2013

Brandon Tezak, LEED Green Associate
Construction Management Option
Faculty Advisor: Dr. Anumba
January 9, 2013

[THESIS PROPOSAL]

North Hall – American University
Washington, D.C.

Executive Summary

After American University's 2011 Campus Plan was approved the by District of Columbia Zoning Commission on March 8, 2012 Grunley Construction Company was awarded the construction contract on April 23, 2012 for American University's newest dormitory, North Hall. North Hall is an eight story, tracked for LEED Gold upon completion, dormitory building that is located on American University's Main Campus in downtown Washington, D.C. The 122,200 square foot building will house 358 undergraduate students in 94 suite style dorm rooms consisting of six bed, four bed and, RA units (1 bed). Grunley bid North Hall with a Guaranteed Maximum Price (GMP) of just under $ 29 Million. North Hall is scheduled to house students for the start of the Fall 2013 semester.

This report presents four analyses that will be performed as part of the final thesis report in the spring semester.

Analysis 1: Modularization of Bathrooms
North Hall has both an extremely tight and congested site and well as a very tight schedule. Modularization will more some of the work to an offsite tacitly and will allow the bathroom units to be constructed before they would be onsite. In addition, a labor would be completed in a controlled environment providing an opportunity for both schedule and cost savings.

Analysis 2: RFID Tracking of Precast Panel
The installation of the precast panels is confined to a small window in the schedule and the site entrance for deliveries is extremely congested. With a RFID tag tracking system the precast panel can be tracked from the time they leave the factory until they are installed. The track will not stop at installation, the same RFID tags will be used to track a testing required for the façade panels.

Analysis 3: Solar Panel Upgrade
North Hall will have two arrays of solar panels when construction is complete. The current design only has the capability to heat domestic hot water. By upgrading the solar panels to a hybrid solar panel system the capability to generate electricity will be added. This electrical power will be used as a source of renewable energy for North Hall. This analysis will incorporate an electrical breadth.

Analysis 4: Traditional Reinforced Cast in Place Floor Slabs
Currently floors 3 through 8 are post-tensioned floor slabs. This post-tensioning adds extra cost that can be value engineered to a traditional reinforced cast-in-place concrete slab. Along with the savings in cost time has the potential to be saved with the tensioning of the tendons eliminated. This analysis will incorporate a structural breadth.

Table of Contents

Project Background

North Hall going to be American University's newest dormitory building upon its completion in early August 2013. Starting in the Fall 2013 semester North Hall will be the home to 358 undergraduate student living in the 94 suite style rooms spread out through the 8 story, 122,200 square foot building. North Hall is laid out in an elongated "L" shape, the south façade is show in Figure 1. Precast panels will make up a majority of North Hall's façade with small sections of a curtain wall system mixed in.

Figure 1: North Hall South Façade
Photo Taken By: Brandon Tezak

The first floor is home to both the mechanical and electrical rooms. There is also a fitness center as well as two dance studios located on the ground floor that will serve students in the building. All the suite rooms are located on floors 2 through 8. There are three different layouts for the suites, three bedrooms (two students per bedroom), two bedrooms, and a one bedroom (resident assistant). Each suite has a bathroom and shower located within the suite. The two and three bedroom units have a living room area as well.

North Hall will be located directly adjacent to three existing dormitory building and directly behind the President's Office Building (POB) all of which will be fully occupied through the construction process. These surround buildings create a very small and tight sight for North Hall. Careful planning and coordination has been critical by the project team from Grunley Construction. The structure of North Hall is entirely cast-in-place concrete. Additionally, floors 3 through 8 are post-tensioned slabs.

After a review of the North Hall project, discussions with the project team and the discussions and interactions with industry members at the 2012 PACE Roundtable several potential problematic parts of North Hall were identified for future analysis and further research. One of the major problems is the tight site that North Hall is located on. Du to this site logistics and planning are key to the success of the project. My using modularized construction for the bathroom units in each suite extra deliveries can be reduced as wells as onsite construction time being reduced. Along with using modular construction material tracking with radio frequency identification (RFID) tags on the nearly 500 precast will help manage the deliveries to site, thus allowing logistics to help drive the installation of the precast façade. Another part of North Hall that can be improved upon is the current design of the solar panel arrays on the roof. The panels are designed to generate hot water however; if the system was upgraded to a

hybrid solar panel that can produce both hot water as well as electricity may be more beneficial for the owner. Finally, the post tensioning in floor slabs 3 through 8 could be eliminated providing potentials for cost savings.

Analysis 1: Modularization of Bathrooms

Problem Identification

Any way in which the construction of North Hall can be accelerated can be beneficial to the schedule and meeting the completion date for North Hall. North Hall has a very important completion date since the building must be ready for students to move in for the start of the Fall 2013 semester. Modularization of the bathrooms in the suites is a way that the schedule can be accelerated. The bathrooms are typical from suite to suite making the repetitiveness of them ideal for modularization. North Hall contains 94 of the typical bathroom units. With the implementation of modularization on this part of North Hall both time and money can be saved.

Research Goal

The purpose of this analysis is to evaluate the benefits of incorporating modularization in to the bathrooms in each suite.

Methodology

- Identify constraints
- Identify bathroom activities durations
- Identify site logistics related to modules
- Identify module construction activity durations
- Develop cost comparison between current method and modularized method
- Develop schedule comparison between stick built method and modularized method
- Develop logistics plan for module installation
- Analyze constructability issues related to integration of modular units to rest of building
- Analyze cost and schedule comparisons
- Draw conclusions if modularization is feasible for North Hall

Resources and Tools

- Industry Professionals
- Related Literature and Case Studies
- Grunley Construction Project Team
- AE 570: Production Management in Construction, Modularization Information
- AE Department Faculty

Expected Outcome

The analysis of modularizing the bathrooms in the suite units of North Hall is expected to illustrate the benefits of using modularization. It is expected that by using modularization that both the schedule and cost impact will be beneficial. The schedule will be reduced allowing the project team to potentially make up some of the delays encountered early on in the construction process. Due to the work on the

bathroom units being shifted from the site to a production facility thus a lower wage rate will be used decreasing the overall cost of the bathroom will decrease. The integration of the modular units to the rest of the building will cause a potential constructability issue for North Hall.

Analysis 2: GPS Material Tracking - Precast Panels

Deliveries to site can be extremely problematic because of the single lane access to the site as well as the extremely tight site. Once a truck pulls onto site it is next to impossible for another truck to get in or out of the gate essentially shutting down the access road to until the truck is unloaded and leaves. North Hall would benefit greatly from a material tracking system.

North Hall's façade is primarily made up of precast panels and the schedule to erect these panels is extremely tight. The precast subcontractor must have erect all of the over 400 panels in eight weeks. Implementing Global Positioning System tracking system to track the precast panels from the production facility in North Carolina to site in downtown Washington, D.C. and then when they are placed in their correct location. This tag would also be used to track the test done on the panels once they are installed. The GPS tag will allow the project team to better coordinate deliveries to site and track the material when it is onsite. Grunley is currently using a similar technology, RFID tags on the workers' hard hats to track certified business enterprise (CBE) requirements in the contract.

Research Goal

The goal of this analysis is to analyze the benefits of using a GPS tracking system for the precast panel façade for material tracking and site logistics.

Methodology

- Obtain precast façade schedule and details
- Identify erection sequence
- Identify required testing
- Identify potential GPS software programs
- Evaluate information to be included on GPS tags
- Determine best method for implementation
- Analyze cost impacts
- Analyze schedule impacts

Resources and Tools

- Industry Professionals
- Related Literature
- Grunley Construction Project Team
- AE Department Faculty

Expected Outcome

This analysis is expected to provide a very efficient way of tracking the precast panel façade from the time it leaves the production factory until it is installed and any required testing is done with GPS tags.

The tracking will provide the project team to better plan the site logistics with the extremely tight site. In addition, the tracking system will help keep the façade installation and testing on schedule consequently providing both schedule and cost savings on the overall project. Due to the precast panels requiring the tower crane for installation, it is important to keep the installation on schedule to allow the very expensive tower crane off site as soon as possible.

Analysis 3: Solar Panel Upgrade

Electrical Breadth

Problem Identification

North Hall will have two set of solar panel arrays on its roof when the building is complete. The original design of the solar panel array only uses a system that heats domestic hot water. Hybrid Solar Panels have capability to not only heat water but also generate electricity. North Hall is located on a site in which the sun is unobstructed from any neighboring building or trees. The solar energy that will hit the roof and solar panels every can be captured a used to meet the part of the electrical load for North Hall. With an upgrade to the original design, American University has the potential to not only save on their electrical costs over time but also be an example of an environmental steward in Washington, D.C.

Research Goal

The goal of this analysis is to analyze the advantages and disadvantages related to upgrading the solar panels to a hybrid solar panel. Also analyze which of the building's electrical system's load should be supplemented by the new solar panel design.

Methodology

- Investigate hybrid solar panels
- Determine feasibility of proposed upgrade
- Determine cost impacts
- Determine schedule impacts
- Analyze electrical system
- Evaluate where generated electrical energy can best be used
- Analyze effects of upgrade on existing electrical system

Resources and Tools

- AE Electrical Students
- AE Faculty
- Product Specifications
- Project Team
- Related Literature
- Case Studies

Expected Outcome

This analysis is expected to reveal that upgrading the solar panels to a hybrid solar panel system will prove cost effective for the owner. Although there may be a more substantial cost upfront the added electrical benefit will make the upgrade feasible. The panel can serve a portion of North Hall's electrical load as well.

Analysis 4: Traditional Reinforced Cast in Place Floor Slabs

Structural Breadth

Problem Identification

All of the floor slabs expect the ground floor and second floor are all post-tensioned. This post-tensioning requires some extra time to tension all the cables, test them, burn off the excess length and then come back and grout the end compared to traditional reinforced concrete. In addition, the tension cables add some additional costs that traditional reinforced concrete does not require.

Research Goal

The goal of this analysis is to determine the structural, cost and scheduling impacts of changing floor slabs 3 to 8 to traditional reinforced concrete from the current design of post-tensioned reinforced concrete.

Methodology

- Determine post tension costs
- Determine post tensioning activity durations
- Determine cost impacts
- Determine schedule impacts
- Determine reinforcing in slabs 3 to 7
- Determine slab thickness for floors 3 to 7
- Analyze cost and schedule impacts of redesign

Resources and Tools

- AE Structural Students
- AE Faculty
- Industry Professionals
- Project Team
- Case Studies

Expected Outcome

It is expected that by changing the slabs on floors 3 to 8 from a reinforced post-tensioned to traditional reinforced concrete will provide a schedule savings as well as potential some cost savings. It is also expected that the slabs will have to be thickened when the post-tensioning is removed as well as columns may need to be added of repositioned.

Analysis Weight Matrix

Description	Research	Value Engineering	Constructability Review	Schedule Reduction/ Acceleration	Total
Analysis 1: Modularization Of Bathrooms	10%	-	10%	10%	30%
Analysis 2: RFID Tracking- Precast Panels	15%	-	-	10%	30%
Analysis 3: Solar Panel Upgrade	5%	10%	5%	-	20%
Analysis 4: Traditional Cast in Place Slabs	-	10%	10%	5%	20%
Total	30%	20	25	25	100%

Spring Semester Schedule

Please see Appendix B for the Spring Semester Schedule.

The spring semester preliminary schedule outlines all-important dates related to AE 482. This schedule will ensure that each analysis will follow a set schedule so that all necessary steps are completed on time.

Appendix A: Breadth Topics

Breadth Topics

The two topics listed below describe more in-depth analyses in the other technical disciplines, mechanical, lighting/electrical, and structural, within Architectural Engineering. These topics each directly tie into a previously described analysis.

Electrical Breadth

Contributes to Technical Analysis #3

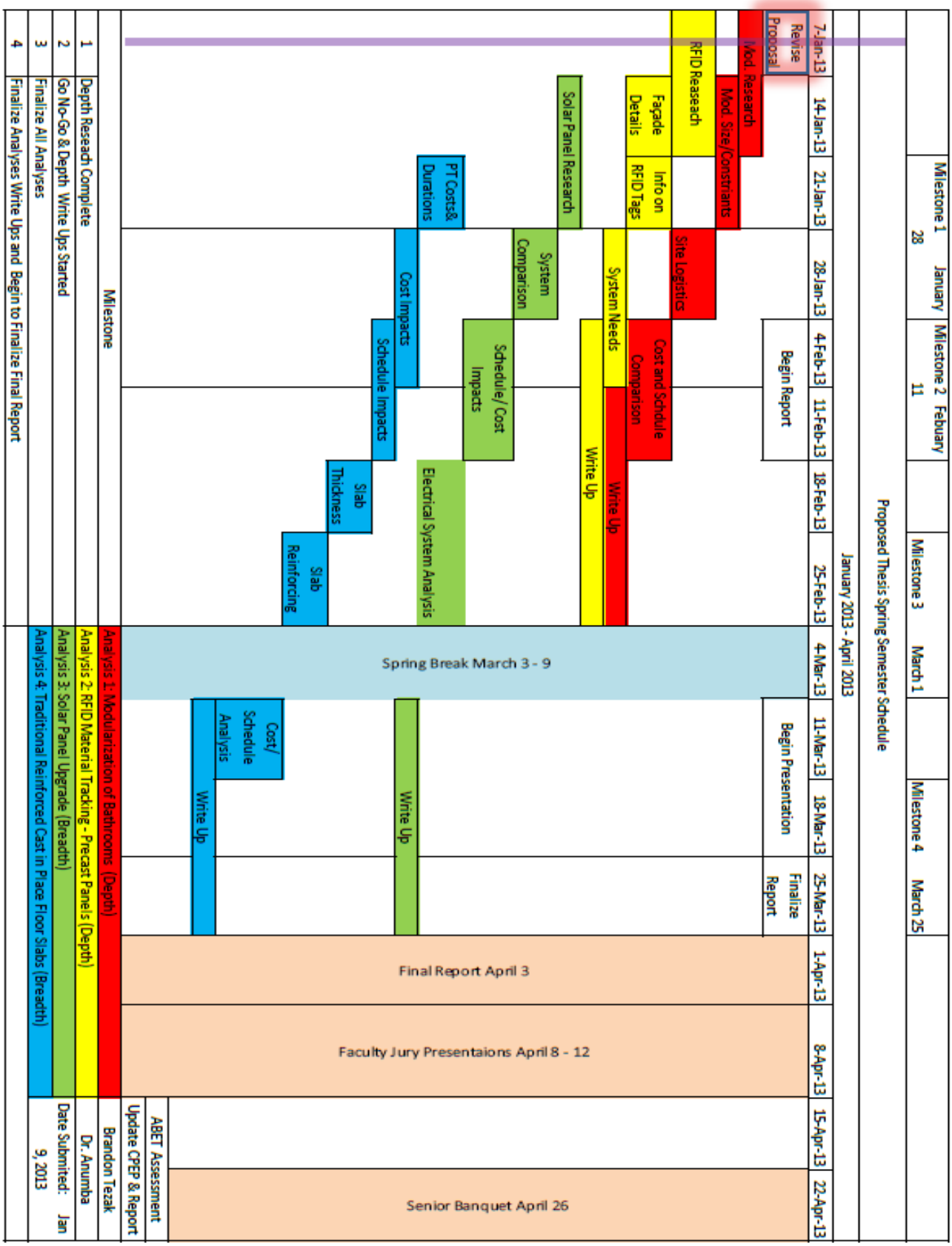
The current design of North Hall has two solar panel arrays located on the roof. Both of the arrays are only designed to heat domestic hot water. This breadth analysis will examine the addition of hybrid solar panel. The hybrid solar panel system will add an ability to generate electricity and for that generated electricity to then be used within North Hall. The electrical system will have to be analyzed to determine where the generated power would be beneficial. With the addition of another form of renewable/green energy to the project will justify the expected increased cost of the hybrid panel.

Structural Breadth

Contributes to Technical Analysis #4

As a way to limit the construction cost of North Hall this breadth will instigate the structural impacts of switching the floor slabs on floors 3 through 8 from the current reinforced post tensioned concrete to a more traditional reinforced concrete floor slab. By removing the post-tensioned tendons the slab thickness and reinforcing as well as the column layout will need to be adjusted for the appropriate loading. Both cost and schedule impact of this change will be investigated.

Appendix B: Spring Semester Preliminary Schedule


Milestone 1 January 28
Milestone 2 Febuary 11
Milestone 3 March 1
Milestone 4 March 25
Proposed Thesis Spring Semester Schedule
January 2013 - April 2013
7-Jan-13
14-Jan-13
21-Jan-13
28-Jan-13
4-Feb-13
11-Feb-13
18-Feb-13
25-Feb-13
4-Mar-13
11-Mar-13
18-Mar-13
25-Mar-13
1-Apr-13
8-Apr-13
15-Apr-13
22-Apr-13
Revise Proposal
Mod. Research
Mod. Size/Constriants
RFID Reaseach
Façade Details
Info on RFID Tags
Site Logistics
Solar Panel Research
System Comparison
System Needs
Cost and Schdule Comparison
PT Costs& Durations
Cost Impacts
Schedule Impacts
Schedule/ Cost Impacts
Write Up
Slab Thickness
Slab Reinforcing
Electrical System Analysis
Begin Report
Spring Break March 3 - 9
Begin Presentation
Finalize Report
Cost/ Schedule Analysis
Write Up
Write Up
Final Report April 3
Faculty Jury Presentaions April 8 - 12
Senior Banquet April 26
Milestone
1 Depth Reseach Complete
2 Go No-Go & Depth Write Ups Started
3 Finalize All Analyses
4 Finalize Analyses Write Ups and Begin to Finalize Final Report
Analysis 1: Modularization of Bathrooms (Depth)
Analysis 2: RFID Material Tracking - Precast Panels (Depth)
Analysis 3: Solar Panel Upgrade (Breadth)
Analysis 4: Traditional Reinforced Cast in Place Floor Slabs (Breadth)
ABET Assessment
Update CPEP & Report
Brandon Tezak
Dr. Anumba
Date Submitted: Jan 9, 2013