Thesis Research Proposal

The Science & Technology Building, Slippery Rock, Pa

Topic Areas

- **Depth – Green Design with Intensive / Extensive roof investigation**
  - Intensive / Extensive roof
    - Benefits
      - University
        - Heating costs
        - Water run off
        - Education use
      - Environmental
        - Air quality
        - Water run off
    - Costs associated
  - Energy Efficiency
    - Materials
    - Systems
    - Costs/ Lifetime savings
  - Green Products
  - Leed Rating

- **Breadth - Steel Superstructure vs. CIP Concrete**
  - Investigation of Slab type
    - Multi joist one-way slab
    - 2 way flat slab
  - Advantages/ Disadvantages of slab type chosen
    - Cost
    - Schedule
    - Design
    - Aesthetics
    - Constructability

- **Breadth - Schedule Acceleration**
  - 3 months of acceleration will allow for extra semester of occupancy
  - DGS procedure acceleration
  - Cost of Acceleration
  - Misc. Process/ Procedure delays
  - Added Benefits for the school: recruiting/ education

Work Breakdown

This is a breakdown of the work I will be performing this semester and the concentration percentages associated.

Weight Matrix

Description	Research	Value Eng.	Constr. Rev.	Sch. Red.	Total
Green Design w/ Intensive/ Extensive Roof	20%	15%	10%		**45%**
Concrete Design	20%	10%		5%	**35%**
Schedule Acceleration	10%	5%	5%		**20%**

Depth Work – Green Design with Intensive/Extensive roof

In today's construction industry, it is important for building design to incorporate much more than just functionality and aesthetics. With the Earths' ozone layer depleting from greenhouse gases and global warming becoming a reality, it is essential to building design that green is included. As the depth of my thesis proposal, I will investigate many different areas of green design and discover ways to implement green design in order to achieve a leed rating.

One main area of investigation includes the design of a green roof. Green roofs have many purposes and uses. Intensive roofs are multi-layered gardens with trees and shrubs with elaborate irrigation and drainage systems. These roofs are generally used as patios and are intended for use by occupants as well as for its environmental functionality. Extensive roofs are very similar only they are not designed for public use. Rather they provide the same great environmental benefits at a lowered cost and less load to the building. Intensive roofs range from a cost of 20-25$ per sq. foot and have an applied load of 80 to 150 lbs/ sq. ft. Extensive roofs range in cost from 15-20$ per square foot, with an applied load of 15 to 50 lbs/ sq. ft. Much of the costs are related to material availability, which in Butler, Pa, soil will be of surplus.

The benefits for these types of roofs are significant in metropolitan areas with tall buildings and streets with very little wildlife. Green roofs provide stormwater management at the same time as improving energy performance, air quality, and the urban ecology. With stormwater runoff problems already existing in Slippery Rock; I believe this system to be of significant value.

Also with the green roof, energy efficiency is enhanced because the soil topping acts as an insulator in the winter, and naturally cools the building in the summer. In this investigation I will look at the details of this added efficiency compared to its added costs. I will prepare lifetime costs for this comparison.

As a main factor of this design extensive roof design will be incorporated, however, intensive design may be added as an addition for student and faculty use. The buildings use is mainly for the sciences including biology. Previously this type of roof was not considered in design neither for environmental functionality nor for educational use. As a small part of my investigation, I will interview university officials to see if this type of roof could be incorporated into its existing curriculum or be an added feature for several classes.

In addition to the green roof design, I will research many different green products that are included in the design already and discuss products that could be implemented for little or no cost. There is a long list of items, construction recycling ways, and materials that provide for a better environmental building. It is my purpose to implement enough new ideas into this building in order to achieve a leed rating and provide future savings for the owner at the same time.

Breadth Work – Steel Superstructure vs. Cast-In-Place Concrete

As the breadth work of my proposal I will investigate a concrete cast-in-place structural system that will achieve the same functionality of the steel system but with greater cost savings.

Initially, 2 types of systems will be compared and one selected to research. These systems include: a 2 way beam and slab system and a multispan joist slab system. These systems will be evaluated for laboratory use and cost savings.

After the design is chosen, I will prepare a detailed estimate of the system using beam and column size conversions from Allens' Fundamentals of Building Construction:

Materials and Methods, John Wiley, Inc. These conversions will allow me to determine a very detailed cost estimate for the newly design system.

I will also compare the system to the steel structure and discuss advantages and disadvantages. One of the main advantages of the CIP system I'm hoping to achieve is to provide extra ceiling space for the chaotic MEP systems. An initial look at the two designs will allow for roughly 3-5 inches of extra space which is extremely significant in a mechanical intense building.

After estimating is complete, the last factor I will investigate is how this new system will compare in terms of schedule. While the actual construction time will be significantly greater with CIP, the procurement time for CIP is very small. Hopefully the schedule of the CIP system can be incorporated into the 2nd Breadth work: schedule acceleration.

The initial looks at the savings from the two systems are noted below:

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Structural steel	**Overall Cost**	**Sq. Ft.**	**Cost/ Sq. Ft.**
Steel Framing	$838,200.00	76,000	$11.03
Metal Joists/ Decking	$150,313.00	76,000	$1.98
Slab on Grade	$158,697.00	28,854	$5.50
Slab on Metal Deck	$192,116.00	48,029	$4.00
Totals	**$1,339,326.00**		$17.62

Cast-In-Place Concrete, Multispan Joist Slab	**Overall Cost**	**Sq. Ft.**	**Cost/ Sq. Ft.**
bay size: 30 x 30 w/ 75#/sq. ft. load	**$1,132,400.00**	76,000	$14.90
bay size: 30 x 30 w/ 125#/sq. ft. load	**$1,197,000.00**	76,000	$15.75

Cast-In-Place Concrete, Beam and Slab, Two Way	**Overall Cost**	**Sq. Ft.**	**Cost/ Sq. Ft.**
bay size: 30 x 35 w/ 75#/sq. ft. load	**$1,356,600.00**	76,000	$17.85
bay size: 30 x 35 w/ 125#/sq. ft. load	**$1,478,200.00**	76,000	$19.45

Breadth Work – Schedule Acceleration

Along with the demand for early occupancy, acceleration of the project schedule in the initial contract by 3 months could allow for an extra semester of occupancy. When thinking in terms of student education, one added semester in a more sophisticated technically advanced facility can mean better experience with new equipment. For a graduating senior, it could mean the difference between obtaining a mediocre job and a great job. Not to mention starting a freshman off in the direction that leads to success instead of postponing a better education one semester. Research into this topic will involve takeoffs of each process and an analysis between the two different schedules in terms of cost.

The Acceleration part of my proposal will also involve interviewing key members in the construction field to find out new methods of acceleration as well as old methods that have been used. In addition to these interviews, I will research acceleration methods that have been used on similar projects and how they affected cost and coordination. I will also need to do takeoffs for the critical processes that will be accelerated; mainly labor takeoffs. I will also talk with the contractors on site to see how time could be made up, and how an initial accelerated schedule would have affected the bid.

Part of the acceleration research will involve aspects from my 1st breadth work: cast-in-place concrete. With the lead time for steel on this building being roughly 8 months, I will have many options to accelerate the schedule prior to construction with the use of a concrete structure.