Office Building

Washington, Dc

Katey Andaloro

Construction Management

Project Information:

Building Name: Office Building
Location: Washington, DC
Occupancy types: B1 - Business; Commercial Office Building
Size: 529,000 SF, 10 stories
Dates of Construction: August 2006 - April 2009
Base Building Cost: $99,000,000
Project Delivery Method:
Design-Bid-Build

Project Team:

Construction Manager:
Balfour Beatty Construction

Architecture:

- State-of-the-art technology
- Three paver terraces
- Three levels of parking
- Well-located core services
- Flexibility to meet the needs of small, medium, and large space users
- LEED Silver certified
- Direct access to MACR Train Service, Virginia Railway Express trains, Amtrak, Metrobus and Washington's Metrorail
- Offer tenants high visibility, access to natural light and air, and spectacular views of Washington, DC

Structural:

- 4'-6" Reinforced Mat slab with a "false slab" underneath to aid in water proofing
- 12" Post-tensioned Concrete Floors
- Building Envelope features a glass curtain wall system with granite stone panels on three elevations
- Thermoplastic single-ply roofing membranes (TPO)
- 9" thick two-way reinforced concrete slabs on the underground and ground levels

Mechanical:

- (4) Chillers with a capacity of 500 tons, located on the P3 Level
- (4) Cooling Towers located on the Roof
- (30) Air-Handling Units service the building with CFM values ranging from 4000 to 23400
- VAV fan powered terminal units with electric heat serve multiple ducts

Electrical:

- 4000A at 480/277V 3 phase
- (3) 4 Wire Switchboards
- Transformers provide step down voltage from 480/277 to 120/208 volt power for panels on every level of the each riser
- 750Kw, 208/120V back-up generator will provide power to all emergency systems
- Fluorescent lighting throughout the building

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Dr. John Messner

Technical Assignment #III

November 21, 2008

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Executive Summary

Technical assignment #3 is meant to identify issues of the project that show potential areas of research for my thesis. Included in this report is a glance at constructability challenges the team faced, schedule acceleration scenarios implemented, value engineering topics that were agreed or disagreed upon, problems identified for my thesis project, and technical analysis methods for each area of study.

It is always important to consider what could have been done better after a construction project is complete, this allow individuals to learn from the mistakes. The problem identification section identifies several problematic features of the office building that could be analyzed in a more detailed analysis of technical building systems and construction methods. Problems were also identified under the topics of value engineering, constructability review, and schedule reduction.

Finally, the technical analysis methods are a more in-depth look at several problems affecting the office building's design and construction. These analysis topics include the placement of cast-in-place concrete, the utilization of a short interval production schedule, benefits of using structural steel vs. concrete as the main structural material implemented for the M Street Ramp, and the potential benefits of using a floor slab compared to the composite metal decking in the M Street Ramp structure.

Figure 1: View of the Office Building from M Street

Construction Challenges

Provided in this segment of the technical analysis are three unique construction challenges that the team faced while constructing the Office Building. Explained in each challenge is the problem definition followed by how the team proceed to solve and correct each dilemma.

1st Challenge: Bracing at the M Street Ramp

Challenge:

Figure 2 & 3: Bracing at the M Street Ramp

Prior to mobilizing on site, a structural investigation was performed to determine the M Street Ramp's level of stability prior to the excavation phase of the Office Building. The investigations revealed that the existing columns supporting the M Street Ramp consisted of steel wide flange members encased in concrete. This encasement terminates at the existing grade elevation (Elevation 0) with a series of temporary caps and grade beams that were constructed as part of the first building during the first phase of construction. These steel wide flange members extend downward continuously through the caisson caps and are embedded into concrete caissons located below the anticipated Office Building mat foundation. Prior to the Office Building's construction, the wide flange columns are laterally supported by their encasement in a corrugated metal casing filled with PEA Gravel. The Office Building's design requires that the existing caps and grade beams designated as temporary be demolished and that the existing wide flange columns be exposed during excavation from the existing grade to the top of the caisson below the P3 Level. This would cause the preliminary foundation design for the Ramp, initial support required to counter against moments present in the ramps structure frame, to be absent during the excavation process. This process will allow for the Ramps structure to become weakened and have possible signs of buckling where moments are large.

Team's Solution:
To begin solving the problem the team set forth by hiring a Professional Structural Engineer licensed in the District of Columbia area. The engineer provided the team with calculations and a 3-Dimensional Model simulating the bracing system necessary to temporarily support the Ramp before being permanently tied into the Office Building structure. Thus as excavation progresses, temporary bracing will be added to maintain the above limitation on the unbraced length until permanent concrete encasement and floor diaphragms are complete. The permanent solution proposes that the exposed portion of the wide flange columns will be encased in concrete and poured integral with the Office Building frame. In the Building's finished condition the wide flange columns will be braced by the Office Building below-grade floor diaphragms and provide structural stability to the Ramp's frame.

2nd Challenge: Dewatering

Challenge:
During the preconstruction phase, a subsurface exploration and geotechnical engineering analysis was created to allow for the team to evaluate the site conditions, regional geology, soil conditions, and groundwater observation currently present at the project site. Ground water levels were found to be at about 13 to 35 feet below the existing surface grades. However the project requires that the excavating crew remove soil at an approximate depth of forty-five feet below existing grade to reach the bottom of the project's foundation. As a result of the water table being approximately 25 feet above the bottom of the scheduled excavation and the soil content of the site being heavy clay, installing the dewatering system prior to the beginning of excavation was critical to maintain the project.

Team's Solution:
Again, to begin solving the problem, the team set forth by hiring a Local Contractor who was experienced with the regional geology, soil conditions, and groundwater table indigenous to the District of Columbia area. The contractor designed a dewatering system that recommended a combination of deep well points along with sump pits and pumping that will be utilized in two steps during construction of the project.

The first step was nineteen (19) deep well points being place immediately outside the excavation and, if possible, drilled into the interior of the excavation. It is anticipated that the well points will need to extend to depths of 60 to 70 feet. It is also recommended that the wells be fully screened from a depth of 10 feet to the termination depth of the well, so that surface water and temporary French Drains can be channeled into the deep wells and subsequently pumped out. The purpose of the deep wells is to remove the higher volumes of water from the granular layers.

Upon reaching Elevation 0, battered wells along with a trench, filled with No. 57 stone or equivalent, will be installed around the perimeter of the site as well, but arranged closer together, approximately a foot from each other, compared to the deep well points. This system acts secondary to the deep well points, thus aiding in the removal of near surface dewatering during excavation and at the excavation sub grade. The battered wells will be placed several feet below the proposed sub graded elevation.

On the completion of the 10th floor structure, the deep well points will be shut off, because the building structure will create the required load needed to resist the uplift force produced from the site's groundwater table.

3rd Challenge: Plan Unit Development (PUD) Restriction

Challenge:
Due to being located in the greater District of Columbia area, the Office Building project had to abide by the Planning Unit Development (PUD) Restriction set by the local government. This agreement requires the team to hire from the DC market sector, obey preapproved construction traffic routes, follow noise ordinance regulation, and interface with neighbors of the project site, along with many other guidelines.

Team's Solution:
The team implemented the solution from the very start in the preconstruction phase by writing the PUD restriction straight into each and every subcontractor's contacts, thus the subcontractor's had to agree to and full understand the limitations and consequences of them not abiding by these restrictions. If the subcontractors or any of their employees did not follow all the restrictions the team proceeded to reprimand the subcontractors through fines or by releasing the person that did not "follow the rules" from the jobsite permanently.

Schedule Acceleration Scenarios

Schedules previously shown and analyzed in the initial two Technical Assignments reveal that the Office Building's critical path behaves in a progressive linear fashion. Displayed in the overall schedule below, it begins with the site's excavation, and moves through to the building's foundation, structure, curtain wall system, elevators, and MEP core, and concludes with the lobby finishes.

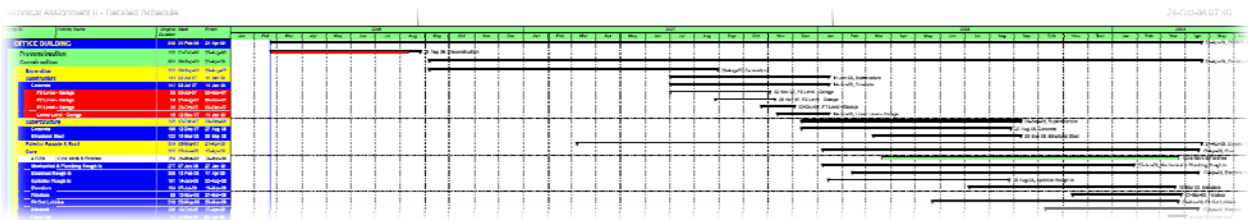

Figure 4: Summary of Overall Schedule

A pressing concern that is currently transpiring in the project schedule is the completion of the elevators and their entry way finishes seen from the building's lobbies. This predicament was created due to the deficiencies found in the manufactured elevators and its parts upon arriving at the construction site. Because of these elevator defects this long lead item had to be reordered, therefore requiring the team to re-sequence and reevaluate this piece and others in the project schedule.

In the past the team has accelerated the schedule by re-sequencing or re-designing a specific system and/or piece of the schedule to gain back lost time, henceforth eliminating cost impacts by utilizing this technique. A good example of this approach is how the team re-sequenced and re-planned the method in which the cast-in-place (CIP) structure would be coordinated. Initially the CIP structure was coordinated so that an entire floor was poured in one day, this sequence then continued with placing the columns needed to continue to the next floor. This method required more time from the schedule and labor due to the fact that a whole floor was to be completed in _ weeks. The actual method began with the team dividing each individual floor of the CIP structure into several equivalent sections, thus decreasing the amount of CIP structure required to be built at one time. This gave the team the opportunity to use two smaller crews by begin the next level of the building halfway through the floor they were currently working on. Consequently, this approach utilized by the team accelerated the schedule, allowed more work to be performed in other areas of the structure, and provided greater flexibility in concrete pours.

Presented with the elevator deficiencies, the team once again modified the schedule to allow for break points in the floors that separated the lobby finishes from the elevators and their entry way finishes. This allowed for the lobby finishes to be completed during the time frame that was meant for the elevator finishes, thus having the schedule drive forth in finalizing a different piece of the project.

Value Engineering Topics

Provided below are two lists, one containing the value engineering ideas that were implemented by the project engineers and the other listing the value engineering ideas that were considered but disagreed upon for the Office Building.

Table 1: Value Engineering Ideas Utilized

Value Engineering Ideas Utilized
Eliminated Drywall Column Covers
Changed the Typical Coupling at Storm and Sanitary Piping
Eliminated Storm Pipe Insulation
Utilized PVC Piping Instead of Cast Iron Piping in Mat Foundation for Plumbing Systems
Changed Building Controls Manufactures from Trane to Seman
Improved Curtain Wall System to Eliminate Metal Heat Barrier

These ideas were used because they agreed with the owners' goals for the project, as well as remaining within owners' budget and time demands. The ideas presented below did not meet these needs for the owner, thus being disapproved.

Table 2: Value Engineering Ideas Not Utilized

Value Engineering Ideas Not Utilized
Removal of Humidifier on AHU's
Utilizing Aluminum Wiring Instead of Copper Wiring for Electrical Systems
Utilizing Individual Cooling Units Instead of Centralized Cooling Unit for Drinking Fountains
Provide Battery Powered Instead of Manual Flush Values for Toilets

Problem Identification

Problem #1: Garage Levels – CIP vs. Precast

The underground garage levels are entirely constructed of CIP concrete. This design was used to minimize the floor depth and maximize the total number of floors in the building. The problem associated with the CIP concrete is schedule time. During excavation, dewatering systems were installed to decrease the amount of water present on site, however once excavation was finished there was a push to accelerate the CIP concrete and following floors above so as to keep the schedule on track. This was difficult to accelerate, because of the time required to properly place the reinforcing steel for the mat slab foundation, garage walls, and floors, then to pour and cure the concrete before work could be done on the slabs. One solution I present is to switch the CIP concrete with a precast concrete system instead.

Problem #2: Steel Structure over M Street Ramp Flooring – Composite Metal Decking vs. Precast

The Office Building is primarily a CIP concrete structure with a post-tension system, however part of the building, specifically the structure above the M Street Ramp, is composed of structural steel framing and composite metal decking with CIP concrete flooring. Due to the structural steel and composite decking being erected after the primary structural systems are complete, separate pours must be made for the CIP concrete infill. Using precast panels for the flooring instead will allow the concrete to come to site already cured and ready to be placed, therefore accelerating the schedule.

Problem #3: Steel Structure over M Street Ramp – Steel Structure vs. Concrete

A more extensive view on replacing one structural material with another, as used above, would be to replace the structural steel in M Street Ramp with concrete. Utilizing concrete instead of structural steel would allow the team to construct one complete level of the building as they progress upward. This would eliminate the time needed for construction on what feels like a "separate" entity of the overall building.

Problem #4: Coordination of Material in the Post-tension Slabs

In addition to overall site coordination, many painstaking steps have been taken to ensure the proper placement of MEP penetrations and embeds within the post-tensioned concrete floor slabs. Between conduit, tendons, and cables there is little room for mistakes when it comes to punching holes into the slab. Cutting penetrations after the slab has been poured can become rather time consuming, expensive, and dangerous. If the contractor needs to make a cut after a floor slab is cured, the slab must be X-rayed to ensure they are not puncturing any stressed tendons. If someone were to accidently rupture one of the highly stressed bands, the results could be fatal. Careful planning ensures that every cable, conduit, and penetration is in the correct location.

Problem #5: Placement of CIP Concrete

While on site this summer, I noticed that a crane and bucket is used to pour the columns of Office Building while a pump is used to pour the large sections of floor slab. It seems like productivity would increase if a pump were used for both, especially since they pour several columns in a given amount of time.

Problem #6: Utilization of Short Interval Production Schedule (SIPS)
On this ten-story core and shell Class A office building, there is a lot of repetition involved in the construction. This repetitious activity, when combined with equivalent sized spaces, allows for implementation of “parade of trades” or a short interval production schedule, also known as SIPS. Each trade involved in a certain area has a defined amount of time to complete their task. The service core and bathrooms of the typical office floors from the Lower Level to the 10th Level will allow for SIPS to be effectively implemented.

Problem #7: Utilization of a Different Elevator Subcontractor
As explained previously in the Schedule Acceleration Scenarios, deficiencies where found in the manufactured elevators and their parts upon arriving at the construction site. I propose utilizing a different elevator subcontractor; one that will properly make and place the elevators.

Problem #8: LEED Change Order
During the bidding phase, the Office Building was non-LEED rated. However, with LEED certified buildings becoming the future in construction, the owner wished to achieve a LEED Silver rating for the project. Thus a LEED design was noted as a bulletin to the drawings and priced as a change order to the contract. If LEED was considered in the initial design of the building, a more accurate cost and execution plan could have been developed, therefore avoiding any complication created from the change order. Through this, more points could have possibly been obtained at the beginning of construction.

Problem #9: Pre-Designs for Tenant Fit-Out
Since BBC’s contract with the owner does not include a tenant build out package. I would like to investigate the benefit to approving pre-designed typical office layouts available to the tenants upon signing their leasing contracts. Hence allowing for the contracts to possibly be picked up by BBC to be managed before they demobilize from the project site, therefore decreasing the tenants wait period to move in.

Technical Analysis Methods

Researching information for the past three technical assignments, including this one, has enabled me to draft preliminary ideas for my future thesis. All of my ideas have manifested from either small or large problematic areas found during construction or the utilization of methods implemented and materials chosen to construct the project. Presented are ideas I feel could be researched as see what possible benefits or disadvantages they would create for the overall project.

Analysis #1: Steel Structure over M Street Ramp Flooring – Composite Metal Decking vs. Precast

The goal of this analysis is to evaluate the differences in using precast floor panels as opposed to the composite metal decking with CIP concrete infill held within the M Street Ramp structure. The precast floor panels will require constructability, LEED, schedule and cost effect analyses. This will likely require various phone calls to manufacturers and material providers in the area, as well as designers and those responsible for installing or constructing the items in question. After all information has been collected and studied, a final conclusion can be drawn as to whether or not prefabrication is a viable and beneficial alternative for M Street Ramp Flooring.

Analysis #2: Steel Structure over M Street Ramp – Steel Structure vs. Concrete

By re-design of the structural system above the M Street Ramp, convert the steel structure to a completely concrete structure, a cost, constructability, and schedule analysis would be completed to determine the affects of the change. The cost of steel and concrete would be compared to see if the cost could be driven down, while allowing the building to remain LEED silver. Because CIP concrete is used throughout the rest of the building, the time required to get the concrete is minimum. By using CIP concrete, the steel structure will be eliminated; therefore, the time needed to order and deliver the steel can be reduced. With CIP concrete, the slabs in this area can be poured with the rest of the slabs in the building, whereas the steel structure will only be placed later in the construction process. Industry professionals familiar with projects of this caliber, as well as those involved with steel and concrete structures, would be able to see the comparison not only on an economical level but also a LEED level. I would be able to determine if a steel skeleton makes more sense than a concrete structure even in an area like the D.C., which is dominated by concrete.

Analysis #3: Utilization of Short Interval Production Schedule (SIPS)

I intend to create a short interval production schedule to decrease the overall duration of the building service core and interior bathroom finishes. In order to do this, zones within the building and bathroom core will be defined, thus standard work durations will be established in which each activity will need to be completed. Based on the current activity breakdown, activities will be combined into activity groups that can be completed with the proposed work duration. Based on these activity groups a resource analysis will be performed in order to assess which activities may need additional labor resources in order to be completed in the specified time frame. In order to determine the productivity rates, industry members will be contacted, namely subcontractors. R.S. Means is another source I can use to assist me in my research, which will primarily focus on schedule reduction methods. After all activities have been established and resource leveling has occurred, the SIPS will be assembled. Finally, an analysis will be performed to determine how much schedule reduction has occurred and the cost impacts associated with changes in labor resource usage.

Analysis #4: Placement of CIP Concrete

I realize this may be a costly alternative, but I would like to analyze the cost and schedule impact that would result from using two pumps during concrete construction as opposed to one. This would allow one of the tower cranes to be available for other activities and possibly lead to one final idea of optimizing crane efficiency and potentially demobilizing one of the two tower cranes onsite earlier than predicted. If one tower crane can efficiently service all areas of the building, I don't see why two cranes will be needed to supplement the other one. Eliminating the crane and bucket pours might be enough of a reduction to get rid of the second tower crane, thus resulting in a huge contractor savings. In order to obtain this information, research will be done to ensure the correct tower crane and pumps are selected. This can be done by contacting tower crane and pumps vendors, as well as evaluating individual specification for each piece of equipment. After obtaining the necessary information from both methods, a comparison of cost, time, and practicality will be done.