Thesis Proposal
Alternative Methods

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A. Executive Summary

The following proposal contains three topics that will be examined and researched to provide alternative methods in order to adjust the cost, schedule, constructability, and offer any value engineering that may be discovered during the research. These areas are meant to be similar and illustrate an overall theme to the second semester coursework for this particular thesis project.

The first breadth analysis will review the foundations of the structure and the soil bearing capacity. This analysis will provide information regarding the cost and constructability of three different options, deep dynamic compaction, a complete soil exchange, and drilling steel mini-piles. After completion of the analysis I hope to provide a less expensive and viable alternative to achieve proper soil bearing.

The second breadth topic will review the structural system of Residence Hall 2. A complete precast system will be researched and compared to the existing system of CMU load bearing walls and precast plank. As part of this analysis there will also be a design of a temporary heating system that will be necessary for the existing conditions as the exterior masonry will be erected during the winter months.

The final research topic will be precast concrete safety in the construction industry today. An analysis of previous projects that required more stringent safety requirements than those required by OSHA will be used to develop a site specific safety plan for Residence Hall 2 and information about the need for more stringent safety guidelines to be followed by the construction industry.

B. Technical Analysis 1

Residence Hall 2 is located on the north campus of Ursinus College. The site for the building was found to have unsuitable soils. The soil currently on the site is soil that has been placed there over the past several years from other construction projects that were built. This soil was not compacted properly when it was placed on the site and therefore did not meet the soil bearing capacity required. David Blackmore and Associates (DBA) performed the geotechnical analysis on the site and proposed several alternatives to remediate the soil bearing capacity issue. This problem was an added cost for the college. It was not budgeted for because the bearing capacity was unknown when Warfel Construction Company (WCC) estimated the project and the college approved the budget for this project. Therefore this soil remediation was an unexpected cost and as well as a schedule set back.

The goal of this analysis is to compare three different soil remediation techniques proposed by DBA on the basis of cost, schedule impact, and any value engineering analysis that may be uncovered through the analysis of the foundations. The following list outlines the proposed solutions and what procedures will be used to analyze each solution.

Deep Dynamic Compaction

Warfel Construction Company reviewed Geo-Piers and Deep Dynamic Compaction as alternatives for the soil bearing capacity issue on site. They chose to move forward with deep dynamic compaction.

1. Review technical requirements for compaction
    a. How compaction is obtained
    b. What depth is required to pass bearing specifications
2. Cost and schedule analysis
    a. Duration required for compaction
    b. Overall cost of compaction
    c. Crane cost for duration

Soil Exchange

The second alternative that will be analyzed is a complete soil exchange of the material on site. This was another solution proposed by DBA and the following will be considered.

1. Requirements for new soil
    a. Complete site soil exchange/building footprint soil exchange
    b. Bearing capacity of new fill
    c. Compaction of fill as it is placed on site
2. Cost and Schedule Analysis
    a. Cost of equipment and soil for soil exchange
    b. Cost per cubic yard of soil required for exchange
    c. Duration of soil removal
    d. Duration of new fill and compaction

Steel Mini Piles

The third and likely most expensive option is to drive mini piles in key locations of the foundation to stabilize the building. This alternative method will have the least threat of settlement over the life cycle of the building due to the depth of which the piles will be driven. During the construction noise will have to be considered due to an existing residence hall directly to the south of the site.

1. Design of Mini Piles
    a. Calculate typical load requirement for building
    b. Size piles and quantity of piles
    c. Determine location of piles on building footprint
2. Cost and Schedule Analysis
    a. Cost of a typical steel pile
    b. Total cost of driving piles
    c. Duration required to complete piles

After these three analyses are performed I will compare and contrast each on the basis of duration, total cost, cost per square foot (using the building footprint as the sf total), and any value engineering that may be presented. This analysis topic will cover structural breadth. I hope to find a reasonable alternative to the deep dynamic compaction; however I feel now that the deep dynamic compaction is the best solution to the soil bearing capacity problem on this site.

Resources to complete these analyses:

- AE Structural Staff
- Warfel Construction Company
- RS Means Cost Estimation Guide
- Structural Team on Project

C. Technical Analysis 2

The second technical analysis will focus on the structural system of the building. I will change the system to a complete precast system. The current system consists of precast hollow core plank sitting on load bearing CMU walls with cast in place concrete footings. The roof structural system will remain the same for this analysis area. The primary roof structure is a wood roof truss system with asphalt shingles. The problem that this structural system is creating on the project is that masonry work will need to be occurring over the winter months. The building is scheduled to be enclosed by February 19, 2007. There is a push to get this project dried in and interior work beginning. By applying a complete precast this eliminates masonry work over the winter months and accelerates the schedule. Cost will be an issue however and a comparison of the two systems will be completed. The following outlines the work to be completed for this analysis.

1. Design Precast Structural System
    a. Design enough typical precast members to allow for accurate cost and schedule analysis
    b. Design temporary heating system for existing structural system
    c. Layout of members for new system
    d. Exterior Precast Panels to include brick and window mullions
    e. Allow for glazing to be only piece of exterior panels to be installed after panel is in place
2. Cost Analysis
    a. Determine cost of precast panels
    b. Determine erection costs (Crane/hoist)
    c. General conditions savings on items necessary for masonry work
    d. Determine cost of temporary heating system
    e. Identify all areas of cost savings for structural and temporary heating systems
3. Schedule Analysis
    a. Calculate duration of erection and enclosure
    b. Review sequence of erection
    c. Calculate total schedule saving achieved

This new structural system will push the schedule of this project. Included in this analysis is the design of a temporary heating system to be used for the current project. This will include the analysis of keeping the interior of the building at a temperature of

50 degrees. As masonry work will be completed during the three coldest months of the year it will be important to keep this project heated so not only quality is controlled but as well as the masonry worker's on the job will keep productivity at a constant rate. Brief research will be completed to determine what the current mason's plan for heating is as well as the costs associated with that plan. Certain intangibles will be questioned as well, such as the productivity of crews and how this is directly related to the weather. There may be no cost savings with using a temporary heating system but the construction manager may see a positive influence on the productivity of the project.

The goal of this analysis is to accelerate the schedule and have the building enclosed before the winter months arrive. The goal of the temporary heating system is to keep productivity rates constant and quality of the masonry to meet contract requirements. These two analysis areas will provide structural and mechanical breadth. After completing this analysis I believe the schedule will be significantly accelerated but there will be a negative impact on the cost of the system. Both systems will be compared to make a final decision.

Resources used to complete these analyses:

- AE Mechanical/Structural Staff
- Masonry Subcontractor
- Precast Concrete Fabricator/Erector
- Warfel Construction Company
- RS Means Cost Estimating Guide

D. Research Analysis

A guest lecture was presented on a precast concrete parking garage that collapsed while work was taking place. Bill Moyer, Senior Vice President of Davis Construction, gave the presentation and did a very good job presenting a catastrophe that happened to his own company. This collapse had a fatal impact on members of the construction team and critically injured others. This accident brought to the surface the issue of safety during the erection of a precast concrete structure. After the analysis completed of making Residence Hall 2 a complete precast system, this research will be conducted on how safe precast erection actually is. The main focus of this research will be directed on how contractors and subcontractors feel about the current OSHA codes on precast concrete erection and if they adjust bids and schedules on projects where added safety measures are required.

Davis Construction is a company that has established a more stringent set of rules for all precast projects. They require that subcontractors agree to follow those rules prior to any construction taking place. These subcontractors will be surveyed to determine if they escalate bids or add float to their schedules to compensate for added safety measures. They will also be surveyed to determine if they made the same changes to the schedule and budget after completing one precast project and being asked to bid for another with the same company. Subcontractors included in this survey will be fabricators, erectors and the construction manager on the project as well.

The research conducted will be through surveys and interviews that will be set up either over Christmas break or early next semester to ensure the results will be received in enough time to compile results. The plan for research is as follows.

1. Contact Davis Construction
    a. Obtain precast safety policy
    b. Obtain list of contractors who have completed precast work for Davis
    c. Any issues Davis would be interested in researching
    d. Possible questions for a survey they would have
2. Warfel Construction Company (WCC)
    a. Set up meeting over winter break with Ashley Steffy (Safety Director WCC)
    b. Develop safety survey with Mr. Steffy
    c. WCC Job-site Safety Plan Review
3. OSHA Feedback
    a. Contact OSHA to receive information on precast Safety
    b. What changes do they feel are necessary

After this research is complete I would like to establish a more strict guideline for precast concrete safety and apply this to my thesis project. I will apply my research by developing a job specific safety plan during the phase of precast concrete erection. This will be a very interesting topic to research and I look forward to what results may come back.

Resources used to complete this research:

- Davis Construction Company
- Warfel Construction Company (Mr. Ashley Steffy)
- OSHA Handbook
- Surveys

E. Weight Matrix

The following table is a weight matrix that illustrates how I plan on distributing my research analysis throughout the spring semester. The areas that the analysis will be weighted on include the four categories for core thesis investigation areas. In this case more time will be place on technical analysis two and critical issue research as they are the most important. Less time will be spent on the alternatives to soil bearing capacity

Description	Research	VE	Const. Rev.	Schedule Rev.	Total
Analysis 1		2.5%	7.5%	5.0%	15%
Analysis 2	5%	5%	10%	10%	30%
Temp. Heat Analysis	5%	5%	10%	5%	25%
Research Analysis	20%		10%		30%
Total	30%	12.5%	37.5%	20%	100%