Technical Report

STRUCTURAL EXISTING CONDITIONS AND PROPOSAL

Photo Courtesy: Castlebrook Development Group

Flats on Fifth

1655 Fifth Avenue
Pittsburgh, Pennsylvania

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1 Executive Summary

Flats on Fifth is an apartment building in Pittsburgh, Pennsylvania. The site is just off of the parkway system that runs through the city. Five levels of apartments are located above two levels containing parking, fitness center, business meeting room, and a few more apartments. All seven floors combine for a total building height of 82'-8" and floor area of just shy of 90,000 square feet.

Structurally, Flats on Fifth is a podium-style building. In accordance with Chapter 6 of IBC, noncombustible materials, such as steel and concrete, are used to construct a two story podium utilizing Type 1 construction methods. The remaining floors are constructed with more combustible materials, such as wood, to fulfil requirements for type 3 construction.

The first two floors are framed with steel wide flange beams and girders connecting to columns with both shear and moment connections. The floor system at these levels is concrete slab on metal deck. The apartment levels are constructed with wood trusses bearing on stud walls. The trusses support a blocked, wood structural panel diaphragm. Columns are supported by caissons at the building's base. Remaining loads are carried by grade beams which also span between caissons. At the ground level, the floor is a concrete slab on grade.

Three masonry shafts are prominent in the design. They are roughly centered along the building's short axis with one on each end in the long axis and the third tower slightly offset from the center of the building. These towers serve as the main lateral force resisting system. Load is delivered to the towers through the floor diaphragms and ultimately to the grade beam and caisson foundation. Other elements within the building, such as steel moment frames, are supplementary to the main lateral force resisting system.

The proposed thesis will investigate the applicability of converting the existing system to cold-formed steel (CFS) trusses bearing on metal stud walls. This system will be used in an attempt to remove the need for a podium. Hot-rolled steel shapes will be used to supplement this system where bearing walls cannot be placed. The lateral force resisting system will remain as reinforced masonry shear walls.

The first proposed breadth topic will alter the first two floors of the building. The goal will be to add an additional floor of apartments by moving parking below grade. Cost benefit to the owner will be assessed for this scenario. The second breadth topic will analyze the acoustic requirements of the new apartments on the second level, now closer to the roadway.

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2 Introduction

2.1 Scope

This report is intended to provide a description of the existing structural systems and features of Flats on Fifth in Pittsburgh, Pennsylvania. In addition to discussing the systems, a brief discussion of applicable codes and standards will be included along with a description of loading criteria. The focus of this report will be discussing one system at a time from bottom to top. Graphics and images are included to assist in conveying points of topic.

Following the review of the existing structural systems of this building, this report will present a proposal for an alternate structural system. This section will include a brief review of the existing system with a statement of the intended goal of the proposal. A description of how this will be resolved will be given with a general overview of milestones for the project. Brief descriptions of work to be done not directly related to the structural system will also be stated.

2.2 Building Summary

Flats on Fifth is a seven story residential building completed in September of 2016. This building is located in the Uptown District and is part of a plan to revitalize the area. The site on Fifth Avenue, just off of the Parkway, is a prime location for residents. PPG Paints Arena is within a few blocks from the site and with quick access to the Parkway, the other major sporting venues, as well as Downtown, are not lengthy commutes. Near the site also, within a few blocks, is a major hospital.

74 apartment units make up this approximately 90,000 square foot building. Dwelling units make up floors three-seven with a few additional units on floor two. The first two floors enclose a parking garage with a bicycle storage room. Due to a sloping site, low in the front and high in the rear, the garage has no ramps. Advantage was taken over the elevated street to the rear of the building and two entrances are used. Also within the first two floors are additional spaces for resident use. Of these include a fitness center, business meeting room, and kitchen.

The exterior of the building is broken up into two distinct portions. Most existing buildings in the uptown area are two story brick buildings. Flats on Fifth respects the local history by using brick veneer on its lower floors. Its upper floors are a more modern style. Most of the façade is vinyl siding, ribbed metal panels, and fibrous cement panels.

This combined structure type is the result of an investigation including several structure methods. Other systems investigated include typical steel framing for the entire building and block and plank. Block and plank utilizes CMU bearing walls with hollow-core concrete plank. The outcome of the conducted investigation was a noncombustible, type 1, podium as a base for the remaining combustible, type 3, floors.

3 Structural Systems

3.1 Foundations

Following the recommendation of the geotechnical engineer, the structure of Flats on Fifth bears on a system of grade beams spanning drilled, cast-in-place caissons. All concrete used for this design is 3000 psi normal weight concrete. Grade beams range in size from 24-30 inches wide and 32-60 inches deep. The most common reinforcement includes #8 bars at the bottom and #5 or #8 bars at the top with #4 stirrups. Figure 01 shows conditions with and without a concrete pier. Per the detail, dowel connections change for this condition. When no pier is needed, 4 - #6 dowels are used to make this connection. When a pier is specified, dowels extending into the caisson match the vertical reinforcement of the pier.

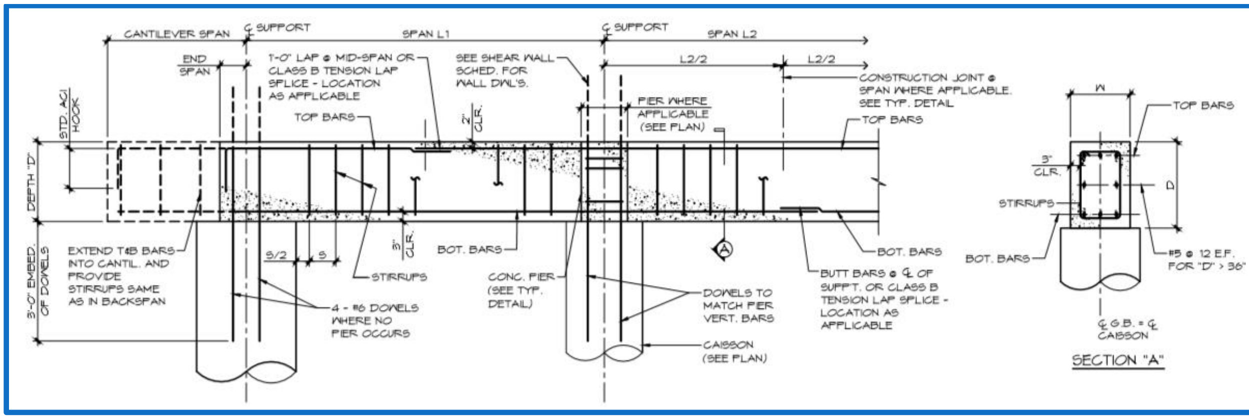


Figure 01: Grade Beam Reinforcement (Keystone Structural Solutions (KSS))

The geotechnical report suggest to design caissons to bear directly on solid bedrock, drilling into the rock by at least one foot. Further drilling for skin friction socketing is permitted by the report to allow caisson diameters to be reduced, but a minimum of 30 inches is given. Caissons in the existing design range from 30-42 inches in diameter. Vertical reinforcing changes with diameter but is generally#7, #8, or #9 bars with #3 ties. Depth of caissons are typically 25 or 45 feet to end bearing with an average 4.5 foot skin friction socket in rock. Caissons are designed to transfer most of their load by bearing directly on rock. Sockets are added to aid load transfer by allowing it to pass through the sides or the caisson in addition to the end. This also helps resist uplift forces. Figure 02 shows a typical reinforcement detail for caissons. In some areas, concrete piers are required above the caisson as shown in figure 03. Concrete Piers are square of 24 or 26 inch sides with #8 vertical bars and #4 ties.

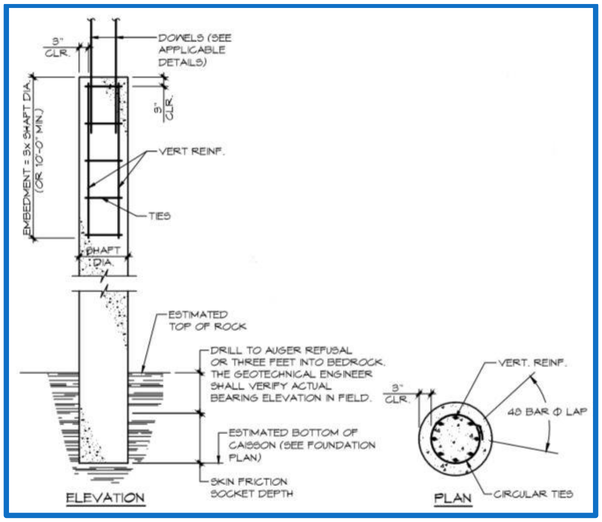


Figure 02: Caisson Reinforcement and Socket (KSS)

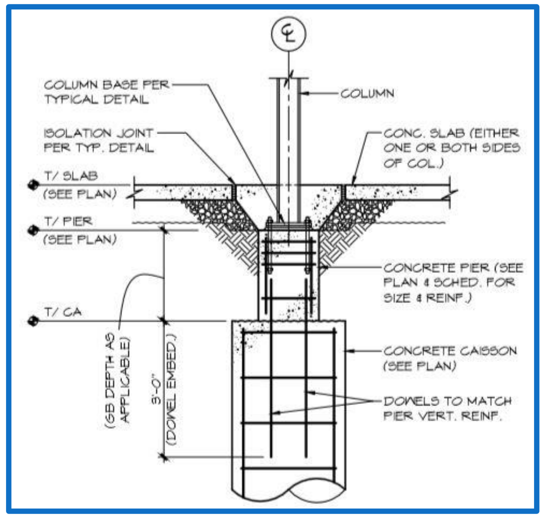


Figure 03: Concrete Pier over Caisson (KSS)

The ground floor of the building is slab-on-grade. This is also designed with 3000 psi normal weight concrete. The slab is typically 5 inches thick with fiber mesh reinforcement. Underneath the slab is a 6 inch bed of compacted, well graded granular fill. Figure 04 illustrates this design.

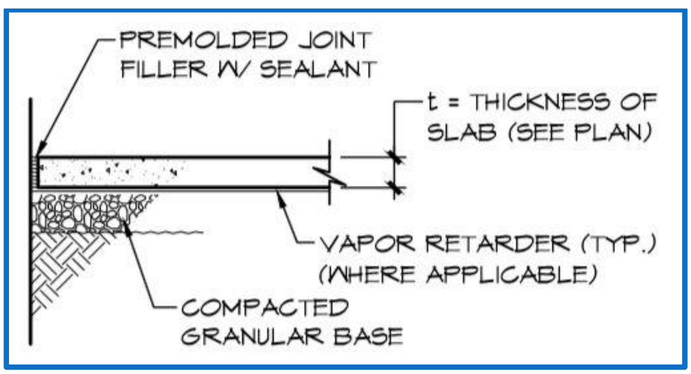


Figure 04: Typical Slab-on-Grade (KSS)

3.2 Typical Bay

This section will focus on the gravity load design of Flats on Fifth. Since there are two prominent construction types, both will be described. Continuing in the fashion of moving from the bottom of the building to the top, the steel systems will be discussed first followed by the wood systems.

3.2.1 Steel

The building divided into three distinct column lines which divide the building longitudinally. This creates two major spans for infill beams of 40 and 43 feet. Laterally, the building is divided into seven distinct column lines. Girders span from line to line at most 28'-6". Figure 05 shows an example of one of the steel framed floors in the building. Figure 06 is a closer image of a typical bay of 28.5 feet by 40 feet. Some of the more common infill sizes include W24x55 and W21x44. Of the more common girders include W21x44 and W36x135. As shown in figure 07, most of the beams and girders in this design are composite acting with the concrete slab it carries. Most members use an average of 20-30 shear studs.

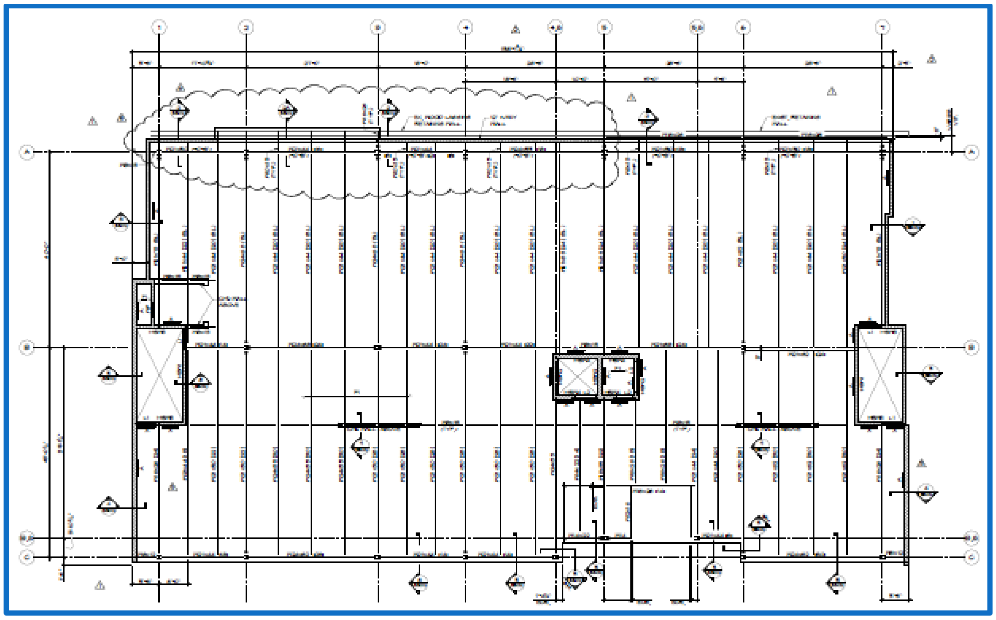


Figure 05: Level 1 Steel Framing Plan

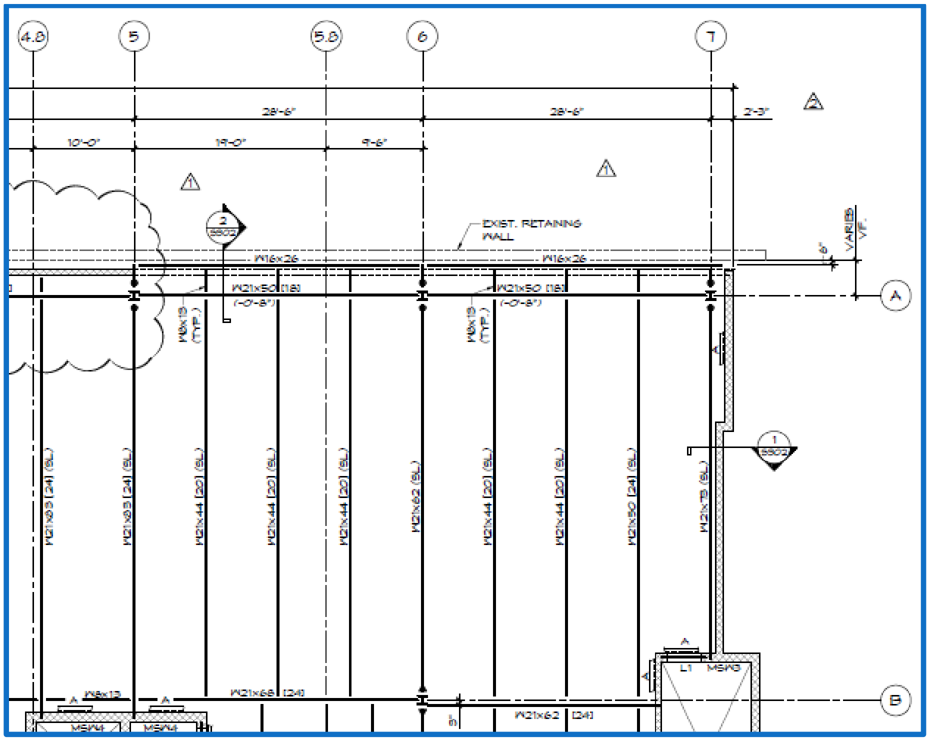


Figure 06: Close Up of North-East Corner of Steel Framing Plan

The floor structure is a 2 inch, 18 gage composite deck with normal weight concrete. Table 01 lists thickness and reinforcement of concrete topping per floor. In addition to the welded wire fabric, fiber mesh is added to the concrete mixture for increased strength.

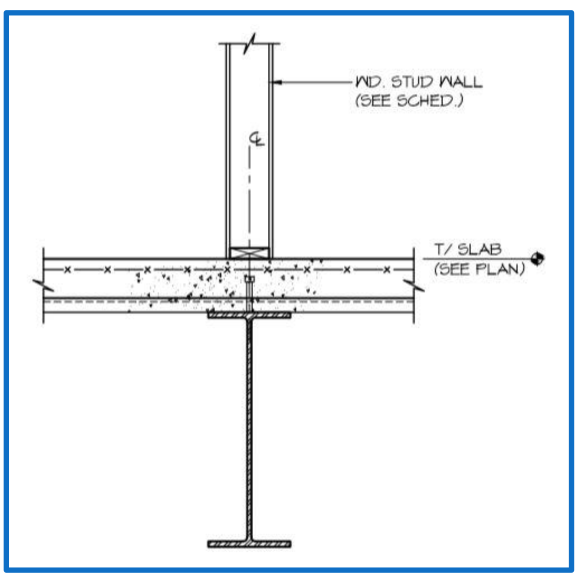


Figure 07: Composite Beam (KSS)

Level	Topping	Reinforcement
1	4½"	4x4 – W8xW8 WWF
2	5¼"	6x6 – W2.9xW2.9 WWF

Table 01: Slab Topping and Reinforcement

3.2.2 Wood

The upper five floors of Flats on Fifth are of wood construction. Typical infills span from wall to wall. Open web joists 16 inches deep and spaced 16 inches maximum are used to support the floor structure. Other members throughout the plan include a 1¾ x 9¼ LVL and a series of 2x10's grouped in threes.

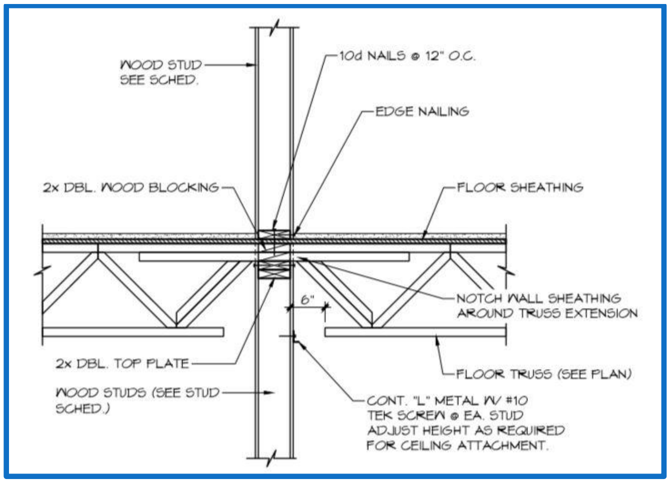


Figure 08: Wood Joist at Stud Wall (KSS)

Image 01: Wood Joists (KSS)

Typical floor diaphragms consists of 1 inch of gypcrete with a ¼ inch sound control mat over wood sheathing. Sheathing is either ¾ inches thick for floors or 5/8 inches thick for roofs with 2x4 wood blocking at the edges of all panels.

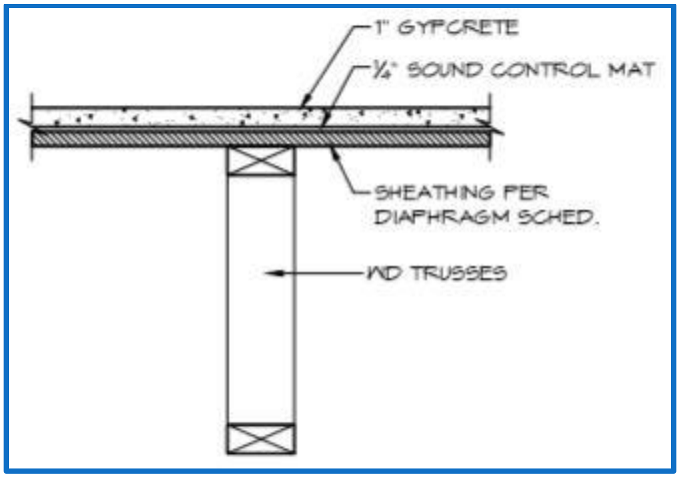


Figure 09: Wood Diaphragm Structure (KSS)

3.3 Columns

Similar to the last section, this section will discuss first steel members followed by wood members.

3.3.1 Steel

Steel columns extend from the foundation of the building to just below the second floor. Columns are a range of W12 shapes. The maximum load delivered to the foundation is 565 kips. Base plates are most commonly 18 inches square and on average 1½ inches thick. Columns extend full height. Beams connect directly to the sides at floor 1 and lay on top at floor 2 as shown in figures 10 and 11 respectively.

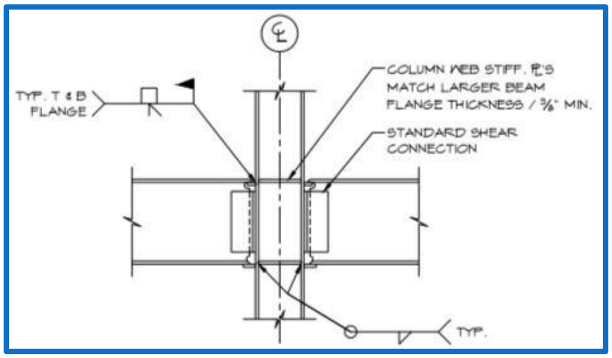


Figure 10: Beam to Column Side (KSS)

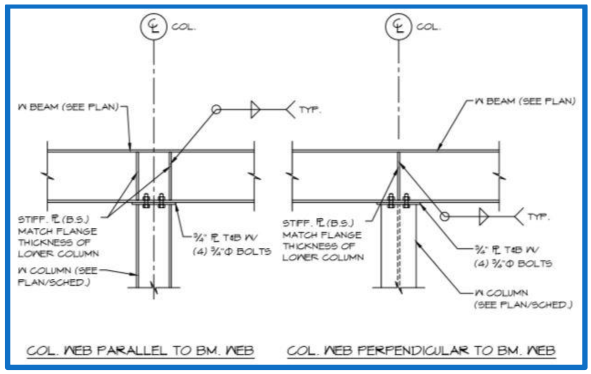


Figure 11: Beam over Column (KSS)

3.3.2 Wood

Stud walls make up most of the vertical members in the upper five floors. Typical walls are 2x6 studs spaced either 12 inches or 16 inches on center. These stud walls frame into wood posts which run along the main corridor. Wood posts are either (3) 2x8 dimensioned lumber or one 5¼"x5¼" engineered lumber. Engineered lumber is produced to provide higher strength capacities than traditional sawn lumber. These posts seem to be used only in places where excessive load is expected, such as bearing walls with several long headers.

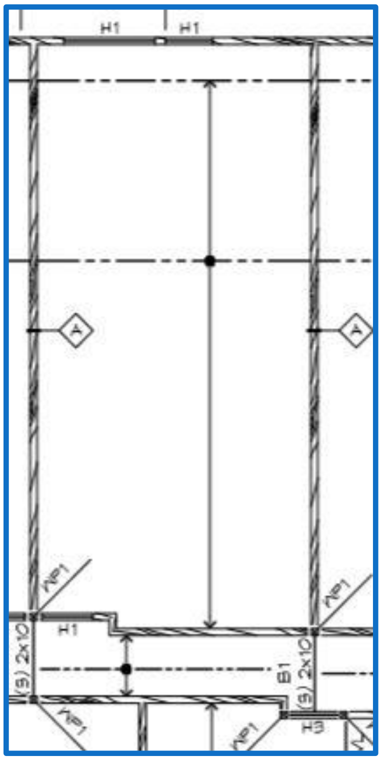


Figure 12: Excerpt From Level 3-6 Structural Plan (KSS)

3.4 Lateral Systems

Reinforced masonry shear walls are used as the main lateral force resisting system.

3.4.1 Masonry Shafts

There are three main masonry shafts that surround elevators and stairs. These can be seen outlined in red in figure 13. These shafts provide stiffness for the entire building to resist lateral loads. Reinforced masonry shear walls are constructed of 8 inch or 12 inch ivany block. Typical reinforcement includes #5 bars every 48 inches with #8 bars at each end vertically with #4 bars every 16 inches horizontally at each face of the wall.

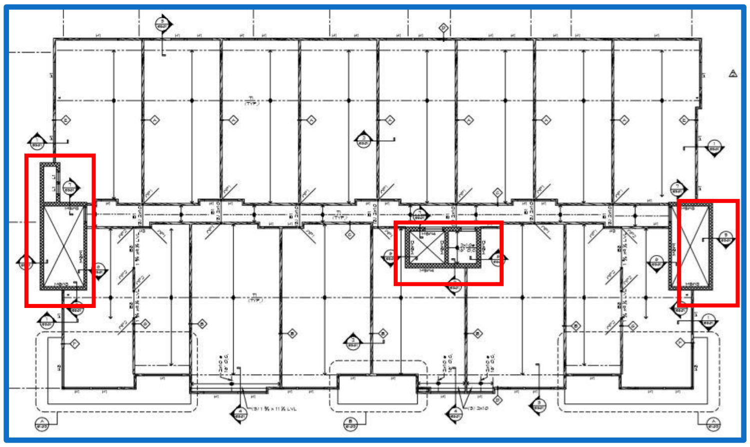


Figure 13: Apartment Level Floor Plan, Masonry Shaft Callout (KSS)

Image 02: Masonry Shafts (KSS)

3.4.1 Other Lateral Elements

While the masonry shafts are the main lateral force resisting system. Other smaller systems are used for extra measure.

Moment Connections

As mentioned in a previous section, the gravity system for the first two floors is steel. This system includes moment frames and connections to supplement the reinforced masonry shear walls.

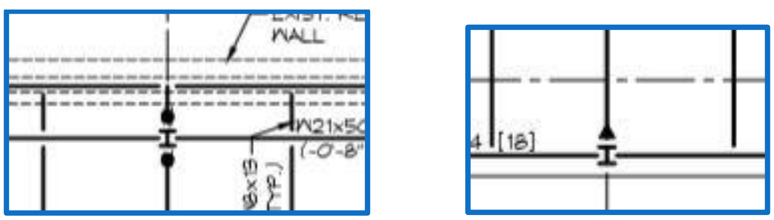


Figure 14: Plan Marked Moment Connections (KSS)

Floor Blocking

Apartment level floor diaphragms are constructed with 2x4 blocking. Due to high shear in these diaphragms, this blocking was added to aid in transferring load to the vertical lateral lead resisting elements such as the masonry shear walls.

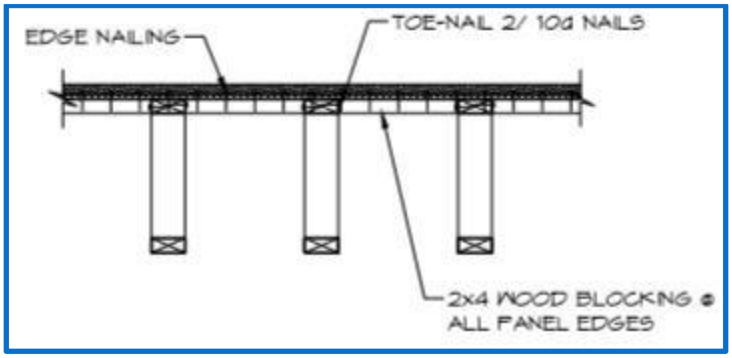


Figure 15: Floor Diaphragm for Shear Transfer (KSS)

3.5 Other Structural Elements

Flats on Fifth features balconies for its residents. Unlike the rest of the structure of the apartment level floors, the balconies are steel construction. Balconies are constructed of mostly 8 inch channels. 8 inch wide flange members are used typically where moment connections are required. Edge members, as well as members extending into the building, are 12x4 rectangular HSS.

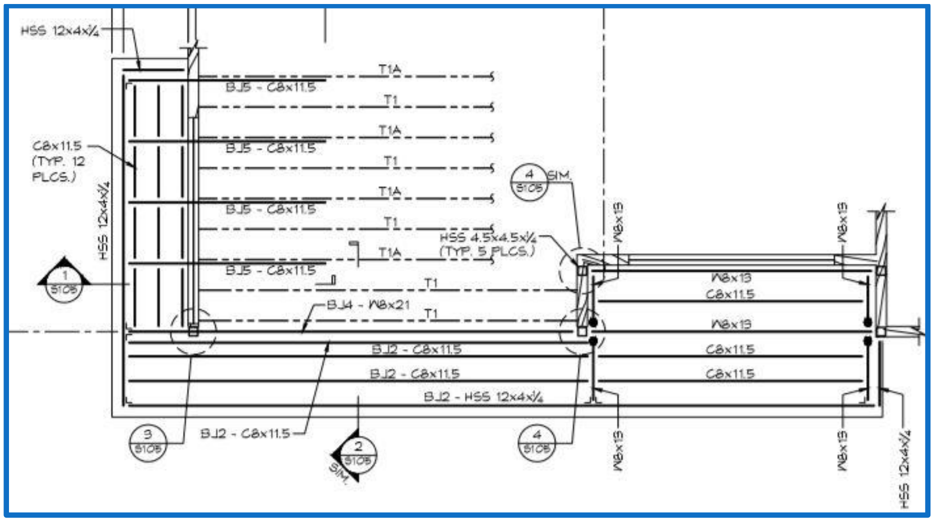


Figure 16: Balcony Structural Plan (KSS)

Image 03: Balcony Structure

Crowning the front of the building is a decorative overhang. The extent of this overhang can be seen in figure 17 with the gray hatching.

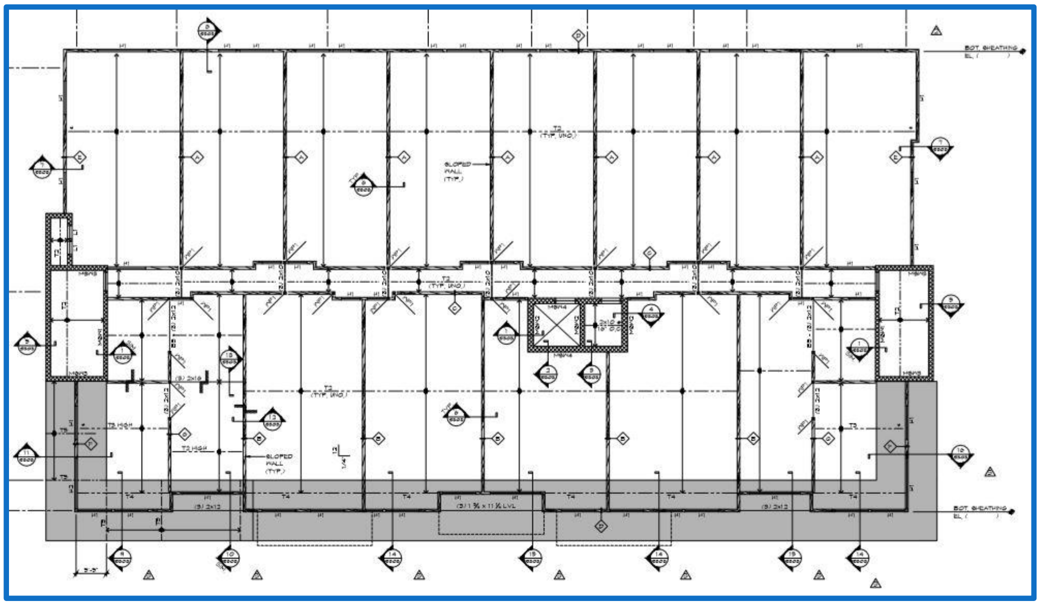


Figure 17: Roof Framing Plan (KSS)

The crown has two styles. Towards the left-front corner of the building, the crown is larger and more outward reaching. Along the rest of the building front, it is shorter and more vertical. Two different wood structures were implemented for these pieces. The first, as shown in figure 18, uses a step down truss to cantilever off the edge of the building. Figure 19 shows the second type, a more block and stud type truss to create the shorter cantilever.

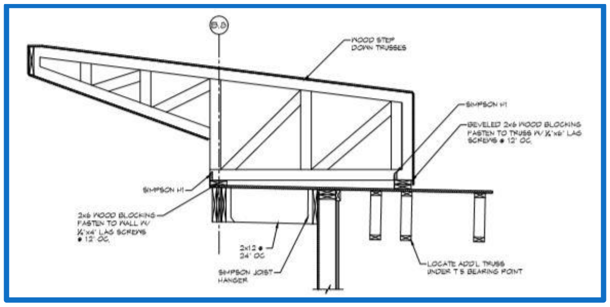


Figure 18: Larger Crown Truss (KSS)

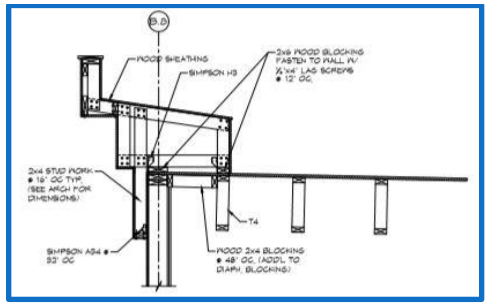


Figure 19: Smaller Crown Truss (KSS)

3.6 Joint Details

Moment Connections

There are two different types of moment connections used in the steel framing. Standard moment connections, like the ones shown in figures 20 and 21, are welded connections. Shear and moment are resisted by the entire connection. Plates are added to the column to increase stiffness of the joint. The wind moment connection, shown in figure 22, is bolted at the flanges and welded along the web. Here, shear is resisted completely by the web connection and the bolted flanges resist moment.

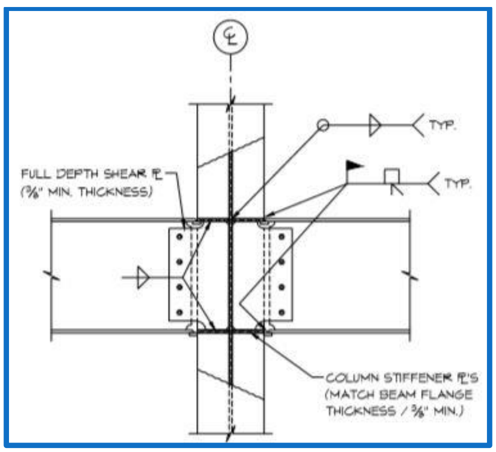


Figure 20: Moment Connection to Web (KSS)

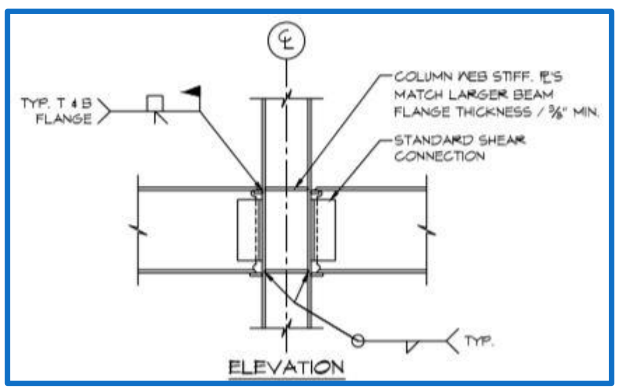


Figure 121: Moment Connection to Flange (KSS)

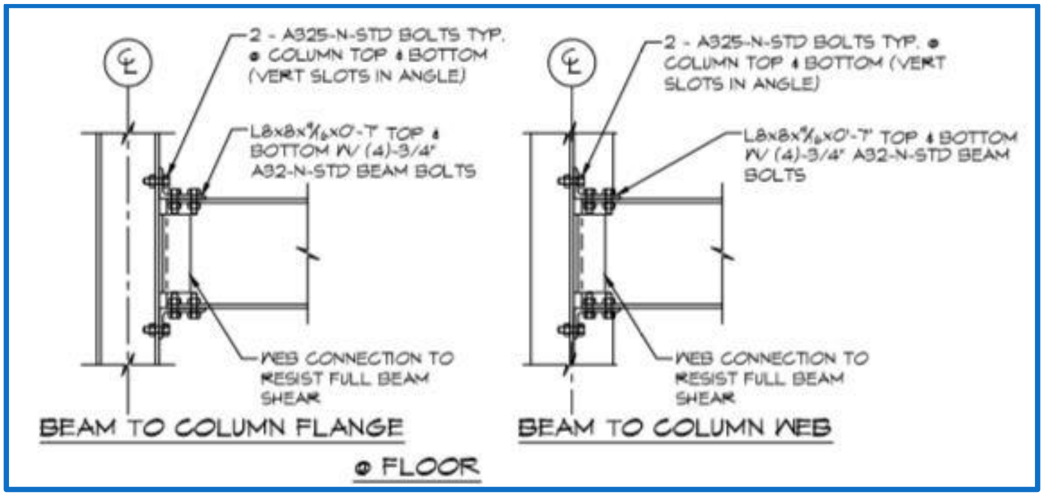


Figure 22: Wind Moment Connection (KSS)

Truss to Bearing Wall

Wood trusses are made continuous at stud walls. The top chord of the truss is extended through the partition to adjacent trusses. In addition to being continuous, the top chord is also double layered to better resist moment transfer through the chord. Being a continuous member, the stud wall must carry twice the load at a single spot. The double 2x top plate helps distribute the load over the length of the wall.

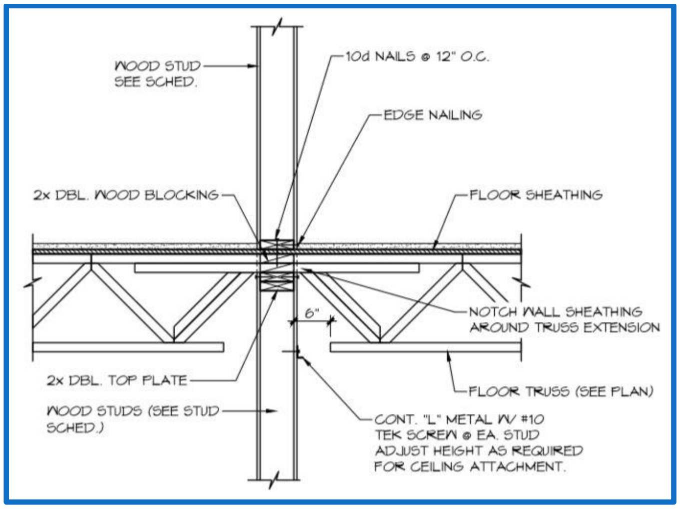


Figure 23: Wood Truss End Bearing (KSS)

4 Load Path

This section will analyze the path loading takes from its respective points of loading to the foundation. Load path will be discussed from the top of the building to the bottom.

4.1 Gravity Loads

Beginning at a typical apartment level, gravity loads enter the floor diaphragm and are carried by the wood trusses of beams. Trusses deliver load to stud walls while beams deliver load to posts. This structural plan is consistent for each level until level two. The wood structure is carried by concrete slab on deck. In most cases, wood stud walls lay directly above steel beams. Any remaining load carried by the slab and deck is transferred to the steel infils. This load is eventually transferred through the girders and into the columns. At the foundation, grade beams carry remaining loads from the ground floor. These loads, as well as the loads from the steel columns, are directed to caissons.

4.2 Lateral Loads

Lateral loads are initially resisted by the floor diaphragms. Diaphragms are designed to be rigid to transfer load to vertical members. Throughout the entire building, the main vertical members for this transfer are the masonry shafts. Other minor details resist small amounts of lateral force, such as the moment connections in the steel framing. Accumulated load from each floor is ultimately transferred into grade beams and caissons supporting the towers.

5 Design Criteria

5.1 Codes and Standards

Structural design for Flats on Fifth follows the 2009 edition of the International Building Code (IBC). IBC 2009 makes reference to the following for design limitations.

American Concrete Institute	Building Code Requirements for Structural Concrete	2008
American Institute of Steel Construction	Specification for Structural Steel Buildings	2005
American Society of Civil Engineers	Minimum Design Loads for Buildings and Other Structures	2007

Other referenced codes include the Timber Construction Manual from the American Institute of Timber Construction and the National Design Specification for Wood Construction. General notes call for use of the latest edition of each standard.

5.2 Load Values

Load values for gravity and lateral systems are listed or explained in the International Building Code and ASCE 7.

5.2.1 Gravity Loads

Dead Loads

Dead loads are determined by the materials used to construct the building. This includes structure, equipment from mechanical and electrical systems, finishes and any other item considered to be permanent.

Live Loads

Live loads are dependent on building use and occupancy type. Garage loading requirements are needed for the first two floors. These floors also require corridor and classroom loading. Multi-family and corridor loading is required over the upper five floors. The roof of the building requires only loading requirements for maintenance.

Rain and Snow Loads

Rain and snow loads will be calculated using site local averages. This requires finding the average rain and snow fall for the area. Parapets on the roof require an additional snow drift analysis.

5.2.2 Lateral Loads

Wind Loads

Wind loads are calculated according to the IBC wind load provisions. Items such as risk category and exposure are key factors to the calculation of this loading. These factors combine to create an adjusted wind pressure that acts on the side of the building and changes with the height of the structure.

Seismic Loads

Seismic loads are also calculated by IBC procedures. Calculation of these loads are location specific. Certain factors such as short and one second periods are dependent on site location. These, as well as a few other factors, are used to determine the seismic response category and ultimately calculate the seismic load on the building. This load is applied as an equivalent lateral load.

6 Proposal

6.1 Background

Flats on Fifth has a building footprint of 156 feet by 86.5 feet. Built seven stories tall, total floor area comes to roughly 90,000 square feet. Designed as a podium building, type 1 construction supporting type 3 construction, this building has a combined structure of both steel framing and wood bearing walls. The first two floors are built of steel framing with concrete slab on deck and serve as the podium. The remaining five are constructed from wood trusses spanning stud bearing walls with blocked wood sheathed floors. Laterally, Loads are resisted by three reinforced masonry shafts located around the stairs and elevator.

6.2 Problem Statement

The goal of this proposed thesis is to design an alternate structural system to remove the need for a podium-building. Analysis will be done to design using materials conforming to a single construction type. In addition to this requirement, existing floor to floor heights are to remain the same. Many components of the current system are able to be prefabricated before being transported to the construction site, allowing faster construction speeds. It is therefore important that the new system is able to be constructed at a fair rate.

6.3 Proposed Solution

The proposed new system will use cold-formed steel (CFS). CFS studs will be used to design trusses and bearing walls in a similar style to the existing design. These components can be prefabricated in the same manner as the existing wood components. This system will continue through the first two floors, allowing the full building to be classified as type 1 construction and removing the need for a podium building.

To keep the garage areas on the first two floors open, bearing walls will not be used. Here, hot-rolled steel beams and columns will be used in areas where a bearing wall would have been used. Floors throughout the building will be concrete slab on metal deck.

Reinforced masonry shear walls are the existing lateral force resisting system. This system will remain the same. Redesign will be necessary since the structural system is changing and load distribution to the walls will be altered.

6.4 Solution Methods

Hand calculations will be used to design the alternate system. Standards such as the AISI CFS Design Specification will be used along with member properties from CFS providers to design adequate members. Knowledge gained from classes such as AE401 and AE431 will supplement the design specification. In such areas where hot-rolled steel shapes are required, calculations will be based on the AISC steel manual and design specification.

Reinforced masonry shear walls will be designed in accordance with the Masonry Building Code and Design Specification. Computer analysis programs, such as STAAD or ETABS, may be used as a supplement and verification of hand calculations for lateral elements.

6.5 Preliminary Analysis

A brief analysis for a possibly structural layout has been conducted and the resulting plans are presented below. Please note that the North side of the first floor is enclosed by a pre-existing retaining wall. This has been omitted from the sketched plans as they are meant to show new construction. In addition to the layout analysis, a few structural members have been preliminarily sized with general loading. This will help better predict the sizes of members when performing more precise calculations.

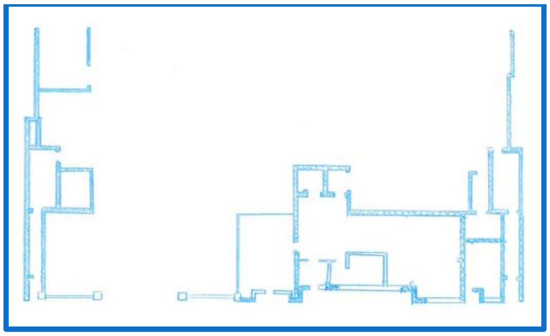


Figure 24a: First Floor Plan

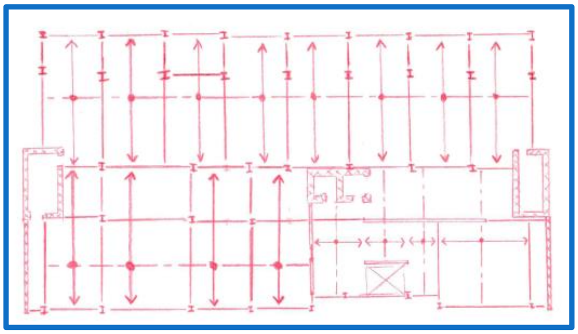


Figure 24b: First Floor Structural Plan

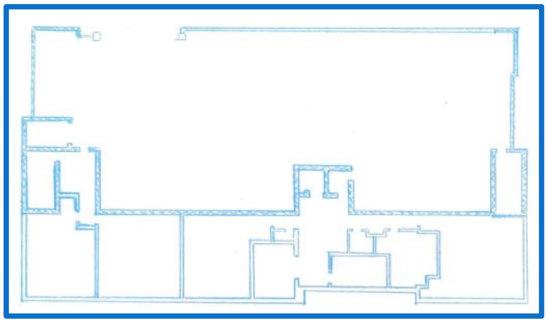


Figure 25a: Second Floor Plan

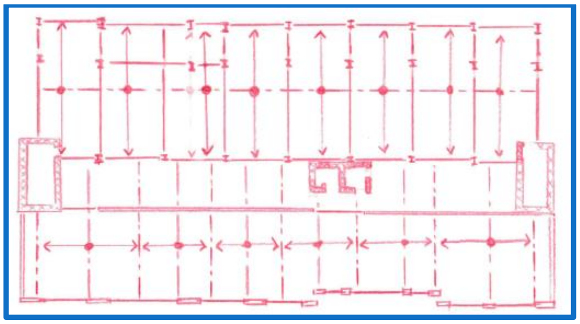


Figure 25b: Second Floor Structural Plan

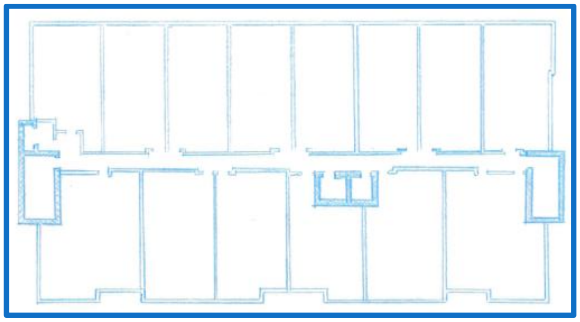


Figure 26a: 3rd-6th Floor Plan

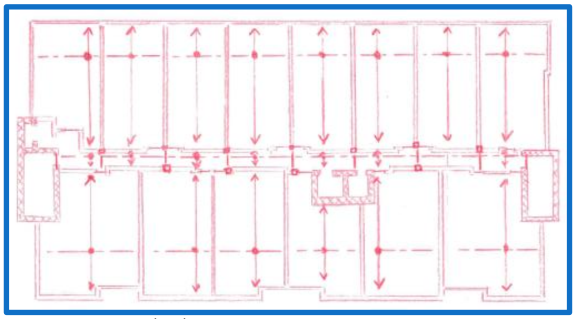
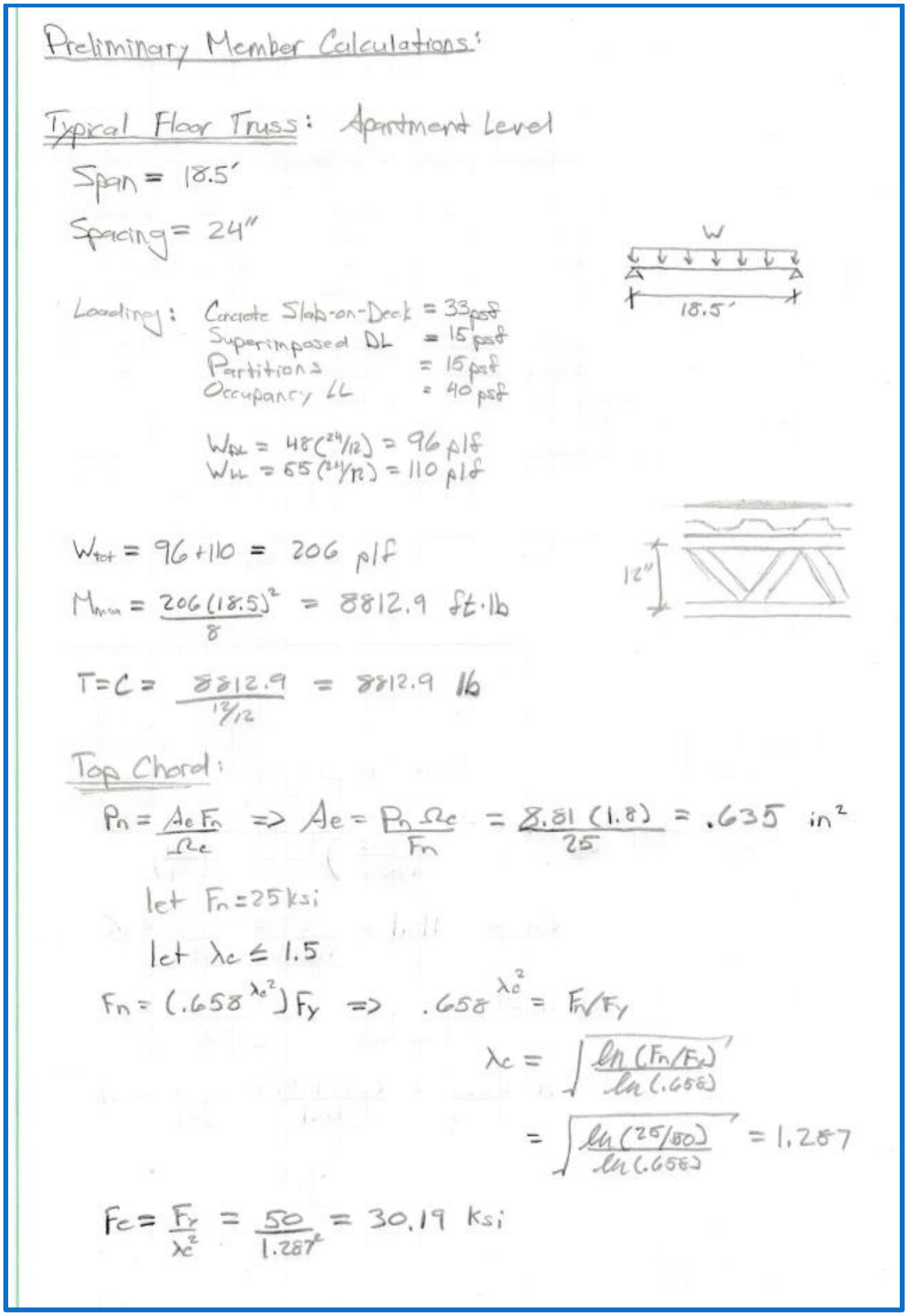


Figure 26b: 3rd-6th Floor Structural Plan

The following calculations are for a typical floor truss, a wall stud at the lowest apartment level, and a wide-flange beam supporting five levels of bearing walls. Results are collected in Table 02.

Floor Truss	600S200-68	Clark-Dietrich
Wall Stud	600S300-97	Clark-Dietrich
Wide-Flange Beam	W21x182	AISC

Table 02: Preliminary Size Calculation Results



Preliminary Member Calculations:

Typical Floor Truss: Apartment Level

Span = 18.5'

Spacing = 24"

Loading: Concrete Slab-on-Deck = 33 psf
Superimposed DL = 15 psf
Partitions = 15 psf
Occupancy LL = 40 psf

$$W_{DL} = 48(24/12) = 96\ plf$$
$$W_{LL} = 65(24/12) = 110\ plf$$

$$W_{tot} = 96 + 110 = 206\ plf$$

$$M_{max} = \frac{206(18.5)^2}{8} = 8812.9\ ft \cdot lb$$

$$T = C = \frac{8812.9}{12/12} = 8812.9\ lb$$

Top Chord:

$$P_n = \frac{A_e F_n}{\Omega_c} \Rightarrow A_e = \frac{P_n \Omega_c}{F_n} = \frac{8.81(1.8)}{25} = .635\ in^2$$

let $F_n = 25$ ksi

let $\lambda_c \leq 1.5$

$$F_n = (.658^{\lambda_c^2}) F_y \Rightarrow .658^{\lambda_c^2} = F_n/F_y$$

$$\lambda_c = \sqrt{\frac{\ln(F_n/F_y)}{\ln(.658)}}$$

$$= \sqrt{\frac{\ln(25/50)}{\ln(.658)}} = 1.287$$

$$F_e = \frac{F_y}{\lambda_c^2} = \frac{50}{1.287^2} = 30.19\ ksi$$

Figure 27a: Preliminary Calculations

$$r = \frac{KL}{\sqrt{\frac{\pi^2 E}{F_e}}} = \frac{222}{\sqrt{\frac{\pi^2(29000)}{30.19}}} = 2.28 \text{ in}$$

$A_{req} = .635 \text{ in}^2$
$r_{x,req} = 2.28 \text{ in}$

Per Clark-Dietrich: 600S200-68 $A = .764 \text{ in}^2$, $r_x = 2.32 \text{ in}$

Bottom Chord:

$$A = \begin{cases} \frac{T_n \Omega_t}{F_y} = \frac{8.81(1.67)}{50} = .294 \text{ in}^2 \leftarrow \text{Controls} \\ \frac{T_n \Omega_t}{F_u} = \frac{8.81(2.0)}{65} = .271 \text{ in}^2 \end{cases}$$

Per Clark-Dietrich: 400S137-54 $A = .401 \text{ in}^2$
use same as top chord

Figure 27b: Preliminary Calculations (Continued)

Stud Bearing Walls: Lowest Apartment Level

Wall Height = 11'-6"

Stud Spacing = 16"

Loading: SW of Wall = 80.5 plf

$$DL \text{ from Truss} = 2\left(\frac{96(18.5)}{2}\right) = 1776 \text{ lb}$$

$$LL \text{ from Truss} = 2\left(\frac{110(18.5)}{2}\right) = 2035 \text{ lb}$$

Load to one stud:

$$80.5\left(\tfrac{16}{12}\right)(5) = 537 \text{ lb}$$

$$(1776 + 2035)(5) = 19055 \text{ lb}$$

$$P_{total} = 19592 \text{ lb}$$

$$A_e = \frac{P_n \Omega_c}{F_n} = \frac{19.59(1.8)}{35} = 1.01 \text{ in}^2$$

let $F_n = 35$ Ksi

let $\lambda_c \leq 1.5$

$$\lambda_c = \sqrt{\frac{\ln(F_n/F_y)}{\ln(.658)}} = \sqrt{\frac{\ln(35/50)}{\ln(.658)}} = .923$$

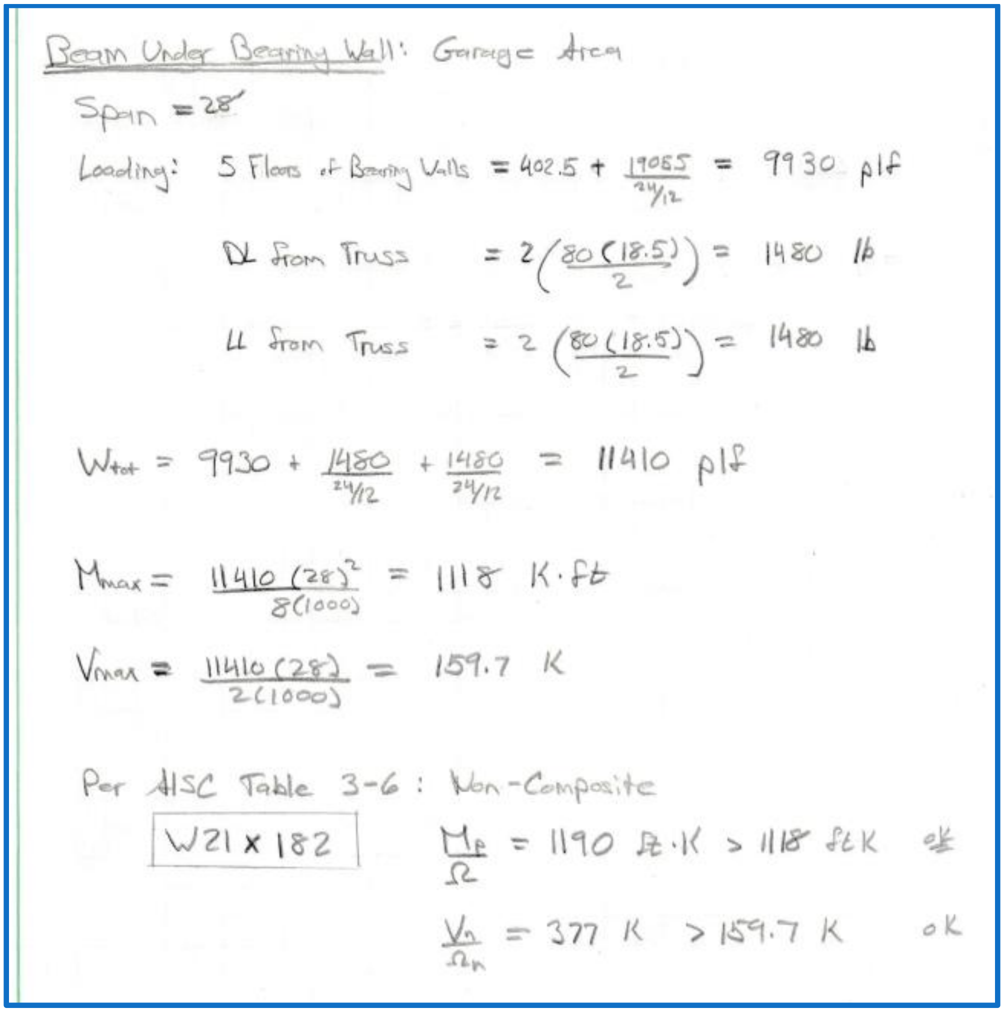
$$F_e = \frac{F_y}{\lambda_c^2} = \frac{50}{.923^2} = 58.69 \text{ Ksi}$$

$$r = \frac{KL}{\sqrt{\frac{\pi^2 E}{F_e}}} = \frac{138}{\sqrt{\frac{\pi^2(29000)}{58.69}}} = 1.98 \text{ in}$$

Per Clark-Dietrich:

600S300-97	$A = 1.27 \text{ in}^2$ $r_x = 2.41$ in

Figure 27c: Preliminary Calculations (Continued)



Beam Under Bearing Wall: Garage Area

Span = 28'

Loading: 5 Floors of Bearing Walls $= 402.5 + \frac{19065}{24/12} = 9930$ plf

DL from Truss $= 2\left(\frac{80(18.5)}{2}\right) = 1480$ lb

LL from Truss $= 2\left(\frac{80(18.5)}{2}\right) = 1480$ lb

$W_{tot} = 9930 + \frac{1480}{24/12} + \frac{1480}{24/12} = 11410$ plf

$M_{max} = \frac{11410(28)^2}{8(1000)} = 1118$ K·ft

$V_{max} = \frac{11410(28)}{2(1000)} = 159.7$ K

Per AISC Table 3-6: Non-Composite

W21 x 182

$\frac{M_p}{\Omega} = 1190$ ft·K > 1118 ft·K ok

$\frac{V_n}{\Omega_v} = 377$ K > 159.7 K ok

Figure 27d: Preliminary Calculations (Continued)

6.6 Breadth Topic One

This topic would explore the possibility of moving the parking areas from the first two floors to a sub-grade level. The remaining spaces on the existing first and second level would be repositioned to fit on one floor. This would lower the building's height and allow for an additional floor of apartments. Along with adjusting the architecture, an analysis will be done to compare the cost of constructing the additional floor below grade to the rent to be charged to tenants to determine how profitable this would be for the owner.

6.7 Breadth Topic Two

In topic 1, parking will be moved below grade so an additional level of apartments can be placed at the second level of the building. This means apartments will be closer to the roadway. Quieter rooms, such as offices and a meeting room, will be directly above the garage. The quality of life in these areas can be effected if the acoustic separation is not adequate. This topic would review the acoustical requirements for these spaces.

6.8 Tasks and Timetable

Task 1) Establish Structure Layout
- a) Review Building Architecture
- b) Ensure Proposed System will not Interfere with Architecture

Task 2) Determine Gravity Loads
- a) Dead, Live, Snow

Task 3) Design Gravity System
- a) Concrete Slab on Deck
- b) Floor Trusses
- c) Bearing Walls
- d) Hot-Rolled Girders/Columns

Task 4) Determine Lateral Loads
- a) Wind, Seismic

Task 5) Design Lateral System
- a) Distribute Loads to Walls
- b) Design Shear Reinforcement
- c) Design Bending Reinforcement

Task 6) Breadth Topic 1
- a) Move Parking to Subgrade Level
- b) Place all Public Residential Spaces on Ground Floor
- c) Replace Current Second Floor with Residential Floor
- d) Evaluate Benefit to Owner

Task 7) Breadth Topic 2
- a) Determine Acoustical Requirements
- b) Calculate Necessary Acoustical Barrier

Flats on Fifth

Proposed Thesis Schedule for Spring 2019

Derek Gombos | Structural

Dr. Thomas Boothby, P.E., R.A.

Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8		Week 9	Week 10	Week 11	Week 12	Week 13	Week 14	Week 15	Week 16
Jan 7-11	Jan 14-18	Jan 21-25	Jan 28-Feb1	Feb 4-8	Feb 11-15	Feb 18-22	Feb 25-Mar 1	Mar 4-8	Mar 11-15	Mar 18-22	Mar 25-29	Apr 1-5	Apr 8-12	Apr 15-19	Apr 22-26	Apr 26-May 3
Task 1								Spring Break				Assumed Deadline				
Task 2																
Task 3	Task 3	Task 3	Task 3													
			Record Findings													
				Task 4												
				Task 5	Task 5	Task 5	Task 5									
							Record Findings									
									Task 6							
										Task 7						
									Finalise Report	Finalise Report	Finalise Report					

Figure 28a: Proposed Schedule for Thesis Tasks

Key	
(light blue)	Gravity System
(light red)	Lateral System
(light green)	Breadth 1
(light yellow)	Breadth 2

Figure 28b: Schedule Key

7 Conclusion

Flats on Fifth is an apartment building in Pittsburgh, Pennsylvania constructed in 2016. The building is a total of seven stories broken into two floors of type 1 construction and five floors of type 3 construction. The first two floors are framed with wide flange steel shapes in bays roughly 28 feet by 40 feet. The remaining five floors are framed with wood trusses spanning bearing walls. Lateral forces are resisted by reinforced masonry shear walls around the elevator and stairs.

The proposed structural redesign consists of changing the existing wood truss and bearing wall system to cold-formed steel. This system will be utilized on the first two floors as well with the exception of the garage areas where hot-rolled steel beams and columns will replace the need for bearing walls. Lateral force resisting systems will remain as reinforced masonry shear walls.

In addition to the proposed structural redesign, an architectural redesign of the first two floors will be done to add an additional level of apartments on the second level of the building. An analysis will be done to determine any benefit to the owner because of this change. Since this change will place apartments closer to the roadway, an acoustical analysis of this level will be done.