Shivam Patel

Senior Thesis Proposal

Construction Option

Advisor: Dr Ed Gannon

December 16th 2013

Executive Summary

The following report details the new construction commercial high rise project and the construction techniques employed to build it. The exact project location and name is to be held confidential but it can be known that the project is located in a major US city. The following proposal will discuss the analyses that will be conducted throughout the spring semester for the senior thesis project

Figure 1: Image courtesy of Hines

Analysis 1 will focus on the opportunity to change the current formwork system that is being used on the project. A guided formwork system is currently being used to cast the system. While this system is quick and efficient, there are always safety concerns and crane-time is needed to lift the form. This analysis will research the use of a self-climbing system and an analysis of the cost and schedule impacts will be conducted. A structural depth will also be conducted in this analysis.

Analysis 2 will focus on the implementation of photovoltaic curtain panels. The implementation of this system can add value for the owner and benefit future tenants that desire to rent space within the building. A cost analysis will be conducted along with a study of how this system can be used as a backup system for the building through an electrical analysis.

Analysis 3 investigates the effects of implementing short interval production schedules (SIPS) on the project, in order to deal with crew balancing sequencing, and work flow concerns. By incorporating SIPS into the construction of the concrete core, coordination concerns and flow of work will be addressed.

Analysis 4 will look into the implementation of material tracking technologies on the project. The technology has the potential to enhance coordination and lessen delays on deliveries for the project. It will have to be determined if the overall benefits will outweigh the costs of this technology.

Throughout the spring semester thorough investigations of the previously stated analysts areas will be conducted. The results will determine if these analyses are feasible and were able to implement into the project to decrease the project schedule, add value to the building, and overall increase the coordination on the project.

Table of Contents

Executive Summary 1
Table of Contents 2
Analysis 1: Guided Formwork to Self-Climbing 3
Analysis 2: Implementation of Photovoltaic Curtain Wall 5
Analysis 3: SIPS 6
Analysis 4: Material Tracking Technologies 8
Analysis Weighted Matrix 10
Conclusion 11
Appendix A: Breadth Topics 12
Appendix B: Senior Thesis Timetable 14

Analysis 1: Guided Formwork to Self-Climbing

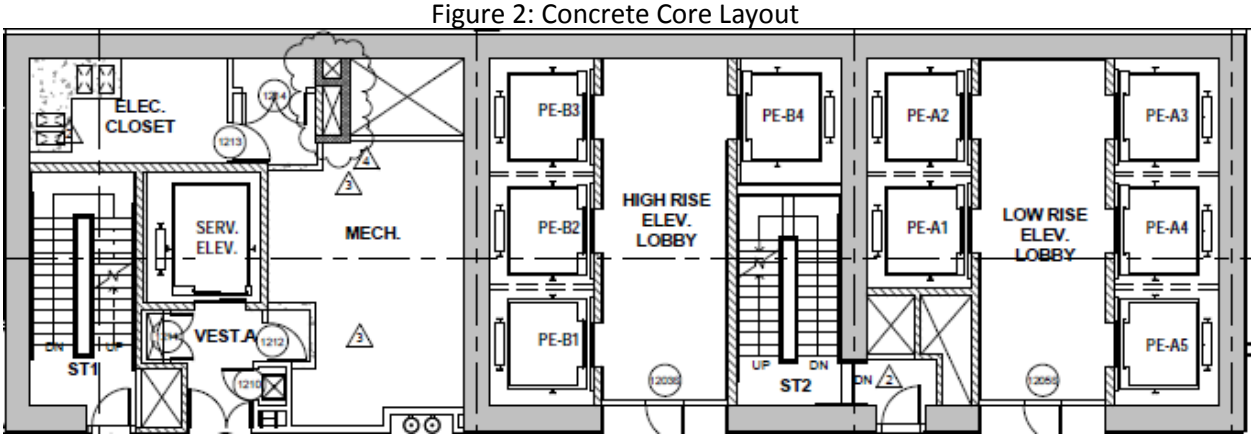
Opportunity Identification

The concrete core is currently the main focus of the project as it is the first activity for each floor and because of this it needs to stay ahead of the other activities. A guided formwork system is currently being used to cast the system. While this system is quick and efficient, there are always safety concerns and crane-time is needed to lift the form. With a schedule timeline of four days per floor, staying on track and completing the work on time is a critical portion of the project. This analysis will look into how changing the formwork into a pneumatic system can impact the schedule and costs for the project.

Background Research

Once this analysis was determined, background research pertaining to the core was conducted. The guided formwork is a system commonly used on high rise construction projects. The system is guided on vertical profiles that are fixed to the concrete core and the climbing unit is repositioned in a single crane cycle. The concrete core will have a layout as seen in Figure 2 below.

Figure 2: Concrete Core Layout



The formwork is sectioned off resulting in multiple lifts to the next level. The crane is used for these lifts along with the lifting of the rebar and the pouring of the concrete. In order for the formwork to be lifted guiding shoes are used. Additional crew members are used for the installing and dismounting of these guiding mechanisms on top of the crew members used for the reinforcement and the pouring of the concrete.

Potential Solutions

In coming up with ways to decrease the crane time and number of crews needed, it was important to ensure that these potential solutions would not add any additional safety hazards and costs to the owner. The following solution was evaluated and further analysis will be conducted further.

- The use of a self-climbing system

The use of a self-climbing system can eliminate the multiple lifts needed to be done by the crane operator. This can ultimately speed up the workflow per floor and have the crane be used in other areas. The forming can also be easily opened and closed and can prevent fall-hazard locations from opening during reposition, as the entire platform can be raised in one lift.

Analysis Steps

In order to complete the analysis the following steps need to be taken

1. Research current formwork manufactures
2. Contact project team and obtain average durations for crane lift and number of crews
3. Cost analysis between two formwork systems
4. Schedule impacts
5. Structural formwork design and connections needed

Resources

1. Thesis Advisor – Ed Gannon
2. Industry Professionals
3. Formwork Manufactures
4. Turner Project Team

Expected Outcome

The implementation of a self-climbing formwork system can decrease the cranes activities and allow for the flow of work to be simpler. This new system can reduce crane costs, and shorten the concrete core schedule. This can lead to a decrease in the general conditions cost on the project and save the owner, Hines, some additional money. This can also speed the activities that follow the concrete core further along

Analysis 2: Implementation of Photovoltaic Curtain Wall

Problem Identification

The buildings enclosure consists of high vision glass with low iron IGU with Low E coating and a mullion module of linen finish stainless steel spandrel panels. With the building being a core and shell project, tenants will choose the layout of the floor they decide to rent. Changing the current system to a Photovoltaic system can be used a source of renewable energy for the building and can also serve as a backup system if needed. This adds value to the tenants that wish to rent space in the building and also adds value for the owner.

Research Goal

The goal of this analysis is to research how the implementation of a Photovoltaic Curtain Wall can add additional benefits for the owner and the tenants that rent space in the building. This system can provide an additional renewable energy source for the building and lower costs for the owner if enough power is generated.

Analysis Steps

In order to verify if the implementation of this system is feasible the following steps should be taken

1. Research case studies of buildings in the same major city that currently have this system
2. Conduct a Solar Study
3. Analyze the cost impact of adding this system
4. Analyze the amount of energy that can be generated with this system
5. Redesign electrical system in order to add this system

Resources

1. Relevant Case Studies
2. Industry Professionals
3. Project Team
4. Photovoltaic system manufactures

Expected Outcome

The expected outcome for this analysis of the implementation of photovoltaic wall panels should provide an additional renewable energy source for the building. This technology has the ability to provide backup power in certain situations and can also be used a passive system. This can lower costs for the tenants that rent space and can add value for the owner.

Analysis 3: Implementation of SIPS

Problem Identification

Being a core and shell office building the schedule activities are very repetitive. With the current schedule there is a greater need for coordination and planning to ensure that the schedule remains on pace. Although the entire schedule is considered critical, the most important activity is the casting of the concrete core. The core is the first activity to be completed for each floor, which makes the entire schedule dependent on this activity. Without the core in place, steel framing, superstructure, SOFP, and enclosure cannot begin.

Research Goal

SIPS takes the project schedule and breaks the task into smaller and more detailed items, which can include crews, crew sizes, and durations. The information for a SIPS analysis can be gathered using the input from the construction management team and responsible subcontractor's foremen, which can create a more accurate depiction of the time to be allotted for tasks. The goal of this analysis is to increase the coordination on the project by designating work areas and providing a better detailed schedule of work.

Analysis Steps

In order to properly investigate this analysis, the following steps must be performed

1. Perform research on the implementation of SIPS, specifically case studies
2. Obtain average durations from project team and subcontractor
3. Develop a strategy to implement SIPS for the concrete core with consideration to current project schedule and man power.
4. Conduct an analysis of the potential use of SIPS on the project.

Resources

1. Project Team
2. Relevant Case Studies

Expected Outcome

It is believed that the use of SIPS will accelerate the overall project schedule by creating greater coordination during the construction of the concrete core. The incorporation of SIPS will generate greater coordination and a better sequencing strategy, while providing every project participant a greater understanding of what they are responsible for at any given time. Using the information gathered from all of the involved parties, accurate and feasible SIPS should be able to be produced to successfully expedite the project schedule and improve flow of work.

Analysis 4: Integration of Material Tracking Technologies

Problem Identification

The project has various different materials that will be fabricated and delivered to the site. The deliveries can be very complicated due to the location of the project and the site is very condensed. Many of the materials have long lead times, are manufactured off-site, and require careful planning for deliveries. With the use of such specialized building materials m it is critical that extreme planning and consideration goes into tracking materials. Due to the surrounding streets traffic is a major concern when deliveries are being brought into the site.

Research Goal

There are a number of software programs that are on the market that can be used to track the materials being manufactured in the shop and delivered. The goal of implementing a specific tracking technology known as radio frequency identification (RFID) tags on materials will be to track these items easily and have the project team be prepared for onsite deliveries. The tags have the capability of storing information in regards to installation, delivery, storage, and warranties within the tags.

Analysis Steps

The following steps must be performed in order to complete this analysis

1. Research case studies of projects that have incorporated the technology into the construction process
2. Develop an implementation strategy for the use of RFID tagging on the project.
3. Investigate the feasibility, as well as advantages and disadvantages, associated with utilizing material tracking technologies

Resources

1. Case Studies
2. Tracking technology manufactures

Expected Outcome

The use of material tracking technology has the capability of significantly improving coordination on the project, but it also carries expensive cost. Although the technology is expensive, it is believed that the pros will outweigh the cons. With the majority of fabrication and deliveries, the use of this system will allow for better coordination and prevent delays of these deliveries.

Critical Issues Research

One of the leading topics of discussion in the construction industry is Information Management for the Workforce. When discussing this topic the use of material tracking was brought up and how this technology can be used for a variety of situations. The goal of my research is to explore the effectiveness of the RFID tag for materials that are being fabricated in the shop and being delivered to the project. How can the implementation of the technology are used to prevent delays in the flow of work during a delivery and preparing ahead of time will be answered through this analysis. I will research case studies involving material tracking and speak with individuals with previous experience with this technology.

Analysis Weight Matrix

The table shown below in Figure 3 illustrates the emphasis and amount of time that will be spent towards each of the four proposed analyses during the spring semester. The table also displays the amount of focus each analysis will entail within the core areas of investigation required for this course.

Analysis Description	Critical Issue Research	Value Engineering	Constructability Review	Schedule Acceleration	Total
Self-Climbing Formwork	10%		20%	5%	35%
Photovoltaic Curtain Wall	5%	15%	10%		30%
SIPS	10%			10%	20%
Material Tracking Technology	10%			5%	15%
Total	35%	15%	30%	20%	100%

Figure 3: Analysis Weight Matrix

The table shows what areas will be mainly focused on during the spring semester. There will be more time spent on researching information for the self-climbing formwork and the photovoltaic systems s this is where the breadth analyses will come from also.

Conclusion

The main focus for the proposed senior thesis as well as each of the four previously described analyses is to improve on the overall coordination of the project. Analyses 1 & 2 will focus on how using different systems that can improve upon the construction process and the value of the building. Analyses 3& 4 will focus on improving the overall coordination between project team and the workers on site while trying to shorten the project schedule. It is anticipated that through extensive research and study, these four analyses will produce results that would have benefited the project, project team, and owner.

Analysis A: Breadth Topics

Breadth Topics

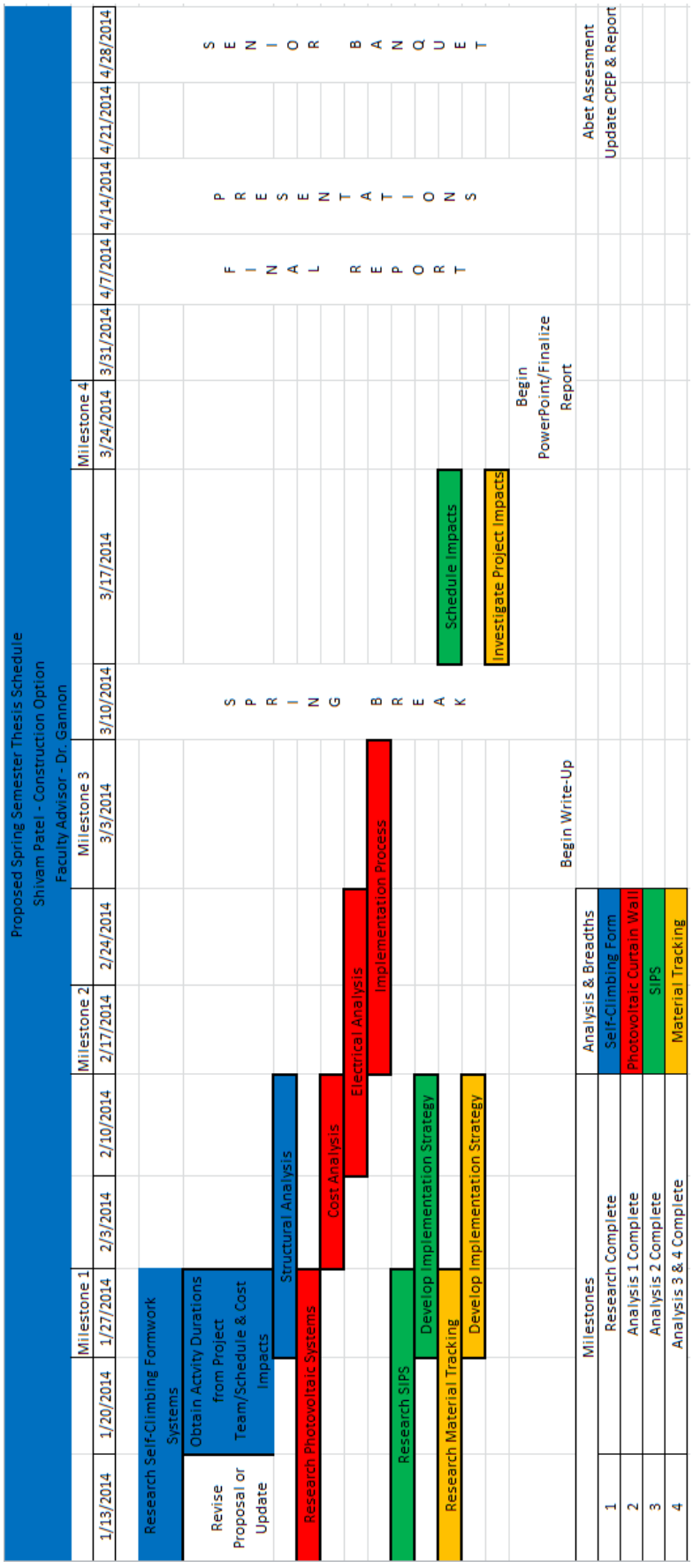
Structural Breadth (Analysis 1)

With the implementation of a new formwork system a structural analysis will need to be completed. The current system is a glided formwork system that attaches to the concrete core. A cost analysis of adding a self-climbing system will be conducted and the impact of using different connections for the hydraulic system will be looked into.

Electrical Breadth (Analysis 2)

Adding photovoltaic curtain wall panels will add a new system that will need to be designed and placed with the current systems for the building. Load requirements will be calculated and the system sized accordingly. Calculations will include sizing of equipment, wire, conduit, etc for the new system. New material and specific equipment will also be selected.

Analysis B: Senior Thesis Timetable


Proposed Spring Semester Thesis Schedule
Shivam Patel - Construction Option
Faculty Advisor - Dr. Gannon
Milestone 1
Milestone 2
Milestone 3
Milestone 4
1/13/2014
1/20/2014
1/27/2014
2/3/2014
2/10/2014
2/17/2014
2/24/2014
3/3/2014
3/10/2014
3/17/2014
3/24/2014
3/31/2014
4/7/2014
4/14/2014
4/21/2014
4/28/2014
Revise Proposal or Update
Research Self-Climbing Formwork Systems
Obtain Activity Durations from Project Team/Schedule & Cost Impacts
Research Photovoltaic Systems
Structural Analysis
Cost Analysis
Electrical Analysis
Implementation Process
Research SIPS
Develop Implementation Strategy
Research Material Tracking
Develop Implementation Strategy
Schedule Impacts
Investigate Project Impacts
Begin Write-Up
Begin PowerPoint/Finalize Report
Abet Assesment
Update CPEP & Report
SPRING BREAK
FINAL PRESENTATIONS
Milestones
Analysis & Breadths
1
Research Complete
Self-Climbing Form
2
Analysis 1 Complete
Photovoltaic Curtain Wall
3
Analysis 2 Complete
SIPS
4
Analysis 3 & 4 Complete
Material Tracking