



UNIVERSITY HEALTH BUILDING
LOCATED IN THE MID-ATLANTIC REGION

THESIS PROPOSAL
EVAN LANDIS || STRUCTURAL OPTION
ADVISOR - HEATHER SUSTERSIC

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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 analyzed and designed.

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 consider the addition of impact resistant glazing due to the wind born debris that it will be subject to in the building's new location. The cost of this improvement will then be assessed. The second 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.

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.

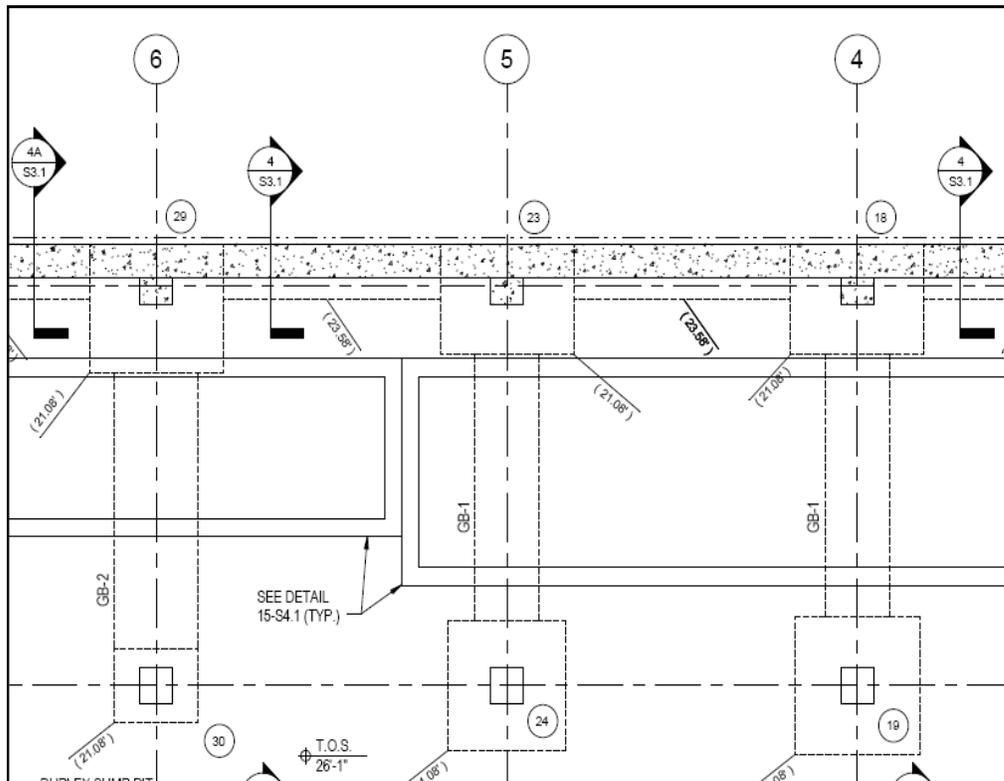


Figure 2: Grade beam and spread footing combination, taken from drawing S1.1

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.

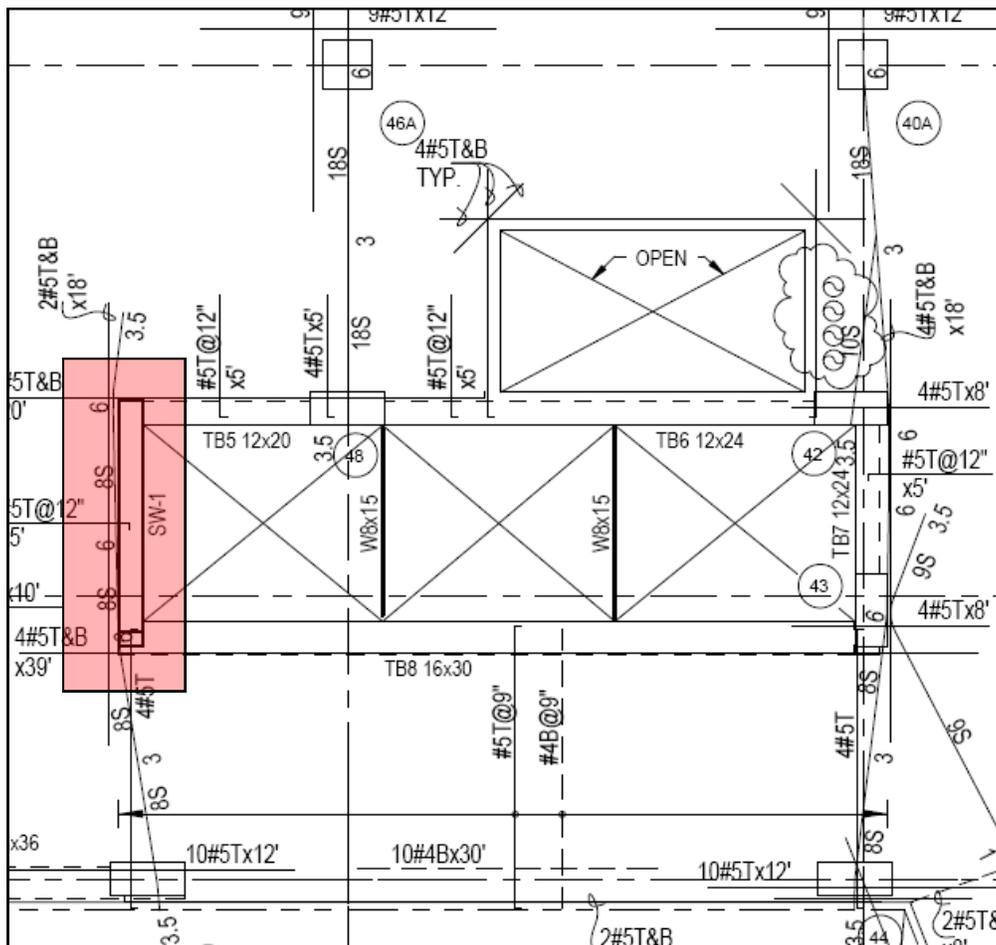


Figure 2.1: Location of shear wall, taken from S1.8

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.

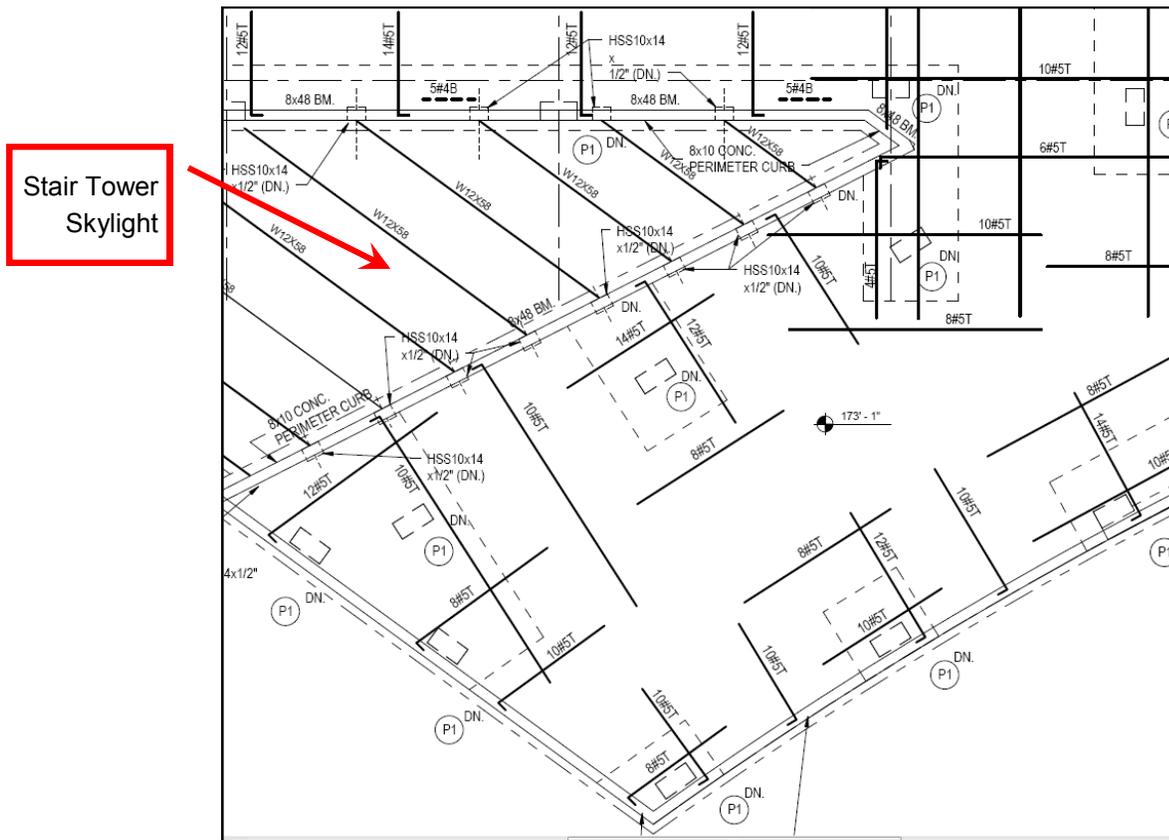


Figure 3: Integrations of both steel and concrete systems on roof, taken from drawing S1.11

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.

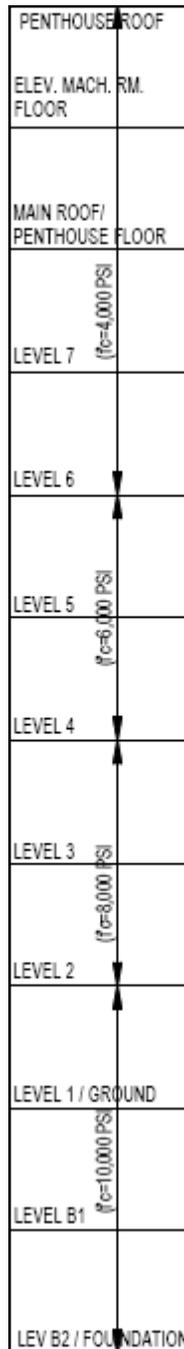


Figure 6: Variations in column concrete strengths per level

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

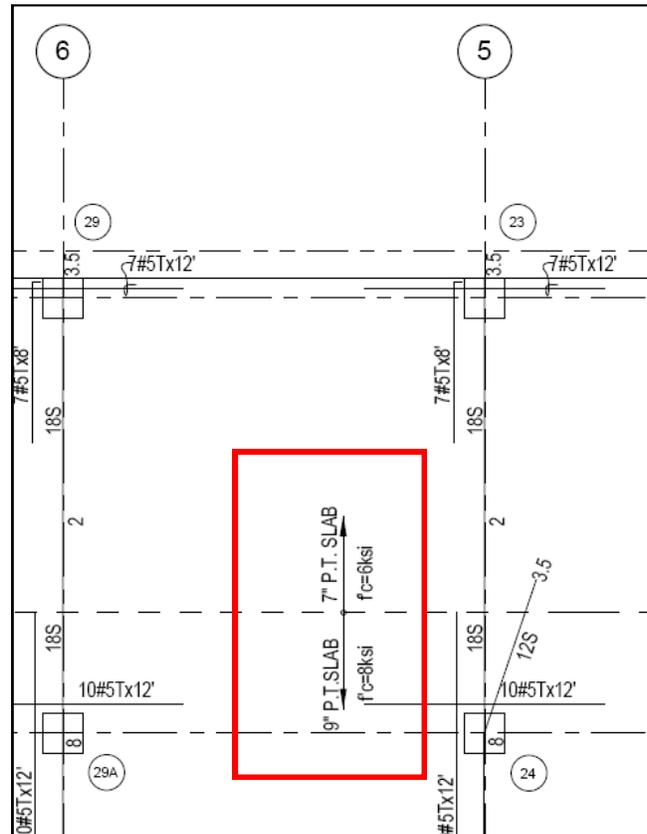


Figure 7: Variations in slab concrete strength

Problem Statement

Many companies and institutions have trademark building architecture that distinguishes their brand. On the outside these buildings may appear very similar but on the inside they may be very different depending on the building's location. The building's location can determine what lateral loading will control, wind or seismic, as well as the effects of a high snow load.

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 differently.

Problem Solution

Depth: Lateral System

For the Depth of my senior thesis, I will explore the effects to the lateral system of the UHB if it were to be moved from the Mid-Atlantic states to Orlando, Florida. This will be an interesting academic experiment as the lateral system will need to be revamped to account for the hurricane wind forces. 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 shear walls will have to be incorporated into the building's architecture. This may require small alterations to the floor plan or not depending on the necessary locations and the amount of shear walls. The additional cost of the shear walls will then be calculated to determine the increase in cost to the project.

Also, the foundation will then be checked and designed for uplift if 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: Building Envelope

The first breath study of my thesis will be to design impact resistant glazing for the window openings in my structure. This is relevant to the new location of the building because the owner will want to prevent a breach of the building during a high wind event. Preventing a breach will protect the items inside the building as well as help the building to be reoccupied sooner after the storm. The money lost due to the building being inoperable is usually much greater than the cost of the repair. The cost of the glazing will be more expensive, but in the event that there is severe weather, the building will lose less money.

Breath: Mechanical Alterations

The UHB will be moving from a mixed climate to a primarily cooling climate. The cooling units of the UHB will need to be checked to determine if they can accommodate the increased cooling load. A breath study will be conducted on the UHB in order to determine if its cooling units will need to be resized, and if needed, a new unit will be chosen that will accommodate the increased cooling load.

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 choosing and calculating the loads of the new glazing design.

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

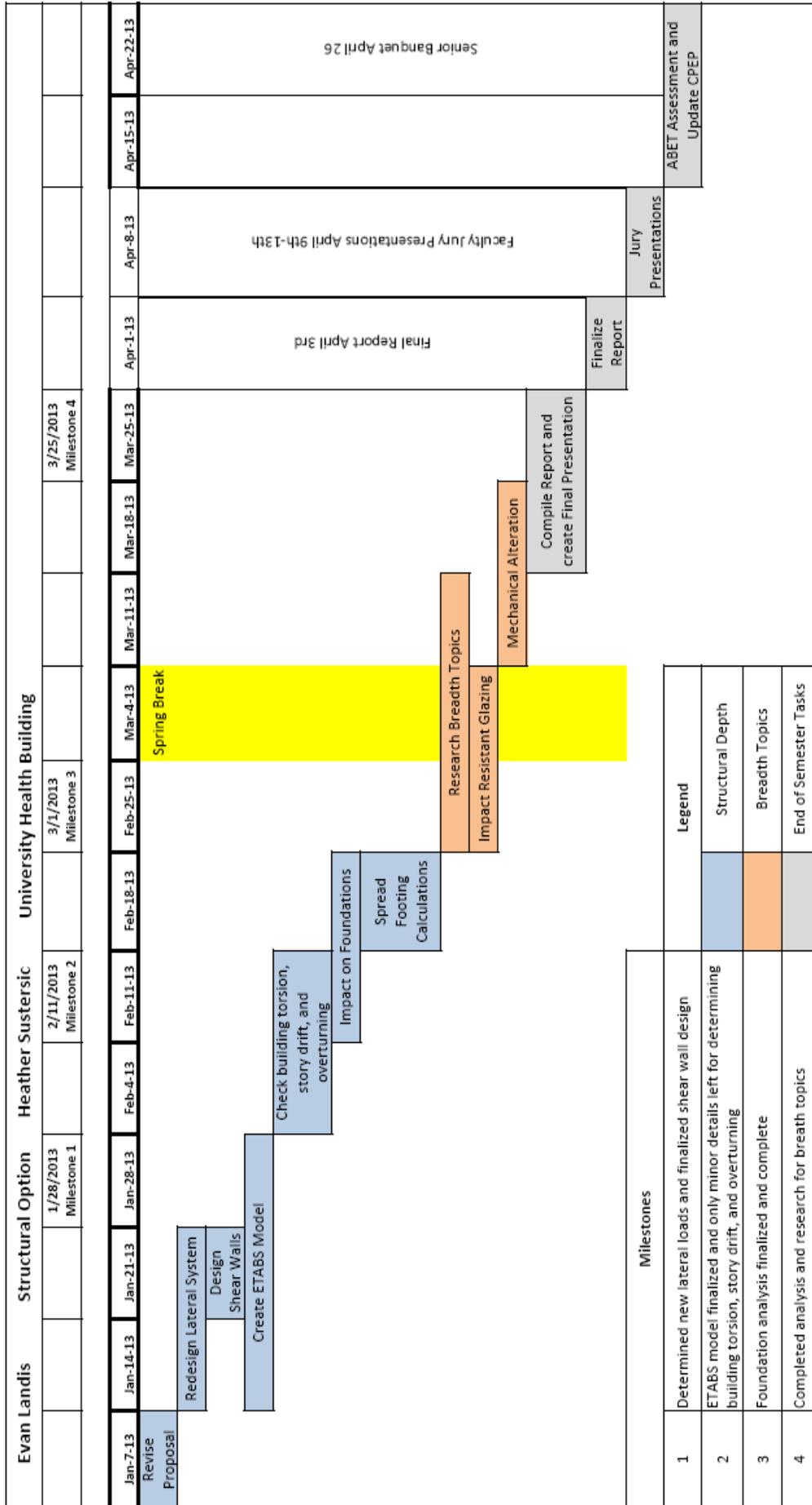
V. Impact Resistant Glazing

1. Determine probability or breakage desired
2. Determine loading on glazing
3. Design glazing to withstand loading per ASTM

VI. Mechanical Alteration

1. Analyze existing cooling unit
2. Calculate new cooling load for the building (or building quadrant)
3. Choose new cooling unit
4. Compare to existing cooling unit

Schedule



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.