DORMITORY BUILDINGS C & D

MANSFIELD UNIVERSITY, MANSFIELD PA

THESIS PROPOSAL

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Department of Architectural Engineering
Construction Management Option

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EXECUTIVE SUMMARY

The Senior Thesis Proposal introduces the four areas of analysis which will be covered in the Final Report. Modular construction and prefabrication is the central theme of these analyses. These four topics were picked after talking with the project management team and the AE department construction advisors.

Analysis 1: Flooring System Analysis

The current 2x10 wood joist with plywood sheathing flooring system is unconventional for a structural steel frame. This analysis will compare the current flooring system to a concrete on metal deck flooring system. A structural breadth will be used to design the concrete floor. The flooring systems will be compared on cost, quality, performance, schedule and safety. An acoustical breadth will be used to evaluate the sound isolation performance of each system. The goal is to see if switching to the conventional flooring system would be a better value than the wood joist and sheathing flooring.

Analysis 2: Modularization Preconstruction Planning

This project decided to use modularization to accelerate the schedule. Research on the preconstruction time needed to optimally use modular construction will help to evaluate the value of modularization. BIM will be investigated throughout this analysis to increase preconstruction coordination. The goal is to evaluate the planning time required for modularization, and when is the latest a project could switch to modular construction in the preconstruction or design phase.

Analysis 3: Exterior Façade Redesign

These buildings have a brick and cast stone masonry façade. This masonry work takes a lot of manpower and time to create. A prefabricated façade skin will be examined. A precast concrete panel façade will be designed. The schedule duration and cost of this system will be calculated. The goal is to determine if the precast concrete façade is a better value than the current masonry façade.

Analysis 4: Modular Unit Connection Procedure

Modular units have great quality inside, but the joints between the units can be an issue. If the bottom course of units is set with a small error, the error will increase with additional height. Research will show how other projects guaranteed their connection quality. There needs to be coordination between subcontractors to ensure modular unit setting precision. Planning meetings will help with the coordination. The goal is to create a procedure that ensures connection precision.

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TECHNICAL ANALYSIS DESCRIPTIONS

ANALYSIS 1: CORE FLOORING SYSTEM ANALYSIS

PROBLEM IDENTIFICATION

The current structural design has a 2 x 10 wood joist floor with plywood sheathing flooring in the core area of both buildings. The core also has a structural steel frame to support the flooring system. This type of structure and flooring is an unconventional pairing. This analysis will examine a different flooring system.

BACKGROUND RESEARCH

Technical Report No. 3 consisted of some initial research into different flooring systems. After research and speaking with industry professionals, a concrete on metal deck flooring system was found to be the most conventional flooring system for a structural steel building. Additionally, issues with the current flooring system were discussed with the Project Manager.

POTENTIAL SOLUTIONS

1) Constructability: There are risks of potential schedule delays due to lack of previous wood joist flooring construction experience.
2) Value Engineering: The cost of each flooring system compared with their performance, including strength, durability and sound isolation.
3) Safety: Safety concerns have been identified with multiple trades working in a small space.

METHODOLOGY

1) Discuss the wood flooring system with the project team. Try to gain additional information for the concerns of either system. Schedule durations and cost for the current system will be needed also.
2) Develop a Structural Breadth by creating the concrete and metal deck flooring system.
3) Analyze the concrete flooring system. Talk with industry professionals to fully evaluate the concrete flooring system.
4) Develop an Acoustics Breadth by evaluating the sound isolation of both systems.
5) Compare the cost, quality, performance, schedule and safety both systems.

RESOURCES AND TOOLS

1) Industry Professionals
    a. Structural Engineer
    b. Concrete Subcontractor
2) AE – Faculty

    a. Construction Management
    b. Structural
    c. Acoustics
3) Wohlsen Project Team
4) Applicable Project Documents

EXPECTED OUTCOME

The research into the decision to use the wood flooring system will set the initial points to base the comparison of the systems on. The schedule demands of the current system will need to be met by the new concrete flooring system. In addition to the cost, the value engineering will also show the performance of each system. Safety will be included into the analysis. With the additional exploration through a Structural Breadth, as detailed in Appendix A, this analysis will create the design of the concrete flooring system. An examination into the sound isolation quality through an Acoustical Breadth, as detailed in Appendix A, will provide an added analysis area into the comparison. Both systems are expected to have advantages, but a professional decision will be made upon which is the best system.

ANALYSIS 2: MODULARIZATION PRECONSTRUCTION PLANNING

PROBLEM IDENTIFICATION

Modularization requires additional planning and design in order to full advantage of it. There will be an investigation into the additional time of planning before the project starts compared to the time saved during construction. There is an optimal time frame needed in order to completely plan for modular construction.

BACKGROUND RESEARCH

From Technical Report No. 3, a modularization and prefabrication session was attended during the PACE Roundtable. From the session, preconstruction for modularization directly related to the Mansfield University dormitories. The owner created two similar dormitories a year ago that were stick built. Initial research into the reason the owner wanted to modularize this project was performed by contacting the owner along with the project team. The design and construction time for the modular units was found by contacting the project team. The architect and modular contractor communication line must be examined.

POTENTIAL SOLUTIONS

1. Precision in design coordination. BIM could be used to facilitate coordination.
2. Lead times examined earlier in the construction process.
3. Plenty of storage for materials, decreasing amount of deliveries.

METHODOLOGY

1. Find the current way that the architect and modular subcontractor communicate.
2. Investigate the current schedule, lead times, and modular facility construction.
3. Determine BIM coordination used during preconstruction. Analyze if it could be used in other ways.
4. Compare the modularization planning duration to the time saved during construction.

RESOURCES AND TOOLS

1) Industry Professionals
    a. Modular Subcontractor
    b. Structural Engineer
2) AE – Faculty
    a. Construction Management
3) Wohlsen Project Team
4) Applicable Project Documents
5) Modular Case Studies

EXPECTED OUTCOME

Investigation into the preconstruction phase of modular construction will give insight into planning time required. Coordination techniques, including BIM, will be included into the analysis of the preconstruction duration. A conclusion on the preconstruction time needed to optimally use modularization as a schedule acceleration technique will be made.

ANALYSIS 3: EXTERIOR FAÇADE REDESIGN

PROBLEM IDENTIFICATION

These dormitories have a cast stone and brick façade. The masonry facade requires full four story scaffolding to complete. A different façade may accomplish the same aesthetic look with taking less labor and installation time.

BACKGROUND RESEARCH

In Technical Report No. 2, value engineering techniques were investigated for the façade. EFIS saved the most money, but was rejected by the owner and architect due to the way it looks. The owner wants the façade to have the same look as other buildings on Mansfield University's campus. Discussion with the preconstruction team at Wohlsen provided the exact level of aesthetics that the owner is wants. Research into precast concrete panels, similar to the ones used on the Millemium Science Building at Penn State, will provide the feasibility of using them for these dormitories.

POTENTIAL SOLUTIONS

1. Value Engineering: A cost benefit for precast façade system.
2. Constructability: Prefabricated façade pieces require less labor force on site.
3. Acceleration: A schedule speed increase due to prefabrication.
4. Safety: Jobsite safety is improved because of less site congestion.
5. Quality: A more sustainable façade system.

METHODOLOGY

1. Analyze the current masonry façade. Find the estimated cost and schedule duration associated with the brick and cast stone system.
2. Contact a prefabricated concrete panel manufacturer. Create design for the new façade system.
3. Analyze the new prefabricated façade. Find the estimated cost and schedule duration for this system.
4. Compare the two systems to find the best value.

RESOURCES AND TOOLS

1) Industry Professionals
    a. Masonry Subcontractor
    b. Architect
    c. Precast Concrete Supplier
2) AE – Faculty
    a. Construction Management
    b. Structural

    c. Mechanical
    d. Architectural Design
3) Wohlsen Project Team
4) Applicable Project Documents
5) Prefabricated Façade System Case Studies

EXPECTED OUTCOME

The research will show the owner's aesthetic expectations. The design of the prefabricated façade will have to meet those expectations. The cost and schedule for the current system and the precast façade will be calculated. Analysis of both systems will be compared to evaluate the best value. The comparison will incorporate the cost, schedule, quality, and safety aspects. After the best value is found, a professional conclusion can be deducted.

ANALYSIS 4: MODULAR UNIT CONNECTION

PROBLEM IDENTIFICATION

The quality inside the modular units should be better than any stick built building. The only place where the quality could be worse is at the joints between the units. These joints can be very hard to perfectly match up. There is a constructability challenge with setting modular units to avoid uneven joints.

BACKGROUND RESEARCH

Technical Report No. 2 initially looked into the constructability challenges with modular construction. The most important issue was to get the first level of units set with extreme precision. The project management team provided additional information on the level of detail that the units needed to be set. The modular subcontractor is completing the setting of the units, but other trades, such as the masonry and concrete foundation subcontractors must be involved in this process.

POTENTIAL SOLUTIONS

1. Constructability: Precise setting technique which requires fewer adjustments after placement.
2. Acceleration: Fewer adjustments will require shorter setting duration.
3. Quality: The precise unit placement creates higher quality modular unit joints.

METHODOLOGY

1. Review case studies to see how other projects achieved accurate unit setting.
2. Contact modular subcontractor to learn the needed accuracy of the foundation.
3. Create a procedure to achieve precise modular setting.
4. Calculate the time saved on the project from new procedure.

RESOURCES AND TOOLS

1) Industry Professionals
    a. Modular Subcontractor
    b. Masonry Subcontractor
    c. Foundations Subcontractor
2) AE – Faculty
    a. Construction Management
3) Wohlsen Project Team
4) Applicable Project Documents
5) Modular Case Studies

EXPECTED OUTCOME

The main objective is to create a procedure that will provide the necessary accuracy to create high quality joints between the modular units. This procedure will involve the foundation, masonry and modular subcontractors. The coordination before the units are ready to set will avoid any unnecessary delays in the schedule. A new modular unit setting schedule will be compared to the actual schedule. This comparison will show the value of the added coordination of modular procedure.

SPRING THESIS OBJECTIVES

MATRIX

Description	Research	Value Engineering	Constructability Review	Schedule Reduction	Total
Flooring System Analysis	0	20	20	0	40
Modularization Preconstruction	10	0	0	5	15
Exterior Façade Redesign	0	10	10	5	25
Modular Unit Connection Procedure	5	0	5	10	20
Total	15	30	35	20	100

SCHEDULE

**See Appendix B for Spring Semester Schedule*

CONCLUSION

The four analyses and two breathes will provide the construction efficiency of the modularization used during the Mansfield University Dormitories Project. Research and schedule acceleration will be used in the modularization preconstruction planning and modular unit connection procedure depths. Value engineering and constructability review will be used in the flooring system analysis and exterior façade redesign depths. The Final Report should show the level of quality that the Mansfield University Dormitories project team executed modularization.

APPENDIX A

BREADTH TOPIC ANALYSIS

BREADTH TOPICS

The following is a description of the two breadth topics used during the flooring system analysis depth. These breadth topics are additional analysis into topics covered in different technical options, other than construction management, in the Architectural Engineering Program at Penn State.

STRUCTURAL BREADTH

The structural breadth will be used in designing the concrete on metal deck flooring system that will be compared to the current flooring system. This breadth will require the information taught during the AE 404 course at Penn State. The design of the concrete floor will require finding the design loads from the *IBC Code Book 2009*. Once the design loads are found, the type of metal deck and thickness of concrete topping must be chosen. Finally, structural load calculations will tell if the flooring system meets the code. Once the flooring design is complete, the value engineering can be performed for the concrete floor.

ACOUSTIC BREADTH

The acoustic breadth will be used in determining the sound isolation of the wood joist and plywood sheathing flooring and concrete on metal deck flooring. This breadth will require the information taught during the AE 309 course at Penn State. This analysis requires finding the sound transmission class (STC) of each of the components of the flooring systems. The STC is created by finding the transmission loss at different frequencies. Impact noise will then be calculated for both systems. Once these two acoustical ratings are found, a full acoustical evaluation can be found and added into the value engineering analysis for the two flooring systems.

APPENDIX B

SPRING SEMESTER PRELIMINARY SCHEDULE

Mansfield University Dormitories
Mike Mahoney

Proposed Thesis Semester Schedule
January 2013 - April 2013

Senior Thesis Proposal
Ray Sowers