Revised Thesis Proposal

Redesign Project

Slippery Rock University Student Union

Slippery Rock, PA

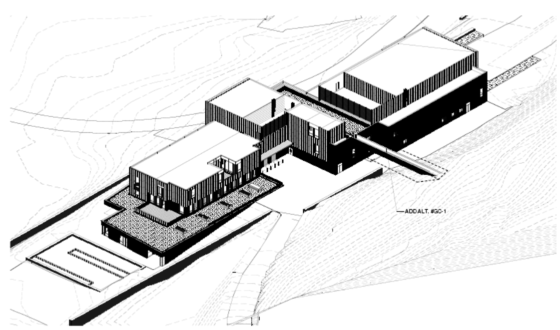

Table of Contents

Executive Summary

The purpose of this report is to summarize the information and conclusions found by research and calculations performed in the previous technical reports in efforts to redesign the mechanical system. This proposal will set the schedule, various systems, and techniques that will be evaluated throughout the spring semester.

The main topic of research for my overall building redesign is value engineering. My interests upon graduation include becoming a project manager for a mechanical contracting company. I therefore wish to investigate potential ways to decrease initial costs of the mechanical systems. Techniques used to do the cost analysis are included in the report.

Research to determine if a photovoltaic or solar thermal storage system can replace the green roof is also another topic related to the mechanical redesign of the building. A feasibility study is to be conducted to see benefits, if any, to this change in design.

The breadth work will be a result of the mechanical redesign. A structural analysis will be done to reduce the members further decreasing the materials needed and cost of construction. Therefore, a construction breadth will also be conducted. The purpose of the construction breadth will be to reduce construction time and implement cost savings. A site utilization plan will also be created to improve site circulation. A tentative work schedule for the spring semester is also included at the end of the report.

Project Summary

The Slippery Rock University Student Union construction is currently underway with building completion estimated to be in late November of 2011. The 105,000 square foot building will serve many different types of activities and will house spaces such as a bookstore, kitchen, cafeteria, ballroom, theater, student lounges, and will also have numerous offices and conference rooms. The building is currently predicted to achieve a LEED Silver Rating.

The SRU Student Union will be used by students and faculty year round. The ground floor will contain the large bookstore and house all of the interior mechanical equipment. The second floor has spaces available to hold club meetings and conferences for the student organizations within the university. The faculty will also be occupying the building, with a portion on the second floor of the building dedicated into individual offices. The remaining west side of the floor will contain a full kitchen and dinning commons. A ballroom and theater room is located on the floor directly above the kitchen and dinning area on the third floor. The east side of the third floor will house the remaining meeting rooms.

The exterior landscape of the building will allow the students and faculty to have areas where outdoor seating is available. The SRU Student Union will hope to be the central meeting and gathering place of the campus.

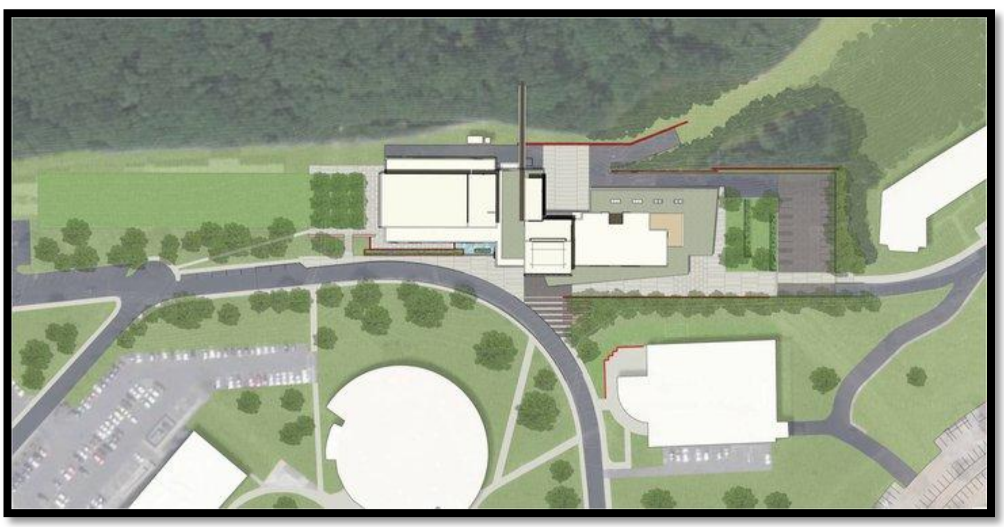

Figure 1 – Campus Site Plan

Mechanical System Description

The SRU Student union has occupational hours throughout most of each day and will be used throughout the entire year. With such a diverse environment, it is important to ensure comfort and wellbeing for the occupants throughout the long operation hours during all months of the year. In order to achieve this, careful planning was incorporated into the design to allow the occupants to have control of each space as much as possible.

In most cases, the building far exceeds minimum ventilation requirements set forth by ASHRAE Standard 62.1 and the minimum system efficiencies stated in ASHRAE Standard 90.1. The SRU Student Union is designed in order to obtain a LEED Silver Rating. To able to accomplish this achievement, efficient energy recovery units with a hot water heat transfer system are used with auxiliary back up. Both use steam from the university campus steam plant as a means to heat the water. Due to the different types of spaces in the building, simultaneous heating and cooling will be occurring, which allows for these units to run effectively.

Comfort is another major priority within the SRU Student Union. Each office, conference room, and lounge area in the building is equipped with a VAV box along with a thermostat so the individuals can have the space at their own comfort level. The nature of the building requires the larger spaces to be monitored by automatic controls to keep each space at a satisfactory temperature and humidity throughout the operational hours. When outdoor conditions are suitable, operable windows can utilize natural ventilation where applicable. With careful consideration, the SRU Student Union will be a safe and comfortable environment for the occupants.

Proposal

Overview

The purpose of my redesign will be to value engineer several systems that are contained within the building that will hopefully help to cut down on the initial costs for the owner. System efficiencies may also be increased resulting in a lower cost for operation. The building is hoping to achieve LEED Silver, with the redesign, I will investigate the possibility of still attaining a LEED rating.

Redesign Considerations

The redesign will consist of changing a portion of the current energy recovery unit with hot water heat transfer system to a DOAS system with passive chilled beams. This will hope to cut energy costs and be able to cut down operation time of the system.

Next, a look at the ductwork and piping runs will be analyzed. I plan to change the ductwork material to a cheaper alternative than sheet metal where applicable. I will also explore the ductwork runs to reduce the amount of material consumed based on the lower amount of air being pushed through the system. Due to the change in the air handling units, less piping will be used from changing the hot water heat transfer system between the energy recovery units. By reducing these elements, the exhaust fans and pumps may have the opportunity to be downsized as well.

Finally, I will take an approach to determine if there is a benefit from replacing the green roof with a thermal storage system. The maintenance and potential for issues with leakage into the spaces below pose the idea of replacing the green roof. Located beneath the green roof is the bookstore with vast amounts of merchandise and currently an energy recovery unit. If leakage were to occur, this could cause a great financial burden to the owner. A solar thermal storage system could decrease the mechanical construction time and also result in potential energy savings. A detailed cost analysis of replacing the green roof will be conducted to determine if there is any initial cost benefit to the owner.

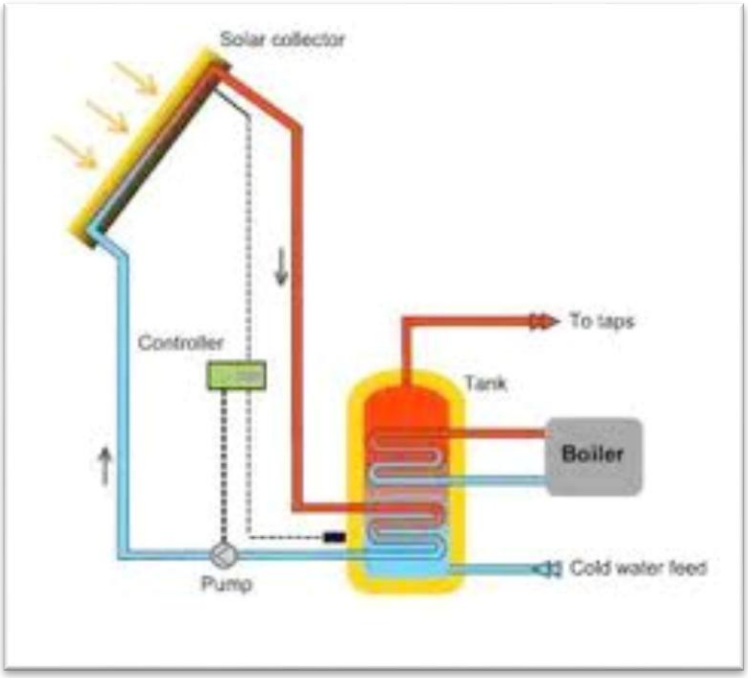

Figure 2 – Solar Thermal Storage System

Breadth Work

I will be investigating a system that will decrease the amount of materials used in the mechanical system; a structural breadth will be investigated to further emphasize the value engineering intent. A study will be conducted to determine if a prefabricated floor system can be utilized and the structural implications of doing so on a portion of the existing framing system. The beam and girder framing holding the precast panels will be redesign in hopes of reducing the amount of steel. Prefabricated panels will be analyzed in a section of the building to determine if there is any cost and construction benefit. Both the structural and mechanical redesign will have an impact on the construction process of the building. The investigation will look to accelerate construction time and perform an overall cost analysis due to the redesign. As a result, this will tie in with the value engineering aspect to reduce initial costs of the building.

Figure 3 – Prefabricated Floor Panels

Project Methods

There will be a variety of methods used to perform the project redesign, most of which will be done by hand calculations. I will perform ductwork takeoffs by measuring the duct runs then figure out the gauge of sheet metal based on the dimensions of the ducts. Once I find the gauge, I will then be able to figure out the entire amount of sheet metal used and determine a cost estimate of the ductwork. I will then redesign the duct runs and explore different material types that could potentially replace the sheet metal at a lower cost. I will do the same with the piping in the hot water heat transfer system used between the energy recovery units. Then resize and change the energy recovery units to a DOAS system that may be more cost effective and more efficient. I will conduct a price comparison between the two types of units from the estimate received by the mechanical contractor. Once the major system equipment is finalized, I will look into potentially downsizing the fans and pumps to further decrease the total mechanical system cost.

Next, I will conduct a feasibility study of replacing the green roof with a solar thermal storage system. Using weather and solar data for the area and manufacturer data, I will determine whether or not it is worth replacing the green roof with the system or not. I will then do hand calculations from my solar thermal storage class to determine if enough hot water can be generated in order to be of use within the building. Space that will be saved by replacing the energy recovery unit on the first floor can be used as an area to contain the storage tank and equipment needed for the solar thermal system.

The structural analysis will be conducted by mostly hand calculations. I will perform calculations to determine the strength and deflection of the prefabricated floor slabs through the dead and live loads on the floor. The beams will be checked based on live and dead loads to ensure adequate strength and deflection. The columns will be resized based on the axial loads by using the tributary areas. In practice, the beam and column systems are typically oversized. This analysis will be able to decrease the amount of steel used resulting in lower cost.

The construction schedule will be analyzed based on the accelerated time that will be created from using the prefabricated slab panels rather than cast in place concrete floor slabs. Microsoft project will be used to create a new schedule. The prefabricated panels will help to decrease congestion on the site. Potential cost savings will be accessed from accelerated construction time.

Predictions

I predict that the redesign will result in a reduced construction time and initial cost to the owner. Based on the current design, I feel I will be able to adequately reduce building materials. I believe that the efficiency may be increased resulting in points awarded for the energy and atmosphere criteria for LEED. Based on the solar thermal water storage system, more points may be able to be obtained depending on square footage.

Preliminary Research

The following list of resources was used to develop preliminary research. As the research progresses, more sources will be added to the list.

ASHRAE Handbook, HVAC Systems and Equipment. American Society of Heating, Refrigeration, and Air Condition Engineers, INC., Atlanta, GA 2004

ASHRAE Handbook, HVAC Fundamentals. American Society of Heating, Refrigeration, and Air Condition Engineers, INC., Atlanta, GA 2004

ASHRAE Handbook, HVAC Applications. American Society of Heating, Refrigeration, and Air Condition Engineers, INC., Atlanta, GA 2004

Beckman, Duffie (2006), Solar Engineering of Thermal Processes, John Wiley & Sons, Inc.

Tentative Work Schedule