STEM Building

Science **T**echnology **E**ngineering **M**athematics

Hagerstown Community College

Hagerstown, MD

Proposal Revised

Craig Owsiany

Construction Management

Adviser: Robert M. Leicht

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Executive Summary

This proposal will outline the analyses that will be performed over the course of the spring semester. These analyses will cover two breadth studies in the structural and mechanical option. They will also investigate areas of critical industry issue research, value engineering analysis, constructability review and schedule acceleration.

These analyses include:

1. Mat Slab Redesign (Lower Mat Slab and Extend Foundation Walls)
2. Green Roof Redesign (Extensive to Intensive)
3. Curtain Wall Redesign (Stick Built to Unitized)

The first analysis will meet the structural breadth and investigate into value engineering and constructability review. This analysis was chosen when it was discovered that competent rock was found at a lower elevation than planned. An alternative method of lowering the footing will be explored in this analysis.

The second analysis will meet the mechanical breadth and research critical industry issues and value engineering. Redesigning the green roof will lead to lower heating and cooling loads which can provide long term saving for the STEM Building. The long term savings and overall load reduction from installing the green roof will be investigated in this analysis. PV panels as en educational tool will also be analyzed, specifically how information will be relayed to student.

The third analysis of converting the stick built curtain wall system to a unitized curtain wall system will help cover the constructability review and schedule acceleration requirements. A unitized curtain wall system offers a quicker on site construction time and higher quality product.

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Analysis I: Mat Slab Redesign

Problem Background

Footings and mat slabs for the STEM Building must be set on competent rock. During the excavation process, competent rock was located at a lower elevation than originally designed. To remedy this problem, lean concrete was formed up to the original footing elevation so construction could continue as planned. This can be seen in Figure 1 below. Although this was a simple solution, it was costly in terms of material.

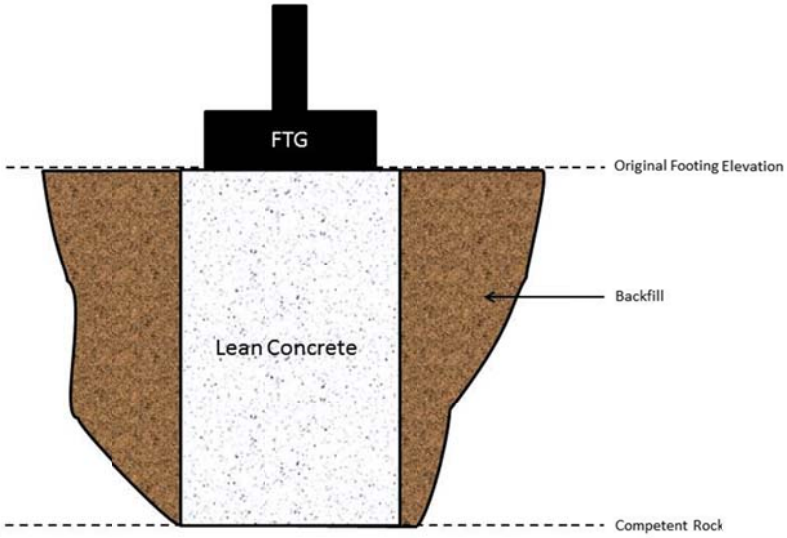

Figure 1

Potential Solution

Analysis one will look into a more cost efficient option, forming minimal lean concrete for leveling purposes and lowering the mat slab and foundation wall to the competent rock elevation. See Figure 2 below.

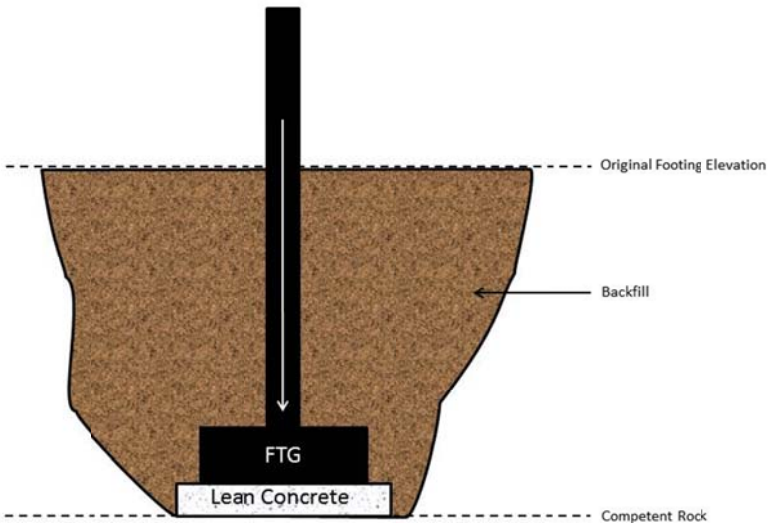

Figure 2

Solution Methodology

1. Calculate actual loads applied to mat slab. Items that need to be taken into account:
    a. Concrete
    b. Rebar
    c. Steel Beams
    d. Doors and Frames
    e. Handrails
    f. Live Loads (determine tributary width)
    g. Waste Factor
    h. Decking
    i. Elevator
2. Determine the added load of extending the foundation wall 5'.
3. Combine actual load and added load. Compare to design load.
4. If actual load plus added load is less than design load, the same reinforcing will suffice. If actual load plus added load is more than design load, the mat slab will need to be resized.
5. Knowledge learned in AE 404: Building Structural Systems in Steel and Concrete will be utilized if resizing the mat slab is warranted.
6. Compare material quantities in regards to estimating.
7. Analyze if changes in the sequencing and coordination are necessary.

Expected Outcome

The expected outcome is for the actual load plus added load to be less than the design load. If the footing can carry the additional load of the extended foundation wall, cost savings will be found through the decreased amount of concrete that will be used. If the footing needs to be redesigned, the amount saved on concrete is assumed to be greater than the cost needed to increase the rebar and concrete.

Analysis II: Green Roof Redesign

Problem Background

The STEM Building utilizes green roof at two levels of the building on the third and fifth floor roofs. The fifth floor green roof also utilizes PV panels as an educational factor. Rain water will be collected from these green roofs and collected in a cistern within the building. While this is a great addition to the building, the green roof design itself does not take advantage of its thermal properties which can help reduce heating and cooling loads.

The architect has designed the fifth floor green roof as an aesthetically pleasing accessible space. The green roof incorporates wood floor paneling and concrete pavers for students to walk on alongside of mixed vegetation. After meeting with the owner, it was determined that the green roof is not meant to be an accessible space and therefore, mitigates the need for wood floor paneling and concrete pavers.

The PV panels are integrated into the building design to act as an educational tool. The issue comes to light as to how the information will be relayed to students and how the energy produced will be utilized.

Potential Solution

Analysis two will propose to eliminate the wood floor paneling and concrete pavers, and convert the extensive green roof to an intensive green roof. Additionally, sensors on the PV panels and green roof will be proposed to help communicate to student how much rainwater is collected and energy produced. These sensors will relay the information to monitors in the third floor lobby to communicate to students the benefits of green building systems.

Solution Methodology

1. Eliminate wood floor paneling and concrete pavers.
2. Determine total square footage of green roof.
3. Meet with structural engineer to determine if current structural system will support the additional load.
4. Determine maximum rain water collection.
5. Meet with MEP engineer to determine how much heating and cooling loads will be reduced.
6. Identify whether or not additional plumbing is needed.
7. Perform estimating analysis of current design verse proposed design.
8. Determine impact on scheduling and sequencing.
9. Speak with Alternate Energy Program instructor at the college.
10. Research sensors, servers, software and monitors that can be implemented to track and relay information as well as costs.
11. Contact the college's IT department to determine feasible of the sensors and monitors.

Expected Outcome

This analysis will determine how much the heating and cooling loads can be reduced. These loads will be reduced because an intensive green roof provides a higher R value, making it a better insulator than the extensive green roof, wood floor paneling and concrete pavers. This will add to savings that will reduce the payback period of the green roof. Savings are also expected to be seen in heating and cooling expenses.

Another aspect of this analysis will delve into the structural integrity of the roofing system which the green roof will rest. The intensive green roof brings additional loads that have to be accounted for to ensure the roofing system is adequate.

Lastly a sensor, software and monitor are expected to be found that can handle such requirements as tracking rainfall and energy product. Where these items will be found is unknown at this point. After meeting with the Alternate Energy Program instructor, better insight will be gained in this area.

Analysis III: Curtain Wall Redesign

Problem Background

The current curtain wall on the STEM Building is a stick built system. This can be a timely process which has potential for schedule acceleration.

Problem Solution

Converting the curtain wall from a stick built system to unitized system provides an area for schedule acceleration

Solution Methodology

1. Perform quantity takeoff to determine total square footage curtain wall.
2. Determine increase of upfront cost and lead time.
3. Determine duration of installing unitized system and compare to stick built system duration in current schedule.
4. Contact the GC scheduling department to identify how the original duration was derived.
5. Contact the GC estimating department to determine what the difference in price would have been for a unitized system verse stick built
6. Relate schedule acceleration of curtain wall system to duration of neighboring metal panels and brick veneer.
7. Perform analyses on how curtain wall, brick veneer and metal panels tie together. Take into different tolerances of different materials.
8. View sequencing plan of enclosure materials in regards to finish dates. Try to sequence trades in a fashion that delivers an earlier water tight date. May also need to look back and adjust steel sequencing plan.
9. Finalize effects on estimating, sequencing and coordination.

Expected Outcome

Lead time and initial cost will increase but a unitized system provides faster construction and less labor hours. In the end, the stick built system and unitized system may similar prices when taking into account decreased labor hours, decreased schedule and increased initial cost. There are also benefits of having fewer laborers on site and less material. This allows for easier sequencing and material staging due to the small site.

Appendix I – Breadth Studies

Structural Breadth

The structural breadth will be met primarily by the first analysis of lowering the footings and foundation walls to the competent rock. A well rounded analysis will be performed to ensure that the footings and foundation walls will have adequate strength to support its additional loads. If the footings and foundation walls are discovered to be inadequate, they will be redesigned through further investigation.

Mechanical Breadth

The second analysis of this proposal, redesigning the green roof, will be the main means of showing mechanical breadth. Total heating and cooling load reduction will be calculated and compared against the designed loads. From here, money savings will be able to be determined.

Weight Matrix

Description	Research	Value Engineering	Constructability Review	Schedule Reduction	Total
Lower Footings and Foundation Walls	0	10	20	0	30
Expand Green Roof	20	20	0	0	40
Convert Stick Built Curtain Wall to Unitized Curtain Wall	0	0	10	20	30
Total	20	30	30	20	100