Final Proposal

900 16th Street

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Construction Management | Leicht

EXECUTIVE SUMMARY

The 900 16th Street NW is a nine story building, primarily office space, located in the heart of Washington DC. The project began with the demolition of two existing buildings on site in the beginning of February 2014 and the core and shell construction was set to reach substantial completion in November 2016. The purpose of this report is to document the construction of a project from start to finish. This report in particular will highlight areas of the project that were problematic or have an opportunity to be improved. Topics in the following pages will focus on topics that include value engineering, schedule acceleration scenarios, and alternative methods of construction. The four analyses that will be highlighted shall provide a description of the opportunity, the potential solutions or alternate methods, the methodology behind the analysis, and the expected outcome of said analysis.

Analysis I:

The first technical analysis will be focused on the utilization of modular concrete formwork for the cast-in-place concrete structure. Throughout construction the team used traditional stick built formwork, which lends to longer durations between pours. This labor intensive process also requires a larger amount of man hours then its modular counterpart. Included within this analysis will be research as to how modular formwork compares to stick built, possible schedule, cost, and man hour savings associated with the implementation of modular formwork, and the transportation and storage of forms on site.

Analysis II:

This second technical analysis will focus on an alternate exterior façade to the precast concrete panels that were used. Included within this analysis will be a cost and schedule comparison between the current system and the alternate system. In addition the mechanical and structural properties of the alternate façade system will be analyzed. This will lead to a structural breadth to ensure that the current design of the cast-in-place structure can support the new system and what connection changes must be made. It will also contain a mechanical breadth to analyze the thermal efficiency of the new façade system. The purpose of this analysis is to provide an alternate façade system that will increase the thermal efficiency of the exterior wall while providing similar quality to the original system an minimal impact to the project schedule. I will also conduct an analysis on to see if the overall amount of man hours can be reduced by implementing a new system.

Analysis III:

The third technical analysis will focus on value engineering the glazing for the 3D structural curtainwall based upon a risk analysis of its supply chain. Within this analysis the cost of the glazing, cost of delivery to the project, delivery distance, delivery method, delivery duration will be conducted. A comparison between the alternate product and the current product will be conducted will be completed. A risk analysis between the possible delays and changes to the above topics will be conducted as well. The main purpose of this analysis is to provide a similar product that is manufactured closer to the jobsite to reduce the risk of unforeseen costs associated with possible delays.

Analysis IV:

The focus of the final analysis will be a research based topic that will look into driving collaboration in the field through implementing lean construction principles. Driving collaboration is an issue that most all construction projects have. The lean construction tools of last planner and collocation create an extremely collaborative atmosphere by nature which will assist in furthering the collaboration between trades in the field day to day.

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TECHNICAL ANALYSIS I - MODULAR CONCRETE FORMWORK

Problem Identification:

It is typical for Washington DC the projects to feature a cast-in-place concrete structure. In this type of construction the schedule relies heavily on the completion of the concrete slabs, beams, and columns. The formwork needed to support this type of structure is extensive. On the 900 16th Street project traditional stick built formwork was when completing the cast-in-place structure. This type of formwork was used to allow for the drop panels surrounding the columns. Due to the intensive labor needed to construct the formwork, the total number of man hours and duration of construction was higher than if an alternate system would have been used.

Background Research:

Since stick-built formwork is labor intensive it creates a longer duration for the pours of the concrete structure. The price for material, labor, and equipment required to construct the cast-in-place structure was $6.9 million. The structure uses a mixture of 2-way slabs, on the subgrade levels, and post tensioned slabs for the nine above grade levels. All types of concrete slabs that make up the structural system contain drop panels at the columns. Drop panels in the subgrade parking levels are 5" thick while the above grade levels feature 8" drop panels. Throughout the structure the sizes of the bays vary greatly but the most common bay measures approximately 30' by 30'.

Potential Solutions:

The solution or change I would like to propose is the use of modular formwork throughout the construction of the cast-in-place concrete structure. This style of formwork is becoming heavily favored on large scale construction project throughout the globe. Modular formwork requires less skilled labor than traditional formwork which could yield less cost due to labor. It can also offer a significant savings in erection time which will accelerate the pours of the concrete structure and in turn the project overall.

Methodology:

In order to complete the analyses that I plan to conduct, the following steps will be taken:

- *Research*
    - Research modular formwork systems that are popular throughout the industry and select three possible options
    - Conduct a feasibility analysis of each of the three systems chosen in order to select the one that best fits the project
    - Interview several industry professionals on the impacts using said system would have on the current design of the structure

- *Technical Analysis*
  - Determine the cost and total man hours associated with the current formwork system used
  - Determine the cost and man hours associated of the modular formwork system
  - Conduct a cost comparison of the two systems
  - Estimate the installation time of the new system and compare with the pours and sequencing that the current formwork system allowed for
  - Compare the costs and schedule duration for both systems
- *Recommendations*
  - Make recommendation based upon cost savings, schedule logistics, and the impact that modular formwork would have on the structure

Expected Outcomes:

It is expected that the introduction of modular formwork, in lieu of traditional stick built formwork, will have a positive impact on the overall project schedule with a slightly modified structural design. With a schedule acceleration it is probable that the total number of man hours required to construct the cast-in-place structure will also decrease, resulting in a reducing of associated costs.

TECHNICAL ANALYSIS II – Exterior Façade System Redesign

Refer to Appendix A for Structural and Mechanical Breadths embedded within Technical Analysis 2

Problem Identification:

The 900 16th Street project features a variety of façade systems. However, the main system used on this building are precast concrete panels. The panels themselves vary from a typical precast panel that one may see on a project because these featured high end finishes (limestone, granite, and marble) inlayed within them. These high end stones added a significant amount of weight to the panels therefore the connections to the cast-in-place structure needed to be strengthened to ensure they would be supported. These connections required extra care in the field upon installation and a number of the connections were overly complex taking hours to complete. One main issue that arose of delays of materials to site, some of which were created by lack of material and others were shut down by the secret service for special events occurring in the area. Delays were created on several circumstances because there was no material on site to erect. Also delays incurred when the cranes erecting the panels needed to be used to fly in materials for other trades.

Background Research:

In its entirety the precast façade system features over 250 individual precast panels, and had cost just over $1.2 million for both the material and labor. The erection of the panels began on May 5th 2015 and erection was completed, not including broken panels, on the 14th of July. In total the duration for the erection of the precast panels was 7 weeks and 4 days (including work on Saturdays). Conducting research on an alternative system could create a great value engineering opportunity, while also helping to reduce the load the façade will have on the structure and increase the thermal resistance of the façade system. Because this building was design to be a trophy class office building with various high end finishes it is imperative alternative must give similar visual appeal and lifespan.

Potential Solutions:

A vast number of façade systems exist throughout the building market. However, the main goal of this analysis is to provide an alternate system that is both cheaper and provides better thermal resistance than the one already in use. Depending on the system selected to replace the precast panels there is an opportunity to reduce cost of installation by removing the second erection crane required to erect panels on the East façade and possible reduce the capacity of the tower crane. Also, depending on the alternate system the schedule has a possibility of being accelerated, allowing the floors to be turned over to the interior contractor at an earlier date, and a reduction in the total man hours required to install the system.

Methodology:

In order to complete the analyses that I plan to conduct, the following steps will be taken:

- *Research*
    - Research innovative façades that provide similar aesthetics, durability, and lifespan to the façade system that is in use
    - Select the system that best fits the needs of the clients requirements and the goals of this analysis
- *Technical Analysis*
    - Determine the cost of the system in use (material, labor, equipment)
    - Conduct a constructability analysis of the alternate system chosen
    - Estimate the cost of the alternate system (material, labor, equipment)
    - Determine the estimated installation duration of the alternate system and how it impacts the overall project schedule
    - Compare the cost and schedule of the façade system in place to the alternate system chosen
    - Conduct a structural breadth analysis by ensuring the structure can support the loads of the alternate system
        - If the system in place does not work with the current connection method design a typical connection for the alternate system
    - Conduct a mechanical breadth analysis by assessing the thermal resistance of the alternate façade system
    - Evaluate the aesthetic appeal of the alternate system selected with the requirements of the client
- *Recommendations*
    - Make recommendation based on the overall impact of cost, project schedule, and aesthetic appeal of the alternate system

Expected Results:

Overall the results of this analysis are expected to be positive. There is a fantastic opportunity to reduce the cost of the project by utilizing an alternative façade system to the precast concrete system in place. It is also possible that the schedule can be accelerated. In addition, the overall impact the alternate system will have on the structure will be decreased and more simple connections will be created. Moreover the thermal efficiency of the exterior façade will increase with an alternate system.

TECHNICAL ANALYSIS III – VE Analysis of Structural Curtainwall System

Problem Identification:

The main goal of owner in constructing the 900 16th Street building is to create trophy class office space in downtown Washington DC. For that reason the building features a variety of extremely high end finishes on both the interior and exterior. Take for instance the entrance to the church located on the North end of the building (see Building Statistics I for more detail on the floor area designated to the church). This entrance features a 3D structural curtainwall system that happened to be designed in Germany. The glazing itself was fabricated by a manufacturer in the United Arab Emirates. Slow turn-around time on the shop drawings for this extremely complex system created initial delays in the production of the glazing. Further delays in the fabrication process lead to the glazing needing to be air-freighted to the United States for the project to remain close to the planned schedule. This caused a significant up charge on the already pricey curtainwall system.

Background Research:

The glazing for this particular curtainwall system uses a mixture of double pane glass panels. The two main types of glazing that the project specifications call out include clear laminated heat-strengthened low-iron glass and clear laminated heat-strengthened. The cost of this curtainwall system was bid at just below $1.8 million. The cost associated to air-freight the material to the job is not included in that value. Glazing for this curtainwall system is not so specific that it cannot be manufactured by another company.

Potential Solutions:

In this circumstance there is an opportunity to apply value engineering to the glazing system and the manufacturer used by the curtainwall contractor. The glazing used is not specified to be attained from a specific manufacturer only that all types of glazing come from the same manufacturer. Another manufacturer could be used that is closer to the project site in order to reduce the extra costs that were incurred due to project delays.

Methodology:

In order to complete the analyses that I plan to conduct, the following steps will be taken:

- *Research*
    - Conduct research to find a comparable type of glazing and a manufacturer that will provide that glazing
        - Plan to contact DAVIS team to attain the contact information of well trusted glazing contractors

    - Conduct research on supply chain risk management techniques that could have helped mitigate the risks associated with the procurement of the curtainwall glazing
    - Use the collected information to choose a different manufacturer to provide the glazing
- *Technical Analysis*
    - Calculate the cost of the glazing of the structural curtainwall currently used
    - Calculate the initial cost to ship the material to the job site and the upcharge associated with air-freighting said material
    - Estimate the cost of the new type of glazing and the shipping costs associated with it
    - Create a weighted system based on the different risks associated with the procurement of the material
    - Provide in depth analysis on the cost associated with each risk to support or oppose the new glazing and supply chain
    -
- *Recommendations*
    - Recommend a supply chain of the material based upon the weight of each risk and the potential costs and delays associated with each

Expected Results:

It is expected that this analysis will provide a positive impact on the construction budget and schedule. By providing a more efficient supply chain while providing a similar product will hopefully get rid of the upcharges and delays associated with the risks of the current supply chain for the curtainwall glazing.

TECHNICAL ANALYSIS IV – Driving Collaboration with Lean Construction

Critical Industry Issue:

One of the difficulties of the construction industry is getting individuals within a project team to collaborate to achieve a common goal. Collaboration on a construction project creates teamwork and understanding among the various trades. Furthermore, this atmosphere increases the quality of communication on the project and will result in a high quality final project. The issue that the industry is presented with is how exactly a management team supposed to drive collaboration in the field. This question was one of the breakout discussions at the 24th Annual PACE Roundtable. During this breakout it was discussed that one of the main things needed to drive collaboration in field is contractor buy in and creating a sense of accountability. Some of the best ways to do just that are to implement lean construction principles on the job site. The most important of these principles include last planner and collocation.

Background Research:

The areas within lean construction in which the research will focus on include the use of the last planner system and collocation. Collocation entails bringing the entire project team into a single site office so as to create the most collaborative atmosphere as possible. By bringing the team together in a collaborative atmosphere issues that would normally have to travel through several lines of communication to resolve can be solved face to face and confirmed with a confirming RFI. This shortened problem resolution allows work to continue at a more rapid rate. The last planner system and in turn pull planning is a great way to mitigate coordination issues that would typically arise in the field. This lean construction tool allows for contractor involvement in creating the schedule by taking milestones and working backwards to identify the tasks that need to get done to complete them. Contractor involvement in creating the schedule creates more accurate timeline of construction because they are more aware of the duration a particular task will take then the general contractor is.

Goal of Research:

Identify the effects, positive or negative, that using last planner and collocation have on a project. Using that information, develop a plan that the 900 16th Street project team could have used to benefit the project.

Methodology:

Reference Appendix B for draft interview questions concerning the interview of the HHD projects PM

In order to complete the analysis of lean construction tools the following steps will be taken:

- Research
  - Conduct further research on leading practices concerning collocation and last planner
    - Focusing on how these practices increase collaboration and decrease the number of RFI's
  - Review academic studies previously completed on the positive and negative effects of lean construction tools
  - Create an interview containing questions related to the effectiveness of last planner and collocation
  - Conduct an interview with the project manager of the Penn State HHD project
  - Analyze the possible issues regarding implementation of lean principles on jobs where a contractor is only scoped for the interiors or the base building
  - Use the information attained to determine in what ways the 900 16th Street project could have benefitted from using last planner and collocation

Expected Outcome:

It is expected that the research and analysis of said research will show that the lean construction tools of last planner and collocation provide the drive behind collaboration in the field. These tools create a sense of accountability and open a line of communication between contractors that would not have previously existed. In general, the level of collaboration that these lean construction tools create will lead to a significant decrease in RFI's and rework.

Conclusions

The previous pages of this proposal outlined potential areas for improvement on the 900 16th Street construction project. Following the identification of this opportunities for improvement, extensive research and technical investigation will take place to find solutions that will have the greatest impact while keeping or increasing the final quality. Three of the technical analyses that will take place in the Spring 2016 semester will include topics related to constructability, schedule reduction, and constructability. The fourth topic will be a research topic related to a critical industry issue that was discussed during the breakout sessions of the 24th Annual PACE Roundtable.

Appendix A:

Breadth Studies

Breadth Studies

Along with the four depth analyses that are required by this senior capstone project students are required to show their competence of in areas that are outside of their focus within the Architectural Engineering program. In order to fulfill this requirement, two breadth studies focusing in structural and mechanical will be included with the technical analysis that will focus on the redesign of the exterior façade system.

Structural Breadth

The first breadth study that will be conducted is within Technical Analysis 2, the redesign of the exterior façade system. Upon changing the exterior façade the loads that are applied to the cast-in-place structure will change. A dead load analysis will be completed to ensure that the structure will be able to support the alternate system that is selected. Furthermore, an analysis of the effect of the wind load will be completed on the alternate system. If the analysis yields that the proposed alternate system cannot be supported by the current structural design then another façade system will have to be selected. Also, the current connection method will be analyzed to see if is able to support the alternate system. If the connection method does not meet the needs of the alternate system a new connection method will be designed.

Mechanical Breadth

The second breadth analysis will have a mechanical focus and again be a part of the depth concerning the redesign of the exterior façade system. The main focus of this analysis will be to evaluate the mechanical properties and thermal efficiency of the alternate exterior façade system selected. Thermal efficiency and mechanical properties of both the alternative system and the current system will be compared. Overall the goal of this mechanical breadth is to ensure that the new system preforms better than the system that is already in place.

Appendix B:

Analysis IV Draft Interview Questions

Draft of Interview Questions

1. In your opinion what is the most difficult part of implementing last planner and collocation on a project?

2. What do you think are the most positive impacts of last planner and collocation?

3. Do you think that these practices are key to driving collaboration into the field? If so, How? If not, what else needs to be done?

4. What parties are the most important to collocate for a typical project?

5. Do you see using collocation and or last planner as an additional cost to the project?

6. If so, does this premium outweigh the costs associated with mitigating possible risks that may arise during construction?

7. Taking into consideration the added costs, is it of utmost importance to have a full-time architect or engineer on site?

8. If no, what is that appropriate amount of times per month they should be on site?

9. Do you think it is easier or more effective to implement collocation and last planner on a project whose scope includes both the base building and interiors or a project that is only base building or interiors?

Appendix C:
Project Timeline

900 16th Street Spring 2016 Timeline

	Milestone 1 - 22-Jan			Milestone 2 - 12-Feb			Milestsone 3 - 4-Mar				Milestsone 4 - 1-Apr		
12-Jan	19-Jan	26-Jan	2-Feb	9-Feb	16-Feb	23-Feb	1-Mar	8-Mar	15-Mar	22-Mar	29-Mar	5-Apr	12-Apr
Research Alternate Façade Systems													
		Implement Alternate Method Chosen											
			Complete Mechanical and Structural Breadth Studies										
						Evaluate Results of Alternate System			Develop Final Report				
Evaluate current product supply chain & Research Risk Analysis													
		Develop & Implement Alternate Supply Chain						Spring Break					Final Presentations
				Evaluate Alternate Supply Chain & Risk		Develop Final Report							
		Evaluate Current Formwork System & Research Alternatives											
				Analyse new system chosen & evaluate results		Develop Final Report							
				Research Critical Industry Issue									
						Evaluate Results of Research Methods			Develop Final Report				
Revise Proposal													
										Finalize Report			
											Create Presentation		