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THESIS PROPOSAL DRAFT
DECEMBER 8, 2006

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EXECUTIVE SUMMARY

This proposal includes four analyses conducted on the Ambridge Area High School (AAHS). Included is a detailed description of the problem, the goal of the research, the methods and tools to be used to attain the research goal, and the expected outcome. Since the AAHS did not seek a LEED rating, the overall theme for the analyses is providing a green design to public school projects, to help lower the operation and maintenance costs at minimal or no added first cost. Below is a preview of each analysis.

Analysis 1 – Green Design in Public Schools

This analysis will attempt to identify the desires of public school districts along green design principles to reduce operation and maintenance costs of school buildings. Design professionals suggestions of green design principles will be compared to the requests of owners to develop a list of techniques to achieve green design at the lowest first cost.

Analysis 2 – Precast Brick Façade

Will focus on an alternative exterior wall system, replacing unit masonry construction with precast architectural panels to achieve the same aesthetics. Areas of interest are reduction in the construction schedule, reduction in trade coordination, and an increased thermal value of the wall unit.

Analysis 3 – Structural Steel Erection Sequencing

It will analyze the steel erection sequence used in construction against a proposed sequence to drastically reduce the construction schedule to provide earlier owner occupancy. A proposed reduction in general conditions costs will offset the potential increase in the steel contract.

Analysis 4 – Green Roof System

Finally the addition of a green roof system will be compared to the existing EPDM membrane system in terms of energy efficiency, primarily the affect on the mechanical system. The structural system will be analyzed to ensure sufficient support for the added dead load.

ANALYSIS 1

Green Design in Public Schools

Problem

The new Ambridge Area High School will replace a building over 80 years old and will certainly provide the school district with lower operating costs. LEED® accreditation and design principles were not utilized in their entirety on this and many other public school projects because of the desire to provide low first costs to satisfy tax-paying citizens. Aiming at providing a public school district with a green and efficient building at a minimal additional cost is of major concern, as these buildings tend to have extensive operation and maintenance costs over time.

Goal

The goal of the proposed research would be to identify the barriers public school districts have to designing LEED® rated buildings and discover items, which are aligned with the green building ideals and help to lower the life-cycle costs of the building. Items such as green roofs aim to lower cooling loads in a building as well as serving as an educational feature to the educational center it tops. I aim to identify the LEED points available to the project with the current design and suggest additional points and contrast the additional costs versus the savings in operating costs. I will identify the barriers from both sides of the school design table, collecting information from public school districts on the LEED® design principles which aim to lower the operation and maintenance costs of the building, and the green design suggestions of architects involved in the design of new school buildings.

Methodology

1. Develop a list of interview questions to be asked to public school owners with recent or ongoing school construction projects.
2. Develop a list of interview questions to be asked to design professionals involved in new school design.
3. Identify and interview 10 different owners and architects of school construction projects both determining the owners desires and whether the design professionals incorporated green ideals in the design.

4. Compare the expectations of the school district versus the suggestions and design intent of the architect to use LEED® principles.
5. Construct a list of LEED points desired to owners and suggested by designers, generating a list of combined points desired.
6. Calculate LEED rating from supplied points and comparing additional cost to savings in operation cost.

Tools

The following are tables of questions to be asked to public school owners (Table 1) and designers of public school projects (Table 2) during an interview. The list will be revised and expanded if necessary before conducting research.

1. U.S. Green Building Council Website (www.usgbc.org)
2. LEED Green Building Rating System for New Construction & Major Renovations (LEED-NC Version 2.1)
3. Penn State Architectural Engineering Faculty
4. Questionnaires to public school districts and design professionals

Expected Outcome

The expected results of this analysis should help to educate public school districts as well as the tax paying public about the importance of green design principles in school design. It will aim to aid public school districts in suggesting design methods and technologies be incorporated into their projects to lower operation and maintenance costs, as well as identify the green desires of the districts to the design professionals.

ANALYSIS 2 - BREATH

Precast Brick Façade

Problem

The current façade design of the Ambridge Area High School uses the traditional construction of concrete masonry unit (CMU) backup with insulation and Norman face brick as the finish façade layer. Masonry work on the project took months to complete, and with masonry scaffolding surrounding the entire footprint of the building during that time, slows other enclosure trades who must wait for masonry work to finish. Also finish trades inside the building may begin earlier if enclosure comes earlier.

Goal

The goal of this analysis is to examine whether replacing the current composite wall system with an architectural precast panelized system will help to reduce the construction schedule and allow building enclosure at an earlier date, as well as increase the thermal resistance of the wall system, aiming to lower heating and cooling costs. Since the panels are built in a controlled environment, less material will be wasted and the quality of the finished product will hopefully be higher.

Figure 1 - Mason scaffolding around building footprint.

Methodology

1. Determine quantity of brick to be replaced
2. Select a panelized system to replace the brick
3. Contact the manufacturer to determine potential cost and erection time savings
4. Examine R values of both systems and estimate savings in mechanical loads (heating and cooling costs)
5. Compare the results of these findings

Tools

1. Energy-10 Software Version 1-8 (To estimate mechanical load savings)
2. R.S. Means 2005 Edition
3. Panelized system manufacturers
4. Penn State Architectural Engineering Faculty

Expected Outcome

The expected results of this analysis could prove precast wall systems more efficient than conventional methods at reducing mechanical loads as well as a reduction in erection time and multiple trade coordination as is the case with masonry construction. With a reduction in the construction schedule may come reductions in general conditions and labor costs.

ANALYSIS 3 - BREATH

Structural Steel Erection Sequencing

Problem

The construction schedule of the AAHS was 24 months when the project was bid. Delays in funding delayed the project start date. Since the new school is being built adjacent to the existing school, no temporary classrooms were necessary, but the old school is slated for demolition following occupancy of the new school. Substantial completion is scheduled for August 23, 2007, with classes starting after the holiday break on January 8, 2008 in the new building.

Goal

The goal of this technical analysis is to examine the possibility of reducing or accelerating the schedule by several months focusing primarily on the steel erection sequence and crane positioning. This will allow turnover to occur in May 2007 so occupancy occurs Sept 2007, at the start of the school year to reduce impact on students. The schedule reduction should decrease general conditions costs but may force increased costs in structural steel work.

Methodology

1. Examine steel erection sequencing used on project
2. Determine alternative sequence to reduce schedule
3. Model alternative sequence using 4-D modeling
4. Compute any additional costs attributed to accelerating steel erection
5. Compute reduced general conditions costs after reduction in overall schedule

Figure 2 - Steel erection underway

Tools

1. Penn State Architectural Engineering Faculty
2. AISC Steel Manual
3. Navisworks (4 Dimensional Model Capability)

Expected Outcome

The expected outcome of this analysis is to derive a steel erection sequence which will aid to reduce the overall schedule duration and general conditions costs. Delivering the AAHS earlier will reduce the transitional effects on students of the building from building to building during the school year.

ANALYSIS 4

Green Roof System

Problem

The current design of the roof utilizes an EPDM membrane over tapered insulation. As is the case with all roofs, they can be a place for solar heat gains from the sun radiating on them all day long. With the EPDM membrane being black, this heat gain increases as dark colors absorb the sun's energy.

Figure 3 - EPDM Roof System on AAHS

Goal

The goal of this analysis is to examine the use a green roof in place of the designed EPDM membrane and study the effects this has on reducing the HVAC loads and operating costs. This addition may also force additional structural sizes as it places an increased load on the roof. Utilizing a green roof will allow for a higher LEED® level of accreditation as well. I will study the increase in structural sizes and the effect on the HVAC equipment, pertaining to operation cost benefits versus costs. A green roof system may also serve as a unique educational tool to demonstrate the benefits of green building techniques to countless students every year.

Methodology

1. Examine current roof construction
2. Analyze thermal properties of existing roof
3. Analyze thermal properties of green roof
4. Analyze additional structural loads attributed to green roof
5. Determine additional cost of adding green roof
6. Determine operation cost savings with green roof
7. Compare additional cost to cost savings

Tools

1. Penn State Architectural Engineering Faculty
2. AISC Steel Manual
3. Energy-10 Software Version 1-8 (To estimate mechanical load savings)

Expected Outcome

The expected outcome of this analysis may prove the addition of a green roof system over the EPDM roof has a benefit to reducing the mechanical loads of the building. Also expected is the addition of this system to work with the existing structural system and allow for possible reduction in size of mechanical equipment.

WEIGHT MATRIX

Table 1 below illustrates how I plan to distribute my effort among the different analyses proposed.

Analysis	Description	Research	Value Engineering	Constructability Review	Schedule Reduction	Total
1	**Green School Delivery**	25%	----	----	----	25%
2	**Precast Brick Façade**	----	10%	10%	10%	30%
3	**Steel Erection Sequencing**	----	----	15%	15%	30%
4	**Green Roof System**	----	10%	5%	----	15%
	Total	25%	20%	30%	25%	100%

Table13 - Weight Matrix