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Thesis Proposal

Penn State AE Senior Thesis

Office Building - G

Eastern USA

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EXECUTIVE SUMMARY

The final thesis proposal in intended to discuss the four analyses that will be performed on the new Office Building-G project. Each is related to improving efficiency in the construction industry. The three analyses include: the use of a tieback system, implementation of photovoltaic glass in the curtain wall, and material delivery details during peak traffic hours.

Analysis #1: ***Use of Tieback System***

The adjacent metro station calls for special considerations to be taken during the excavation phase on the new Office Building-G project. While the project team decided to use a raker system to account for the underground metro tunnel, it was suggested in the geotechnical report to use a tieback system. The goal of this analysis is to determine whether the use of the tieback system is more cost efficient as well as more suitable for the subsurface conditions of the project site and adjacent metro tunnel.

Analysis #2: ***Implementation of Photovoltaic Glass in Curtain Wall***

After attending the PACE conference in October, I became interested in the use of photovoltaic glass that was mentioned in one of the sessions I attended. The new Office Building-G is projected to attain a LEED Silver rating and I thought this would be my best opportunity to focus more on this product and learn more about it. By using this photovoltaic glass in the curtain wall system on the building, that can help provide a reduction in the building energy usage overall. I believe that through extensive research, the usage of this glass will help reduce the overall energy consumption of the building and provide the owner with life-cycle cost savings and incentives.

Analysis #3: ***Material Delivery Details During Peak Traffic Hours***

The new Office Building-G site is located between an adjacent metro station and the parking garage where the metro's users park daily. The pedestrians will walk past the site everyday during their commutes to and from work. During this time, pedestrian traffic will be high and material deliveries should be reduced to a minimum for safety of the pedestrians. This analysis will encompass an in-depth re-structuring of the material delivery schedule to limit materials from being delivered during the peak pedestrian traffic hours and limited to a time window when pedestrian traffic around the site is at a minimum.

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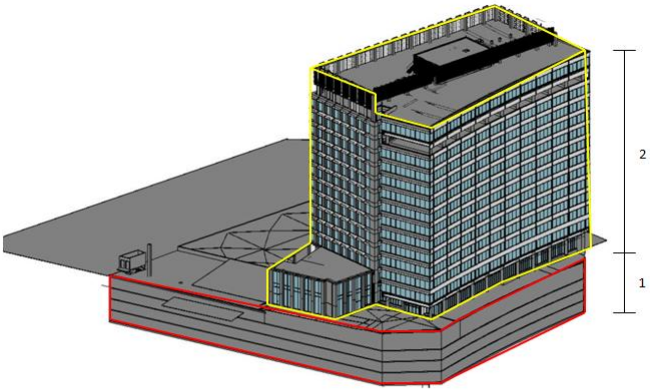
Project Background

The new Office Building-G is a 14 story, 380,100 SF office building along with a four level underground parking garage that totals around 269,000 SF. The building features a glass curtain wall along the southern elevation with the rest being made up of architectural precast concrete with punched out glazing. LEED Silver status is projected for the project with the usage of green and white roofs, water reuse/ reduction techniques and the use of recycled materials to name a few key aspects.

The project began in November of 2009. Turner was not the first to be awarded the project at the beginning, another contractor was selected. However, things did not work out with that contractor and Turner was awarded the project on December 4, 2009. The process for the building and the garage permits began in March 2010 and the Guaranteed Maximum Price (GMP) contract with the owner began development in May 2010. The GMP contract is for roughly $70 million. Turner plans to implement a design-bid-build delivery system as well.

The project is scheduled to take around two years to complete with a project completion date on September 12, 2012. In figure 1, you see a graphic the building structure along with the underground parking levels.



1. Four Level Underground Parking Garage (Outlined in RED)
2. 14 Story Office Building (Outlined in Yellow)

Figure 1

The project team has many challenges to overcome on the project, but none more evident than the adjacent metro station to the west of the building footprint. Many careful considerations and guidelines needed to be followed according to the metros adjacent construction manual. Figure 2, below, shows the metro station in relation to the building footprint.

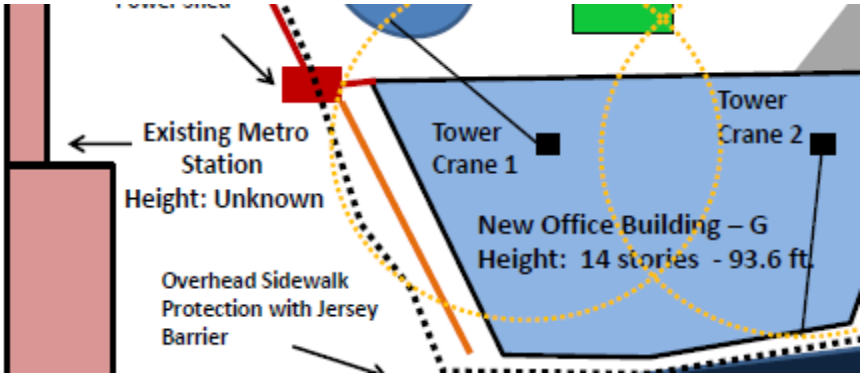


Figure 2

Listed below are details on the main building systems that include the electrical, lighting, mechanical, structural, fire protection, and transportation.

Electrical

The electrical contractor on the new Office Building-G project is the same as the mechanical contractor, GHT Limited. The main system consists of a 265/460V, 3 phase, 4 wire with a 4000A breaker service. The main electrical room is on the top level of the underground parking garage with electrical rooms on each floor of the building, including the penthouse.

Lighting

There are many different lighting fixtures that make up the new Office Building-G. They range from simple ceiling lighting in the office spaces to aesthetically pleasing pendant and recessed lighting for specialty areas. The lamp types also vary as much as the mounting type. Regular T8 lamps up to highly technical LED lamps are used. The vast majority of the lighting fixtures use a 265V source while others use 120V.

Mechanical

The mechanical contractor on the new Office Building-G project is GHT Limited. The mechanical system has rooms dedicated to mechanical support on the penthouse and first floor garage level. The system includes three variable speed drive chillers that provide chilled water to the air handling units (AHUs). Because of the core and shell type building, each floor will have 1 VAV system. A fully integrated building automation system is also included in the mechanical system. The building has a total of eight elevators throughout the building.

Structural

The structural system on the new Office Building-G is a composition of three system types: a gravity system, lateral system, and foundation system. The gravity system will distribute the loads of the building through a combination of interior and exterior concrete columns and a shear wall core. The columns use between 3000 psi and 10,000 psi concrete strengths and

5000 psi for the concrete slabs. The lateral system will resist wind and seismic forces by use of the interior shear wall core as well. The concrete strength of the shear walls will vary with the amount of floors above them. The basement shear walls use a f'c = 10,000 psi, levels 1-4 use f'c = 8,000, and levels 5-14 use f'c = 5,000. The foundation system will be used for the four level underground parking garage. Spread footings that range in size from 4'x4' to 15'x15' will be placed under the columns. Shear walls and a concrete bearing wall around the perimeter will also be used for the foundation structural system.

Fire Protection

The fire suppression system that will be used in the new Office Building-G is a wet sprinkler pipe system. The structural frame that includes the columns, girders, and trusses will have a 2 hour fire rating as well as all exterior and interior bearing walls. The flooring beams and joists will have a 2 hour rating and the roof beams and joists will have a 1 hour rating.

Transportation

The new Office Building-G is well equipped with transportation means for its occupants. The building has two hydraulic elevators that travel from the bottom floor of the parking garage(B1) to the main lobby floor. Also, the parking garage contains five individual stairwells as means of egress.

The building itself contains a total of eight elevators throughout its structure. The main lobby elevators are highly decorated with steel doors and framing. All six are traction controlled elevators. The two other elevators that the building are shuttle elevators. Along with the eight total elevators, two staircases are used in the inner core of the building and one on the outer shell of the building as well.

Analysis #1: *Use of Tieback System*

The Problem

Due to the adjacent metro station to the west of the new Office Building-G footprint, excavation support is most critical along with following the guidelines to the metro's adjacent construction design manual. Currently, the support system along the metro's side of the building is a raker system. From the geotechnical report conducted, it was suggested that the use of a tieback system would be best suitable for excavation support.

Potential Solution/Goal

The goal of this analysis is to determine whether the use of the tieback system is more cost efficient as well as more suitable for the subsurface conditions of the project site and adjacent metro tunnel.

The Methodology

- Research on tieback systems and situations where they are most effective
- Compare and contrast tieback systems vs raker systems
- Contact Turner's excavation contractor
- Collect cost data on tieback systems
- Analyze advantages and disadvantages of a tieback system
- Develop a summary of findings and provide details as to which system would be best for the new Office Building-G project
- Checking to make sure tieback system is in accordance with adjacent metro's construction design manual.
- Analyze schedule acceleration with use of tieback system

The Resources

- Turner Project Team
- AE Faculty - Structural/CM
- Tieback system product website
- Industry Professionals
- Applicable Literature
- Adjacent metro's construction guide & engineers

The Expected Outcome

Through research and analysis, it is expected that the use of a tieback system will be better suited for excavation support. The tieback system will provide the necessary support for the metro's tunnel structure as well as the building as detailed in the geotechnical report. While cost differences are not yet known, a tieback system can provide schedule acceleration through its installation period compared to a raker system.

Analysis #2: *Implementation of Photovoltaic Glass in Curtain Wall*

The Problem

The new Office Building-G is projected to attain a LEED Silver rating. These building types usually account for large amounts of energy usage throughout their lifetime. Lighting, computers, security and MEP systems will require a large amount of energy and most of these systems will be running constantly. Photovoltaic features could be looked at to help reduce the total building energy consumption. They are an effective sustainable technique that can be utilized on this project.

Potential Solution/Goal

The goal of this analysis is to perform a design of the implementation of photovoltaic glass into the curtain wall on the southern elevation of the building. Also, to determined whether the use of photovoltaic glass is feasible and if it will reduce energy costs of the building. This analysis will serve as my critical industry research.

The Methodology

- Research photovoltaic glass and the design techniques
- Contact glass manufacturer on design techniques
- Analyze the structure to determine the effect of the photovoltaic loads
- Analyze the connection between the existing power and photovoltaic glass
- Perform analysis on life-cycle cost and payback
- Determine quantity of glass needed for curtain wall

The Resources

- Industry Leaders
- AE Faculty - Electrical, CM
- Turner Design Team
- Product Website/Personal
- Applicable literature

The Expected Outcome

Through research and analysis, it is expected that the implementation of photovoltaic glass will provide an energy savings technique to add to the LEED techniques already being used on this project. While the whole building will not run off of the renewable energy from the glass, it will account for a good portion of the total building energy. Through cost research, it is believed that the photovoltaic glass will be affordable to the owner and both beneficial through the life-cycle costs and incentives.

Analysis #3: *Material Delivery Details During Peak Traffic Hours*

The Problem

The new Office Building-G is located between the heavily used metro station and parking garage where metro users park. The pedestrians walk past the project site and must cross the construction entrance of the site in order to reach the metro station. During the morning commute hours and afternoon commute hours, pedestrian traffic will be at its highest along the project site. With material deliveries being made daily, it is important that the majority of these deliveries be made when pedestrian traffic is not high.

Potential Solution/Goal

The goal of this analysis will be to perform an in-depth scheduling analysis on material deliveries and re-structure the schedule to cut down on any major deliveries being made during the high pedestrian traffic hours.

The Methodology

- Interview Turner Project team on re-sequencing
- Contact metro officials
- Determine highest pedestrian traffic timetable
- Re-sequence material delivery schedule
- Develop sequence diagrams for material delivery flow

The Resources

- Turner Project Team
- Metro officials/engineers
- Industry Professionals
- Applicable literature

The Expected Outcome

Through analysis and research, it is expected that the material delivery schedule will be congested into a timeframe where major deliveries will be made within the time window where pedestrian traffic is at its lowest. It is believed that from this analysis, a delivery schedule will be produced that will concentrate deliveries within the safest timeframe to limit any accidents that can occur during peak pedestrian traffic hours.

Analysis Weight Matrix

In order to measure the expected effort for each analysis, a weight matrix has been used to show the amount of time and effort allocated towards each of the four main research analyses. The matrix is shown in figure 3 below.

Description	Critical Issues Research	Value Engineering	Constructability Review	Schedule Reduction	Total
Analysis #1: Tie Back System		15	10	10	35
Analysis #2: Photovoltaic Glass	20	10	10		40
Analysis #4: Activity Schedule During Peak Hours			10	15	25
Total	20	25	30	25	100%

Timetable

To stay on task and meet project goals, a preliminary spring schedule has been generated to schedule work progression for each research analysis. The preliminary spring 2011 timetable can be found in ***Appendix B***.

Conclusions

After performing in-depth analysis through research and investigation for each analysis, a review of all three analyses will show an improvement in all areas of the project. It is expected that the tieback system will prove to be very beneficial during the excavation process. The implementation of photovoltaic glass will help reduce the overall energy consumption of the building. And finally, re-sequencing the material delivery schedule will not only help reduce project congestion and confusion, but most of all increase the safety of the pedestrians who will pass the project site daily. This proposal is a working submission and revisions will be made periodically throughout the Spring semester.

Appendix A: Breadth Topics

Breadth Topics

The following breadths listed involve a more detailed analysis of technical disciplines within the major. Each contribute to one or more of the previously listed research analyses.

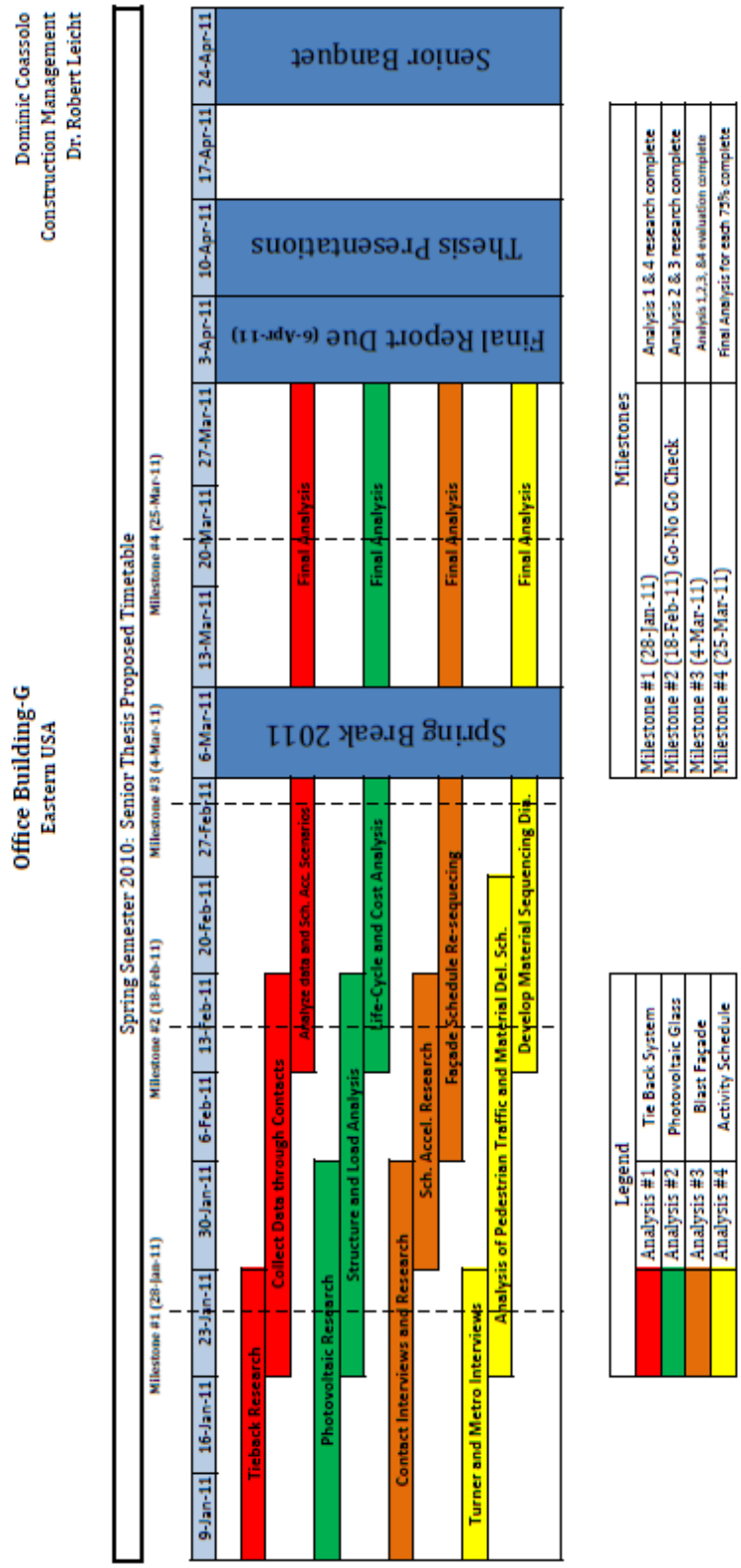
Electrical/Renewable Energy Breadth: Contributes to Analysis #2

While implementing the photovoltaic glass into the curtain wall, that presents the option to research further into the integration of renewable energy from the glass into the existing building energy system. The energy system will be analyzed to determine the electrical equipment and connection requirements in order to tie-in the renewable energy. A tie-in location will be determined on the electrical system to account for the source of renewable energy from the photovoltaic glass. A constructability review will also be performed to make sure that the current system can be used with the photovoltaic glass. The main system currently consists of a 265/460V, 3 phase, 4 wire with a 4000A breaker service.

Structural Breadth: Contributes to Analysis #1

With the analysis of the tieback system implemented in analysis #1, the option to conduct a structural analysis of the tieback system presents itself. Each tieback system used on a project is structurally designed specifically to that project. A structural analysis will be performed to calculate loading and support requirements for the tieback system. The geotechnical report along with other resources will be used to perform this analysis. The new Office Building-G site is adjacent to a metro station with an underground tunnel a few feet below ground level. That constraint will also need to be taken into account with the structural analysis of the tieback system. Any additional support in relation to the metro station will be designed and evaluated for cost and schedule impacts as well.

Appendix B: Spring Semester Preliminary Timetable


Office Building-G
Eastern USA
Dominic Coassolo
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Dr. Robert Leicht
Spring Semester 2010: Senior Thesis Proposed Timetable
Milestone #1 (28-Jan-11)
Milestone #2 (18-Feb-11)
Milestone #3 (4-Mar-11)
Milestone #4 (25-Mar-11)
9-Jan-11
16-Jan-11
23-Jan-11
30-Jan-11
6-Feb-11
13-Feb-11
20-Feb-11
27-Feb-11
6-Mar-11
13-Mar-11
20-Mar-11
27-Mar-11
3-Apr-11
10-Apr-11
17-Apr-11
24-Apr-11
Spring Break 2011
Final Report Due (6-Apr-11)
Thesis Presentations
Senior Banquet
Tieback Research
Collect Data through Contacts
Analyze data and Sch. Acc Scenarios!
Final Analysis
Photovoltaic Research
Structure and Load Analysis
Life-Cycle and Cost Analysis
Final Analysis
Contact Interviews and Research
Sch. Accel. Research
Façade Schedule Re-sequecing
Final Analysis
Turner and Metro Interviews
Analysis of Pedestrian Traffic and Material Del. Sch.
Develop Material Sequencing Dia.
Final Analysis
Legend
Analysis #1
Tie Back System
Analysis #2
Photovoltaic Glass
Analysis #3
Blast Façade
Analysis #4
Activity Schedule
Milestones
Milestone #1 (28-Jan-11)
Analysis 1 & 4 research complete
Milestone #2 (18-Feb-11) Go-No Go Check
Analysis 2 & 3 research complete
Milestone #3 (4-Mar-11)
Analysis 1,2,3, &4 evaluation complete
Milestone #4 (25-Mar-11)
Final Analysis for each 75% complete