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North Elevation

Thesis Proposal

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Executive Summary

In this Proposal, you will find the four analyses that are to be conducted on various aspects of the Columbia Heights Community Center. This document is intended to give the reader a detailed view of these analyses, how they are to be conducted, and what tools will be utilized in the process. Since Columbia Heights Community Center is LEED® Silver Rated, the overall theme for the analyses will follow this topic. Outside of the research component, the other investigations will look at ways of improving the performance and constructability of several systems in the Columbia Heights Community Center while also reducing the amount of material needed for its construction. Below is a quick preview of each analysis:

Analysis 1 – LEED® Point Alignment

This will include research to develop a tool that can be used to align building owner's goals with LEED® points that are both functional and achievable.

Analysis 2 – Precast Brick Façade

This will look to use a Precast Architectural Brick façade in lieu of Norman Bricks on the south wall. The precast assembly will increase the productivity as well as allow for the ease of construction since the south wall is extremely close to an existing apartment building.

Analysis 3 – Alternate Structural Systems for the gymnasium

An investigation will be performed that will look at alternate systems to replace the current structural steel system in the gymnasium, which includes large members such as a W40x215x60'. Ideally, the new system should reduce the quantity of steel and costs.

Analysis 4 – Foundation Placement Method

It will analyze the option of pouring the foundations into excavated pits instead of excavating to the bottom elevation, using forms, and then backfilling around them with stone. It is to be expected that the quantity of stone fill and the quantity of soil removed will be reduced through the proposed method.

Analysis 1

LEED® Point Alignment

Problem

Despite the initial goal and investment for certain level of LEED® certification, it is very difficult to maintain that level and achieve each point throughout the construction process. Aligning the owner's goals with corresponding LEED® points can result in a better quality building for its intended use and a more structured approach towards obtaining the initial LEED® certification level.

Goal

The main goal of the proposed research would be to identify LEED® points that are associated with the owner's initial goals for the construction, function, operation, and maintenance of their building. With this knowledge, an interactive tool can be produced to identify the most achievable and functional points based on the input of the owner's goals. For example, the goal of maximizing day lighting in a school for better reading conditions can best be aligned with the LEED® credit *EQ 8.1 Daylight & Views*.

Methodology

1. Literature review to become familiar with the different LEED® points.
2. Develop a list of interview questions to determine the owner's goals.
3. Identify and interview 10 different owners on 10 different LEED® Rated projects.
4. Compare the owner's goals with the LEED® points that were achieved on that project.
5. Compile the results and generate a specific set of questions. These questions, when answered, will align the goals of the owner with a set of LEED® points.
6. Assemble an interactive program that can be used for the purpose mentioned above.

Tools

1. U.S. Green Building Council website (www.usgbc.org)
2. LEED® Green Building Rating System for New Construction and Major Renovations (LEED®-NC) Version 2.1
3. Microsoft Excel

Expected Outcome

The expected results of this research could provide a resource with which building owners, architects, and construction managers can develop a list of LEED® points that can optimize the performance of their building and that are achievable. Ideally, from the research findings, a tool can be developed to generate a list of LEED® points that are based on a set of goal-oriented questions. Also, this research could yield results that can be used to identify a typical set of LEED® points for each building type (educational, office, residential, etc.).

Analysis 2 - Breath

Precast Architectural Brick façade in lieu of Norman Bricks on South Wall

Problem

The south wall of the Columbia Heights Community Center runs parallel to the adjacent apartment complex at a distance of roughly 10'-0" away (see Site Plan in Existing Conditions Report). Approximately 1/4 of the south wall lies directly alongside the complex. The close proximity of the apartment restricts any deliveries of material to this wall from the south, and the east is restricted by the existing park. Space is very limited for material staging and most of it will be located within the building footprint. In this configuration, bricks will have to be fed to the masons from the inside, decreasing production.

Goal

The goal of this analysis is to see if replacing the bricks with Architectural Precast Brick Panels can reduce the construction time, labor costs, and the amount of wasted material. The analysis will focus on impacts to cost, schedule, and quality. Also, since the panels are prefabricated in a factory, material waste is generally less. This analysis will look at this issue as well.

Methodology

1. Determine the quantity of brick to be replaced by the panels.
2. Select an Architectural Precast Brick Panel to replace the brick.
3. Contact the panel manufacturer to determine costs and typical erection times.
4. Compare cost and duration to those in estimating tools (R.S. Means).
5. Analyze the impact on the structural system.
6. Compare costs, durations, and material amounts between the existing brick façade and the proposed panel system.
7. Analyze the impact on mechanical loads through a heat-loss analysis.
8. Assemble the data.

Tools

1. The Blue Book of Construction (http://www.thebluebook.com/)
2. R.S. Means 2005 Edition
3. AISC - LRFD Manual of Steel Construction 3rd Edition
4. Penn State Architectural Engineering faculty

Expected Outcome

The expected results of this analysis could prove that the precast panels are more efficient to erect and that they reduce material waste. It can be expected that the panel system will ultimately cost more than the brick due to the extra crane use and the prefabrication, but there should be savings in labor costs and a noticeable reduction in schedule. After analyzing the heating loads, findings might indicate that the new system will not degrade the performance of the wall.

Analysis 3 - Breath

Alternate structural systems to replace the large steel I-beams in the gymnasium

Problem

Structural steel members in the Columbia Heights Community Center gymnasium are extremely large. They span a distance of 60'-0" and receive loading from the open-plan office above as well as roof loads through transfer columns. The gymnasium is a two-story space and the average steel beam in this area is a W40x215x60'. These large members are very costly in terms of material and also require a larger crane to set them in place.

Goal

The goal of this analysis is to see if this system can be replaced with an alternate system that can save costs through use of less material. The systems that will be analyzed include open-web steel joists, high strength steel, and pre-cambered members.

Methodology

1. Determine the building loads that the current steel members support.
2. Design alternate systems using these loads.
3. Analyze the systems' impacts to cost and schedule.
4. Perform comparison between the proposed systems.
5. Select best viable solution.

Tools

1. R.S. Means 2005 Edition
2. AISC - LRFD Manual of Steel Construction 3rd Edition
3. Penn State Architectural Engineering faculty

Expected Outcome

This analysis should prove that there are other systems that can replace the current steel structure in the gymnasium to reduce the amount of material and costs. For example, if open-web steel joists can replace the current system, there will be less steel material and a smaller crane could be used. The new system must be able to perform to the original design loadings and must be easily incorporated into the surrounding structure.

Analysis 4

Alternate method for placement of the building foundation

Problem

Originally, the general contractor proposed that the entire footprint be excavated to the bottom elevation of the foundation system and then forming will be used for the pour. After the concrete pour, the footings will be stripped and then the area will be backfilled with stone. This method not only involves more soil to be removed, it also requires more stone fill.

Goal

The goal of this analysis is to see if pouring the foundation system into excavated pits can reduce labor costs, schedule, and the amount of material used. This method of placement eliminates the need for forming and reduces the amount of material removed and the amount of stone fill.

Methodology

1. Determine the quantities of soil to be removed for each placement method.
2. Verify the amount of stone to be used in both scenarios.
3. Estimate the forming costs and labor productivity.
4. Assess the change in demand for the excavator.
5. Compare the material costs, labor costs, and activity durations.

Tools

1. R.S. Means 2005 Edition
2. Penn State Architectural Engineering faculty
3. Forrester Construction Company – General Contractor

Expected Outcome

The outcome of this analysis should show if there is a savings in cost and time from the new placement method. It is to be expected that more time will be needed to excavate the pits for every grade beam and footing, but hopefully the savings from eliminating the forming can offset this. If this new method is feasible, it will reduce material quantities and further support the building's LEED® aspect.

Weight Matrix

The following table is designed to illustrate the distribution of effort between the different analyses.

Analysis	Description	Research	Value Eng.	Constr. Rev.	Sched. Red.	Total
1	LEED® Point Alignment	25%				25%
2	Precast Brick Façade		10%	10%	10%	30%
3	Alternate Structural System in Gymnasium		15%	10%	5%	30%
4	Foundation Placement Method			10%	5%	15%
Total		25%	25%	30%	20%	100%

Table 1 – Weight Matrix