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A. Executive Summary

The proposed senior thesis study of the Harrisburg University of Science and Technology's Academic Center will focus on the structural floor system, curtain wall, and building design and construction. There will be three different analyses performed. The issues will consider value engineering analysis, constructability review, schedule reduction and acceleration, along with issues research.

- **Analysis 1: Building Owner/Developer and LEED™ Awareness Study**

A study will be conducted to analysis why current owners and developers are not considering going “green” and having their buildings rated by the U.S. Green Building Council's rating system. The study will take into consideration those that have used this building design and construction philosophy to better understand the party who chose not to design/construct in this manner, and why.

- **Analysis 2: Curtain Wall Thermal Gradient Detail**

The curtain wall system was chosen so that the structure could use expansive floor plans, use a smaller foot print for a larger amount of square footage (high-rise construction), and have the possibility to change the specific floor arrangements as the University felt necessary. The analysis will see if the current glazing system is the best for efficiency, and see if a more-efficient one can be put in its place. Life cycle analysis calculations will also be completed.

- **Analysis 3: Pre-cast Concrete vs. Structural Steel**

The existing structural system consists of steel girders, beams, and columns; precast concrete wall panels; and composite slab on metal deck. The analysis will be done on the advantages, costs and schedule, of an alternate structural system of pre-cast concrete. A constructability review will done seeing if the alternate system allows for required plenum space and spanning distances.

B. Building Owner/Developer and LEED™ Awareness Study

Problem

There is a growing need and understanding to consider ways of saving energy and non-renewable resources. Owners and developers have limited knowledge of design and construction principles relating to green design and the U.S. Green Building Council's rating system of LEED™. With the number of LEED™ Accredited Professionals on the rise, there still is a need for awareness with owners and developers to implement the U. S. Green Building Council's rating system for green building design. The importance of green building projects needs to be displayed in a different light so that those interested in constructing projects can see the immediate and long term benefits of such building designs, etc. It will show environmental effects and life cycle cost analysis.

Goal

The goal for the research will be to understand why more projects are not becoming LEED™ Certified through the USGBC's rating system or even referred to as "green buildings". Architectural and engineering magazines and other publications have produced various articles for either displaying green projects, advertising for products currently and potentially on the market to save energy, and works by professionals showing work with research relating to findings of environmentally-friendly solutions to solve a particular building projects needs. However, many of these articles are for an educated audience and do not explain on a general level the benefits of such design ideas and methodologies. The study will conclude with a suggestion or way of educating those who make the final decision whether to consider green design and construction.

Research Technique

1. I will continue to educate myself of the U. S. Green Building Council's rating system for green building design, LEED™ and green building in general. Throughout the summer during my internship with Reynolds Construction Management, I had the opportunity to attend study sessions for those interested in becoming LEED™ Accredited. Through this experience, I obtained study materials that break down the ideas and methodologies of the rating system and go about describing in detail what LEED™ is.
2. Interview successful owners and developers to find out what their interests, concerns, and ideas about using LEED™ for their projects are/were. I will also interview potential owners and developers to see why or why not the rating system was implemented. From this, I will conduct further research by asking other questions relating to their knowledge of green buildings. See sample survey.
3. I will gather the results from the earlier mentioned discussions and compile this as the basis for my specific research. Two examples are (if they are aware of green buildings) if they knew green building concepts prior to their construction project or if the owner's representative directed them into considering an environmentally-friendly approach.
4. I will speak with individuals who have developed similar projects to those that have been questioned about LEED™ and green building and ask why the system was not

implemented. Potential reasons could be finances or benefits to the environment seemed to small or insignificant to them.

5. Assemble the information from the surveys and develop a goals sheet for what I plan to research further.

6. Develop from the data taken a way to show owners and developers the benefits from using the LEED™ rating system and what green building design can do for the environment. I will also keep in mind initial and life-cycle costs and break down what benefits their building specifically will do for the environment or the area in which it is located. (The benefits of the environment, etc. will be from results gathered in the owners and developers who are not using the rating system. I will tailor it to suit the questions they might still have and show them potential changes and solutions.)

7. I will return to my chosen thesis building project, the Harrisburg University of Science and Technology, and show them future potential changes they can consider when expanding the university's campus.

Sample Survey

*Given to owner, developer, owner's representative to survey particular project about knowledge of green building design, awareness of LEED™ system

*Building statistics for each project referenced will be considered for use, size, cost, location, and year design and constructed

For contacts with LEED™ certified or green building project

- How was the idea of green building design for the project first introduced?
- Were you aware of it prior to the idea of this building project?
- Can you tell me when you were first introduced to the idea and concept of green building and a rating system for it from the USGBC? How long have you been aware of this?
- Can you rate or describe your knowledge of green building design?
- In order to construct more green and LEED™ certified buildings, do you think it is necessary to teach owners and developers of the idea prior to the design or during this phase of the construction of a project?

For contacts without LEED™ certified or green building project

- Are aware of green building design?
- Are you aware of LEED™?

If so,

For how long and where did you first hear of it?

Were you aware of it prior to the idea of this building project?

Can you tell me when you were first introduced to the idea and concept of green building and a rating system for it from the USGBC? How long have you been aware of this?

Can you rate or describe your knowledge of green building design?

In order to construct more green and LEED™ certified buildings, do you think it is necessary to teach owners and developers of the idea prior to the design or during this phase of the construction of a project?

If not,

Would you be interested in learning more about green building design and the USGBC's LEED™ rating system?

Would it be beneficial to see the breakdown of costs saved and added to specific areas of the project?

Out of the following, can you tell me the most influential factor in the decision to not go green with [specific project]?

*Not in budget

*Not aware of LEED™ /green building design

*Could not see benefits clearly in green design

*Design professionals were not educated/not a choice in design

Expected Results

The expected results for the research study of LEED™ awareness among building owners and developers will be to have a focus on educating those that ultimately make the decision for design and construction philosophy, specifically green design. Results will be analyzed and displayed in clear format to explain what the most influential factor in the decision to not go green with a specific project.

C. Curtain Wall Thermal Gradient Detail

Problem

The curtain wall system was chosen so that the structure could use expansive floor plans, use a smaller foot print for a larger amount of square footage (high-rise construction), and have the possibility to change the specific floor arrangements as the University felt necessary. With the growing popularity of the concept of green design, considerations for thermal efficiency should be taken into consideration with buildings using extensive amounts of glazing on their facades. Was the glazing system chosen the best for efficiency? See detail of Enlarged Plan @ University Floor Exterior Wall on next page.

Goal

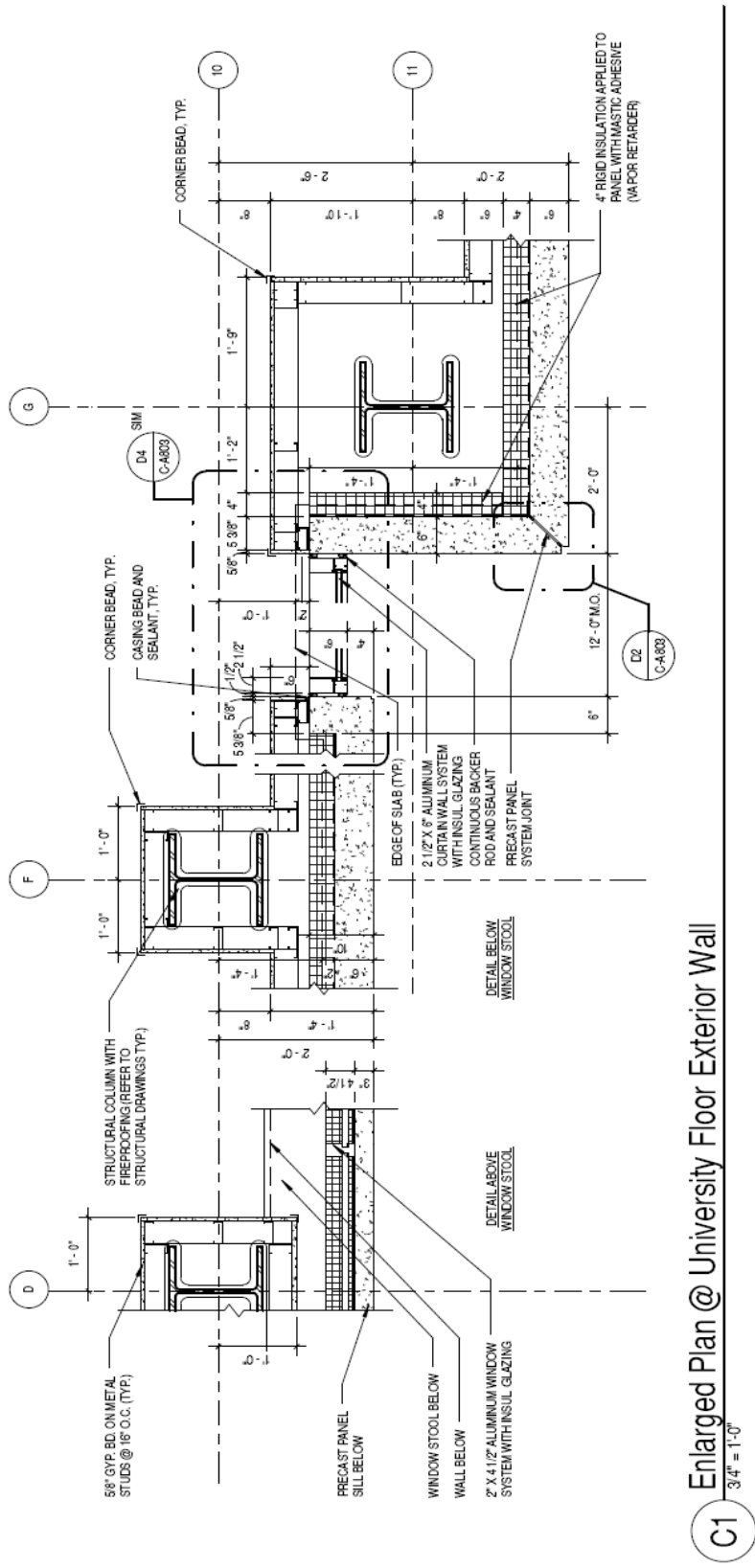
The goal for the analysis will be to determine if the glazing system in place is the best for efficiency. An alternative type of glazing will be chosen and compared to the current system. Value engineering analysis, especially life cycle analysis will be studied. Lead time for both the current and alternate glazing systems of the curtain wall will be taken into consideration with a study of schedule reduction time and possible schedule acceleration. This analysis will be the mechanical breadth study of the thesis.

Analysis Techniques

1. Architectural drawings will be studied and analyzed relating to curtain wall of building project, specifically glazing system.
2. An alternative glazing system will be chosen.
3. Calculations of thermal gradients and R-values will be performed.
4. If necessary, a second alternative glazing system will be chosen and analyzed again for thermal gradients and R-values.
5. Life cycle cost analysis will be performed to see if the current or alternative glazing system is the better one for thermal efficiency.

Expected Results

The expected results for the analysis study of the glazing system will be to see if thermal efficiency and life cycle analysis was taken into consideration when choosing the specific glazing material on the Harrisburg University Academic Center. The alternative system is anticipated to be the better one for thermal efficiency.



D. Pre-cast Concrete vs. Structural Steel

Problem

The Harrisburg University Academic Center is a high-rise building in the city of Harrisburg. The current structural system consists of steel girders, beams, and columns; precast concrete wall panels; and composite slab on metal deck. During the beginning of the erection of the steel structure for the Academic Center, there were a number of schedule delays including the need to reposition the tower crane on site. As discussed above, the structural system currently in place has a long lead time for the fabrication of the steel members. To relieve site congestion because of the project's location, pre-fabrication would be an alternative to casting of concrete on site. With the use of pre-cast interior wall panels and curtain wall system, the use of a precast concrete structure seems as though it would have been a better choice for the Academic Center.

Below is the steel staging located on Market Street. Part of the street is blocked off for pedestrian and vehicular safety, as well as for more space on site. Would the use of a pre-cast concrete structural system affect traffic on one of the main roads through the city as the use and staging of steel?



Steel Staging on Market Street

Goal

The goal for the analysis will be to determine if the structural system in use currently is the best choice for the area, site, project, and budget. The steel framing will be analyzed with the current pre-cast interior partition walls and curtain wall panels. It will be compared to a pre-cast concrete structure since most of the structural elements are pre-cast currently. Considerations of a pre-cast concrete structure would include staging for the pre-cast concrete, lead time for the pre-cast concrete, integration with mechanical, electrical, and plumbing systems. Continuing, studying the costs of each system, plenum heights allowed, spanning distances, and green building design will be analyzed. With the integration of the existing pre-cast concrete wall panels, there could be a reduction or acceleration of the schedule if a structural pre-cast system was in place. However, in order to implement such a change in design, considerations for this modification to the structure would have to have occurred during the design phase of the project. The conclusions of this research will be to allow for similar projects to see the advantages of this system as well as the Harrisburg University of Science and Technology to have a better understanding of the current and alternative structural systems in place for further development of future buildings. This analysis will act as the structural breadth for the proposed thesis.

Analysis Techniques

1. Structural drawings will be studied and analyzed relating to current structural system, specifically typical bay system of floors 5-15.
2. A typical bay redesign will be done using pre-cast concrete.
3. Calculations tributary areas and loads for both current and alternative structural system will be performed.
4. Plenum heights will be calculated for the alternative system to see if there is proper space for MEP systems.
5. A schedule analysis will be conducted to see if the structural system erection can be accelerated or erection time reduced.

Expected Results

The expected results for the analysis study of the structural system will be to see if the use of a pre-cast concrete structure has schedule reduction time benefits. In addition, the feasibility of the alternative system relating to plenum space, site coordination, and cost will be taken into consideration when analyzing the structural system of the Harrisburg University Academic Center. The alternative system is anticipated to be a better choice for the particular project analyzed.

Weight Matrix

The following is the weight matrix associated with the evaluation of my thesis research for the spring 2008 semester. At least 15% of every core thesis investigation will go toward my final grade. The descriptions for the 2 breadth studies and main thesis research area are listed as well. Due to the fact that analyzing and researching LEED™ green design is highly extensive and will put me as a candidate for becoming a LEED™ Accredited Professional, more weight is added to this research area. Since the other analysis include green building design concepts, the total percentage for LEED™ is greater.

Description	Research	Value Eng.	Const. Rev.	Sched. Red.	Total
LEED	25	10	15		50
PCC vs. Steel	5		15	10	30
Glazing	5	10		5	20
Total	35	20	30	15	100