PROPOSAL

BRIDGESIDE POINT II

PITTSBURGH, PA

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Structural Option

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EXECUTIVE SUMMARY

The Bridgeside Point II project consists of five above grade stories with a combination of office and laboratory space. It is located in the Pittsburgh Technology Center, which is just east of downtown Pittsburgh, Pennsylvania. The building is approximately 150,000 square feet and reaches a height of 75 feet above grade, and consists of 5 concentric and eccentric braced frames.

The ultimate goal of this thesis will involve two structural studies: an alternate lateral framing system and an additional floor with a redesigned lateral system. The alternate lateral framing system will be designed and compared to the existing lateral framing system. The intent is for drift optimization and reduced member sizes. The second main study will be an additional floor being placed onto the building. The study will involve a complete lateral framing system redesign, as well as relocation of the mechanical room. The breadth studies will focus on façade performance per new connection criteria, sound isolation, and new building demand loads. The culmination of all this work will allow for a complete cost and feasibility analysis. In the end system recommendations will be presented.

INTRODUCTION: BRIDGESIDE POINT II

The Bridgeside Point II project consists of five above grade stories with a combination of office and laboratory space. It is located in the Pittsburgh Technology Center, which is just east of downtown Pittsburgh, Pennsylvania. The building conveys a feeling of progression from a historic steel mill town to a fast-paced, innovation driven city through its use of clean lines, visible lateral system, and open plan. A glass curtain wall lends itself for a feeling of transparency on the upper floors, while dense, pre-cast panels wrap the ground floor.

The building is approximately 150,000 square feet and reaches a height of 75 feet above grade. The building floor template is an open plan with a design core capable of housing office and laboratory spaces as each floor is roughly 15 feet floor to floor (Figure 1). A typical bay is 30 feet by 32 feet, and is comprised of composite steel with a concrete slab on deck. The lateral system is a series of braced frames, two in the east – west building direction and three in the north – south building direction. The foundation system is a driven pile system. A typical pile cap hosts between three and seven piles and has a thickness of 3'-6" to 4'-6". The ground floor is a reinforced slab on grade with grade beams around the perimeter.

Flexibility is the main concept this building expresses. At the time of design, no definite tenant had been selected; therefore, this fueled the design to be extremely flexible. In order to create this flexibility two things are directly affected. The desired large bays require a heavy uniform live load, thus larger structural members. Also placement of the lateral system is limited. The lateral system is placed roughly at the building side's midpoints.

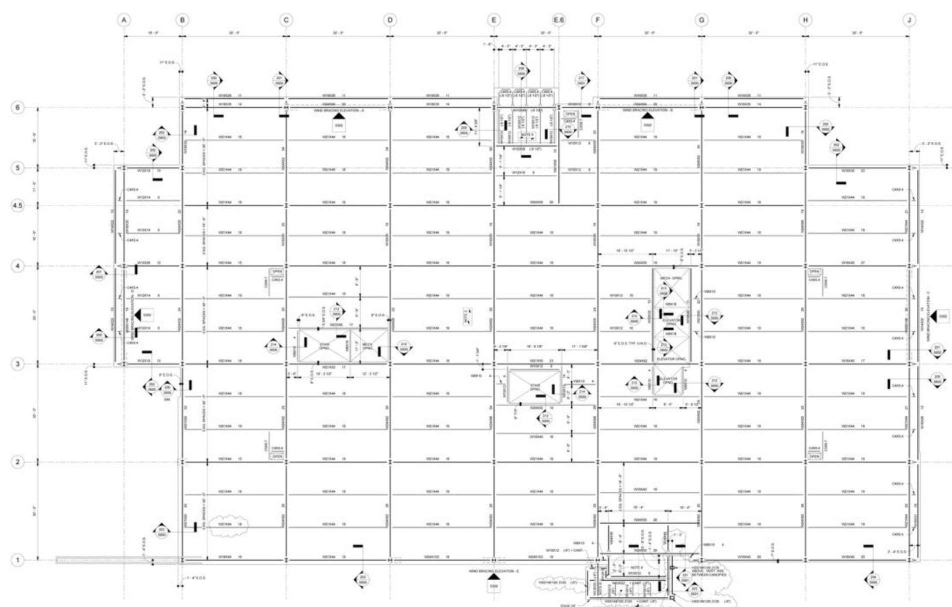

Figure 1: *Existing Floor Layout*

EXISTING STRUCTURAL SYSTEM

Floor System

The floor system of Bridgeside Point II is a composite system with a typical bay size of 30'-0" by 32'-0". A 3" concrete slab rests on 3" composite steel decking. Shear studs ¾" diameter (5 ½" long) are used to create composite action. This assembly provides a 1.5 to 2 hour fire rating which meets IBC requirements. Infill beams are W21x44 spaced at 10'-0" center to center which frame into W24x62 girders. This report will not cover floors systems, for more information please reference Technical Report Two.

Lateral System

Large braced frames make up the building's lateral load resisting system. In order to increase the flexibility of the building plan, the perimeter was chosen for the bracing (Figure 3). Four of the five bracing frames are exposed via windows. In these bays, large HSS8x8x3/8 and HSS10x10x1/2 provide the bracing at the second through fifth floors and are K-Braces, which create a two story "X" in the window (Figure 2). On the first floor these four frames have an eccentric brace, whereas the large fifth frame is two bays wide and is comprised of all W-shape eccentric braces.

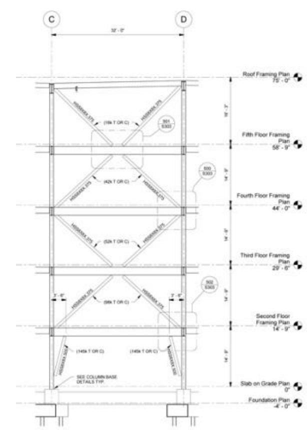

Figure 2: *Typical Lateral Frame*

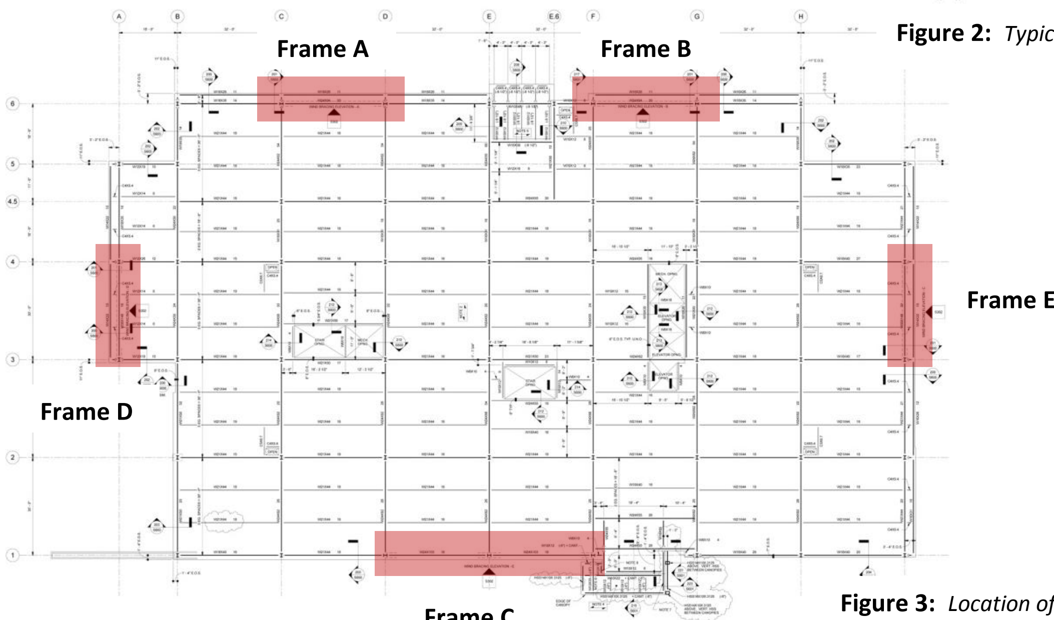

Figure 3: *Location of Lateral Bracing*

Foundations

A driven pile system with pile caps containing between two and nine piles provides the foundation system for the building with an end bearing capacity of 105 to 130 tons per pile. The pile caps vary in thickness from 3'-6" to 4'-6" and have between 9 and 12 No. 9 reinforcing bars. Depending on their location within the site, they are driven to a depth of 45 to 55 feet. These piles support the framing system as well as 12" thick grade beams. The main floor is a 4" concrete slab on grade. Soil conditions are from the geotechnical report provided by Professional Service Industries, Inc. dated May 2007.

PROBLEM STATEMENT

The present design of Bridgeside Point II utilizes a braced frame for the lateral forces experienced on site. Lateral analysis performed in technical report three indicated that the story drift should be optimized on the second story. The upper stories exhibit a very rigid behavior, while the second story is quite flexible in comparison. While this is not a strength issue, it is a serviceability concern. The current story drift could present a problem for the façade at the second and third story interface. If the façade is not designed and fastened properly, the precast and metal panels could experience performance problems.

The building also tops off 15 feet under the maximum zoning height. With an ever increasing demand for real estate, building vertically is a common solution. Adding an additional floor to Bridgeside Point II poses several challenges both structural and architectural; however, if an extra floor could be accommodated more revenue could be generated for the owner. Even with the possibility of increased marketability and revenue, one of the major problems would be the higher upfront cost needed to cover the new floor. Adding a floor could increase the existing column and footing sizes, as well as, alter the lateral system considerably; and, in the case of the current design, would require relocation of the penthouse. The existing heating, cooling, and lighting systems would need to be re-evaluated for the new demand loads.

PROPOSED SOLUTION

Optimization of the story drifts needs to be addressed. A completely new braced system will be implemented. The system will reflect the client's initial idea of exposure via powerful diagonals; however, the mixture of eccentric and concentric braces will be eliminated. The new system will be comprised only of concentric bracing, as that will afford the most rigidity, and what lacks in the current design is uniform rigidity. The two systems will be compared and analyzed based on drift, cost, and feasibility. Along with this, a breadth study will be a façade study to determine the performance of the precast and metal panels. Thorough research will be conducted to determine the governing limit states each panel system. In the event of inadequacy, an alternate system that closely mimics the current system will be investigated and implemented.

Marketability will be addressed next. A feasibility study will be conducted on adding any addition floor to the current structure. The study will look at the projected value of the current five story building and its upfront cost, verses the projected value of proposed six story building and its upfront cost. The expectation is that the six story building bears the potential to dramatically increase building venue while only minimally impacting upfront costs. The additional floor will allow for a complete redesign of the lateral system, which will ensure drift optimization. Along with this, a breadth study will encompass the relocation of the penthouse equipment, as well as, a detailed analysis of mechanical and electrical loads for sizing purposes, and sound isolation for the mechanical room. The result will be a complete cost comparison between the current GMP cost and the "new" proposed cost.

SOLUTION METHODS

Structural Analysis

For drift optimization, several different bracing schemes will be investigated (Figure 4). The most economical brace pattern for both drift and cost will be designed in accordance with the gravity and lateral loads from ASCE 7-05 and methods from the thirteenth edition steel manual. Computer models generated with ETABS will be completed for the existing building and the alternate lateral system. Through a comparison of the two models, it will be determined how to optimize the lateral system in the most economical and least intrusive way.

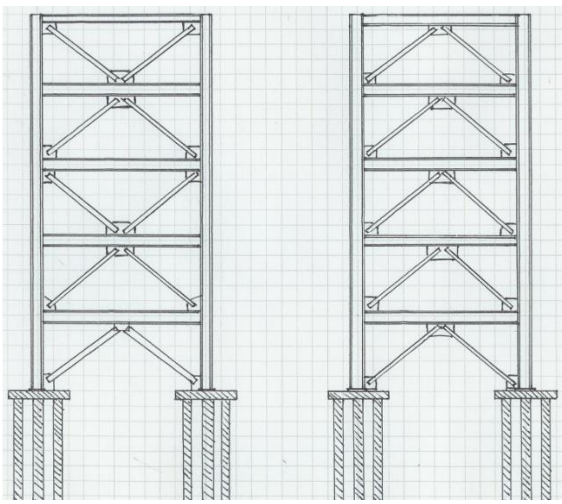

Figure 4: *Possible Lateral Framing Solutions*

For increased marketability, Bridgeside Point II will be given an additional floor for leasing. Pittsburgh Zoning Code allows for a maximum height of 90 feet unless the building is unique in nature, and this will be the benchmark for new building height. To accommodate this increased height, RAM Structural System will be used to design all gravity members with the loads given by ASCE 7-05. This includes, but is not limited to, the new floor's beams, girders, and columns, as well as, the existing columns and footings. The roof structure will be reinvestigated because the penthouse will be removed from the roof and relocated on the first, near the loading dock (Figure 5). This additional floor will require a new lateral system. Optimization will be the cornerstone of the design governed by ASCE 7-05 and modeled in ETABS. Once complete, a very detailed analysis involving cost, drift, and feasibility will be done using RS Means and Engineering Economics for costs, ASCE 7-05 for drift, and scheduling software for feasibility. This analysis will determine the viability of adding a floor and any implications it presents.

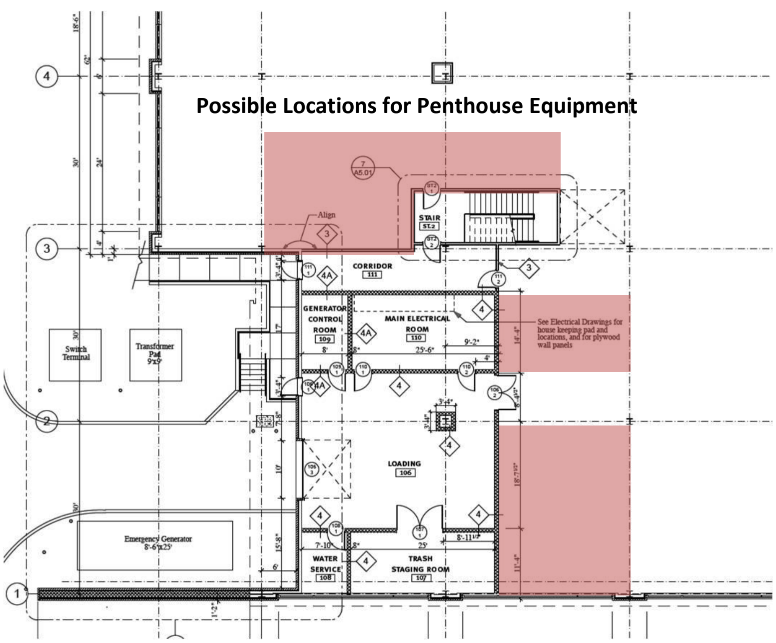

Figure 5: *First Floor Showing Location Options for Existing Penthouse*

Breadth Options

Along with the main structural study, a minimum of two breadth studies will also be performed. The first study will look at Bridgeside Point II's cladding system, more explicitly, how it behaves under the current building drift conditions. This study will emphasize installation, performance, and inspection. The second study will focus on the implications of an additional floor to the structure. This will include an analysis of the new heating/cooling and lighting demand loads as well as sound isolation for new mechanical room now located within the building.

The façade study will focus on the performance and installation of the precast and metal panels. Most of the issues associated with facades are lack of performance and poor weatherproofing, which are sometimes only evident after the building completion. This study will look at the new standard put forth by AISC for 2008, *Façade Attachments to Steel Buildings* to ensure that connections are designed and installed properly. The materials selected to clad the building will also be analyzed so that they too meet this new criteria. Upon conclusion, recommendations will be presented.

The second breadth study will focus mainly on sound isolation; however, if time permits, calculation and design of new heating/cooling and lighting systems will be performed. This study will look at reducing transmission of noise from the mechanical room to the rest of the building as well as ensuring the building is not experiencing any unwanted vibrations from said room. Upon conclusion, cost savings will be presented.

TASKS AND TOOLS

I) Drift Optimization

- *i) Task 1: Design of Alternate Lateral Framing*
  - a) Establish dead, live, and governing lateral loads
  - b) Establish possible framing schemes
  - c) Establish trial member sizes
- *ii) Task 2: Analyze New Lateral Framing*
  - a) Create ETABS model for new system
  - b) Analyze pros and cons of each system
  - c) Determine most economical scheme
- *iii) Task 3: Lateral Framing Comparisons*
  - a) Compare ETABS model with existing design
  - b) Determine cost savings
  - c) Implementation of lateral system to architecture of building

II) Marketability

- *i) Task 4: Design of Additional Floor*
  - a) Establish dead, live, and governing lateral loads
  - b) Establish possible framing schemes
  - c) Establish trial member sizes
- *ii) Task 5: Design of New Lateral System*
  - a) Locate optimal frame locations and schemes
  - b) Create ETABS model for new system
  - c) Analyze the lateral system
- *iii) Task 6: Building Comparisons*
  - a) Calculate the new building costs
  - b) Calculate projected value of the building
  - c) Compare results with current building cost and its project value
  - d) Determine most economical and feasible choice

III) Breadth Studies

- *i) Task 7: Façade Investigation*
  - a) Study specified installation method of current cladding
  - b) Research possible concerns
  - c) Research new connection standard
  - d) Determine proper connection details and materials
  - e) Determine any cost implications
- *ii) Task 8: Sound Isolation and Demand Loads*
  - a) Determine acceptable reverberation times and decibel levels
  - b) Establish optimal location for new mechanical room
  - c) Design sound isolated room
  - d) Determine demand loads for heating/cooling and lighting systems
  - e) Design new systems where appropriate

IV) Presentation

- *i) Task 9: Presentation Development*

SCHEDULE

Task	Weekly Schedule: January to March								
	1/14 - 1/18	1/21 - 1/25	1/28 - 2/1	2/4 - 2/8	2/11 - 2/15	2/18 - 2/22	2/25 - 2/29	3/3 - 3/7	3/10 - 3/14
1									Spring Break
2									
3									
4									
5									
6									
7									
8									
9									

Task	Weekly Schedule: March to April				
	3/17 - 3/21	3/24 - 3/28	3/31 - 4/4	4/7 - 4/11	4/14 - 4/18
1					Presentations
2					
3					
4					
5					
6					
7					
8					
9					

Task 1: Design of Alternate Lateral Framing System
Task 2: Analyze New Lateral Framing System
Task 3: Lateral Framing System Comparisons
Task 4: Design of Additional Floor
Task 5: Design of New Lateral Framing System
Task 6: Building Comparisons
Task 7: Façade Investigation
Task 8: Sound Isolation and Demand Loads
Task 9: Presentation Development

CONCLUSION

For the spring semester, an alternate lateral framing system will be designed and compared to the existing lateral framing system. The intent is for optimization of drift and member sizes. The second main study will be an additional floor being placed onto the building. The study will involve a complete lateral framing system redesign, as well as relocation of the mechanical room. The breadth studies will focus on façade performance per new connection criteria, sound isolation, and new building demand loads. The culmination of all this work will allow for a complete cost and feasibility analysis. In the end, system recommendations will be presented.

The intent of this analysis is to understand why certain choices were made regarding location of bracing, bracing schemes, building layout, and cladding material. This will provide a deeper insight to design. All design values will be done in accordance with the applicable codes. Detailed notes, tables, and figures will be provided in the appendices for further review. Any questions and/or comments should be directed to Antonio Verne through email: adv118@psu.edu.

APPENDIX A: BUILDING LAYOUT

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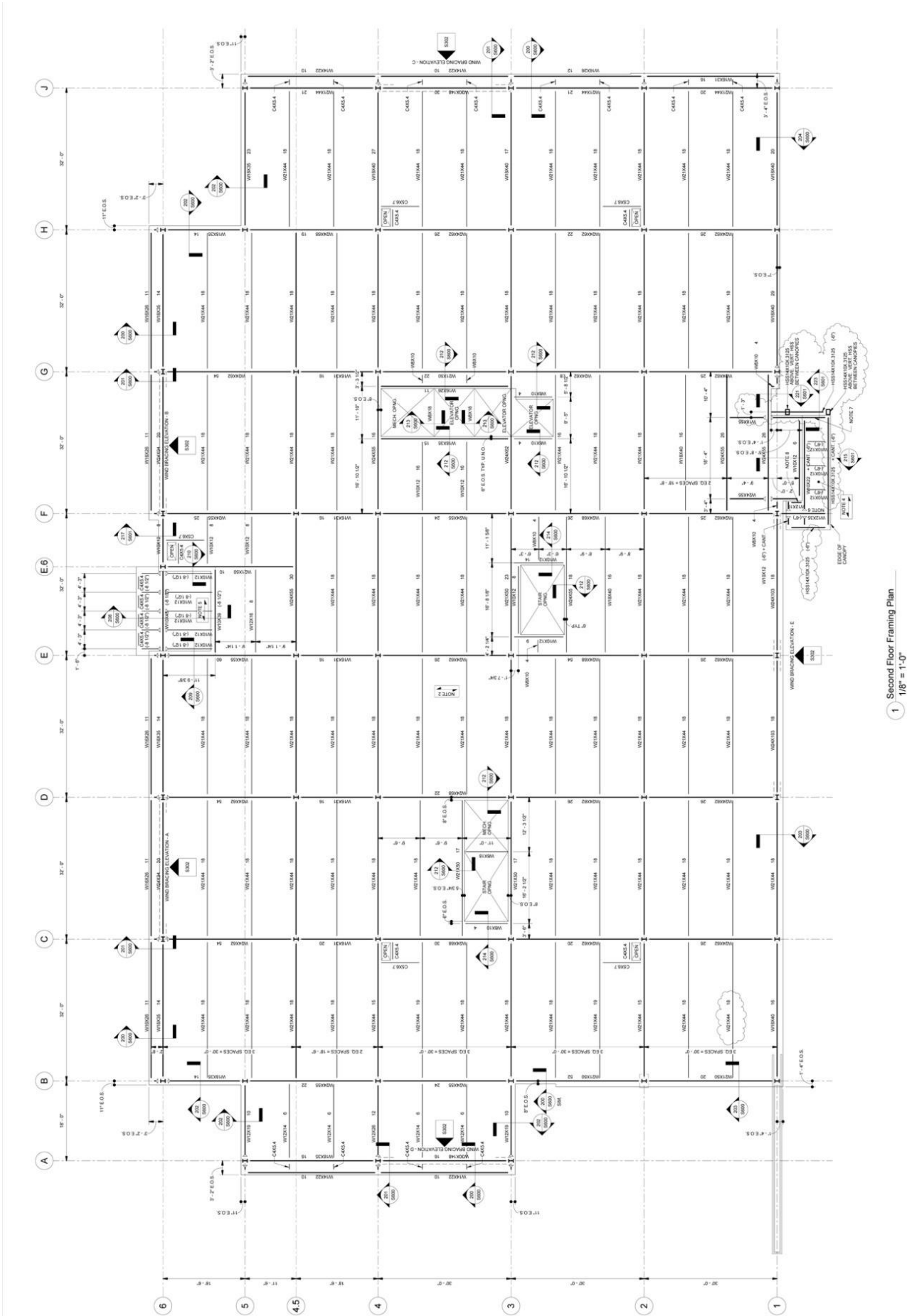
Typical Floor Layout



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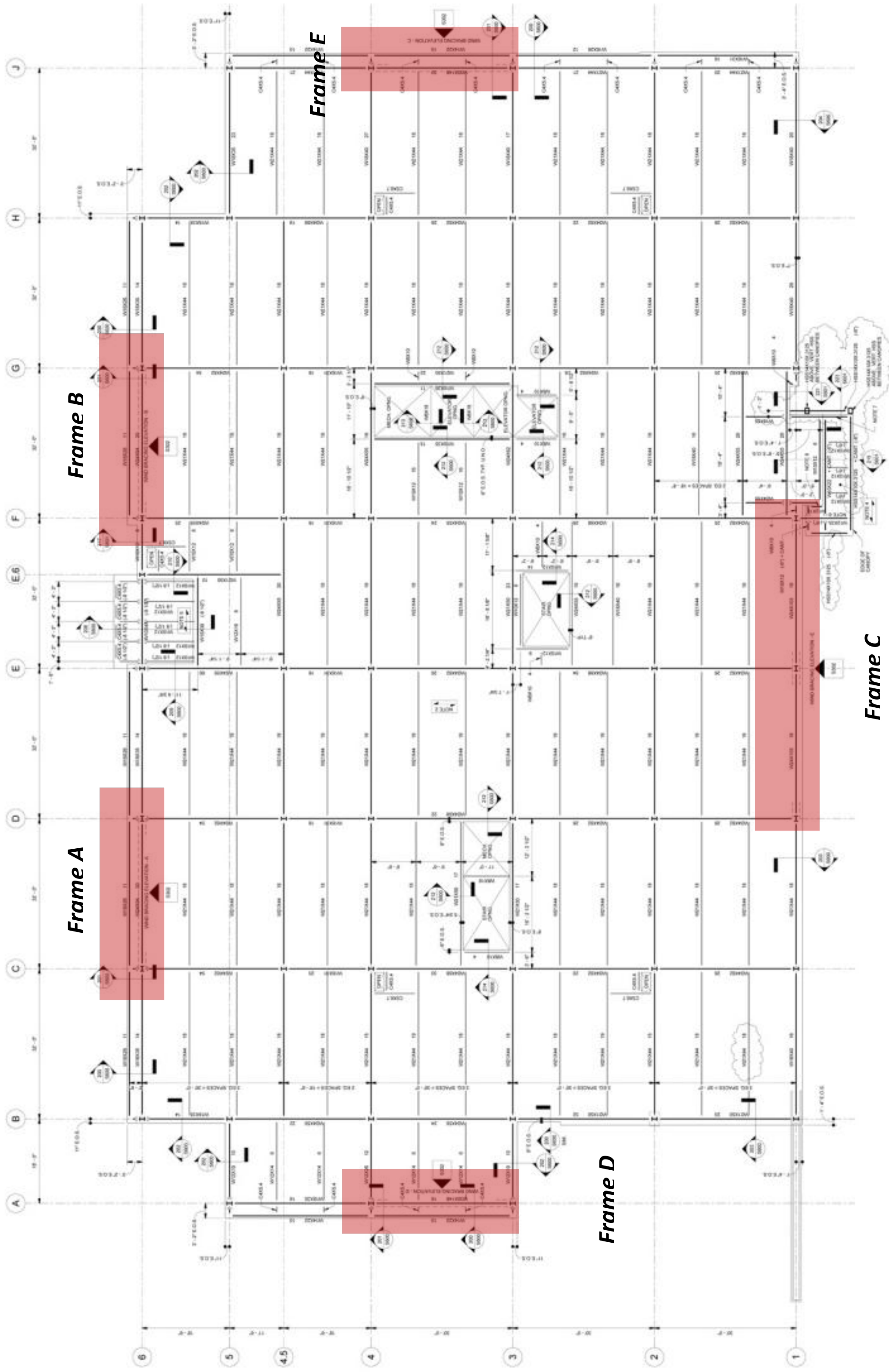
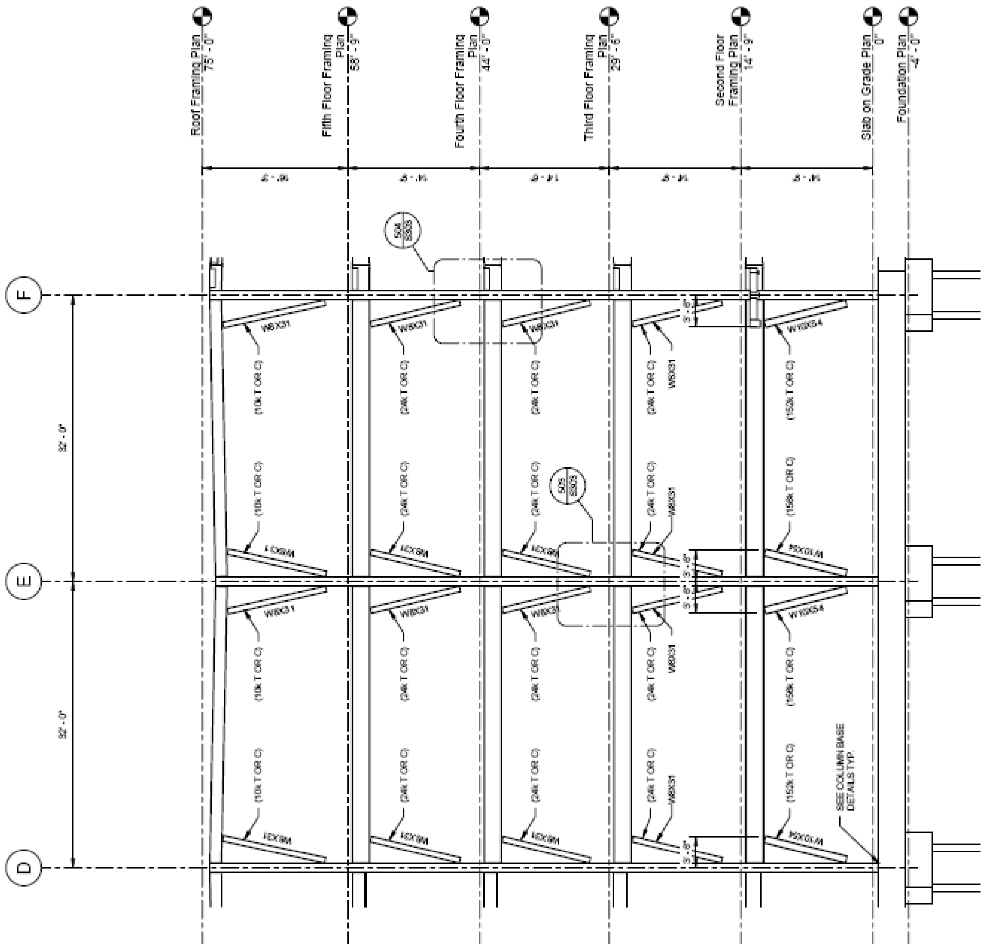
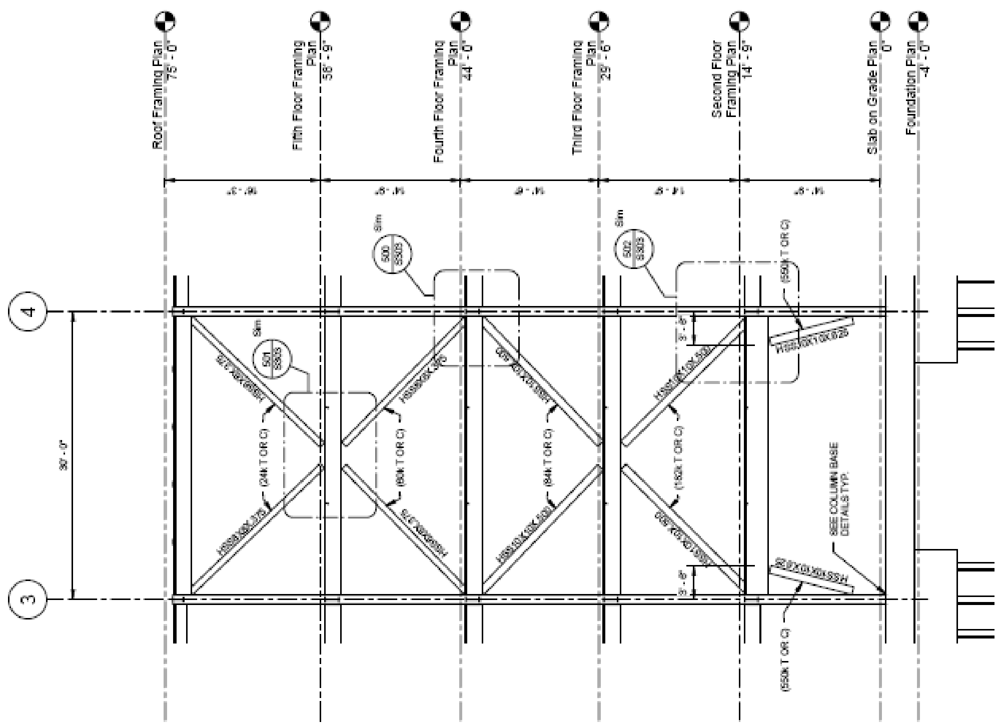
Typical Frame Layout



Frame C



Frame A, B, D, E (Sim.)



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