REDLAND TECHNOLOGY CENTER

540 Gaither Road, Rockville, MD

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Construction Management

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3.1 EXECUTIVE SUMMARY

This technical report has been put together to familiarize the reader to the Redland Tech Center project in Rockville, MD. This tech report includes the results from an interview with the project manager of the project on the topics of constructability challenges, schedule acceleration scenarios, and value engineering topics. Also, I have listed some problems and issues that I've observed on the project and identified 4 construction management topics that I may do my research on for AE Senior Thesis.

Highlights of project manager interview:

Constructability Challenges

- Caissons hit rock during drilling
- Site location
- Parking garage construction

Schedule Acceleration Scenarios

- Accelerate interior trades at $150,000 per month saved on schedule

Value Engineering Topics

- Clark saved Perseus almost $1 million in their VE efforts

My observations and potential technical analysis::

- MEP coordination
- Façade
- Phasing of parking garage
- Bathroom mockups

3.2 CONSTRUCTABILITY CHALLENGES

Through an interview with Jim Martinoski, Clark Construction's Senior Project Manager for the Redland Tech Center project, many constructability issues were identified. Of all the constructability issues for the project, the three main issues are as follows: unexpected rock formations discovered during caisson drilling, construction logistics due to the site location, and phasing of construction for the precast parking garage.

Caissons

Rock formations were discovered approximately 15' below grade in ¼ of the caissons during the drilling and installation of the 46 caissons for Building 2. Whenever the drilling team found these rock formations, they were not able to easily drill the 30' average depth required by the design. The soil geotechnical report did not show rock at this level. After consulting with the geotechnical engineer, the caisson subcontractor drilled a 2" pilot hole in the caissons where rock was discovered to determine if they had hit bedrock or a rock outcropping. The project team determined that the rock found was stray rock formations and was not suitable for foundation bearing. The caisson contractor was directed to continue drilling the caissons to the depth required by the design. Drilling through the rock was naturally slower than drilling through the soils expected from the geotechnical report, a mixture of silt and clay. The completion of the caissons was delayed 3 weeks. The owner issued a change order for $30,000 to the caisson subcontractor for the additional time and expense of drilling through the rock. Fortunately the steel erection subcontractor was able to shorten the scheduled duration of steel erection by 3 weeks by having all the materials fabricated and ready to be erected and through learning curve efficiency gains. This means there were no overall schedule gains to the project duration due to the rock outcroppings.

Site Location

The location of the Redland Tech Center site, in a mixed-used community, led to many problems for the project team. The main issues the project team faced with the site location are site utilization and logistics, sharing a site with an occupied office building next door, and sensitivity to the surrounding community.

With an overview of the site, it seems there is plenty space for construction activities but, due to the large soil stockpile in the southeast corner of the site, space for construction activities is limited on the site, especially for a suburban project. Construction activities such as crane movement and material deliveries are limited to about 20' around the perimeter of the buildings. There is some lay down space south of Building 3, but not enough to allow subcontractors to store materials for long term. The project team was able to manage the site

by coordinating deliveries and construction activities with subcontractors. Materials were delivered to the project site as they were needed and placed directly into the buildings. Deliveries of materials were coordinated around the work schedule of other construction trades. An example would be stocking the floors of the buildings with drywall material on Friday and Saturday, days that the precast façade erectors were not working because they worked four 10 hour days Monday thru Thursday.

The occupied office building in the same complex as the construction project posed many issues for the project team. Clark wanted to have as little impact on the occupied building as possible. To make matters even more complicated, the owner of the building and tenants had no relation to the owner of the construction project, so they had no vested interest in the construction project. Great care was taken by the project team to keep complaints by the occupied building to a minimum. Flow throughout the complex was split between construction activities and office building tenants, construction deliveries and workers were to enter from the Gaither Road entrance and office tenants were to enter from the Redland Boulevard entrance. Please see *Figure 1* below for the exact areas that were deemed construction and tenant areas.

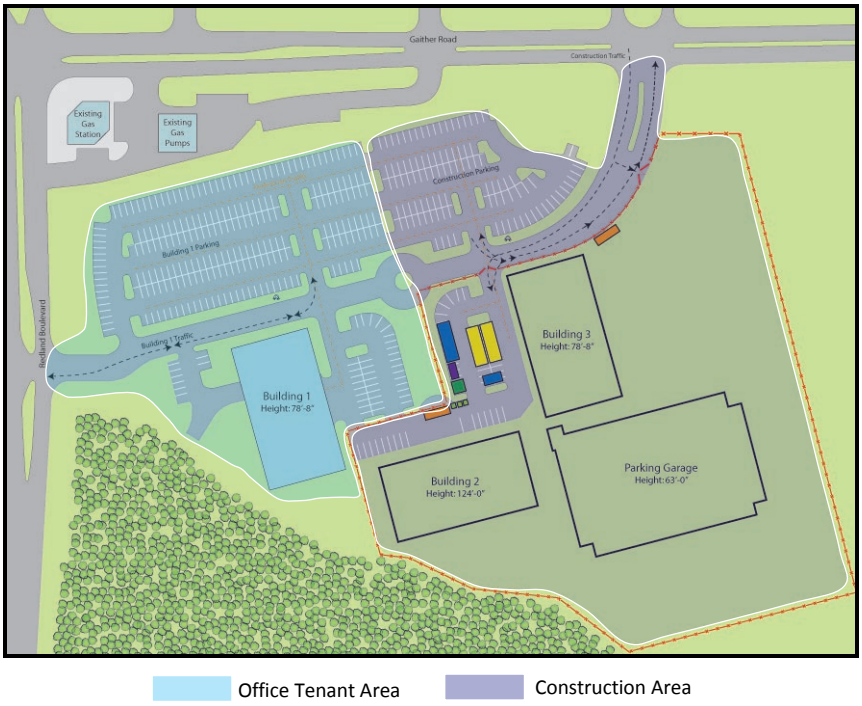

Figure 1 – Separation of Tenant and Construction Areas

The separation of spaces was strictly enforced by Clark so that inconveniences to the office building tenants were kept at a minimum. To ensure good communication between Clark and

the building tenants, the building manager of the occupied building was invited to all bi-weekly owners' meetings. This allowed the project team to inform the building manager of the upcoming activities on the site and enabled the building manager to voice any concern he had with the project.

Clark Construction needed to be sensitive to the surrounding mixed-use community when it planned the construction activities. Noise ordinances are in effect between 7pm and 7 am through the weekdays and between 5 pm and 10 am on the weekend. There were a few instances when subcontractors were working during the noise restriction hours and complaints were made by the community. Clark notified the noise violating subcontractor and insisted on noise limit compliance. Site security was very important for the project. There are many kids living in the surrounding community that could wander on to the dangerous construction site and get hurt. Clark made it a nightly responsibility of an employee to walk the site fence and make sure there were not any damages to the site fence that could allow trespassers access to the site. Signs were used stating the hazard of entering the construction site.

Parking Garage Construction

Clark Construction constructed the precast parking garage in two phases. This was done because of two reasons, the size of the parking garage and the close proximity to surrounding buildings. The parking garage is 175'x319' and 6 stories tall, 1 of which is below grade. If the crane was located on the outside of the garage perimeter, the crane would need to lift the precast members, which weight up to 20 tons, the height and width of the building. This situation would be very cost prohibitive due much more expensive crane rental costs for the bigger crane. Even if a crane was used that could make the picks, there would not be adequate space around the parking garage for the crane to travel. Clark decided it was best to leave the southeast corner of the garage out of Phase 1, including the cast-in-place (CIP) foundation and slab-on-grade (SOG), and erect 90% of the precast members with a smaller crane located in the center bay of the garage basement. Delivery trucks hauling precast members backed down a ramp in the southeast corner and down the east basement bay to the crane. The crane picked the members off the trailers and set them directly in place. Phase 1 was erected from north to south. After the precast erection was finished for Phase 1, the crane was disassembled and taken to another project.

D-F/1-4 line is the area that was part of Phase 2. Whenever Phase 1 was complete, the dirt ramp was removed and the CIP foundation crew finished the foundation walls and poured the SOG in the basement. The concrete crew was still on site so they did not need to remobilize. Whenever the CIP foundation was finished, another crane was brought on site to erect the remaining 10% of the precast members from outside the perimeter of the parking garage.

There was a 60-day gap in the erection of the two phases of precast members. It was decided between by construction manager that there were not any additional remobilization charges for bringing a second crane to the site to erect the final pieces of precast. Clark decided this because of the savings by the precast erector on their crane rentals for a smaller crane working from the basement of the garage. Please see *Figure 2* below for the exact areas of Phase 1 and 2.

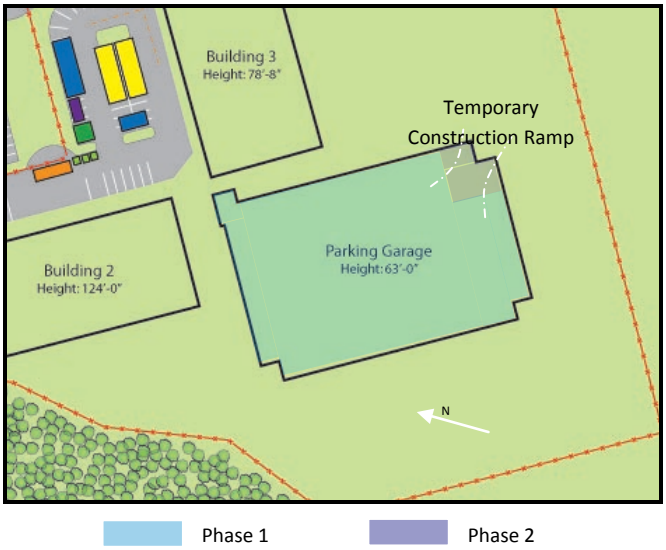

Figure 2 – Phase 1 and 2 Areas of Construction

3.3 SCHEDULE ACCELERATION SCENARIOS

As with most construction projects, the structure, building enclosure, and elevators are on the critical path of the project schedule. The timely completion of these major areas of work are milestones that allow the next type of work to commence. Getting the foundations placed and the steel structure erected were activities that Clark put great effort into completing as planned. Clark hired the structural steel fabricator very early, actually before Clark had a signed contract with the project owner, to ensure that the steel would be delivered by the time steel erection needed to start. Whenever the project site was delayed by the caisson installation, time lost was easily recovered by the steel erector because the steel completely fabricated and ready to be erected. The erector was able to erect the entire steel structure 3 weeks faster than the 3.5 months originally planned for it to take.

The completion of the building enclosure is on the critical path because interior finish trades cannot start their work until the building is watertight. Clark considered accelerating the schedule of the roof to make the buildings partially watertight. With the roof watertight, interior work on the core of the buildings could start early. If Clark had decided to go forward with this schedule acceleration technique, approximately 2 months would have been saved in the overall schedule. In this scenario the MEP, sprinkler, and drywall subcontractors would need additional manpower to meet the accelerated schedule. Clark estimated it would have cost $150,000 to accelerate the schedule of the roof and interior core work. In the end, due to the costs and the needs of the owner, it was determined to complete the work as originally planned.

The construction management team decided to accelerate the schedule of window installation. The main reason to do this was weather related. Clark felt it was worth having the building weather tight as cold weather set in during November. Clark was able to finish the installation of all the windows in the building 2 weeks early. They accomplished this by directing the window subcontractor to work overtime and Saturdays. Clark paid the window subcontractor $25,000 for their overtime work.

One important aspect to completing the schedule on time is keeping subcontractors on pace to deliver their work when needed. Clark closely worked with all of its subcontractors to ensure schedule compliance, but none of the subs was more important than the elevator subcontractor. The 20-man crew the elevator sub costs approximately $10,000/day. Any time saved in the duration of installing the elevators, or conversely a time increase, can directly impact the bottom line of the project.

Interior finish trades have the most room to accelerate the schedule at this point in the project. If it was determined by Clark that the schedule needed to be accelerated, additional crews or overtime hours could be worked to either catch the schedule back up to the planned schedule or deliver the project earlier. There would be increased costs due to the overtime work and extra management needed to coordinate the additional work. Clark estimates it would cost an additional $150,000 each month for the project to be finished ahead of schedule.

3.4 VALUE ENGINEERING TOPICS

Clark's initial contract with Perseus for the entire Redland Tech Center project was $53,739,000. This price includes several allowances for parts of the design that were not completed whenever the first contract was executed, such as bathroom finishes. Through the value engineering (VE) process, Clark was able to reduce the final contract value to $52,800,000, or almost $1 million. Clark was able to reduce the cost of the building but did not reduce the value delivered to the owner. Only the canopy trellis at the top of Building 2 was deleted to save $250,000. All other VE items changed the types and quantities of materials used. Some of the VE items used on the project are below:

- $35,000 was saved on the elevator cab ceilings. The original design had a custom 6-panel design. VE change the elevator cab ceilings to a stock 9-panel design of the same material as the original design.
- $40,000 was saved on the panelization of the elevator cab walls. The same materials for the walls were used, but they were now a prefabricated panel that was brought to site and installed rather than installed piece by piece in the elevator cabs on site.
- Vinyl wall covering was used in less prominent bathroom spaces rather than the ceramic tile specified.
- Similar but less expensive carpet in corridors. Saved $4/sqyd.
- Lights for landscaping and parking areas were to match existing EMCO lights. Subcontractor recommended Gardco products due to similarities and lower cost. Saved $25,000.
- Original landscaping plan too costly, too many new trees. Revised plan had fewer new trees, reused healthy trees on site, reconfigured plan. Saved $100,000.

At a very early point in the project, Clark did a value engineering study on the feasibility to change the structure from structural steel to concrete. It was determined that the structural steel design was $500,000 cheaper than using a cast-in-place concrete structure.

3.5 PROBLEM IDENTIFICATION

I worked for Clark Construction at the Redland Tech Center as a Project Engineer Intern this past summer. During my time working for Clark on this project, I became very familiar with a wide variety of problems that the project team had to solve. I was mainly assigned interior and MEP trade related tasks with only about 15% of my time spent on the structure and building enclosure.

Mechanical, electrical, and plumbing (MEP) coordination for the Redland Tech project was average at best. There were many in field clashes and problems to solve. An example of a problem that occurred in several locations would be duct riser coordination. In the office buildings, there were several duct risers to move air vertically throughout the building. At least half the duct risers had conflicts between the steel structure, openings for the ducts, and wall shafts. Many walls had to be moved and steel beams relocated to accept the duct risers.

The skin of the office buildings is architectural precast panels with ribbon windows and glass curtain wall. Several coordination meetings were needed to begin construction. Issues with the façade system include deciding what each subcontractor owed in their scope of work, acceptability of sealants used to seal joints between the windows and precast panels, and scheduling of work to make the building watertight.

The phasing of the parking garage seemed wasteful and inefficient. The duration of the parking garage construction was 2 months longer due to the phasing. The precast erection subcontractor wanted extra money for the second mobilization and crane setup. While the parking garage will not be used until the project is finished and tenants move into the office buildings, which would be June 2009 at the earliest, it would have been better from a construction management standpoint to complete the building quicker.

Bathroom mockups were a major issue that took several months to resolve. A bathroom mockup was needed early on in the project because the granite countertops were being extracted from a quarry and fabricated in Italy. Whenever the need for the bathroom mockup came about, the design of the bathrooms was incomplete. Many dimensions were missing and issues needed to be resolved. Clark recognized the need to finalize the bathroom details and issued a Request for Information (RFI) to the architect. The architect responded stating that he wanted Clark to construct a mockup but did not give any direction on how to resolve the issue of the bathroom designs. In order build a mockup of the bathrooms from the current design, Clark assigned a project engineer to put together sketches of the layout with possible solutions to the issues with the design. Clark directed the subcontractors to build the mockup out in the field, in an actual bathroom location in one of buildings. To save money, plywood was used in

place of the granite countertops. The process of building the mockup was very time consuming. It took several weeks for the subcontractors to deliver the materials to build it out to the site. The steel supports for the countertops and bathroom partitions took the majority of the time to fabricate but it was also difficult to get the accessories for the bathroom delivered as well. Whenever the bathroom mockup was finished, the architect came out to site, made a few comments and corrections to the mockup, and issued that mockup as the design. By the time this process was complete, all the float time Clark had to fabricate and deliver the granite countertops to the project had been wasted.

3.6 TECHNICAL ANALYSIS METHODS

Four topics that I could possibly complete a construction management analysis on are the following:

1. How could the MEP coordination process been improved?

2. Is there a different façade type that could have met the needs of the project better?

3. Could the parking garage been built in one phase?

4. How could the bathroom mockup been conduct more efficiently?

MEP Coordination

MEP coordination was a 2-month long process that ended with many errors and in field issues to be resolved. I will talk to the different team players and discuss why they feel the process was not more successful. After my interviews, there will be two parts to my research. First, how could the process used been improved to return better results. Second, are there any new types of MEP coordination processes that might have worked for this project. Using Building Information Modeling (BIM) for MEP coordination and clash detection could be a possible tool to improve the results of coordination. I will look at the costs, schedule, potential results, and the ability of the project team to decide how the MEP coordination process could have been conducted more efficiently.

Building Façade

I will look into different façade types that could have been used for the project. Would an all glass curtain wall system better meet the project needs? In this instance 1 subcontractor would replace 3 subcontractors so the coordination issues would be eliminated. I will look into how the different façade types affect the cost, schedule, and aesthetics of the project and determine if a different type would have made sense. The affects of the building skin on the mechanical and structural systems are some things that would be affected by changing the type of skin used for the project.

Parking Garage

I'm not sure that anyone from the project team ran the numbers to determine whether or not it was feasible to construct the parking garage in one phase. I will perform an analysis on crane capacity to see if it was possible to construct the garage from the outside. If I find that there is a crane capable of making the picks required, I will determine how the phasing would affect the costs and schedule.

Bathroom Mockup

The bathroom mockup took a very long time to construct and used all the float time in the delivery time of the granite countertops. I will conduct interviews with the project team to determine if they think there would have been a better way to construct the mockup. One possible solution that I've identified is a virtual mockup using BIM. The project team could have constructed a virtual mockup to visualize the layout of the bathrooms and finalize the design. I will look into the cost and schedule savings. I will also conduct a survey with the project team to determine the appropriateness of a virtual bathroom

mockup. I will need to survey the project team on how effective they think a virtual mockup would be at finalizing the design and if their teams would be able to construct the virtual mockup. I will need to interview individuals outside the project team who have experience with virtual mockups to determine the feasibility of this solution.