ARNE KVINNESLAND | CONSTRUCTION MANAGEMENT

Technical Report #3

Alternative Methods Analysis

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Executive Summary

The following report focuses on developing research topics for further analysis of alternative methods for the various construction methods and design features of the Army National Guard Readiness Center. To develop a better understanding of the project and some of the issues that have been faced during construction and what kind of planning is being done for upcoming challenges an interview was conducted with the project management team. The topics covered in the interview were constructability challenges, schedule acceleration scenarios, and value engineering ideas for the project.

Some of the major constructability issues faced on the project were:

- Dealing with a small, congested site. This required a large amount of preplanning and coordination when dealing with things like material layout and storage, truck paths during excavation, and deliveries to the site.
- Constructing the secant pile wall at the parking garage. This is a unique system and a new experience for much of the management team. Coordinating trades to allow enough space for the large pieces of equipment needed to install the wall was challenging.
- Lowering the high water table on site to allow for excavation. Extensive dewatering systems were used to combat this issue.
- The major stairwell in the main building has a large amount of trades working in the space and requires extensive coordination.
- Managing a project involved with both LEED and BIM using a project team with limited experience/knowledge in both. Educating the team and putting plans in place for success were critical.

The topics chosen for further analysis into alternative construction methods are:

- Dealing with project deliverables at the end of a BIM project. Many owners are unaware of the capabilities of BIM and what they should ask for as a deliverable. There are many benefits to the owner by using BIM on their project and few are aware of the full extent of those benefits. A survey can be done to see where the industry is now which can be compared to a list of benefits developed at the university.
- How to work with subcontractors who are unfamiliar with the BIM process or incapable of doing in-house 3D models of their systems. Developing a management plan on how to implement BIM early on in the process can save both time and money later in the project.
- Redesign of the complex curtain wall system on the project to eliminate the architectural precast or replace it with photovoltaic panels to help with the large electrical power load required to run the building.

- Developing a different soil retention system than a secant pile wall that can save time and money during the installation process by simplifying the system and creating something that everyone is more familiar with.

These ideas are being submitted to give an early idea of what kind of research topics can be done during the rest of my thesis. A proposal will be developed for my thesis after receiving feedback on these ideas.

Project Management Team Interview

An interview with the project management team on site at the Army National Guard Readiness Center was conducted asking about constructability challenges associated with the project, scenarios where schedule acceleration could take place if needed, and whether or not any value engineering was done on the project and, if so, how it took place.

Constructability Challenges

One challenge that the project team faces every day is dealing with a small, congested site. Site logistics for the project are very important and are a constant focus of the construction management team. There are roads along the north and west sides of the project and it is very important to affect local traffic as minimally as possible. There is a lot of excavation involved with this project so during that phase of construction there were constantly dump trucks coming and going from the site. At the main building this was not much of an issue with traffic, but at the parking garage site on the north end of the project site the team faced issues of dump trucks getting backed up along the public road outside, especially early in the morning. The garage site is much more congested than the main building so there was only enough room for the excavators and 3-4 dump trucks in the hole at a time. Truck runs had to be timed and coordinated very closely to minimize impact on traffic patterns around the site.

Due to site congestion and lack of space, there is minimal room for layout and staging areas, especially at the parking garage. The parking garage is cast-in-place concrete for the underground exterior walls and the mat slab and precast concrete for the interior columns and slabs. The delivery of the precast will need to be timed and monitored closely and will require a large coordination effort on the part of the project management team. Deliveries must be made to site and pieces placed directly after being lifted off the truck so as not to impact the site more than needed. This will be a key factor in making sure that the project stays on schedule at the garage.

The secant pile retaining wall located at the garage was also a big challenge for the project management team. The secant pile wall could not be installed as originally designed so the secant pile wall subcontractor redesigned the wall to make it possible to construct. The team ran into issues with the submittal of the new secant pile designed but the owner finally agreed after receiving a credit on the original design. The secant pile wall is located within 6-10 feet of an existing parking garage structure so there were coordination issues and safety concerns during the entire construction process. Vibration was also a major concern during the construction of the secant pile wall and had to be monitored, with installation techniques put in place to minimize vibration and impact on the nearby structures.

At the main building site, there was a high water table. Due to the large amount of excavation on the project, the water table had to be lowered and kept low throughout construction. Dewatering

at the main building was a big concern and a challenge for the project team. Dewatering is important for sheeting/shoring operations and the excavation process and this was something that was carefully monitored by the project team.

The major stairwell in the main building will also be a major constructability challenge for the management team. There is a lot of material going into a small amount of space, from steel to concrete to MEP systems, so this space is a coordination challenge. As the work is being constructed, the steel in the stairwell must be placed along with the concrete of the structural system for the main building so these two trades must work hand in hand to coordinate their work. If something is missed or the schedule lags during this phase, there will be large impacts as the project continues.

LEED and BIM are both being used on this project, and while these concepts are not as new and unknown as they used to be, for many of the subcontractors and some of the project management team this is their first project dealing with these two components. Educating everyone involved on many of the challenges associated with LEED and BIM require extra coordination and more planning for the project team and these two items were mentioned by the project team as general construction challenges that will need to be managed efficiently and effectively throughout the entire project duration.

Schedule Acceleration Scenarios

At this point in the project, the management team does not have any plans to accelerate the schedule. If the owner requests acceleration of the schedule, the project management team will do so as long as the owner picks up the cost. If schedule acceleration is required, it is easier to do so early on in the project during excavation, sheeting/shoring, and concrete. The project is past those phases and any acceleration that would be attempted now would be very risky. There are very complex MEP and curtain wall systems associated with this project and accelerating rough-in phases for those systems would be very challenging and expensive. One area where it would be possible to accelerate the schedule would be on temporary dry-in and inside air for the building. Dry-in for the building will be occurring during the summer months and with a glass façade letting in sunlight, the building is going to be extremely hot. Temporary air to cool the building and allow the installation of finishes will be absolutely critical and this is one area where the team would have an opportunity to accelerate the schedule if the cost was picked up by the owner.

Currently, the critical path items on the schedule include rough-in for all of the MEP systems, dry-in for the main building, drywall framing for the ceilings, electrical device installation, painting, lighting fixtures, and punch list completion.

Value Engineering Topics

There was no value engineering done by the general contractor for this project. It is a lump sum job and the design was already completed for bid by the general contractors. Value engineering is usually seen on Gross Maximum Price (GMP) projects. The owner benefits from value engineering on a GMP project because they get a percentage of the savings. The general contractor also gets a percentage which goes into the contingency pot for the project. This gives both the general contractor and the owner motivation to explore options where money can be saved. For a lump sum project like Army National Guard, substitutes are always a bad idea. No incentive on the side of the owner or general contractor. All substitutes do is expose the general contractor to liability.

Problem Identification

Project Deliverables and BIM

One advantage of using BIM on projects is that via the BIM process an electronic set of deliverables is created in addition to the paper documents. Many owners are unaware of the many advantages of BIM for them after the job has been completed and so they do not know what to ask for in addition to the standard as-built drawing deliverables at the end of a project. Electronic files can be given to maintenance crews throughout the life of the building and give them a much cleaner, easier way to access the building files and drawings than dealing with paper documents at all times. This is just one application of electronic deliverables upon project completion. What other applications does BIM have when dealing with project deliverables? What are some other options for owners? What should an owner ask for and expect from BIM outside of the time/cost savings during the coordination process? Many owners do not know what BIM is capable of and how they could benefit from paying for BIM on their projects. Compiling a list of what can be done and what should be expected to provide owners with a better idea of what can be done would be benefit owners and make them more willing to pay for BIM on a project.

BIM Implementation and Educating the Project Team

Implementing BIM on a project is sometimes very difficult if the project team is not experienced with the process, the software, the strengths and weaknesses of BIM. There are still many subcontractors who are not familiar with BIM and do not have the in-house capabilities to provide 3D modeling of their systems let alone use some of the more complicated and in-depth software associated with BIM. How does the project management team deal with difficult subcontractors? If BIM capabilities are built in as a requirement during the bidding process for subcontractors, how do you deal with subs that claim they have BIM capability and then struggle once the project starts? This can create big issues with the coordination process and can create lag in the schedule due to lack of coordination of their systems. How does a general contractor or project management team set up a plan to implement BIM effectively on a project and deal with all of the challenges that arise?

Curtain Wall Systems

The Army National Guard Readiness Center has a complicated façade system, a mixture of architectural precast panels and curtain wall glass. The interaction between these two systems creates coordination issues beyond a standard curtain wall façade on a typical building. This is something that needs to be coordinated and planned ahead very carefully to avoid schedule issues when this phase of construction is reached.

Large Electrical Loads Required

The Army National Guard Readiness Center is full of the most modern technical equipment that money can buy. With operations centers, training centers, a large number of server rooms, and with general lighting requirements for the building being high, the electrical load that this building will require is large. The project is schedule to receive a LEED Silver rating but is close to a LEED Gold rating, missing it by a small number of points. Finding a way to incorporate photovoltaics into the building to generate some of its own power and help minimize the energy impact it will have may be enough to achieve that higher rating.

Secant Pile Wall Construction

A secant pile wall is a permanent soil retention system that many subcontractors and project management teams are unfamiliar with. There are unique installation procedures and techniques that need to be used to correctly install a secant pile wall. Many subcontractors need special direction and training to successfully install their first secant pile wall. There is a lot of room for error and if mistakes occur, the schedule can be impacted. Even if a secant pile wall is installed correctly with no issues, the time needed to construct a secant pile wall versus a more simple soil retention system is much larger, creating a longer schedule. This also means that more money is being spent on general conditions, labor, and equipment.

Technical Analysis Methods

Project Deliverables and BIM

Owners and even some project management companies are unaware of some of the capabilities that BIM has when it comes to project deliverables. Research will first have to be done to compile a list of all of the possibilities and items that can be considered a project deliverable and why an owner or contractor would want to take advantage of these features. The next step is to find out how educated the average owner and contractor are, where the level of expectation is right now when it comes to deliverables, and to come up with a list of what are thought of as "standards" in the industry. This step can be accomplished by setting up a short survey and talking to owners and contractors throughout the industry. Surveying five to ten different types of contractors and owners can provide us with a quick idea of how educated the average industry professional is on BIM. Finally, a comparison of the originally compiled list of possibilities to the results of the survey will give us an idea of where the industry stands now and what some of the steps to further educating the industry about BIM will be. This idea was given to students at the PACE Conference in October by the attending industry professionals as a possible research topic for thesis and I believe it to be an important one.

BIM Implementation and Educating the Project Team

The most difficult part of successfully running BIM on a project is the start-up phase and laying the foundation of how BIM will work throughout the duration of the project. This planning phase needs to establish a set of guidelines and standards that the entire project team, including designers, project managers, and subcontractors, will need to follow and adhere to to successfully complete their goals. BIM is still relatively new in the industry, although it is gaining in popularity and more contractors and subcontractors are capable of BIM than ever before. However, there is still a long way to go before BIM becomes a standard in the industry.

Many subcontractors do not have BIM capabilities and will struggle throughout the coordination process to keep up with their fellow subcontractors, possibly causing scheduling issues since the original schedule would be created assuming full BIM capabilities. BIM capabilities are now being built into contracts with the subcontractors when the project is awarded to them. How does the project team handle a subcontractor who claims they are BIM capable and then is unable to carry their own weight? This was something that the Army National Guard Readiness Center project team struggled with and after spending a summer as an intern on site working with BIM every day, it was very apparent that what is taught in the classroom about BIM is not what is happening in the industry. Many of the challenges and issues that were faced by the ArNGRC project team could have been avoided by earlier planning and a stronger plan for implementing BIM on the project. This will be a research topic into how these plans should be developed and

implemented on site for a project looking to succeed with BIM and after spending an entire summer dealing with these issues it is a topic of high interest for me.

Curtain Wall Systems

Curtain wall and exterior façade systems are always a critical path element of a construction schedule. The installation needs to be completed correctly and as early in the project as possible to get the building dried in. Curtain wall systems are relatively expensive and can be difficult to construct if the system varies throughout the building. ArNGRC has a fairly unique and complex façade system, with curtain wall glass mixing with architectural precast. The project management team has had issues with the curtain wall design already and the coordination process has been challenging. By taking a more uniform approach to the curtain wall system design and reducing the number of complicated elements, both time and money can be saved. Eliminating the architectural precast and replacing it with glass curtain wall will create a more uniform approach to constructing the system and make coordination and planning more simple.

Large Electrical Loads Required

Incorporating photovoltaic systems into this building will be a challenge. The roof is already covered in mechanical equipment. The idea for this analysis sprung from the above curtain wall analysis: instead of simplifying the curtain wall system, find a way to eliminate the architectural precast and incorporate photovoltaic panels in its place. This would not greatly simplify the construction of the curtain wall so most likely a negligible amount of time would be saved. It may also cost more to incorporate this system into the building that using architectural precast, but the return would be much greater in the end. Running an analysis of how much power a system like this could generate for the building, calculating the cost of this system, and analyzing schedule impacts will all be key features of an analysis like this.

Secant Pile Wall Construction

The construction of the secant pile wall was a major challenge on the ArNGRC project. For most of the project team this was a system that they had never been involved with, so there was a learning curve associated with the planning and preparation for this system. Time needed to be allotted in the schedule for practice runs at drilling each of the different pile types. This created more cost. Once construction began there were numerous problems early on in the installation, with the concrete piles already drilled and poured and needing to be drilled out again. Drilling through the already poured concrete after a mistake had been found caused problems with the drilling equipment being damage and drill bits being broken, causing more delays as new bits were delivered to the site. The original schedule was also very long due to the fact that it takes a long time to construct a secant pile wall retaining system.

Performing an analysis of why the secant pile wall was chosen to begin with and seeing if there are any possibilities for a simpler soil retention system that can achieve the same goals could

have saved the project team a lot of time on their schedule along with a lot of money. Structural loads will need to be calculated for the new system along with impacts of cost and time adjustments to the schedule.