for future technical reports.

Building Overview

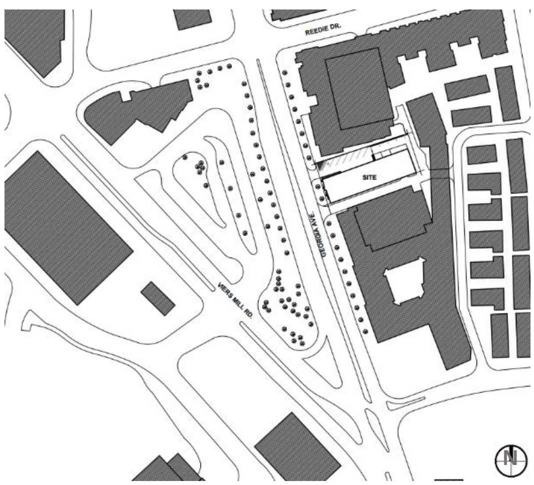


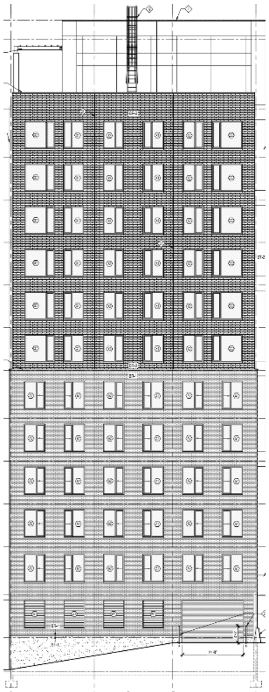
Figure 1: Building Location on Site, Courtesy of Bonstra Haresign Architects

11141 Georgia Ave is a high-rise residential apartment building. The original building, built in the 1960's, was a 5 story concrete office building with 2 basement levels. When the building changed owners, rather than tearing down the old building, it was expanded to meet the needs of the new owner. Construction of a 7 story addition in steel framing on top of the existing building began in February of 2013 and was completed in August of 2014 at a cost of $20 million for the addition.

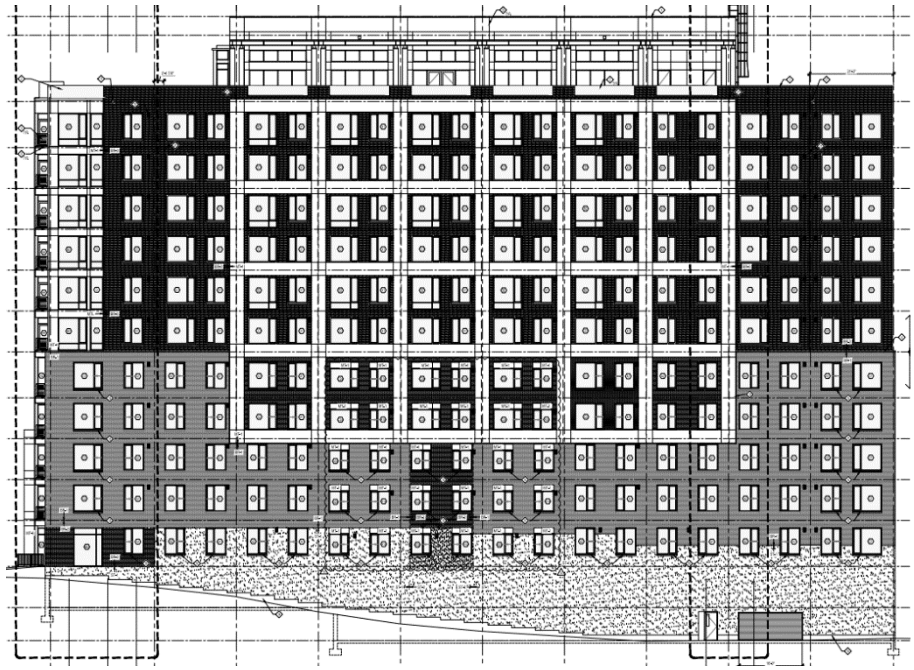
The residential units are one and two-bedroom studio apartments. There is a rooftop terrace with a small wading pool, nice views, and a penthouse lounge for residents of the building, which includes dining areas, kitchen space for events, a fitness center, and a game room. There is a location to store and repair bikes in the building, and the site is closely located to the Wheaton Metro Station. The building is located near the corner of Reedie Drive and Georgia Avenue in Wheaton, MD, as shown in figure 1.

Figure 2: View of Building from nearby mall garage

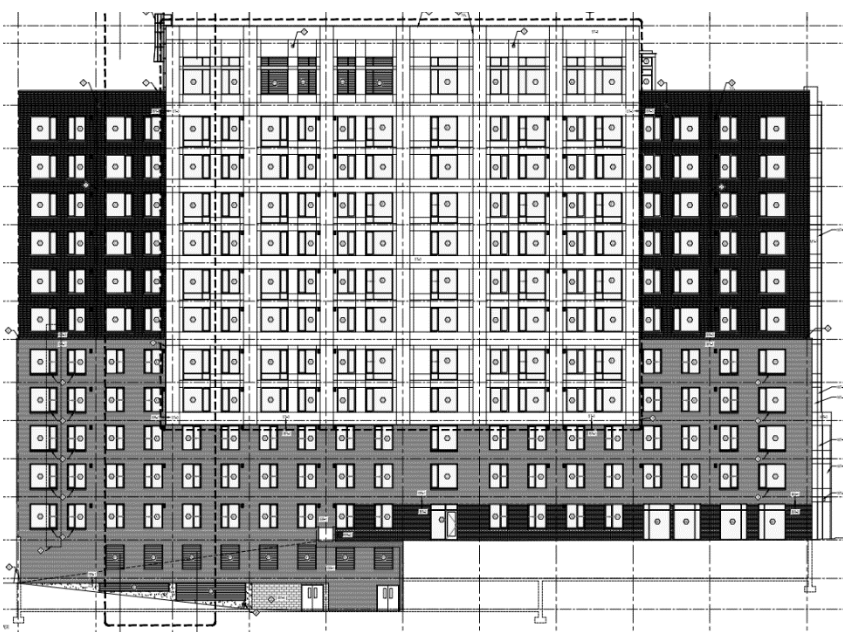
Building Elevations



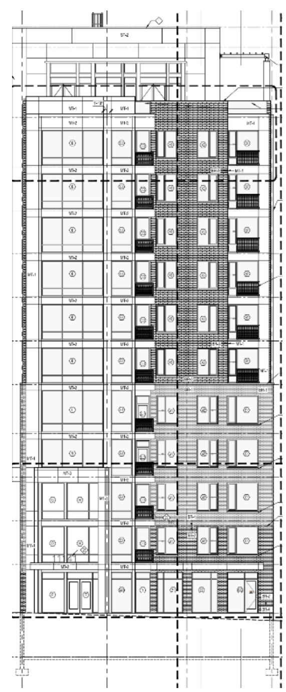
East Elevation



South Elevation



North Elevation



West Elevation

Structural Systems Overview

The original structure was built in concrete on spread footing foundations. The addition to the structure was built in steel. The foundations include spread footings and a retaining wall, which required a few modifications due to layout changes. The original building is framed with structural two-way slabs and concrete columns. The original floor framing also required modifications to account for changes in the layout of stairwells and elevators, and the addition of other openings for new utilities, trash chutes, etc. The new addition of 7 stories is framed in steel with columns that match the original building's concrete column grid. The floors are framed with W-shapes and composite joists, and the roof is framed with joists. The lateral system of the original building is concrete moment frame. Some columns required expansion to resist additional lateral forces from the building's increased height. The steel addition has steel moment frames to resist lateral loads. Many of the connections and joint details include tie-in to the original building. The following sections will cover the buildings structural systems in further detail, covering the original building, its modifications, and the new addition's structure.

Materials

Structural materials and their specifications used in the building are listed below in Figures 3, 4, and 5. These are the strengths which will be referenced in future technical reports and re-design comparisons.

Concrete and Reinforcing		
Use	Strength (psi)	Weight (pcf)
Misc. Foundations	3000	145
Slabs-on-Grade (Interior)	3000	145
Slabs-on-Grade (Exterior)	4500	145
Fill on Metal Deck	3500	145
Topping	3000	145
Use	Grade	
Deformed Reinforcing Bars	ASTM A615, Grade 60	
Welded Wire Fabric (WWF)	ASTM A185	

Figure 3: Concrete and Reinforcing Specifications, from S/0.01

Structural Steel and Steel Deck		
Member/ Item	Grade	Fy (ksi)
Rolled Shapes	ASTM A992	50
Channels, Angles, and Plates	ASTM A36	36
Structural Tubing (Square and Rectangular HSS)	ASTM A500	46
High Strength Bolts	ASTM A325-N (unless otherwise noted)	
Smooth and Threaded Rod	ASTM A36	36
Headed Shear Studs	ASTM A108	45
Welding Electrodes	AWE A5.1 or A5.5, E70XX	
Adhesive Anchors	Hilti Hit HY-150 Maz w/ Hit-TZ Rods System	
Expansion Anchors	Hilti Kwik Bolt TZ	
Nuts	ASTM A563	
Washers	ASTM F436	
Non-Shrink Grout	ASTM C-11.07 Euclid Dry Pack Grout	
Galvanized Metal Deck	ASTM A653	
Painted Phosphated Metal Fl. Deck	ASTM A611	

Figure 4: Structural Steel and Steel Deck Specifications, from S0.01

Masonry		
Material	Grade	Strength (psi)
Load Bearing Concrete	Hollow and Solid: ASTM C90, NW	1900
Brick	ASTM C55	2000
Mortar (Above and Below Grade)	ASTM C270 – Type S	
Grout	ASTM C476	2000
Horizontal Joint Reinforcing	ASTM A82, 9 Gage Truss-Type Galv.	
Masonry		1500

Figure 5: Masonry Specifications, from S/0.01

Foundation System

The foundation system contains the original construction in the 1960's and well as some modifications to account for additional modified layout requirements and new loads. Both will be discussed in the following sections.

Original Foundation System Prior to Addition

The original foundations of 11141 Georgia Ave were designed for 8000 psf from columns lines 1-5 and 4000 psf from column lines 6-12. The foundations consist of spread footings with a pier, on top of which rests the structural column (See Figure 6.) Larger combined footings are used along column lines C and D (See Figure 7 for example of combined footing.)

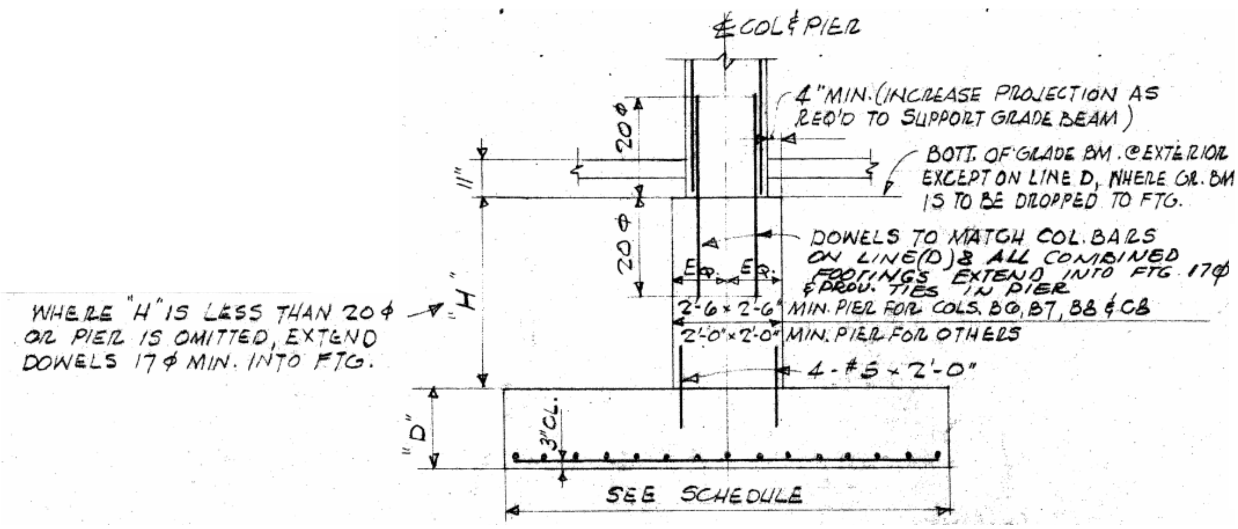


Figure 6: Typical Detail of Pier and Footing, from S1

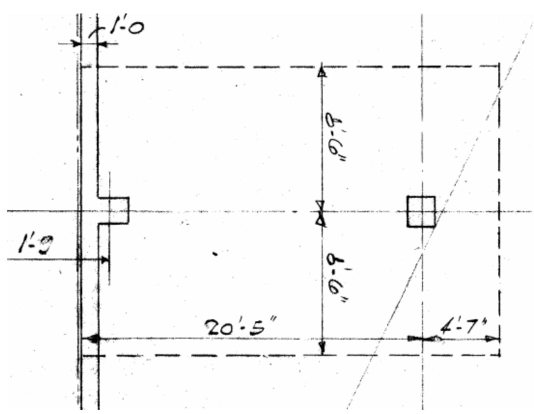


Figure 7: Typical Combined Footing Shown Dashed in Plan, from S1

The building is built on a slight hill. (See figure 8 for relationship between lower levels and hill.) Therefore, there is a basement retaining wall in the basement structure along the north side of the building. Figure 9 shows a section through the cantilevered retaining wall on the north side of the building, and figure 10 shows a section through the retaining wall at the west edge of the lowest level.

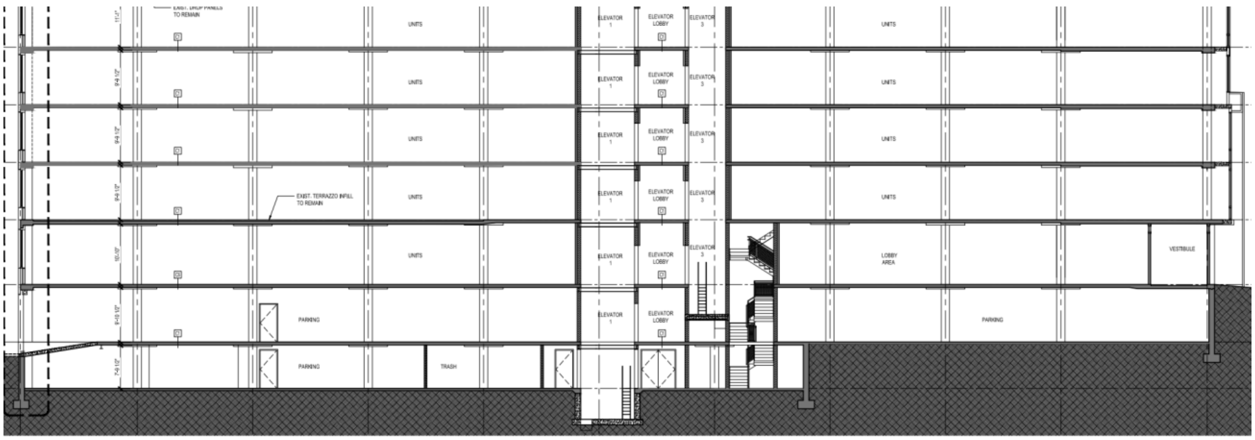


Figure 8: Section through Hillside and lower levels, from A3.01

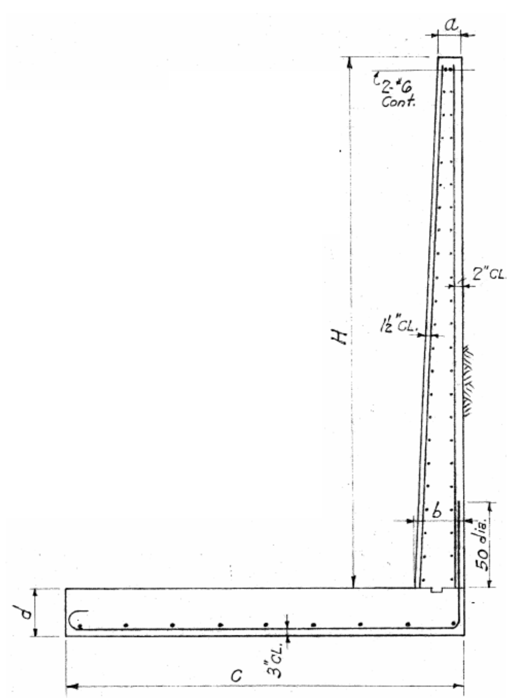


Figure 9: Section through Retaining Wall on North Side of building, from S1

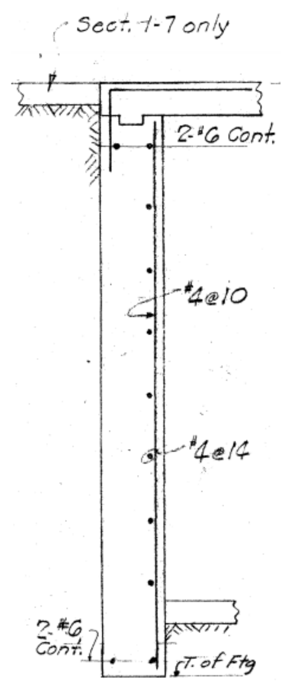


Figure 10: Section through Typical Retaining Wall at Level Step ups, sect. 1-7 on S1

Modifications to Foundations (and Lower Levels)

In November 2011, ATC Associates confirmed through geotechnical exploration the 4000 psf and 8000 psf values from the original 1960 drawing set. The Existing Footings at Columns A-7 and B-7 required underpinning due to the addition of an elevator pit to accommodate 3 new elevators (See Figures 11, 12, and 13). The lowest basement level slab was filled in where the 2 original elevators were removed. The existing stairwell was removed, and 2 new stairwells were added. New load bearing walls were added to support the slab edge at the new openings for the stairs and elevators.

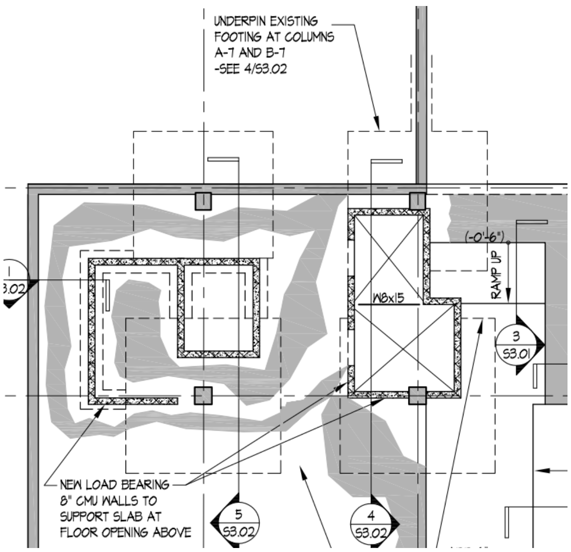


Figure 11: Location of new elevator pit and foundation underpinning shown in plan, S1.01

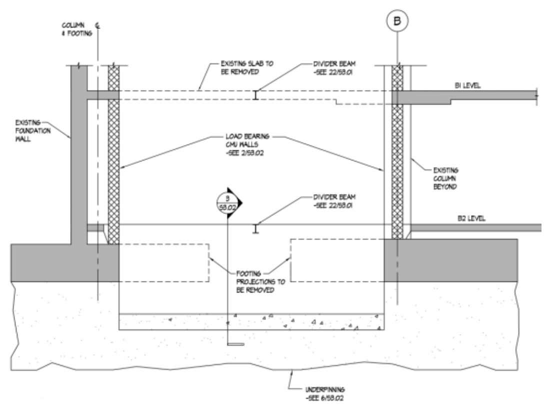


Figure 12: Section showing demo of slab and footing projects with underpinning locations, 4/S3.02

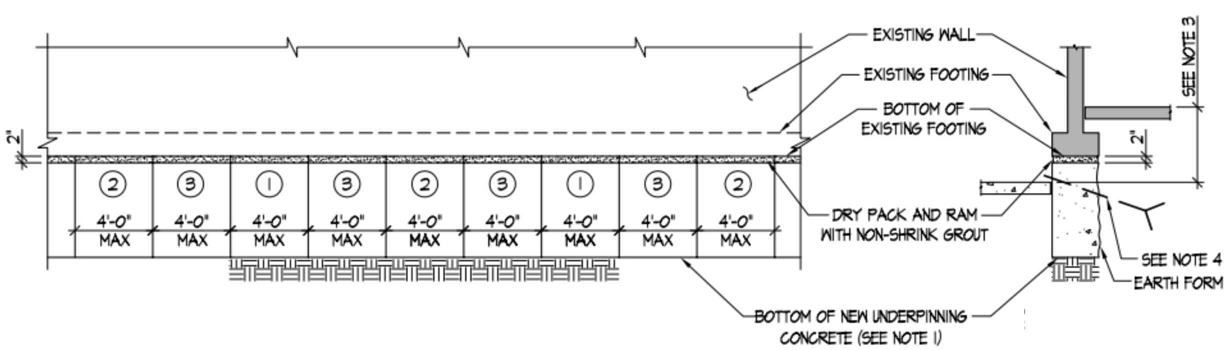


Figure 13: Section showing existing footing and new underpinning (right) and Elevation of sequence for underpinning: All units numbered 1 must be fully installed before excavating for placement of all units numbered 2, etc. (left), 6/S3.02

Gravity System

The existing portion of the building is flat plate slab construction with drop panels at the columns and perimeter beams. Due to differences in the occupancy type of the original building and the new structure, the gravity live loads are smaller. Also, the original penthouse structure was removed. Due to the new live loads, the removal of the penthouse, and the use of steel for the addition which is significantly lighter construction than concrete, very little work on the foundations was required for gravity loads despite the 7-story addition in steel. The original stair and elevators were removed, and 2 new stairs and an elevator pit were added, resulting in modifications to location of slab openings and the addition of slab edge bearing walls. The addition was built out of steel to impose a lighter dead load on the original structure than if it were built out of concrete.

Original Building Floor System

The original building is a concrete structure. The layout consists of a square column grid of 3 bays by 10 bays, each bay approximately 21' by 20', with a single row of 25.5' bays on the west end of the building. See figure 15 on the next page for a typical floor plan.

Level B1 has a 6 ½", the first floor has a 6 ½" slab in the office area, and a 7" slab everywhere else, and all other floors (2nd – 5th) have a 6 ½" slab. The roof has a 9" slab in the penthouse to support the mechanical equipment, and all other areas of the roof as well as the penthouse roof have the typical 6 ½" slab. (See figure 14 for slab thicknesses). There are 7'x7'x3/4" drop panels typical at the columns.

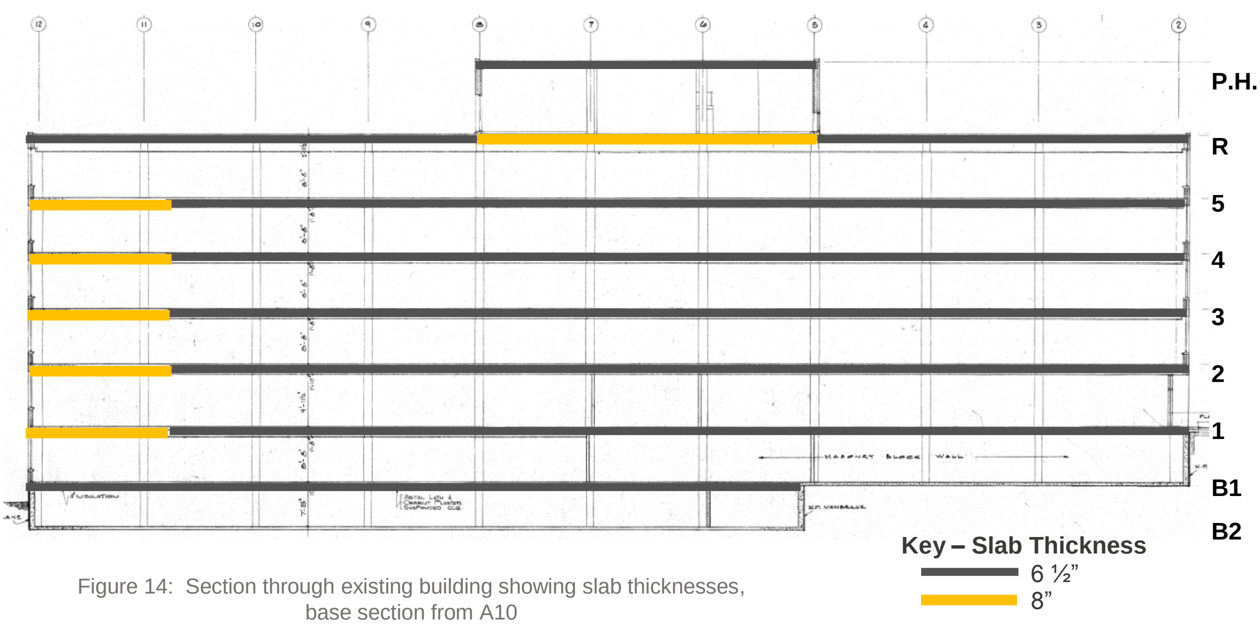


Figure 14: Section through existing building showing slab thicknesses, base section from A10

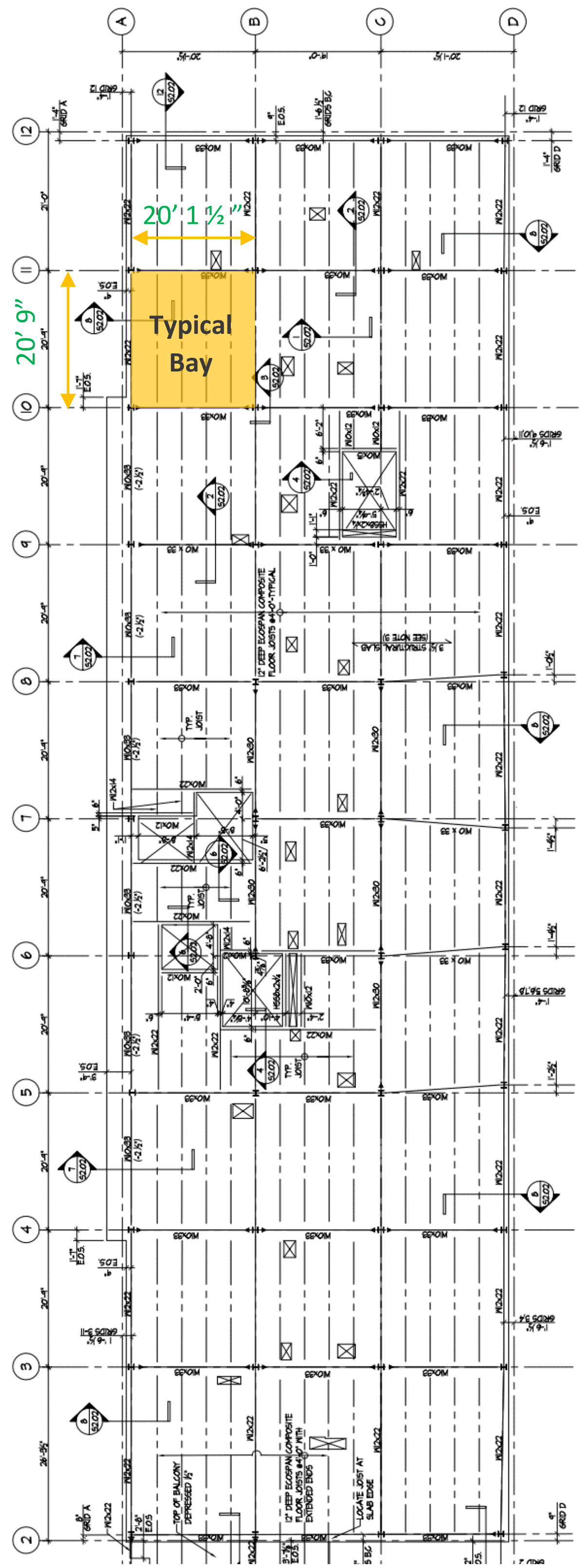


Figure 15: Typical Floor Plan, Grid in new steel floors matches original building's grid, S1.07

Modifications to Floor System

A few modifications were made to the slabs to accommodate layout changes and new openings. Typical on all floors were the demolition of slab to create new openings for new elevator and stairwell positions. A combination of load bearing CMU walls and new steel W-shapes were used to support the slab edges around the new openings. (See figure 16 for section through new CMU walls.) Existing openings at the old elevator and stairwell were filled in with new slab. In spots where new openings were added in drop panels and close to columns, (such as the openings for trash chutes), carbon fiber reinforcement was added. Several new shaft openings were cut in the slab more towards the inner portion of their respective bays and did not receive additional reinforcement. See figure 17 on the next page for locations of typical modifications on a typical floor plan.

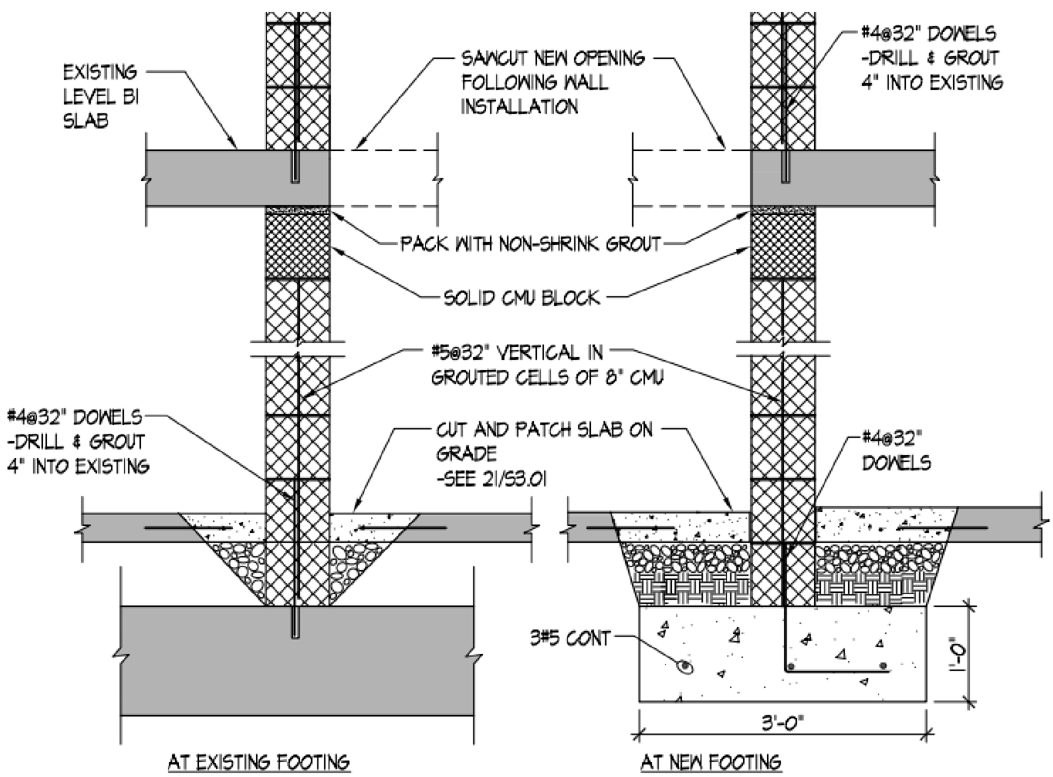


Figure 16: Section through new Load-Bearing CMU Walls. Existing slab was cut to allow walls to bear on existing footings. 1/S3.02

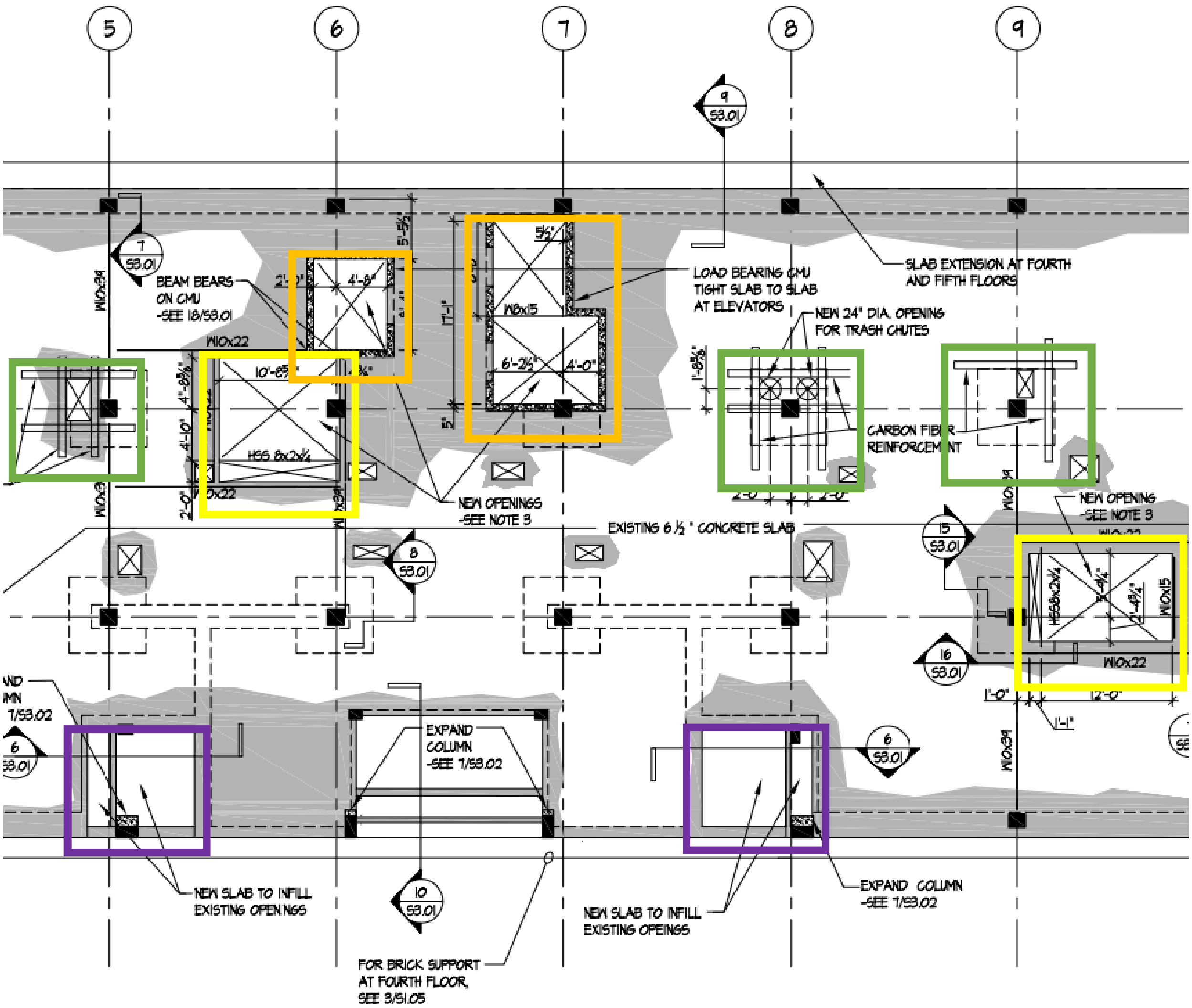


Figure 17: Portion of Typical Floor Plan Shown where Modifications to slab and layout occur in original building's slabs, S1.05

KEY

- Location of Carbon Fiber Reinforcement
- W-shapes added to support slab edge at new openings
- CMU Load Bearing walls added to support slab edge at new openings
- New Slab to Infill Existing Openings

Addition Framing

The 7-story addition is framed in steel with the column layout of W-shapes directly match the original concrete column layout. The typical girder size spanning south to north is a W10x33 due to the small bay size and lower residential live loads. The joists spanning east to west are typically 12" deep ecospan composite floor joists at 4' on center with W12 shapes typical along the column lines. The structural slab consists of a 1" steel deck with 2 ½" of normal weight concrete topping reinforced with welded wire fabric.

Lateral System

This section will provide a brief overview of the lateral system, which will be studied more extensively in a future report. The original building's lateral system and its modifications as well as the new addition's lateral system will be discussed in the following sections.

Original Building Lateral System and its Modifications

The original building resisted lateral loads through its concrete moment frame structure. The addition of multiple stories resulted in increased shear and wind loading on the existing building's concrete moment frames. Therefore, a few of the columns were increased in size by adding concrete to either one or two sides to increase their stiffness. Rebar for the additional concrete was embedded into the original columns and slabs through drilling and grouting for continuity and tie-in purposes. (See Figure 18 for Column Expansion Details in Section and Plan.)

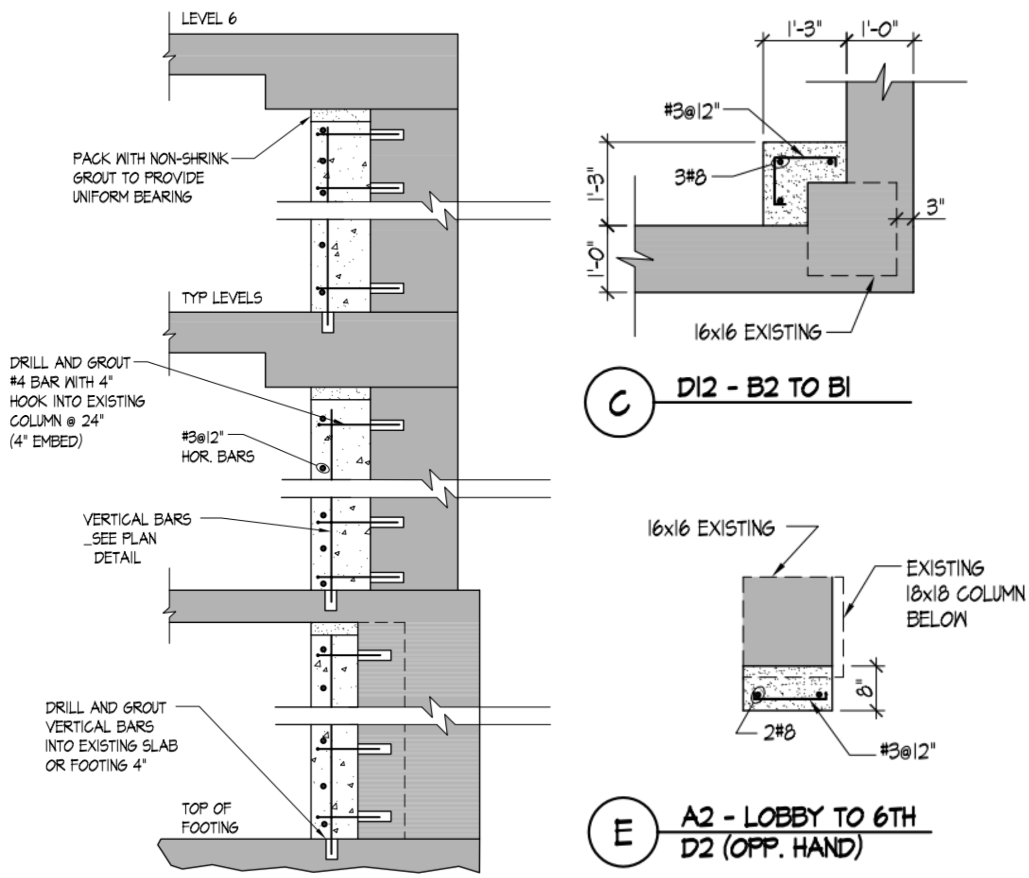


Figure 18: Section through new concrete tie-in (left). Plan of examples of columns expansions on one or two sides (right). 7/S3.02

Addition Lateral System

The new steel frame addition has several moment frames which resist lateral loads. See Figure 19 for typical floor plan with highlighted locations of moment frames.

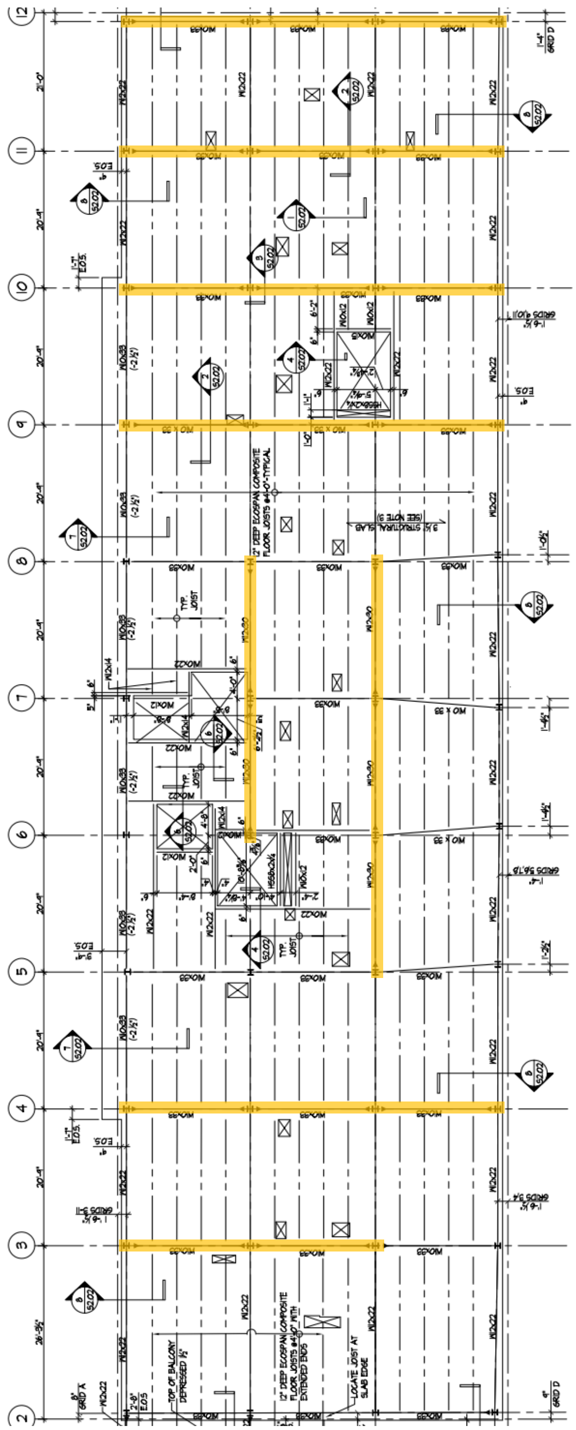


Figure 19: Typical Floor Plan, moment frames shown highlighted, S1.07

Joint Details

This building includes typical connections such as framed beam connections, stiffened beam connections, and fully restrained moment connections in the new steel addition, and the connection of new steel beams, columns, or new concrete to existing concrete members. It is typical for any connection into the existing building to involve drilling out a hole and embedding and grouting the rebar or bolt which will serve to tie in the new member.

Typical Beam Connections

A typical connection of a beam to a supporting member involves a steel angle which is welded and/or bolted at the flange of the beam. (See figure 20 for typical detail.) A stiffened seat beam connection has a stiffener plant and an angle to increase the stiffness of the connection. (See figure 21 for typical detail.)

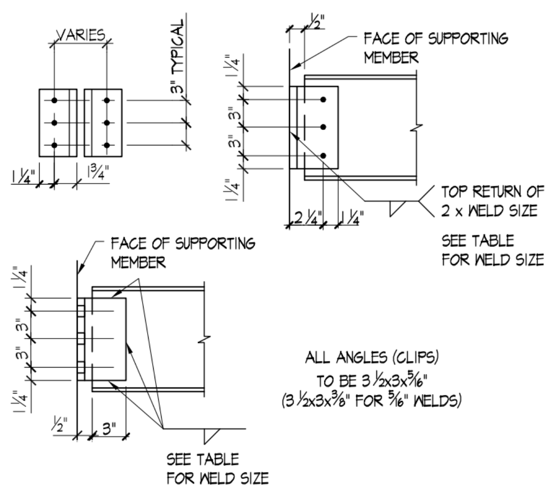


Figure 20: Typical Framed Beam Connections Detail, 1/S2.01

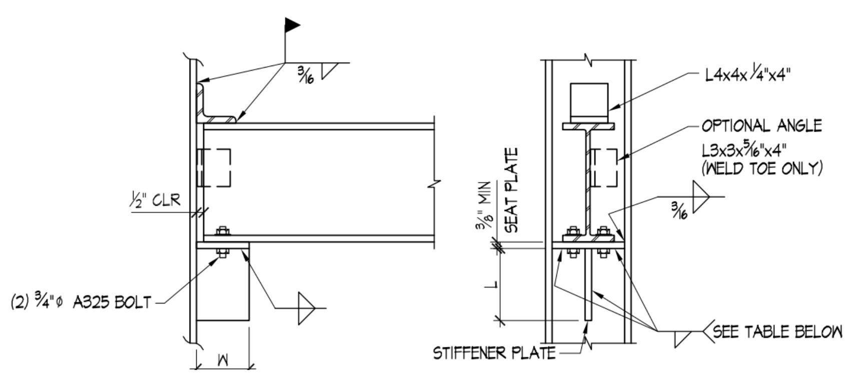


Figure 21: Typical Stiffened Seat Beam Connections Detail, 2/S2.01

Typical Moment Connection

The lateral system in the steel addition includes the use of several moment frames. Figure 22 shows a detail of a typical moment connection, both when the beam frames into the flange, and also when it frames into the web. In both cases, the webs must be bolted or welded depending on the strength required, and the flanges must be welded using a complete penetration groove weld.

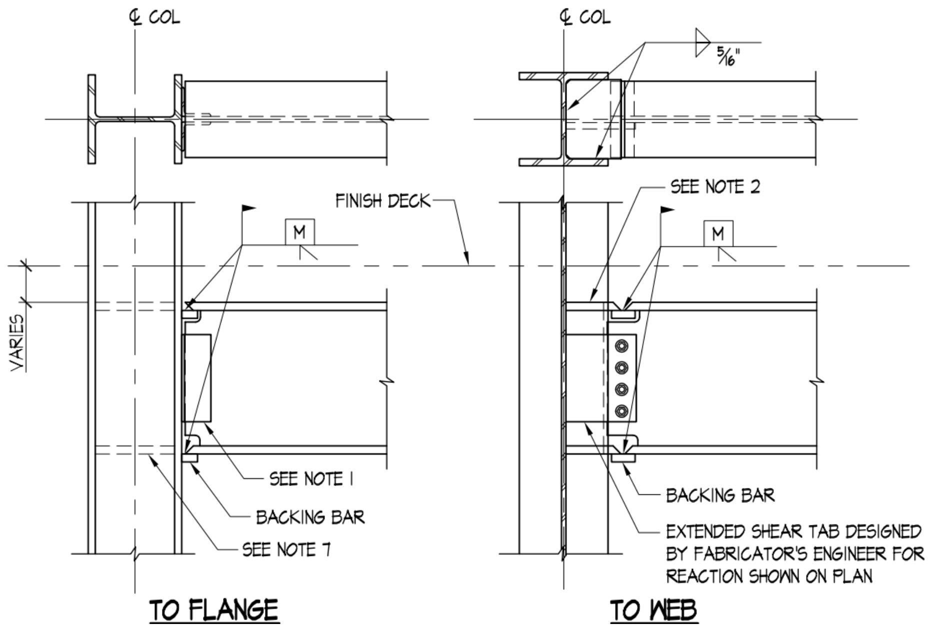


Figure 22: Typical Fully Restrained Moment Connection Detail (Beam to Column), 3/S2.01

Typical Connection of New Steel Beam to Existing Concrete

Where large new openings in the slab exist for elevators or stairwells, the slab edge must be supported. At the lower levels, CMU load bearing walls are used to accomplish this, but from the second floor slab and up, steel W-shapes are added to support the slab edges. In this cases, the steel shape must be anchored properly into the existing column up against the bottom of the slab. (See Figure 23 for detail of new beam connection to existing concrete column.) In the case that a drop panel exists at a column, the W-shape must be custom-shaped to fit tight against the drop panel and the slab (see Figure 23 on next page for detail of beam at drop panel location.)

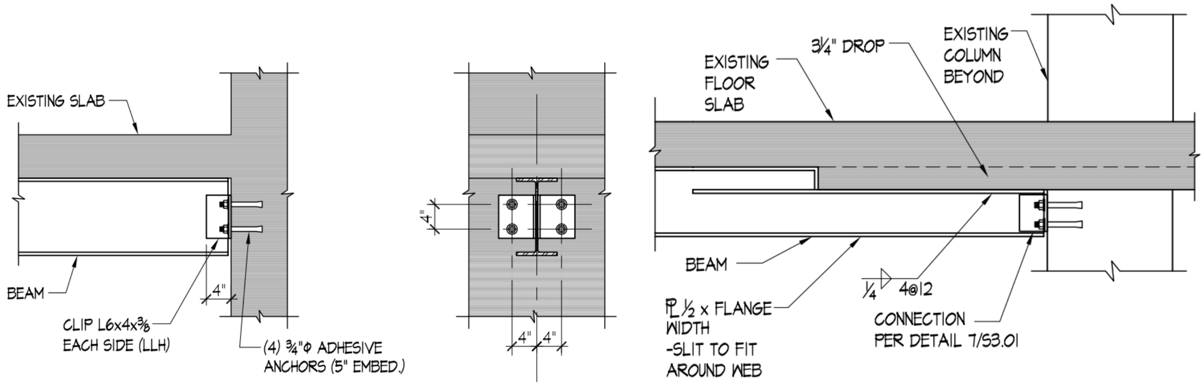


Figure 23: Steel Beam to Existing Concrete Beam of Column Typical Detail (Left) and to Column at Drop Panel (Right), 7 & 15 on S/3.01

Typical Column Connection to Existing and New Piers

At the existing roof level, which is now the 6th floor, piers were required to serve as a connection base for the new steel columns above the existing concrete columns. The original columns at the penthouse level were demolished down to a portion that could be used as an existing pier. At all other column locations, a new pier was built and tied-into the original structure. See Figure 24 for details of both the existing and new piers and the connection of the new steel column.

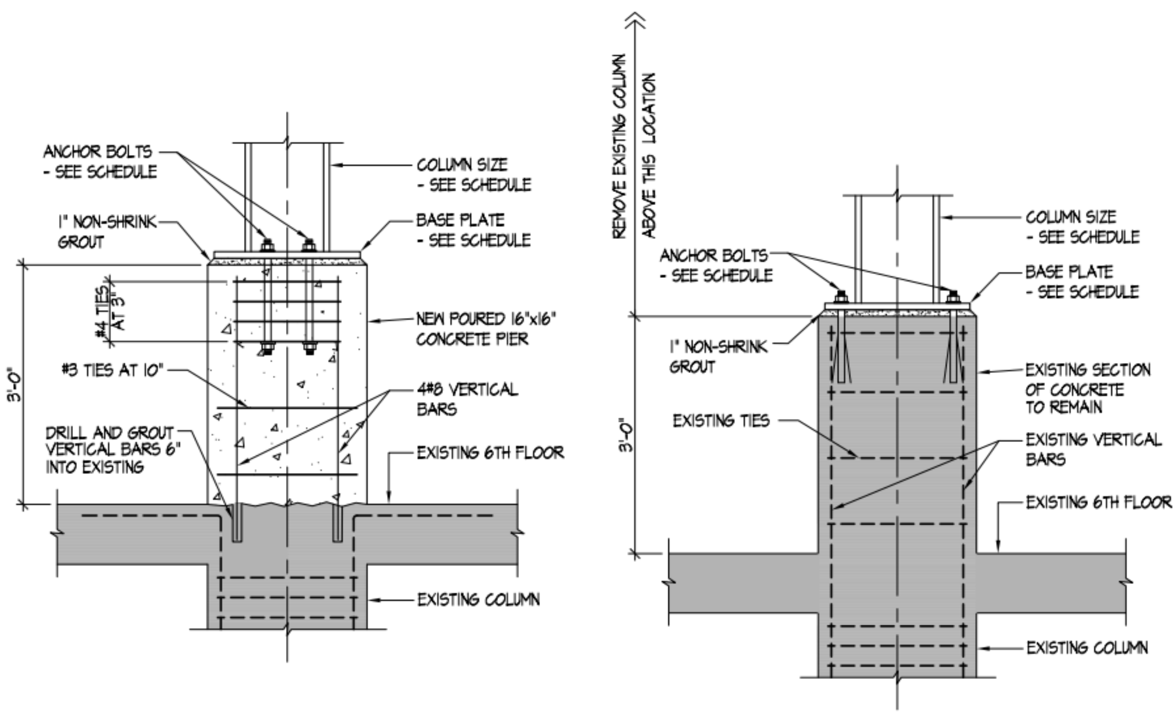


Figure 24: Column Base Typical Detail – New Pier (Left) and Existing Pier (Right), 3 & 4 on S/4.01

Design Codes and Standards

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 all future technical reports and design work for this thesis. The following codes will be used to determine loads and in re-designing the structural systems.

International Code Council

International Building Code 2009

American Society of Civil Engineers

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

American Concrete Institute

ACI 318: Building Code Requirements for Reinforced Concrete

ACI 301: Specifications for Structural Concrete

ACI 530: Building Code Requirements for Masonry Structures

ACI 530.1: Specifications for Masonry Structures

American Institute of Steel Construction

Steel Construction Manual, 14th Edition

Determination of Design Loads

National Code for Live Load and Lateral Load

The live and lateral loads come from IBC 2009, which references ASCE 7-05. Chapter 4 was used in determining live loads, wind loads come from chapter 6, and seismic loads come from chapters 11 and 12.

Gravity Loads

Dead Loads

The structure dead load includes the load from the slab, the girders, beams, and joists, and the columns. The original building used normal weight reinforced concrete, which is 150 pcf. The addition uses a 1” metal deck with 2 ½” topping for a weight of 37 psf. In addition to the structure dead load is a superimposed dead load (see Figure 25.)

Area	PSF
Elevated Floors - MEP	5
Roofing System	7
Rooftop Concrete Pavers	25
Stone Tile & Setting Bed	25
Roof Decking	10

Figure 25: Superimposed Dead Loads, S0.01

Live Loads

Live loads come from ASCE 7-05, and the loads used in the design of the addition are shown in the table below. The roof live load was 30 psf, unless the snow load is larger, and in that case, the snow load would be used. (See figure 26 for live loads used.)

Area	PSF
Framed Floor Areas	40
Lobbies/Stairs/Exits	100
Penthouse Floor	100
Lobby Floor	100
Corridors Above 1st Floor	40
12th Floor Corridors	100
Parking	40

Figure 26: Live Loads used on project, S/0.01

Snow Loads

The ground snow load is 30 psf. Although the load could be reduced per live load reduction, the design firm chooses to keep the full 30 psf load.

Lateral Loads

Wind Loads

Wind Loads were determined using ASCE 7-05. A 90 mph wind speed was used with exposure category B, and an importance factor of 1.0.

Seismic Loads

The equivalent lateral force procedure was used to find the seismic loads. The occupancy category was II with a seismic importance factor of 1.0, site class C, and design category A.

Lateral Soil Loads

The only lateral soil loads occur on the existing structure where the level step-up occurs at the retaining wall. These loads were not found because the existing foundation wall is not affected by the addition. The columns near the foundation wall on the higher basement level extend below the retaining wall, so additional load from the addition does not add a bearing on the soil behind the retaining wall. Therefore, the lateral soil loads were not found since they were not required for the new design.

Load Paths

Gravity

The gravity loads begin at the slab and are carried from the slab to the beams, which are supported by the girders. The load then goes into the columns and down the column line to the foundations. There is a single transfer column where the load comes down through a column onto a transfer beam, where the load goes through the beam over to the column and down the rest of the way to the foundations. Finally the load, after reaching the foundations goes into the soil.

Lateral

The lateral loads in this region are wind controlled, so as wind creates a pressure on the building, it starts at the facade and goes through connections and structural steel backup to the slabs, which act as diaphragms to transfer the load to the lateral force resisting system. In the case of this building, the load goes into the concrete and steel moment frames and is transferred into the foundations. Finally the load reaches the soil as an overturning moment.

Conclusion

This report explored the existing conditions of 11141 Georgia Avenue. Rather than tear down the old building and build completely new, the owner decided to take the option of adding floors on top and renovating the structure so that it would fit his needs. Working with a building which is part new construction, part 1960's construction will be a challenge in other future work. Therefore, this report looked at the original structure, its modifications for the new addition and layout changes, and the addition and its effects on the overall structure.

The materials and their strengths were tabulated in the report. The foundations were looked at and include spread footings with piers, some combined footings, and retaining walls due to the slight hill on which the building was built. Despite the new addition, the foundations did not require modification because in most cases, the loads were found to be less that the original 1962 design loads. The retaining wall was also found to not be affected by the addition because of the elevations of the nearest columns.

The frame of the original building and new addition were explored in this report. It was found that modifications to the original reinforced concrete slabs were required due to layout changes of the elevators and stairs, and that new openings were supported and reinforced using a variety of methods. The new steel frame of the addition was found to be a simple layout with W-shape girders and composite floor and roof joists. The lateral system was found to include concrete moment frames in the original portion of the building and steel moment frames in the addition. Some of the concrete columns were expanded to increase the stiffness of the original structure to accommodate additional wind loads.

The report then looked at a variety of typical connections and joints, both ones that are completely new, and ones that required a method of tie-in to the existing structure. In cases where new members required tie-in to the original building, holes were drilled out to embed rebar or anchors.

The loads were all determined using ASCE 7-05, referenced by IBC 2009. Gravity and Lateral loads were tabulated and/or listed according to the loads noted by the design team in the structural notes. Finally, load paths were described in the report for future reference in analysis and re-design.

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.