Hershey Research Park Building One

Thesis Proposal

Jonathan Krepps Structural Option Advisor: Dr. Hanagan 12/17/12

Table of Contents

Executive Summary

The following is the thesis proposal for the spring semester for the Hershey Research Park Building One. The drawings, specifications, and pictures have all been provided by Brinjac Engineering with permission given be Wexford Equities, LLC. The building was constructed by Whiting – Turner Construction and all the architectural design work was performed by Ayers/Saint/Gross, Inc.

Located outside Hershey, Pa HRPBO is a pretty standard office/research building. It is the first building of a planned twelve to be part of a research park. The building has over 80,000 square feet of available tenant space, with access to the facilities of the Penn State Milton S. Hershey Medical Center.

The primary purpose of the proposal is to determine which area of the building will be further studied. The main depth will be to study the lateral system more extensively, including a redesign of the current system. The Hershey Research Park Building One uses a moment frame to resist lateral forces, and the new system will use braced frames spaced throughout the frame.

Two breadths will also be studied as part of the spring semester of thesis. The first of the two breadths deals with sustainability by adding a green roof to the building. It is the desire the owners of the research park to achieve LEED certification for the all of the remaining buildings in the research park that are still being designed. Currently Building One is not LEED certified so doing a sustainability study will help to obtain certification.

The second of the two breadths will deal with the mechanical systems. By altering the current mechanical systems of the building it can take another step closer to achieving LEED certification. With a new green roof as well as a more efficient mechanical system the building will be LEED certified.

The tasks in this report will be followed in order to stay on track during the spring semester. A schedule has also been created in order to manage the milestones of the thesis. By sticking to the schedule, the proposal should come to life by the end of the semester.

Building Introduction

The Hershey Research Park Building One (HRPBO) is a research facility located in Hershey, Pa., directly across the street from the Penn State Milton S. Hershey Medical Center. It was designed by Ayers/Saint/Gross Inc. with the engineering done by Brinjac Engineering and the construction by Whiting – Turner Constructuion. Building One is the first building to be finished of a twelve building research park known as the Hershey Center for Applied Research or HCAR for short. Completed in Spring 2007, HRPBO is a state of the art research lab home to various medical and chemical research companies. They include Apeliotus Vision Science, Apogee Biotechnology, and vivoPharm along with some departments of Penn State Hershey's College of Medicine. The building has 80,867 square feet of rentable space and cost approximately $10.7 million dollars total to build. It was designed using the 2003 edition of the International Building Code and its supplements along with ASCE 7-02. Building One consists of a steel moment frame with brick, glass, curtain wall and metal panel façade.

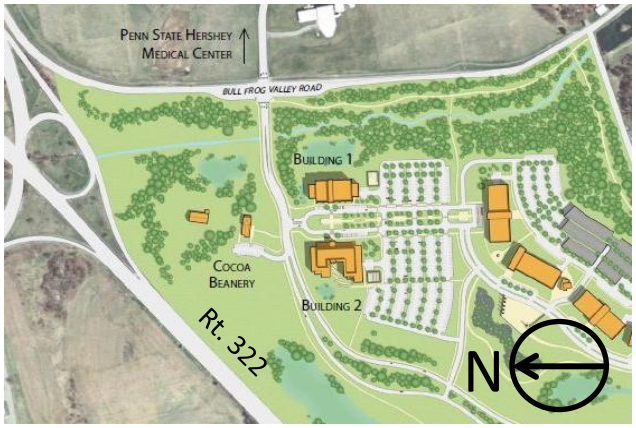


Figure 1: Site Master Plan

The foundation is drilled steel piles system with concrete pile caps. The main superstructure is composite steel floor deck supported by steel beams, girders and columns. Also some parts of the first floor and basement levels are just slab on grade. The roof system is galvanized roof deck with insulation and water proofing placed on top of the beams. The Hershey Research Park Building One is designed to with stand wind gusts up to 90 mph and is seismic use group II along with a seismic site class of "D". The lateral resisting system is an ordinary steel moment frame which resists both the seismic and wind loads on the building. Even though Building One is not LEED certified there are still multiple forms of sustainability integrated into the building. Regional recycled steel was used in the building which reduces cost as well as waste by reuse. The roof system incorporates an efficient thermoplastic that helps reduce the energy used by the HVAC system, leading to overall reduced costs and emissions. Stones for the excavation of the site were reused for landscaping purposes. Also there is a storm management system integrated with green roof technology. The research center developers, Wexford Science and Technology, are planning on achieving a silver LEED certification on building two of the research park.

Structural Overview

Hershey Research Park Building One sits on a combination of footings and piers. Due to problems with the soil, footings are not enough to support the building. Other than a small portion of the basement, the building is composite steel deck spanning between steel beams. The lateral system utilizes a flexible steel moment frame throughout the entire building.

Foundation

Testing Service, Inc. performed geotechnical testing of the soil before the construction of Building One. The test consisted of nine different borings located throughout the footprint of the building with depths ranging from 25 feet to 38 feet. The results of their tests found three types of layers: residual soil with few rock fragments, residual soil with significant rock fragments, and decomposed limestone. In addition, groundwater was observed in seven of the nine borings after drilling was completed.

TSI recommended certain types of foundations to be used for Building One based on the results of their tests. Their recommendation was to use a shallow spread footing to support the building. In the report TSI also found that the proposed area of Building One was prone to sink holes. Keeping this in mind the engineers decide to use piers with concrete caps. Using a deep foundation like this added more support just in case sinkholes began to develop.

Floor System

The main superstructure is composite steel floor deck which is comprised of 4 ½ inch concrete slab on top of 3 inch deep 18 gage, galvanized composite steel floor deck reinforced with welded wire frame mesh. In addition, ¾ inch diameter, 6 inch steel studs are placed evenly across the beams. Also some parts of the first floor and basement levels are just 4 inch thick slab on grade. The concrete is 4000 psi with the reinforcement being grade 60 steel (Fy = 60ksi). On the structural steel side of things, the wide flange steel is A992 steel. Figure 2 is a typical floor section showing the composite metal deck sitting on top of the steel beam.

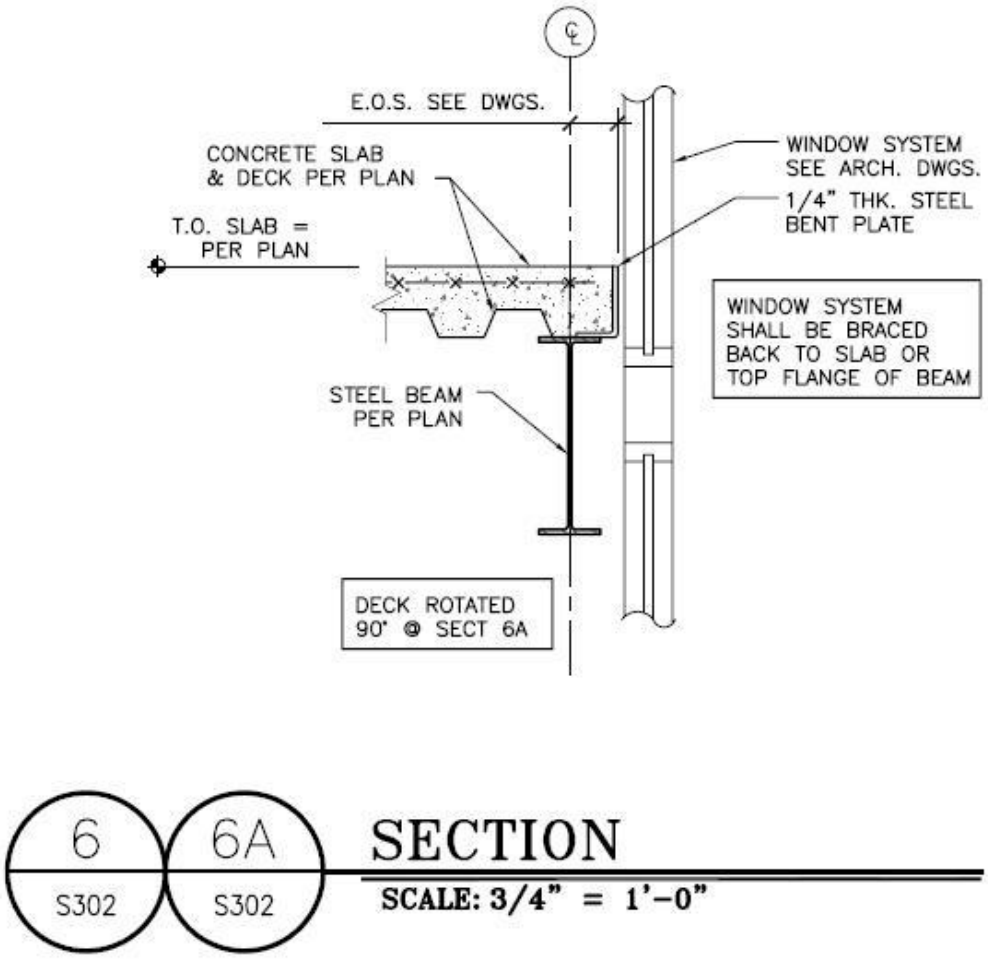


Figure 2: Typical Floor System

Framing System

The framing system of Hershey Research Park Building One is a basic one. It has a steel frame with composite metal deck on top. Beams frame into girders while the girders then frame into the columns which then transfer the forces to the foundation, the basic load path for any building. Figure three shows a basic floor framing plan with a zoomed in view of a typical bay. The numbers within the brackets next to the beam sizes refers to the number of evenly spaces steel studs. The area surrounded by the red box shows where the moment connections are within the frame. The small black arrows are the designator to show which connections are the moment connections. It is also important to note that the 2nd and 3rd floor framing plans are the same. The roof is slightly different.

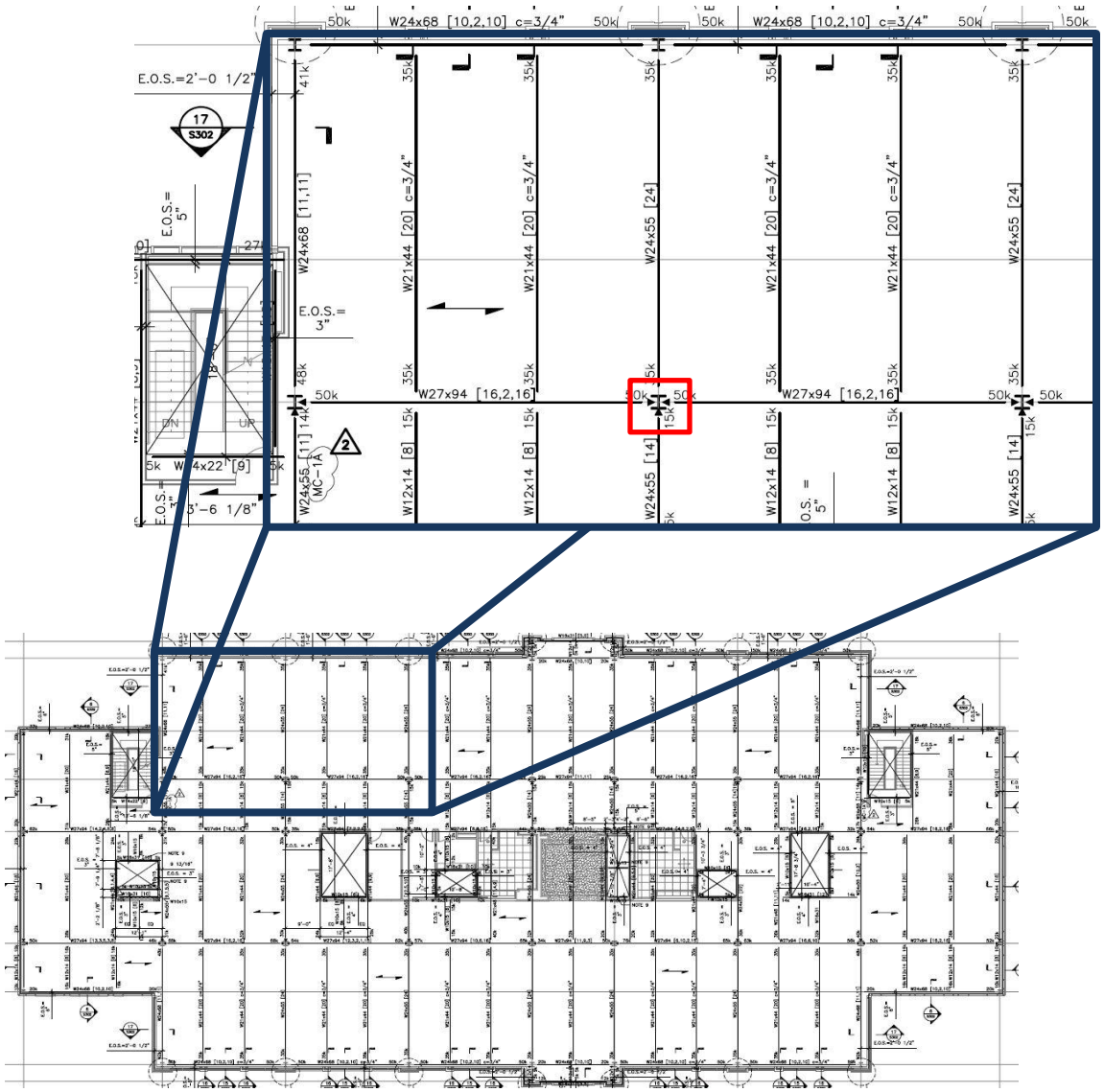


Figure 3: Second Floor Structural Plan with Spot Check Area

Structural Materials Used

Here is a list of all the structural materials as noted in the general notes section of the structural specifications.

Structural Steel Properties	
Material Shape	**ASTM Standard**
Wide Flange	ASTM A992
Tubes	ASTM A500, Grade B
Pipes	ASTM A53
M/S/Channel	ASTM A572, Grade 50
Angles and Plates	ASTM A36
High Strength Bolts	ASTM A325
Reinforcing Steel	ASTM A615, Grade 60
Welded Wire Fabric	ASTM A185
Embedded and Misc.	ASTM A36

Table 1

Structural Concrete Properties	
Type	**f ' c (psi)**
Caissons	3000
Slab on Grade	4000
Elevated Slabs	4000
Stairs	4000
Foundations	4000
Piers	4000
Walls	4000

Table 2 - Note: All exterior exposed concrete is air entrained.

Metal Deck Properties		
Deck Type	**Gage**	**Depth**
Roof	22	1 ½ in
Floors (Composite)	18	3 in

Table 3 - Note: Both types are galvanized steel deck.

Design Codes and Standards

The Hershey Research Park Building One was designed to the following codes.

Design Codes	
Name	**Description**
IBC 2003	International Business Code – Minimum Design Loads
ASCE 7-02	American Society of Civil Engineers – Minimum Design Loads
ACI 318/301	American Concrete Institution – Reinforced Concrete Construction (318) / Structural Concrete for Buildings (301)
ASTM	American Society for Testing and Materials - Various standard use throughout the building
AISC	American Institute for Steel Construction – Specifications for Steel Buildings
NEC	National Electric Code – Specifications of Electrical Components
IMC 2003	International Mechanical Code – Specifications of HVAC Requirements

Table 4

Design Loads

Dead Loads

All the dead loads for the building were designed using IBC 2003 Section 1606. The superimposed dead loads are as shown in the table below. The floor framing dead load is based on the floor deck used and also super imposed dead load. The floor deck used has a weight of 75 psf, and the super imposed load was determined to be 10 psf.

Dead Loads	
Slab on Grade	50 psf
Floor Framing	85 psf
Stair Framing	85 psf
Roof Framing	15 psf

Table 5

Live Loads

Live loads determined through IBC 2003 section 1607, which was the version that was used by the engineers on this project. Compared to the values in the IBC, the design live load numbers were more conservative.

Live Loads	
Slab on Grade	100 psf
Lab	100 psf
Office	100 psf
Mechanical	150 psf
Roof Framing	30 psf

Table 6

Problem Statement

As found in Technical Reports One and Three, the structural system of the Hershey Research Park Building One was deemed to be adequate. The structure is a steel based system supported by piers within the foundation. The floor construction is made up of composite metal decking on composite beams with a typical bay size of 32' x 32.5'.

The lateral resisting system uses a moment frame throughout the core of the building. A redesign of the lateral system may provide a more efficient and cost effective alternative. The current moment frame uses complicated and expensive connections, by switching to braced frames these complications can be addressed.

Proposed Solution

The new lateral system would utilize braced frames distributed throughout the existing frame. By redesigning the moment frames to a braced frame system, any problems can be fixed. The braced frames will be more efficient for resisting the lateral loads compared to moment frames. The current moment frame consists of a huge portion of the overall structure. Using the braced frames would decrease the amount of the system that is required to resist the lateral loads.

The connections in the moment frame require a significant amount of welding which can be reduced by switching to brace frames. This will affect the cost of both labor and materials. Also the overall construction process will be shortened because of the ease of constructing the braced frames compared to the moment frames.

It is also possible to study a combination of lateral resisting frames. Any combination of moment and braced frames as well as shear wall could also be used. If time permits a combination of these three lateral resisting systems will be studied.

Breadth Topics

Breadth One – Sustainability

The Hershey Research Park Building One is currently not LEED certified. During research, it was found the Building Two as well as the rest of the proposed buildings within the research park will all be at least LEED certified. The current building one will be altered to add more sustainable options. The biggest of these will be to add a green roof. This will also lead to column size check to make sure the new roof can be supported. The green roof will also contain a water retention system which will also help with LEED certification.

Breadth Two – Mechanical

Along with the green roof, a study of the buildings mechanical system can help with LEED certification. Exploring different types of air handling units can lead to a more energy efficient building. Since the air handling units are currently located on the roof, the effect of new units on the roof will have to be considered.

Methods

The alternative design will be examined using the following codes and standards:

- IBC 2006
- ASCE 7-10
- AISC Steel Manuel (13th Edition)
- ACI 318
- Journal Articles and design guides

In addition, multiple resources including computer-aided design programs will be used. These include, but are not limited to:

- RAM Structural System
- ETABS
- SAP 2000
- Microsoft Excel
- Google Sketch-Up
- RS Means

Tasks and Tools

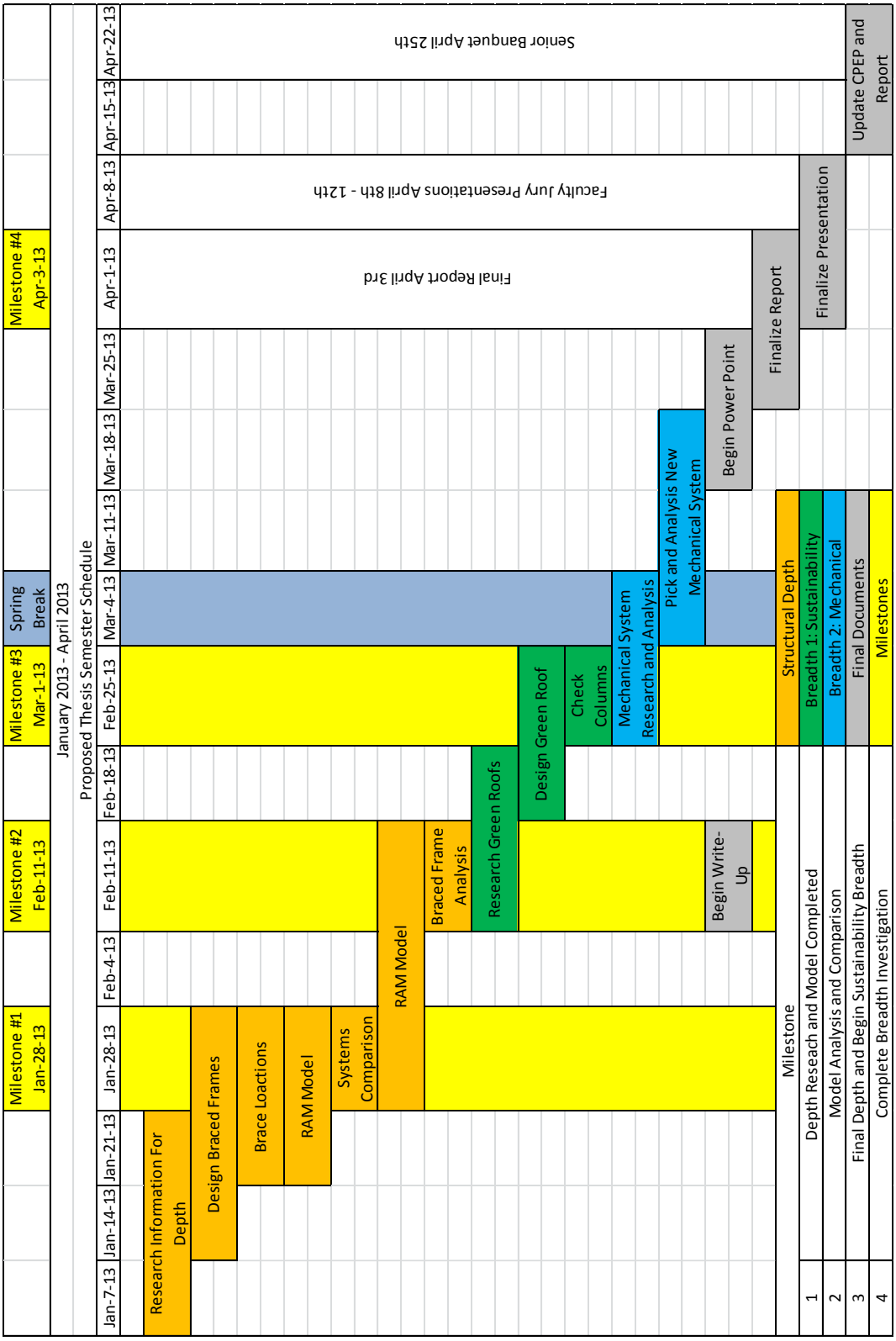
1. Lateral System Redesign
    a. Recalculate Seismic Loads
    b. Assess proper locations for braced frames
    c. Create frames in SAP
        i. Determine Stiffness's
        ii. Compare to original moment frame
        iii. Reevaluate
    d. Implement new frames into RAM
    e. Analyze Model
2. Sustainability Breadth
    a. Research Green Roof Systems
    b. Design Green Roof
    c. LEED accreditation research
3. Mechanical Breadth
    a. Research different types of air handling units
    b. Research LEED requirements for mechanical systems
    c. Compare new mechanical systems to old ones
        i. Energy Efficiency
        ii. Cost
4. Compose Final Report
5. Create Final Presentation

Conclusion

During the spring semester, the lateral system of the Hershey Research Park Building One will be redesigned. The current moment frame system will be altered to a braced frame system. Hand calculations as well as computer modeling programs will be utilized to do this analysis. The new framing system will be more efficient, cheaper, and be faster to build improving the overall quality of the building.

In addition, both sustainability and the mechanical system of the building will be studied. Adding a green roof and including a water retention system will help with the overall building sustainability. Studying the building's mechanical system will also help with sustainability. Adding a more efficient air handling unit will lead to LEED certification.

Schedule


Milestone #1 Jan-28-13
Milestone #2 Feb-11-13
Milestone #3 Mar-1-13
Spring Break
Milestone #4 Apr-3-13
January 2013 - April 2013
Proposed Thesis Semester Schedule
Jan-7-13
Jan-14-13
Jan-21-13
Jan-28-13
Feb-4-13
Feb-11-13
Feb-18-13
Feb-25-13
Mar-4-13
Mar-11-13
Mar-18-13
Mar-25-13
Apr-1-13
Apr-8-13
Apr-15-13
Apr-22-13
Research Information For Depth
Design Braced Frames
Brace Loactions
RAM Model
Systems Comparison
RAM Model
Braced Frame Analysis
Research Green Roofs
Design Green Roof
Check Columns
Mechanical System Research and Analysis
Pick and Analysis New Mechanical System
Begin Write-Up
Begin Power Point
Finalize Report
Finalize Presentation
Final Report April 3rd
Faculty Jury Presentations April 8th - 12th
Senior Banquet April 25th
Update CPEP and Report
Milestone
1 Depth Reseach and Model Completed
2 Model Analysis and Comparison
3 Final Depth and Begin Sustainability Breadth
4 Complete Breadth Investigation
Structural Depth
Breadth 1: Sustainability
Breadth 2: Mechanical
Final Documents
Milestones

Appendices

Appendix A: Structural Plans

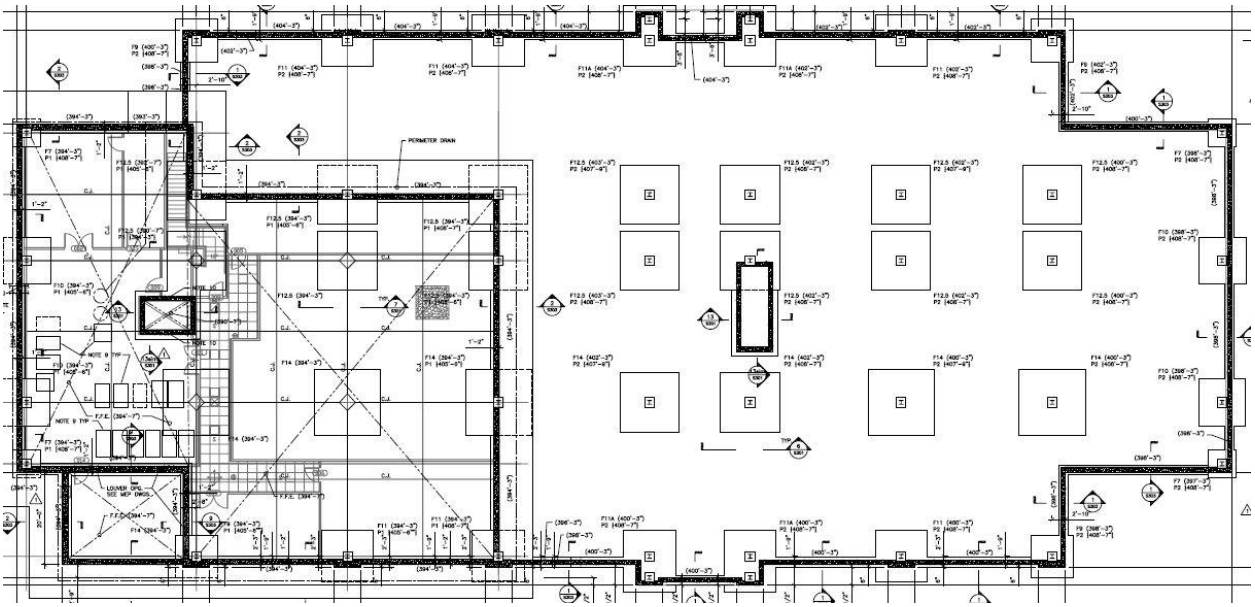


Figure 18 – Basement/Foundation Structural Plan

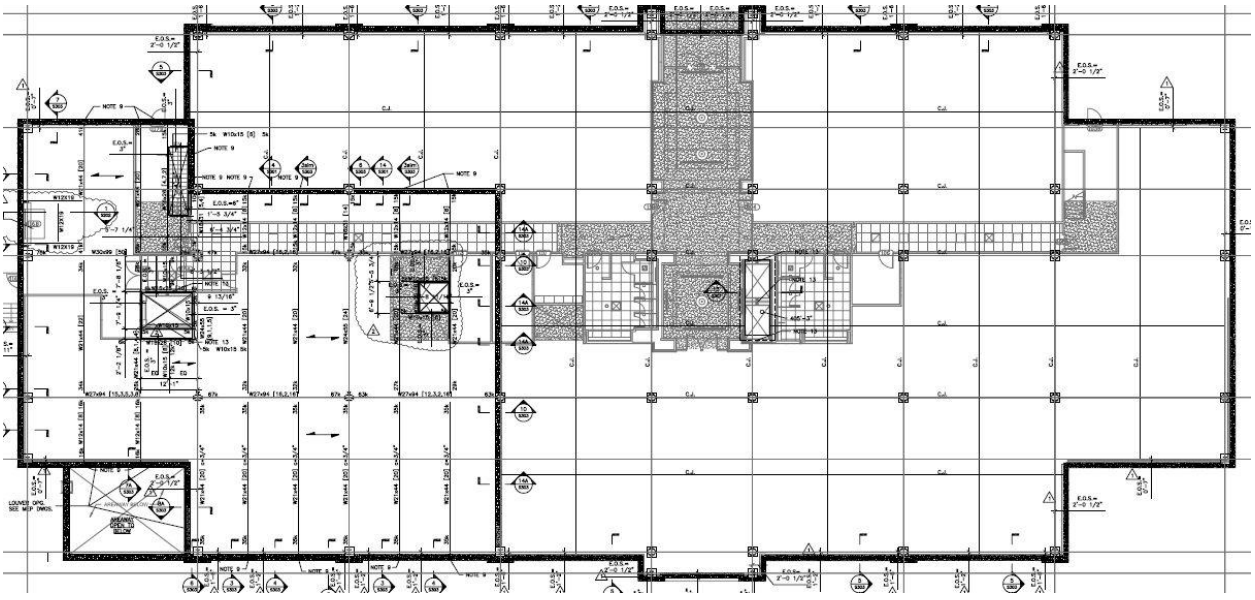


Figure 19 – First Floor Structural Plan

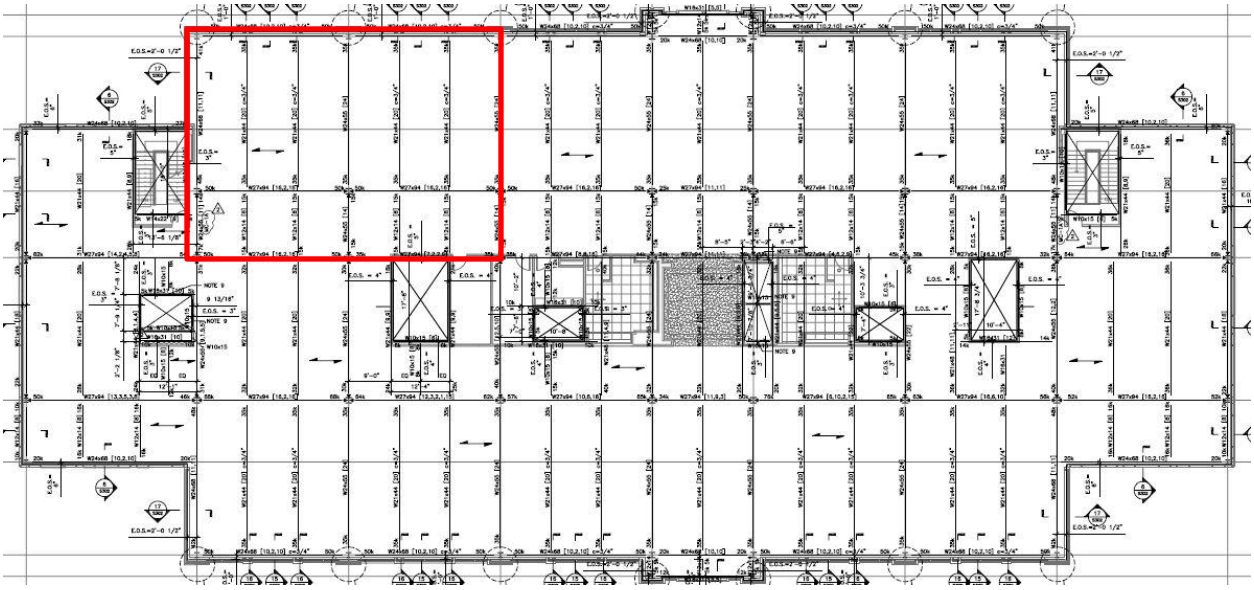


Figure 20 – Second Floor Structural Plan

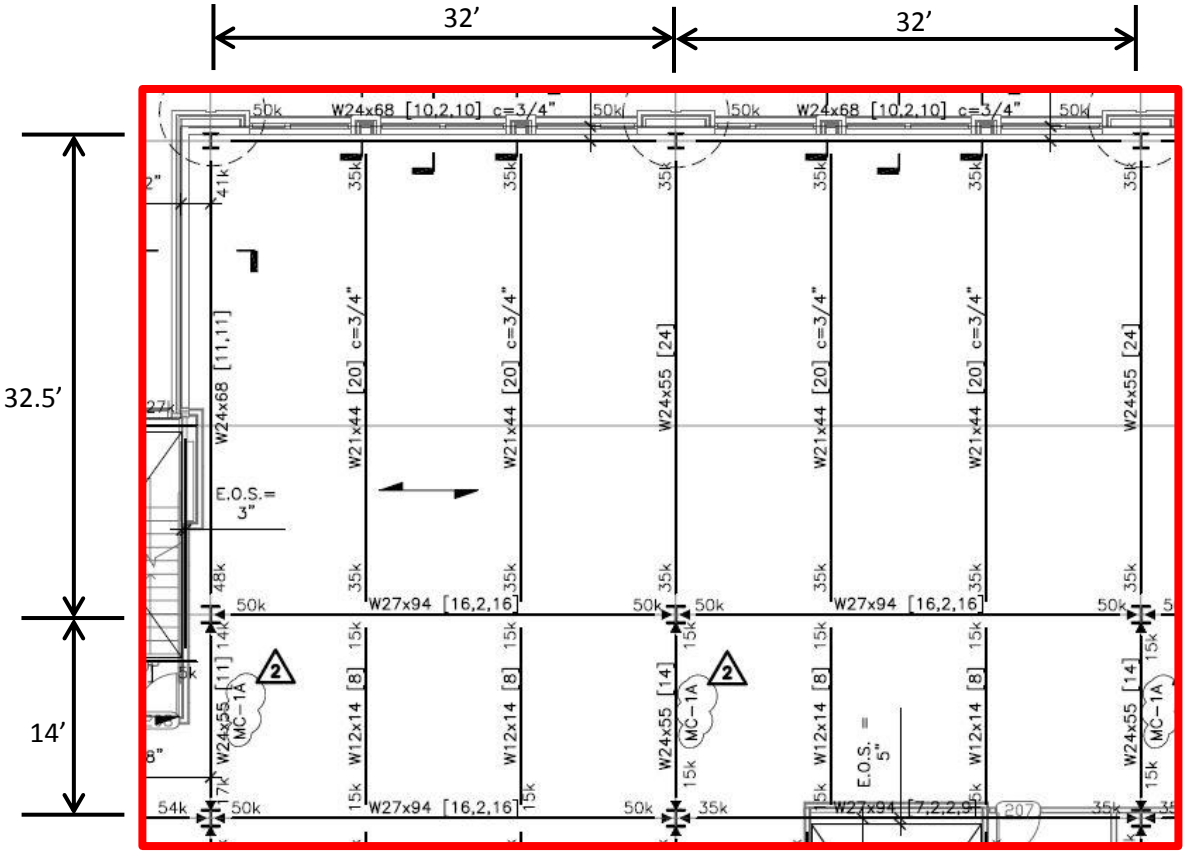


Figure 21 – Spot Check Area

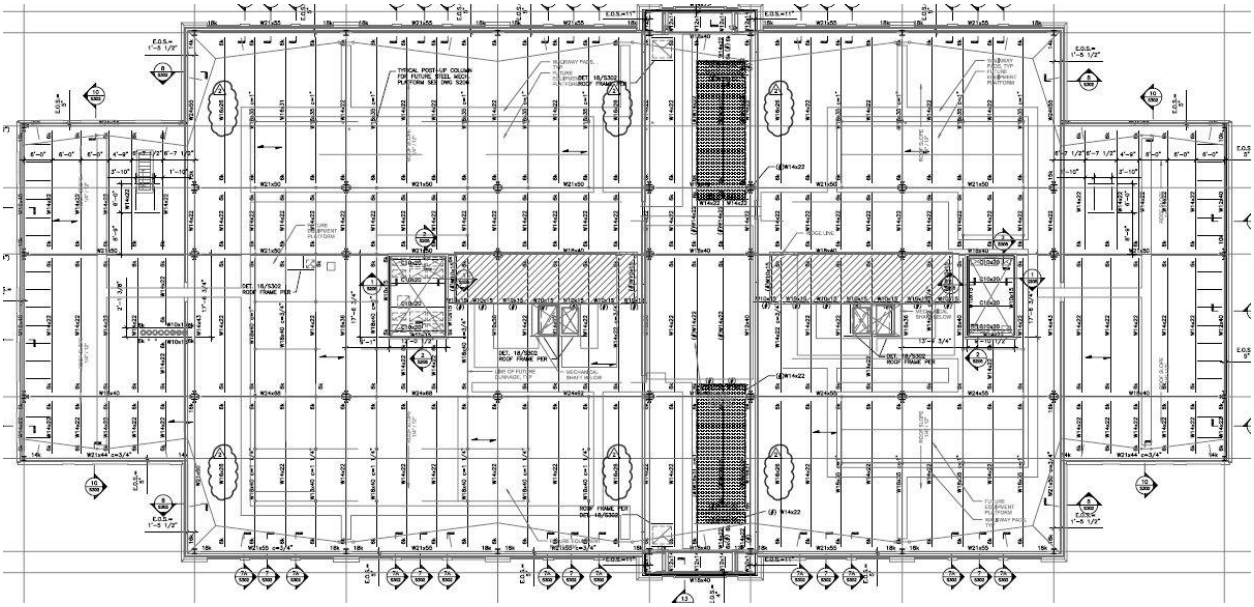


Figure 22 – Roof Structural Plan

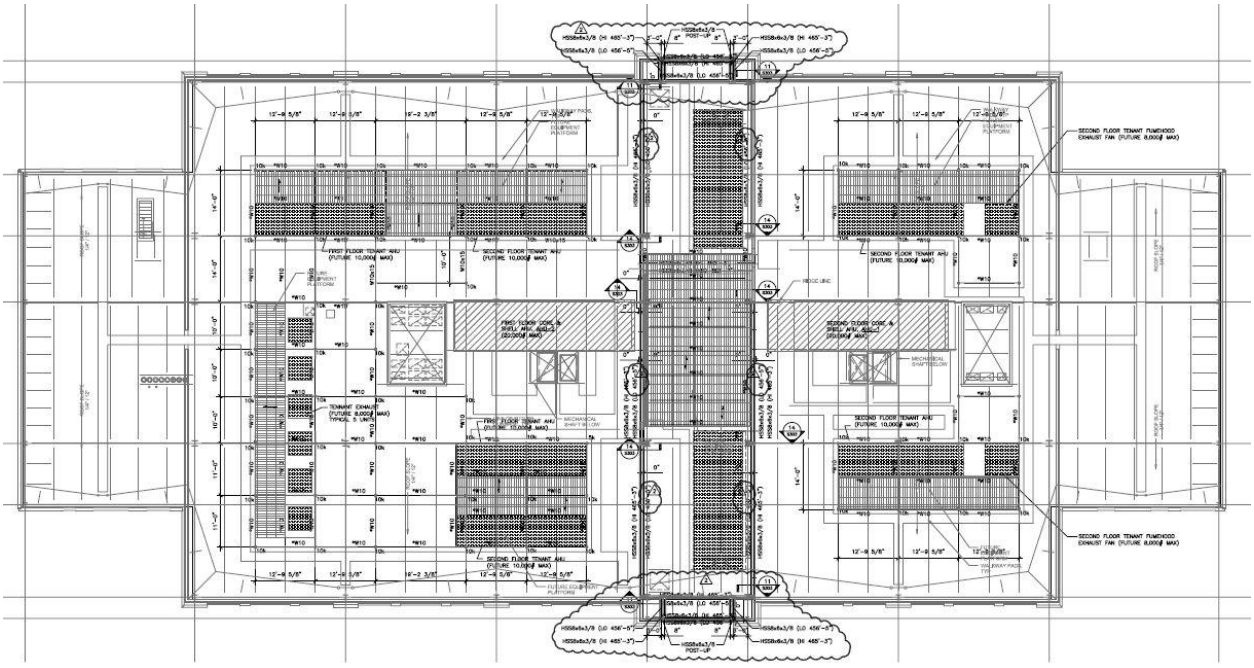


Figure 23 – High Roof Structural Plan