



**UNIVERSITY HEALTH BUILDING**  
**LOCATED IN THE MID-ATLANTIC REGION**

**2ND REVISED THESIS PROPOSAL**  
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## Executive Summary

The proposed thesis is to relocate the University Health Building (UBH) to Orlando, Florida. An academic depth will then be focused on the redesign of the lateral system. Due to the high wind loads in this location, more shear walls will need to be added to the building to increase its rigidity and strength to resist the increased forces. The location and size of the new shear walls will be determined as part of the redesign.

The increased loads will also have effects on the building's foundation. The foundation system will be checked for uplift and also designs will be done for a few critical spread footings and will be compared to the original building.

In addition to the depth, two breadth topics will be addressed. The first breadth topic will analyze the existing cooling system to determine if resizing is necessary due to the warmer climate. If resizing is necessary, a new cooling unit will be specified for the building. Then due to the changes in the mechanical system the second breadth will determine the cost and schedule impact.

## Building Introduction

This new 9 story 161000 square foot building will be a great addition to the university's campus. It is being built to house leaders in the public and private health policy sectors. The building is a mesh between office space and student classrooms nestled around a central sky lit atrium. The architect hopes that this mesh will help to bridge the gap between faculty and students. The classroom area appears as if the classrooms are floating on clouds in a glass enclosure. The concrete structure is enclosed by a curtain wall which is the building's main architectural feature. The curved saw blade-like curtain wall system encompasses one quarter of the building's façade and gives the building an edgy appearance.

The building façade is constructed of many different types of materials, ranging from stone to metal. The building's first floor is covered by a stone veneer giving the building a very stereotomic base. The rest of the building is clad in a mixture of glazing, metal panels, and terracotta. The West and Southeast facades are relatively similar to one another. They both have a pattern of terracotta, metal paneling, and glazing above the first floor with the majority material being covered with the terracotta. The south and north facades are also very similar except the south facade has an aluminum sunscreen system in place. Otherwise, these ends of the building are almost fully glazed. Lastly, the curved curtain wall with reveals located on the northeast side of the building is composed of mainly glazing with the reveals clad in terracotta. Some of these features can be seen in Figure 1.



Figure 1: Photo of Northwest corner of building showing façade materials. Rendering by Payette Architecture.

The majority of the roof is a garden roofing system. The system used on this project is the Sika Sarnafil Extensive Greenroof system. It uses 3in. of growing medium as well as pavers for maintenance. The rooftop penthouse will be covered with a fully adhered white, 60mm thick PVC membrane with a layer of 8in. thick tapered polyisocyanurate insulation boards underneath.

Lastly, the University Health Building is registered as a LEED – NC 2.2 Silver building. This rating includes many different LEED credits involving the façade, roof, and internal systems. The main points came from the heat island effect roof system, the building's proximity to transit, and use of efficient plumbing and lighting fixtures.

## Structural Overview

### Foundation

The foundation of University Health Building (UHB) consists of spread footings at the base of each column. On the western block of the building, the engineers utilized a grade beam and spread footing combination to help with the bracing of the basement wall shown in the Figure 2 below. This was not used on the east side of the building due to the absence of any underground levels. The spread footings are to be set on soils suitable to hold about 5000psf according to the Geotechnical report.

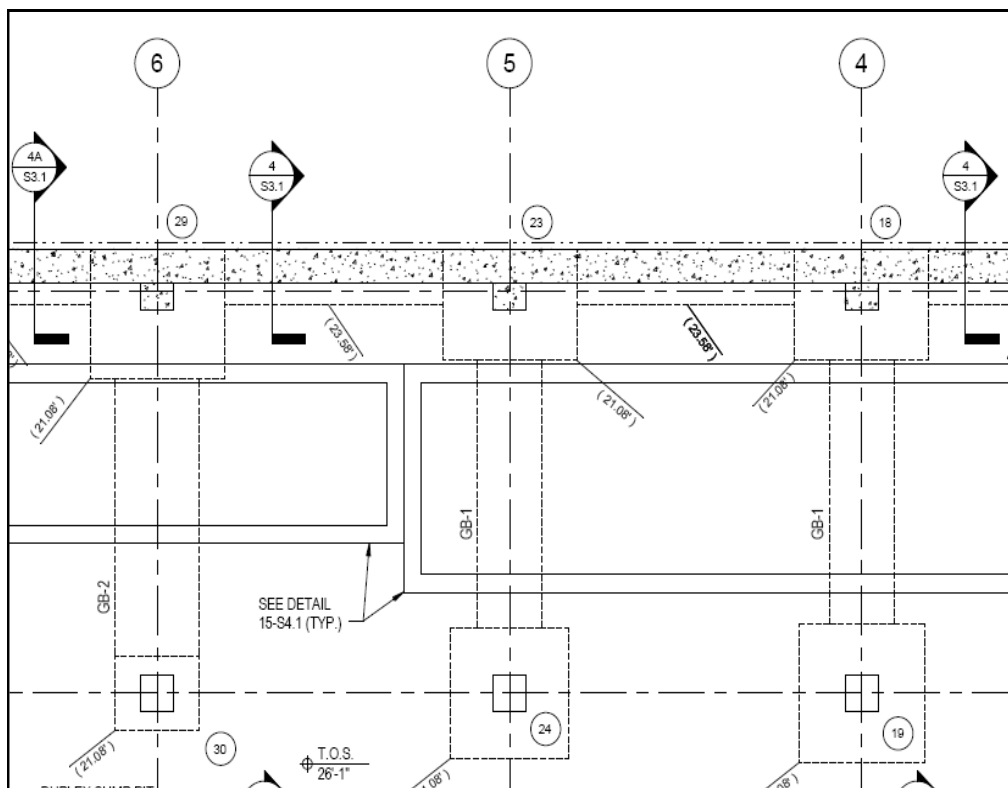


Figure 2: Grade beam and spread footing combination, taken from drawing S1.1

### Floor Slabs

The basement level and ground level floor slabs are similar in the fact that they both have a relatively thick floor slab and drop panels comprised of high strength concrete in order to minimize the amount of beams necessary to handle the 21 ft. spans. Once you leave the ground floor, you will find that the slabs change from what was mentioned above to a post tensioned slab system. Also, above the ground floor on the east half of the building, the slabs have large continuous drop panels running between select columns. This type of system extends all the way to the penthouse slab with variations in slab and drop panel thicknesses.

### Lateral System

Since the walls of the UHB building are non-load bearing, the lateral loads, due to wind and seismic, must be resolved by the columns and slabs of the building. The dominant lateral system of the UHB is concrete moment frames consisting of the post-tensioned slab and interior/exterior column system. In the case of wind, the load is transferred from the cladding to the exterior columns and slab edge. Then, it is distributed to the interior columns through the slab, and finally, its transferred to the foundation through the columns. The lateral system also utilizes one shear wall located beside the elevator shaft. The shear wall is called out in Figure 2.1.

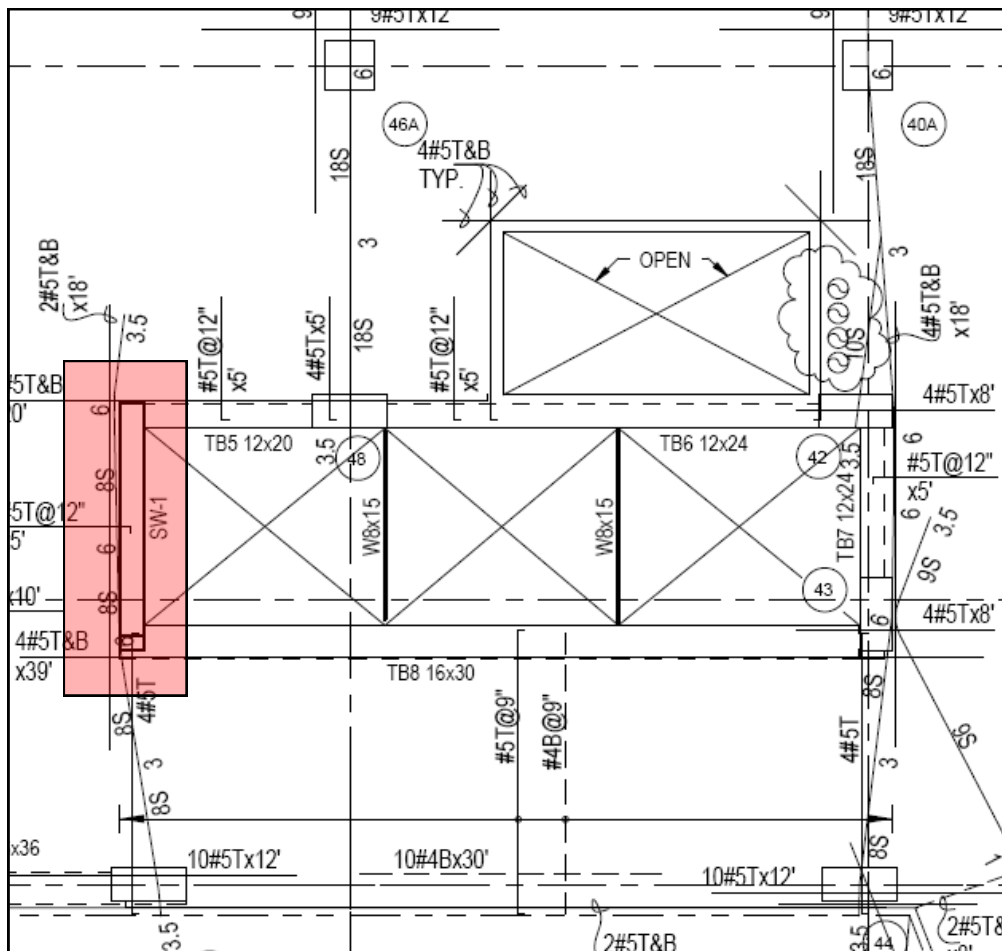


Figure 2.1: Location of shear wall, taken from S1.8

### Roof System

The roof system is comprised of two different levels. The first being the lower roof where the green roof is located, and the second is the upper roof that covers the penthouse. The lower roof is a 12-14in. thick post tensioned slab and topped with a green roof system where exposed to the outside. The upper roof is supported by an 8in. post tensioned slab. Also, a portion of the penthouse roof is spanned with steel beams with a glazing system ovetop to serve are the skylight for the central stair tower. Figure 3 below shows a partial roof plan showing the integration of the post tensioned concrete slab and central skylight area.

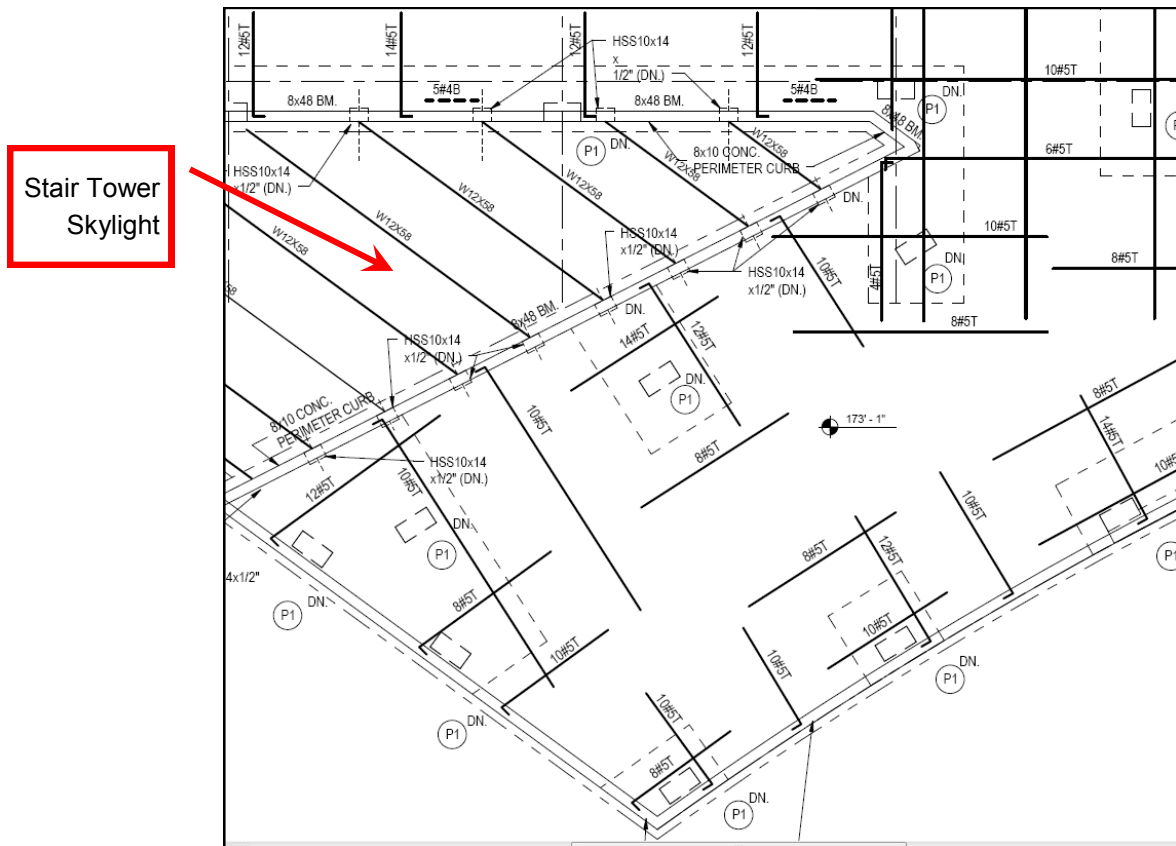


Figure 3: Integrations of both steel and concrete systems on roof, taken from drawing S1.11

## Codes & References

### Design Codes

#### Building Code

International Building Code - IBC 2006 system

#### Reference Codes

American Society of Civil Engineers - ASCE 7-05

American Concrete Institute Building Code - ACI 318-05, ACI 530-05, ACI 530.1-05

American Institute of Steel Construction - AISC 360-05

### Thesis Codes

#### Building Code

International Building Code - IBC 2009

#### Reference Codes

American Society of Civil Engineers - ASCE 7-05

American Concrete Institute Building Code - ACI 318-08

American Institute of Steel Construction - AISC 14th Edition



## Design Loads

This thesis project will be conducted using the Load and Resistance Factor Design (LRFD) method as it is quickly becoming the industry standard. Thesis loads were determined using ASCE 7-05 unless a category were not listed specifically. Then, design loads were used in its place. At the time this report was written, it was undetermined what the design engineer used for dead loads. See Figure 4 below to see the comparison between design and thesis loads.

	(psf)	
Live Loads	Design	Thesis
Roof	30	20
Mechanical Penthouse	150	150
Green Roof	35	35
Stairways	100	100
Corridors	100	100
Loading Dock	450	450
Light Storage	125	125
Retail	100	100
Office	80	80
Partitions	20	20

	(psf)	
Snow	Design	Thesis
Ground Snow	30	30
Flat Roof	21	21
Snow Exposure Factor	0.7	0.7
Snow Importance Factor	1	1

	(psf)	
Dead Load	Design	Thesis
MEP Allowance	-	5
Roof material	-	5
Green Roof	-	50
	(pcf)	
NW Concrete	150	150

Figure 4: Summary of Live Snow and Dead loads

# Material Strengths

General material strengths were found on S4.9 and are displayed in Figure 5. The general types and strengths can be overridden per special callouts on the floor plans. On many floors, slab strengths are a combination of 6000psi and 8000psi. See Figure 6 and 7 for good examples of the drawings superseding the general strengths. The figures show variations in concrete strength as the building elevation increases and slab thickness increases.

PENTHOUSE ROOF	
ELEV. MACH. RM. FLOOR	
MAIN ROOF/ PENTHOUSE FLOOR	
LEVEL 7	$f'c=4,000$ PSI
LEVEL 6	
LEVEL 5	$f'c=6,000$ PSI
LEVEL 4	
LEVEL 3	$f'c=8,000$ PSI
LEVEL 2	
LEVEL 1 / GROUND	
LEVEL B1	$f'c=10,000$ PSI
LEV B2 / FOUNDATION	

Figure 6: Variations in column concrete strengths per level

Item	Type	Strength
Steel Beams	ASTM-A992	Fy= 50
Post tensioning Tendons	ASTM A-416	Fu= 270
Reinforcement	ASTM-A615	Fy= 60
Masonry	ASTM C-90	$f'c=1.5$
Grade Beams	NW Conc.	$f'c= 4$
Column Footings	NW Conc.	$f'c= 5$
Slab on grade	NW Conc.	$f'c= 5$
Floor slabs	NW Conc.	$f'c= 6$
Columns	NW Conc.	See Fig.

Figure 5: Material strength table

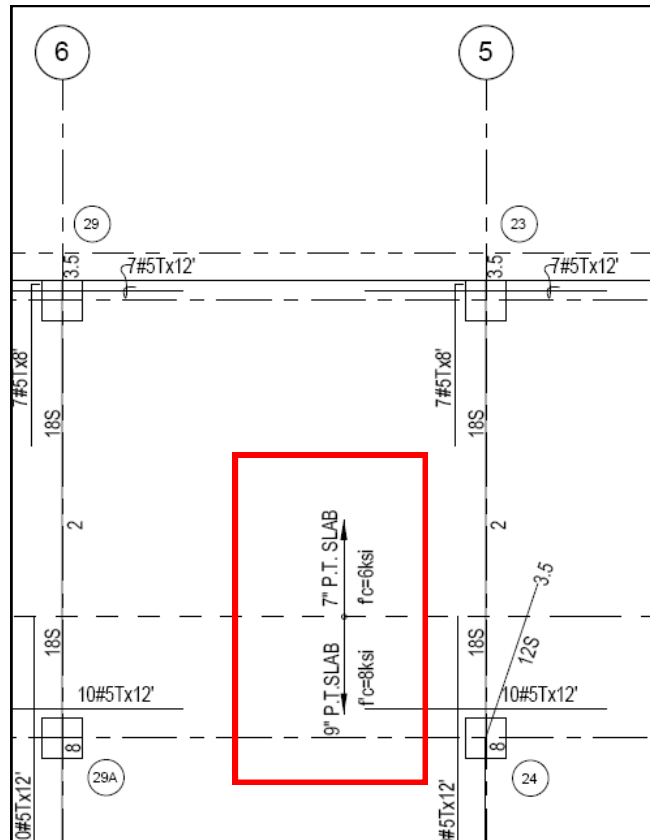


Figure 7: Variations in slab concrete strength

## Problem Statement

As concluded from Technical Reports I, II, and III, the UHB adequately meets structural strength and serviceability requirements for its current location in the Mid-Atlantic, but what if the building were no longer located in the Mid-Atlantic. Many companies and institutions have trademark building architecture that helps them to distinguish their brand, as a form of advertising. On the outside these buildings may appear very similar but on the inside they may need to be very different to meet the structural and serviceability requirements of the building's location. The building's location can drastically change its lateral system due to it being located in either a wind or seismic controlled region.

This is an issue that designers face on a regular basis. To the public, the building will appear the same as its similar counterparts, but the building's internal components will need to be designed to meet the requirements of the building's location.

## Problem Solution

### Depth: Lateral System

For the Depth of my senior thesis, I employ that the university is opening a new branch campus in Orlando, Florida and would like to use the same building. This will have an impact on the building's lateral system as it moves from its current location, where seismic was found to control lateral loading, to Orlando where wind is the controlling lateral load. This will be an interesting academic experiment as the lateral system will need to be revamped to account for the hurricane force winds. This will be done by the addition of more concrete shear walls to the UHB, which currently has one shear wall. The shear walls will help to make the structure more rigid allowing it to withstand the greater lateral loads.

The first challenge is that the new shear walls will have to be incorporated into the building's architecture. This may require small alterations to the floor plan depending on the amount of shear walls necessary.

Also, the foundation will then be analyzed for the new loading and altered as necessary. Due to the increased wind loads, the possibility of having uplift forces on the foundation is increased. Critical spread footings will also be analyzed for the new soil type at the building's new location.

### **Breath: Condensation Analysis of Building Envelope**

The UHB will be moving from a mixed climate to a primarily cooling climate. The summer design parameters in Orlando will need to be checked against the current wall system to determine if the configuration will need to be updated for its new location due to the high humidity found in Orlando. This will be done by analyzing the wall and determining where condensation will form and position the vapor barrier to correct this issue if necessary.

### **Breath: Shear Wall Cost and Foundation Cost/Schedule**

The upgrades to the UHB will come at an increased cost to the owner. This breadth study will determine the increased cost for both the shear walls and foundation. An analysis of the foundation schedule will be done, due to the foundation needing to be changed from spread footings to caissons. The shear wall schedule will not be analyzed due to the schedule increase will be minimal. The shear walls will be formed along with the rest of the building seamlessly.

### **MAE Requirements**

ETABS will be used in order to design and analyze the new lateral elements of the UHB. This will incorporate knowledge that was obtained in the AE 530 Computer Modeling of Building Structures coursework. Secondly, the knowledge obtained from AE 542 Building Enclosure Science and Design will be used when determining wind loads for specialized regions such as Orlando, Florida as well as the analysis of the building envelope.

## Tasks and Tools:

### I. Redesign Lateral System

1. Calculate new design wind loads using MWFRS Directional Procedure in ACSE 7-05
2. Design shear walls
  - A. Determine shear wall size from ACI 318-08
  - B. Determine how many shear walls will be needed for the lateral system

### II. ETABS Model

1. Determine placement of shear walls
2. Check building torsion, story drift, overturning to meet ASCE 7-05 and industry standards

### III. Impact on Foundations

1. Determine if uplift occurs
2. Design spread footings for new loads at critical locations per ACI 318-08
3. Compare to original spread footings

### IV. Impact on Foundations

1. Determine if uplift will occur
2. Retrieve soil information for new location
3. Design spread footings at critical locations in the building
4. Compare new spread footings with original

### V. Condensation Analysis of Building Envelope

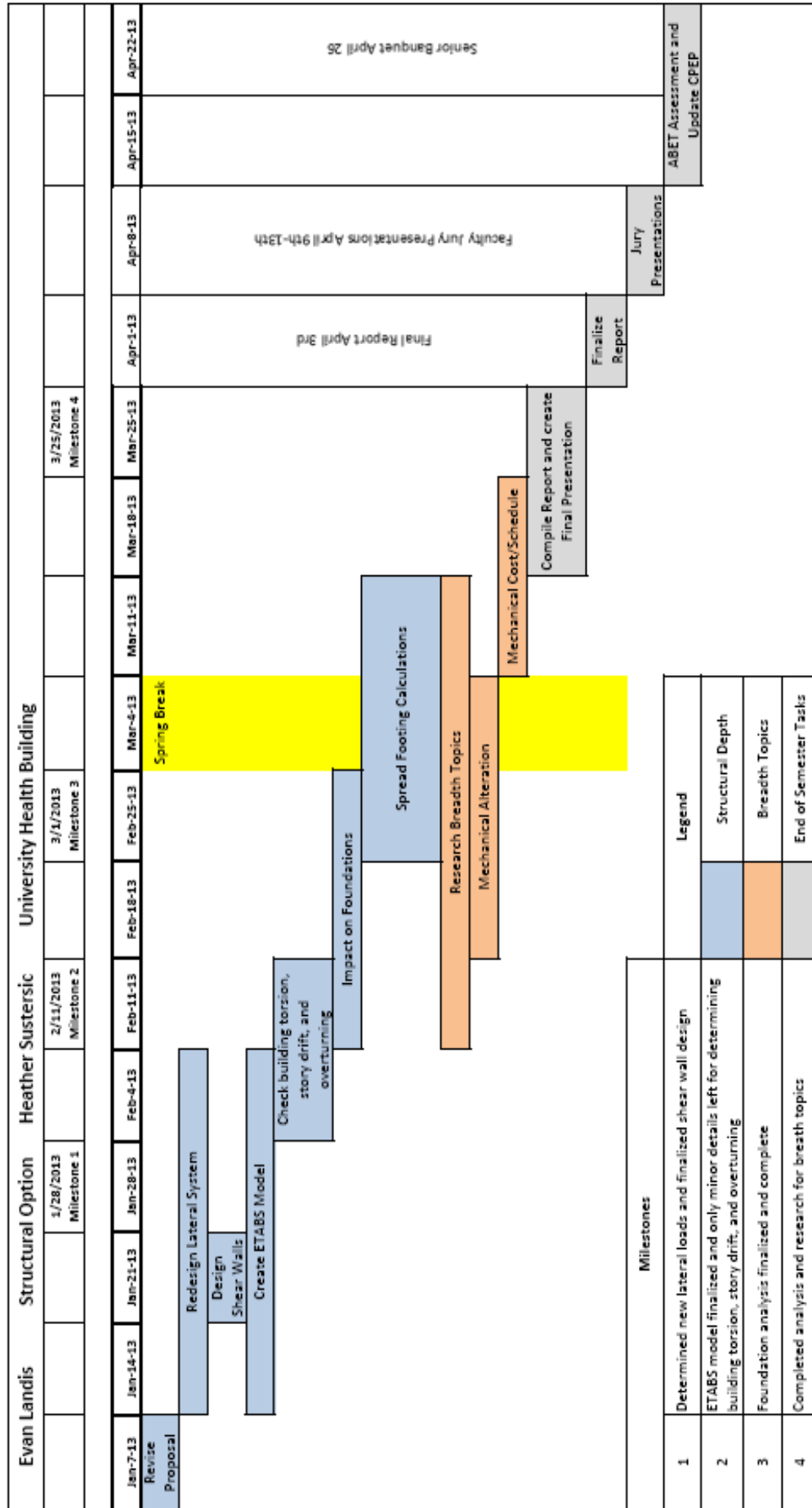
1. Determine R-value limitations
2. Wall section details
3. Use H.A.M. Toolbox to analyze wall

### VI. Cost of Shear walls and Foundation Cost/Schedule

1. Determine Shear Wall Cost per RSMeans 2013
2. Determine existing foundation cost per RSMeans 2013
3. Determine cost of caisson foundation per RSMeans 2013

# Schedule

Note: Breadth topics were altered but still require the same amount of time.



## Conclusion

In conclusion, the UHB will be moved to Orlando, Florida so that the writer may conduct lateral system analysis on the building. This structural depth will include checks for both the lateral system and foundation system. In addition to the structural depth, a breadth will be done with respect to imposing impact resistant glazing on the building due to wind born debris at the building's new location. Lastly, mechanical alterations will be done to the UHB so that its internal climate will be comfortable in its new location.