Technical Report III

Rendering courtesy of DAVIS

The Office Building

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Executive Summary

This technical report is an alternative methods analysis on The Office Building. This report contains schedule acceleration scenarios, value engineering topics, critical industry topics, and research feedback from the PACE roundtable conference.

To discuss any schedule acceleration scenarios, the critical path is first analyzed. In the case of the Office Building, the critical path is as follows: demolition, excavation/support of excavation, concrete structure, façade, core finishes, and the final inspection. With the critical path defined, the risks must be identified. The risks for this project include obtaining the raise permit required to finish demolition and the unknown location of the neighboring foundation and the required changes associated with it. After the risks are described, acceleration scenarios are discussed. These scenarios include adding additional crews to the concrete work, beginning the façade installation sooner, and beginning finishes sooner with the aid of weather barriers or the use of weather resistant materials.

Because both quality and cost are important to the owner, there were major discussions about value engineering and what was truly required in the building. In an effort to save the owner some money, the following changes were suggested and approved: changes to the requirements for the glass curtain wall, eliminating a rain collection cistern on the roof, replacing epoxy coated reinforcing in select locations, switching insulation for a less expensive alternative, and using fluorescent lighting instead of LED in select locations.

The critical industry topics and research feedback, both of which came from the PACE roundtable, discuss designing for construction safety, the delivery of facility management information to an owner and research topics such as cast in place concrete versus shotcrete.

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Schedule Acceleration Scenarios

Along with cost and quality, the schedule is a very important factor to the owner of The Office Building. The critical path is the main baseline for the 22 month schedule of the project. The activities on the critical path have been classified into six main groups shown in figure 1 below:

Figure 1. Critical Path Diagram

Because the building has a relatively small building footprint, the schedule was not organized by area or wing, but by construction activity instead. As previously mentioned in Technical Reports 1 and 2, a nine story steel framed building had to be demolished at the beginning of the project. Once the building was demolished, excavation could start, and along with it, the complicated support of excavation that was required at this site. Upon completion of excavation, the pouring of concrete can begin. While the top floors are finishing up with concrete, the façade will start on the lower levels. Once the façade is complete and the building is weather tight, the finishes may begin. Upon completion of all prior activities, the building will go through the final inspection before the building turnover.

| Schedule Risks |

One of the biggest risks to the completion date came from the demolition process. To demolish the steel structure of the remaining building, the raise permit was needed. For the raise permit to be obtained the utilities needed to be capped and the abatement of all asbestos needed to be completed. Unfortunately, the team kept finding more asbestos. For this reason, the raise permit was not issued when originally planned and the delay of the structural steel pushed the schedule back by six months.

Another schedule risk the team experienced would be finding the neighboring foundation while excavating. Figure 2 shows the neighboring foundation two feet over the property line as well as a buttress in the foundation that was taken out. This finding caused a design changes to the secant wall and foundation wall. The new design increased the size of the secant wall to support the weight of the neighboring foundation. In order to offset this change, the thickness of the foundation wall had to be reduced, keeping the West wall the same thickness.

Figure 2. Neighboring Foundation | Courtesy of DAVIS

| Acceleration Options, Costs, and Techniques|

The repetitive design in the floor plans helps accelerate the framing, reinforcing, and pouring of the floors. Because concrete needs certain time to cure, the acceleration will come from the familiarity in the form and reinforcing layout. Also, more crews will get the forms and reinforcing placed faster, however, there is a fine line where the concrete curing time may take too long leaving crews to wait, and increasing inefficiencies. Although, the use of more crews will increase the cost it is a better scenario than overtime in that the workers will not be overworked.

Another acceleration option would be in the façade phase. If the lower portions of the façade can begin installation earlier while the top of the structure is still being poured, the core finishes can then, in turn, start sooner. Since these are separate specialty contractors, the only extra costs associated with this option would be for safety reasons such as nets for fall protection as there will be concrete workers overhead.

If the façade cannot be rushed, temporary barriers may be used to get the building weather tight before the façade is completely installed. This method would still let the core finishes start soon, advancing the critical path. The design team may also choose materials that can be installed before the weather tight milestone; these materials will increase the cost of the finishes. Like with the façade option above, there would be no extra man power costs for this option; the barriers, however, would require rental costs.

Value Engineering

As mentioned previously, cost is a large concern of the owner. For this reason, the project team met with the owner and discussed where extra cost could be taken out while still obtaining goals for LEED Gold. Together they were able to come up with a list of items to discuss.

With the majority of the façade being a curtain wall of glass, there was much concern with the glazing. Originally, the glass was to go through a heat soaking treatment under the European Union Standard EN14179 to eliminate inclusion related glass breakage. It was determined that replacement cost of broken glass would be cheaper than heat soaking all glass panels. Extra lab testing of the glass panels were also thrown out. These decisions saved the owner almost $150 thousand.

In original design documents, there was a rain collection cistern on the roof. This was to feed water closets and urinals throughout the building. It was decided that the cost of installation was too high and with LEED Gold still being able to be achieved without the cistern, it was taken out of the plans.

The following are some small decisions that helped the owner save on cost:

- The reinforcing in the garage with enough coverage was switched from epoxy coated rebar to plain rebar.
- Paper faced insulation was replaced with foil faced insulation throughout the building.
- LED lighting was switched to Fluorescent in most areas except where the LED's were incorporated into the architectural design.

Some of the changes the construction team recommended, however, were not well liked by the design team. There was a want to decrease the amount of variable air volume devices on each floor, but do to the lack a tenant the owner wanted as much accessibility as possible. The construction team also proposed a change to exterior and interior stone as well as the glass feature wall in the lobby. Both of these propositions were rejected. It was decided by all parties involved that the appearance of the building was still a concern.

Critical Industry Issues

This year marked the 22nd annual PACE (Partnership for Achieving Construction Excellence) roundtable, held on November 7, 2013. The roundtable, whose topic for the year was "Whole Project Delivery," brought together Penn State faculty, Penn State Architectural Engineering students, and industry professionals. The day started out with an update on PACE and news in the AE program, after which was the first breakout session to discuss industry issues. There was a guest lecturer after that, followed by lunch. The afternoon consisted of another breakout session followed by group meetings between students and industry professionals to discuss research ideas.

| Breakout 1: Prevention through design |

The first session I attended was led by Dr. Rob Leicht. The topic discussed how to design for construction safety. It was discussed that design teams do well to design for occupancy, but lack the knowledge to design for it during construction. Education was brought up many times throughout the discussion. Whether it is knowledge of OSHA regulations or even knowledge of operations, it seems design teams are severely lacking the expertise. Some people were talking about more regulations, which didn't really go over well. This just seemed to raise more questions about who to regulate, what to regulate, and who would enforce these regulations. One huge issue that kept reoccurring was the issue of litigation. If the design team incorporates safety into their plans do they them become responsible for any safety failures? It seems that this very question is what's keeping designers from pursuing construction safety in their designs. Although no one wants to take the blame when an injury happens, the overall feeling coming out of this discussion is that designers need to be better educated about safety.

| Breakout 2: Efficient Delivery of Facility Management Information |

This breakout session was about the efficient and inefficient aspects of the delivery of facility management information to owners, led by Dr. Ed Gannon and Dr. Craig Dubler. To begin understanding what information to deliver, the owner and their needs must be defined. By understanding the owner's needs, only the wanted information can be delivered, saving the owner from trying to decipher piles of unneeded information.

With the new technology in the industry, there are many new capabilities for owners to use information after turnover. However, what many people don't realize is whose using the information. Many maintenance workers don't understand computers, let alone the difficult programs we use in our industry. In today's society everybody is trying to get rid of paper and move to computers, but for these maintenance workers, paper is what they know, and what they use. For them it is much easier to look on a sheet of paper to find when a filter needs changed and write down the next time the task will need to be done. Many people feel that we need to train the workers to use the complex computer programs, but do they really want to be trained?

They have a system that works, and in their eyes, if it's not broke, you don't fix it. We can teach them everything we know, but anybody who doesn't want to learn isn't going to retain the information, and in the end we spend a lot of money on a model that will never see use. This scenario does not apply to all owners though. There are workers out there that do understand these models and use them to maintain their buildings; for this reason we must analyze our owners and have more discussion with them about this topic to find out exactly what information they need and on what media they need the information.

Industry Feedback

After the second breakout session I met with Bill Moyer from James G. Davis Construction to discuss research topics for my thesis. To analyze cost and schedule, we discussed the secant wall the team had to deal with and compared it to slurry walls we have learn of in class. Another idea we had of speeding up the schedule was to look into prefabricated drywall corners. Not only would workers no longer have to piece together drywall pieces, tape, mud, and sand the corners, but the end finish would be a seamless corner without defects. Mr. Moyer also suggested I look at roof and storm drains for a sustainability aspect. Lastly, for a structural breadth, we discussed replacing the cast in place concrete foundation walls with shotcrete walls. Not only would this propose a change in the structure, but by eliminating the work required to form around all support of excavation locations, this shotcrete would accelerate the schedule.

Appendix I: Technical Analysis Options

Analysis 1 | Foundation Walls

With the extensive support of excavation (SOE) that The Office Building entails, many complications may arise. One area of concern is with the installation of the foundation walls for the first three levels of parking. Originally these walls were design to utilize cast-in-place concrete. The trouble with this design is the complex formwork. The whales in the SOE are anchored into each pile, which were driven seven and a half feet apart. Each anchor point would require formwork to surround it and the formed hole would need to be grouted in later.

This analysis will investigate the impact substituting the cast-in-place foundation wall with shotcrete has on both the scheduled duration and the cost of the foundation walls.

Analysis 2 | Neighboring Foundation Support Wall

With The Office Building having three levels of underground parking, the need arose for supporting the neighboring foundation. The original design for this support was a wall formed by secant piles. This is an intricate process of drilling and pouring female piles and coming back a few days later to drill and pour the male piles; one that requires much back and forth positioning of the drilling rig. This constant repositioning of the drilling rig caused unforeseen schedule delays. The second analysis will compare the duration of this process with one required for a slurry wall.

Analysis 3 | Prefabricated Induced Schedule Acceleration

Early on in the project, the raise permit, which allowed for the demolition of the previous structure, was delayed by five months which pushed the entire schedule back. Throughout the project, many changes were introduced to accelerate the schedule. The purpose of the third analysis is to assess the acceleration of the schedule with the use of prefabricated drywall corners. These components would eliminate the work time involved in taping, sanding, and finishing all corners of drywall comprised walls.

Analysis 4 | Value Engineering

With cost being of such high importance to the owner, value engineering was a critical task for the project team. The unexpected costs associated with the unforeseen obstructions during excavation demanded another look at value engineering. The fourth analysis looks at three separate items for value engineering. The first being the substitution of bus duct for much of the copper wiring. The next item involves replacing the domestic water copper plumbing with PEX piping. Lastly, the steel sprinkler pipe will be replaced by cpvc pipe, a less expensive alternative.

Structural Breadth

The shotcrete comprised foundation walls, as detailed in Analysis 1, provide an opportunity to apply research and analysis outside of construction management areas. Load calculations will be computed to determine how the shotcrete withstands the same loads as the cast-in-place concrete walls. If any reinforcement is required, the change in both cost and time will be added to the price and time subtracted by the lack of formwork.

Electrical Breadth

Bus duct is run only vertically through The Office Building. Analysis 4 will look at substituting horizontally run bus duct in for large sections of wiring. In order to do this substitution, loads will be calculated and bus duct will be sized accordingly. Consultation with industry professionals will assist in creating an efficient system.