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Construction Management

Proposal

Main & Gervais
Columbia, South Carolina

February 5, 2009

Dr. Riley

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I. Executive Summary

The thesis proposal for Main & Gervais includes background information of the building, four analyses that suggest improvements to the current design, a conclusion summarizing the key points to the analysis including a weight matrix, and an Appendix indicating the specific breadth options within the proposal. The first analysis takes a close look at pre-fabrication and how it could apply to Main & Gervais. The second analysis attempts to simplify construction by altering some of the columns' properties in terms of concrete and formwork. The third analysis examines the curtainwall and the potential cost reduction and schedule acceleration opportunities. The fourth analysis looks at the curtainwall as well and suggests additional methods to prevent heat loss in the winter and heat gain in the summer.

The first analysis raises the concern between stick-built construction and pre-fabrication of curtainwall systems. The current method is stick-built, which means the curtainwall is to be constructed on site. This method slows up the process of enclosing the building, which prevents the inside trades from beginning. The quality is less due to the uncontrolled environment that goes along with onsite construction. Pre-fabrication is gaining traction in today's construction industry because it can increase the quality of the final product and save time/money in the process. With this in mind, it is worth applying the advantages to Main & Gervais.

Main & Gervais is primarily a cast-in-place concrete structure with post-tensioning. The concrete columns for the structure vary in shape and size. There are rectangular, square, and circular columns for the structure. The concrete compressive strength for each of the columns varies as well. Replacing the circular columns with square ones would eliminate the circular formwork and the square formwork already on the jobsite could be utilized. Choosing one particular concrete type could simplify construction on site when it comes to the point to place the concrete. The second analysis dives into this topic and elaborates on the points just laid out.

The third analysis refers to Main & Gervais' façade, which is primarily a glazed aluminum curtainwall with the exception of some areas around the parking garage. On the west elevation, the curtainwall is sloped outward at 5.63^{o} all the way from lobby floor up to the roof of the building. This design adds to the complexity of constructing the curtainwall and removes some floor area of the building. Eliminating the slope could relieve some of the difficulty when constructing this side of the building. It could also provide some cost savings and offer more square area to the building.

Another point to consider with the curtainwall is its thermal properties. The glass assembly for the curtainwall does provide some insulation but compared to most wall assemblies, it is not that great. The final analysis proposed considers additional equipment that could provide some energy savings. By introducing an automated lighting system, the lights can shut on/off to accommodate the natural light. Also, automatic shades could be linked to the system to prevent extra solar gain or heat loss.

II. Project Background

Main & Gervais is an office building located in downtown Columbia, South Carolina, right next to the State Capitol Building. It sits 16 stories high on the corner of Main Street and Gervais Street. There is a lobby on the ground floor consisting of a signature restaurant and a bank. Above the lobby are six levels of parking space available to the tenants of the building. Resting on top of the lobby and parking garage are nine floors of office space with breathtaking views all around.

The structure is primarily composed of cast-in-place concrete that will be post-tensioned. The skin of the building is a glazed aluminum curtainwall that will be tied into the structure. Starting from floor nine extending through floor eleven, there is an exterior terrace that allows the tenant to escape for a moment of fresh air and get a closer look of the downtown landscape.

Main & Gervais started construction July 1, 2008, and will extend to the scheduled completion date of December 31, 2009. The contract value is currently at $41,151,000. The general contractor is Holder Construction Company and the delivery method is design-bid-build.

III. Analysis I – Critical Industry Issue

Problem Statement

The chosen method for constructing curtainwalls in the south is primarily stick-built. There are several problems to consider when choosing the stick-built option. First, it increases the schedule due to the fact that every part must be built on site where other trades or problems could interfere with construction. Second, the quality can decrease because of variable factors introduced on site such as weather, human error, etc. Third, there is more trash on site that must be cleaned off and sent to the landfill. Lastly, the quality of the final product is less than if it were created in a controlled environment such as a pre-fabrication manufacturing plant.

Research Goal

The goal of this research topic is to understand advantages and disadvantages of introducing pre-fabrication into this building. By including the disadvantages it will be clearer if the advantages are actually worth the effort of pre-fabrication. The idea is to find a method to ensure maximum quality in the final project while boosting the economy by employing more workers.

Research Steps

- Interview Curtainwall Subcontractor
    - What methods of curtainwall construction are particular to geographical locations?
    - Why are these methods chosen? Cost Savings? Schedule Reduction?
    - What types of jobs are retaining people and which ones are fading away?
- Calculate schedule/cost differences with pre-fabrication and stick-built
    - Labor Costs
    - Material Costs
    - Delivery Costs
    - Delivery Time
    - Installation Time (pre-fab)
    - Construction Time (stick-built)

Expected Outcome

The interview with the subcontractor should reveal what the preferred methods for curtainwalls are in the construction industry at the moment. The calculations and assumptions will establish some cost/time savings while enhancing the final product's quality. It is important to note that if the building is closed up faster, then the other trades can begin, which can speed up construction. It is expected that there will be certain tradeoffs after the research is completed. For example, by choosing pre-fabrication, some jobs may be lost in the field but they may also be relocated to the pre-fabrication manufacturing plant.

IV. Analysis II – Structural Breadth

Problem Statement

The building's structure is primarily cast-in-place concrete that is post-tensioned. There are a wide variety of columns within the structure's designs. The columns are designed as several different shapes including rectangular, square, and circular. They all also have varying concrete compression strength. The reason this presents a problem is that it could disrupt the continuity flow of the construction process. Having to vary the shape and size of the formwork could cause extra money and labor to construct. Also, having to order various types of concrete at different stages may unnecessarily complicate matters.

Proposed Solution

A probable solution to the problem statement could be to simplify the column properties. By switching from circular columns to square ones, the extra formwork for the circular columns could be eliminated. Also, the formwork from the square columns already in the design could be reused on the square columns replacing the circular ones. Choosing concrete with the same compressive strength would simplify ordering in the construction process.

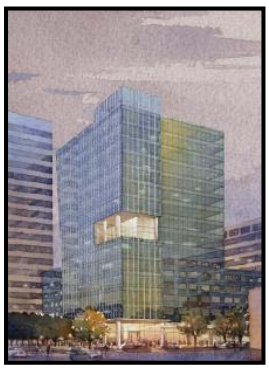
Solution Method

- Calculate the structural strength of a square column and a circular column
- Confirm that the square columns can replace the circular columns
- Calculate the savings from eliminating the circular formwork
- Calculate the difference in compressive strength concrete
- Consider being consistent with using the same concrete for all the columns

Expected Outcome

The proposed solutions could provide some money and time savings during construction. Replacing the circular columns with square columns could help the formwork crews. Sticking with the same formwork would allow for repetition, which could make the crews speed up and reduce the chance for error. Designing the concrete to be similar for all types of columns could ease site congestion a little on a site that is tight as this. Instead of several concrete trucks with different concrete in them, there would just be one type of concrete for when they go to place the concrete for a floor.

V. Analysis III – Curtainwall Breadth



Problem Statement

The building's façade is primarily a glazed aluminum curtainwall with the exception of some areas around the parking garage. On the west elevation, the curtainwall is sloped outward at 5.63^{o} all the way from lobby floor up to the roof of the building. This design adds to the complexity of constructing the curtainwall. The complexity comes from having to install different shaped pieces of glass at different angles. Also, the different shaped pieces of glass necessary will add to the cost since the opportunity to order in a mass quantity is gone. This curtainwall design also eliminates some floor area of the building on the lower levels. The slope can be seen on the left of the building in the picture to the right.

Proposed Solution

The solution to the complex sloped curtainwall would be to simply eliminate the slope. This could be done by extending the shorter horizontal distance to line up in the same plane as the longer horizontal distance, which is at the top of the building. The other idea would be to bring back the longer horizontal distance, thus eliminating some floor area.

Solution Method

- Calculate loads of structural elements near sloped curtainwall
- Add/remove necessary structural elements to extend/retract curtainwall
- Compare cost of sloped curtainwall materials/installation to a straight façade
- Approximate the time saved of constructing a less complex curtainwall system

Expected Outcome

After experimenting with the proposed methods, it will probably show that there are some cost/schedule savings associated with a straight façade as compared to a more complex sloped façade. There will be some cost savings in relation to the material requirements. More specifically, diagonal curtainwall materials, which require specific orders to be made, will not be necessary. Schedule savings arise when it comes time to install the assembly. Installing the curtainwall at an angle to the floor slab and the adjacent façades allows for error, which could prolong the schedule.

VI. Analysis IV – Mechanical/Electrical/Lighting Breadth

Problem Statement

The curtainwall façade lends itself to exposure to the sun all day in the summer and heat loss during the winter. The sun blaring in on a hot summer day can heat up the space substantially, which would then require the air conditioning systems to run longer. Though, extra natural light could reduce the need for artificial lighting. In the winter, the lack of insulation the glazing provides allows for heat to escape much easier, thus resulting in running the heating equipment longer. Each of these scenarios equates to a higher energy bill and an impact on the environment. While the current design includes special glazing with good reflectance and average insulation, there may be additional or alternative methods to alleviate these problems.

Proposed Solution

There are a couple solutions to assist the curtainwall with these problems. With an automated lighting system, the lighting in the building could be adjusted according to the amount of sunlight pouring in through the windows. Using natural sunlight to an advantage could reduce the need for artificial lighting, thus reducing energy costs. Automatic shades could be linked up with this system to provide shade when there is an excess of solar energy. This could reduce some of the energy costs associated with running the air condition units for an extended period of time. During the winter, there is a chance that the shades could provide additional insulation as well as allowing solar energy to enter the building.

Solution Method

- Calculate costs of automated lighting system and shades
- Calculate the savings from running the HVAC systems less
- Compare initial equipment costs to energy savings to approximate a payback period
- Estimate the energy savings on the environment with respect to carbon emissions
- Multiply the savings by a conservative amount of new office buildings to be constructed

Expected Outcome

After computing some calculations and making comparisons, it can probably be expected that it will take a considerable amount of time for the payback period. Though, all along the way, establishing these methods will conserve the environment. The purpose of calculating the savings if the new construction process were to adopt this practice is to get an idea of the energy savings from the construction industry as a whole. An owner's excuse to not choose this may be because of the minimal energy savings and higher upfront costs. But if the owner understands the implications if everyone signs on board, they might be more inclined to invest in the proposed methods.

VII. Conclusion

Key Points

There are various key points to take away from this proposal. Each building is unique in its own way; therefore it is going to have its own particular problems. In the case of Main & Gervais, it is designed to be a spectacular building that shows off downtown Columbia, South Carolina. With that in mind, some of the design aspects lend themselves to be less environmentally friendly. More specifically, the curtainwall façade is not extremely efficient at insulating a building. The ideas proposed in the fourth analysis section are primarily a way to propose new ideas for tackling this problem.

Another key point that coincides with the idea of uniqueness in construction is that during construction, there will be chances to delay/accelerate the schedule depending on the experience of the project team. The second and third analysis take a look at the options for constructing more efficiently while maintaining the designed value of the building.

The current construction method for the curtainwall on Main & Gervais is stick-built. There are some flaws with this particular method including a lower quality finish to that of pre-fabrication, increased schedule time, more trash on site, etc. The first analysis attempts to take a look at an alternative method, pre-fabrication, and how it can be an advantage to Main & Gervais if it is implemented. The advantages to pre-fabrication include better quality control, enclosure of the structure faster, etc.

Weight Matrix

Analysis Description	Research	V. E.	Constructability	Schedule Accel.	Total
Critical Industry Issue	15%	5	5	5	30
Structural Breadth			15	15	30
Curtainwall Breadth		10	10	10	30
MEL Breadth		10			10
Total	15	25	30	30	100

Appendix A

Aside from the critical industry issue and construction management issue, there are two separate breadth options mentioned in this proposal. The first breadth is the third analysis, which is a curtainwall breadth. It takes a close look at the curtainwall's design on the west elevation. Looking into changing the properties of the existing columns is the second analysis, which is a structural breadth. Also included in this appendix is a schedule for the spring semester of 2009.

Curtainwall Breadth

The current design is to slope the curtainwall at a 5.63^{o} angle outward from the bottom of the office floors all the way up to the roof for a portion of the facade. The proposed idea is to straighten out the façade, which would require the structure on the west side of the building to be slightly altered. The curtainwall ties into the concrete slabs of the building's structure. Calculations would be necessary to determine if the slabs could be extended to ultimately straighten out the façade of the west elevation.

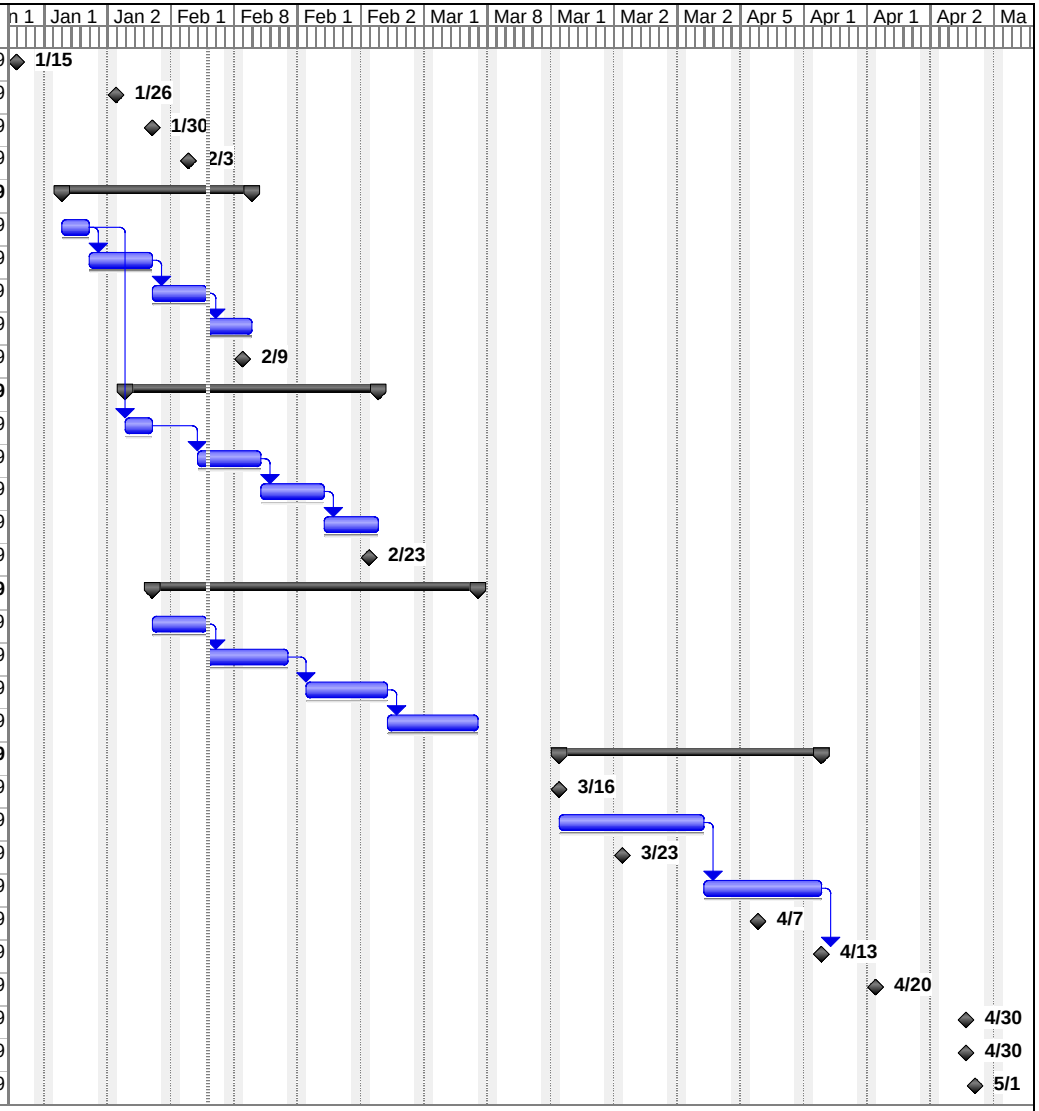
Structural Breadth

The building's structure is primarily cast-in-place concrete that is post-tensioned. There are a wide variety of columns within the structure's designs. The columns are currently set as several different shapes including rectangular, square, and circular. They all also have varying concrete compression strength. The idea proposed would be to change all the circular columns to square ones. Doing so would reduce the variety of formwork on the jobsite therefore reducing costs. Calculations would be necessary to confirm that the replacement columns are sufficient to maintain the structure's integrity.

Schedule for Spring 2009

The schedule on the following page is a rough estimate of how the research will be completed. Note that dates are subject to change.

ID	Task Name	Duration	Start	Finish
1	First Meeting with Riley	0 days	Thu 1/15/09	Thu 1/15/09
2	Received Product Data from Contact	0 days	Mon 1/26/09	Mon 1/26/09
3	Post Discussion Board Question	0 days	Fri 1/30/09	Fri 1/30/09
4	Second Meeting with Riley	0 days	Tue 2/3/09	Tue 2/3/09
5	**Breadth 1 - Structure**	**15 days**	**Tue 1/20/09**	**Mon 2/9/09**
6	Reconfigure Column Allocation	3 days	Tue 1/20/09	Thu 1/22/09
7	Calculate Column Loading	5 days	Fri 1/23/09	Thu 1/29/09
8	Calculate Formwork Savings	4 days	Fri 1/30/09	Wed 2/4/09
9	Summarize Cost Savings	3 days	Thu 2/5/09	Mon 2/9/09
10	Completion of Breadth 1	0 days	Mon 2/9/09	Mon 2/9/09
11	**Breadth 2 - Curtainwall**	**20 days**	**Tue 1/27/09**	**Mon 2/23/09**
12	Calculate Additional Area	3 days	Tue 1/27/09	Thu 1/29/09
13	Add in Columns and Slab	5 days	Wed 2/4/09	Tue 2/10/09
14	Calculate Costs	5 days	Wed 2/11/09	Tue 2/17/09
15	Estimate Schedule Savings	4 days	Wed 2/18/09	Mon 2/23/09
16	Completion of Breadth 2	0 days	Mon 2/23/09	Mon 2/23/09
17	**Depth - Pre-Fabrication**	**26 days**	**Fri 1/30/09**	**Fri 3/6/09**
18	Interview Curtainwall Sub	4 days	Fri 1/30/09	Wed 2/4/09
19	Calculate Cost Savings w/ Prefab	7 days	Thu 2/5/09	Fri 2/13/09
20	Calculate Schedule Savings w/ Prefab	7 days	Mon 2/16/09	Tue 2/24/09
21	Summarize Conclusions	8 days	Wed 2/25/09	Fri 3/6/09
22	**Project Organization**	**21 days**	**Mon 3/16/09**	**Mon 4/13/09**
23	Depth Compl./Progress Report	0 days	Mon 3/16/09	Mon 3/16/09
24	Final Report	12 days	Mon 3/16/09	Tue 3/31/09
25	1 Pg Presentation Outline Due	0 days	Mon 3/23/09	Mon 3/23/09
26	Presenation Preperation	9 days	Wed 4/1/09	Mon 4/13/09
27	Final Report Due	0 days	Tue 4/7/09	Tue 4/7/09
28	My Presentation Date	0 days	Mon 4/13/09	Mon 4/13/09
29	ABET Evaluation and CPEP Update	0 days	Mon 4/20/09	Mon 4/20/09
30	CPEP Site Finalized	0 days	Thu 4/30/09	Thu 4/30/09
31	Evening Event	0 days	Thu 4/30/09	Thu 4/30/09
32	Awards Jury/Senior Banquet	0 days	Fri 5/1/09	Fri 5/1/09



Project: Schedule
Date: Thu 2/5/09

Task
Split
Progress
Milestone
Summary
Project Summary
External Tasks
External Milestone
Deadline