University of Maryland, Baltimore
New Administration Building
Baltimore, MD

Keith Meacham
Construction Management
Thesis Proposal
Dr. John Messner

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Project Team

Owner: University of Maryland, Baltimore
Architect: Design Collective, Inc.
Civil Engineer: Site Resources, Inc.
MEP and Lighting Engineer: BKM & Associates
Structural Engineer: ReStl Designers, Inc.
Design/Build Contractor - CM: Barton Malow Company

Project Information and Architectural Features

80,000 SF of Office and General Use Space
6 Floors Above Grade
Construction Cost: $29,500,000+
Project Duration: March 29th, 2007 - October 22nd 2008
Facade: Brick and Aluminum Storefront
878 SF Glazed Aluminum Curtain Wall
Brick Pavers in Lieu of Concrete Sidewalks

Structural System

Augercast piles tied into pile caps
 -Caps tie into columns and grade beams
 -Piles are 18" in diameter and 4000psi
Two shear walls on the North end
9" post-tensioned concrete (5000psi) elevated slabs

Mechanical and Electrical Systems

One 90,000 CFM Rooftop AHU
Eight AC Units (600 - 2500 CFM)
VAV terminal units (single duct)
Diesel Generator System: rated 200kW, 3φ, 4 wire, 208/120V

e-Portfolio: http://www.engr.psu.edu/ae/thesis/portfolios/2009/kpm5000/

Executive Summary

The University of Maryland, Baltimore Administration Building was finished on time and under budget. All requirements were met by both the Owner, The University of Maryland, Baltimore, and the Contractor, Barton Malow. With any project it is valuable to explore areas of potential improvement. The following proposal highlights such areas where possible schedule and efficiency improvements can be made.

The UMB Administration Building was constructed of post-tension, cast-in-place concrete. The elevated slabs were formed using job built, multi-use plywood and the columns were formed using unlimited use formwork. Forming the entire superstructure out of unlimited use formwork will be investigated in the analysis that follows. The focus will be placed on saving time of the schedule but much time will be used to ensure that the impact on the budget is not significant.

During these economic times a major concern for owners is energy efficiency. Since more energy is lost through windows than any other component of the building an analysis will be made involving the current window system and an alternate window system. The analysis will examine the initial and long term costs and determine if it is logical, financially, to utilize this exchange. In conjunction with a mechanical analysis, a structural analysis will be performed to ensure that the building can support these new loads that will be imposed. If not alterations will be necessary to support these loads.

Safety is the most important issue on any jobsite. Most safety regulations deal with issues that have immediate health risks. Hand Arm Vibration (HAV) is something that construction workers are exposed to on a daily basis but the health risks involved are not seen until it is too late. The injuries associated are debilitating and permanent. While the European Union has adopted standards to prevent injuries due to HAV there are no such laws in America. This proposal aims to educate everyone, from managers to journeymen, about the risks involved in over exposure and improper equipment. Literature will be developed to make people aware of the risks and what can be done to limit injury.

The final analysis will investigate the viability of using prefabricated columns instead of cast-in-place. With the objective to save time on the schedule, evaluations involving the differences in cost and labor will also be made to ensure that the impacts on the budget will still allow the change.

Closing out the proposal are the conclusions of all these analyses and a weight matrix that breaks down how time will be spent for each analysis.

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A. Analysis I – Replace Slab Formwork

1. Problem (Opportunity)

After discussions with various members of the project team on the UMB Administration Building, it was concluded that the schedule in place was very demanding and that finishing on or before the finish date was paramount to the project being considered a success. Therefore, it is logical to investigate ideas that could potentially speed up a certain phase of construction.

2. Potential Solution

The superstructure of the UMB Administration Building was divided into two halves, North and South. One half of an elevated slab was formed, reinforced, and poured in roughly 5 days. The forming of each level was done using a combination of multi-use and unlimited use formwork. Job built, multi-use forms were used for the slabs and unlimited use forms were used for the columns. The proposed improvement will replace the multi-use formwork, used for the slabs, and form the entire building using unlimited use formwork. Comparisons between the systems will be made based on material cost, daily output, and crew sizes needed for that output. The ultimate objective is to learn if changing the system will shorten the schedule but cost must be looked at as well to make sure that the change does not have significant impacts on the budget.

Assistance from industry will be the key component of this research. The first step involves obtaining the material costs for each system. Manufacturers will be needed to provide this information. Next, general contractors and subcontractors who have done projects using unlimited use formwork will be interviewed and a duration will be developed that can be compared to the durations used on the UMB Administration Building. Lastly, crew sizes will be analyzed. Different crew possibilities will be explored, such as smaller crew size doing the same amount of work without sacrificing time or the same crew size doing work faster.

3. Expected Outcome

After the analysis is complete, the expected outcome is that exchanging formwork systems will increase the cost of the building. Although the cost will increase the durations of forming a slab will decrease. This decrease will enable crew alterations that best fit the situation. Since the same crew FRP's slabs, men can be allocated in different ways to make processes more efficient.

B. Analysis II – Replace Facade Windows (Structural and Mechanical Breadths Included)

1. Problem (Opportunity)

With energy prices at an alarmingly high rate and along with the economic situation of the country there is a need to have buildings as efficient as possible. Any area that wastes energy should be examined and there are few areas in a building that release as much energy as windows.

2. Potential Solution

The UMB Administration Building has over 800 windows and an 878 SF curtain wall wrapping around the southwest corner. Being so numerous and having a U-Value greater than the Department of Energy recommended range, leaves the windows open for analysis. This analysis will replace these 800 windows and curtain wall and attempt to make the UMB Administration Building more energy efficient.

Mechanical Breadth

The first step is to conduct load calculations for the entire building with the current windows. Estimations will be made to account for the amount of furniture, temporary partitions, and other absorbing objects. Once this calculation is done, the windows will be replaced with windows having a lower U-Value. Another load calculation will then be performed using all the same information as before except for the new windows. When the calculations are complete the efficiencies will be compared. This comparison will lead into determining how much money can be saved with the new system. These savings will be factored in with the costs at the end of the analysis.

After the loads are calculated, the cost of materials and installation for the new system will be researched. Multiple manufacturers will be called and an average cost of window will be developed. At the same time subcontractors will be contacted to determine what costs are involved with installation of the particular windows.

Some things to consider after comparisons are made include, does the money saved overtime compensate for any increases in material cost? Are these windows the same thickness as the originals and if not how this will affect the entire wall system?

Structural Breadth

The current wall assembly and superstructure have been designed for the loads imposed by the windows that were called out in the specifications. Changing these windows may exceed the wall assembly's bearing capacity. Therefore calculations will be performed to identify the current capacity of the assembly and superstructure, then use these number to determine if the new loads that will be imposed can be supported. If the load cannot be supported, a redesign will occur that will account for these new loads.

3. Expected Outcome

Improving the quality of window installed will undoubtedly increase the cost of material and most likely will increase the load imposed on the building. Installation costs should be similar since the dimensions of the window will not change (except possibly the thickness). The expected outcome is that the windows will save enough energy and money over time to account for the initial cost increase and that the increased load will still be within the bearing capacity of the building.

C. Analysis III – Critical Industry Issue: Hand Arm Vibration in Construction

1. Problem (Opportunity)

Safety is a constant concern on a jobsite. There are always new risks that require protection plans. Even though safety is at the fore front of most companies, Hand Arm Vibration (HAV) is rarely talked about because its effects are not felt till later in life and there are no national standards to protect against the risks of HAV.

Construction workers are among the largest group of individuals who are exposed to Hand Arm Vibration on a daily basis. This exposure leads to permanent and irreversible injuries later in life. Some injuries include vibration induced white finger, carpal tunnel syndrome and vibration syndrome, which includes muscle fatigue, muscle weakness, pain in arms and shoulders, headaches, and more. These may sound minor but can be disfiguring and are very painful.

2. Goal

The European Union has recognized these risks and has developed standards to protect the workers. Currently there are no regulations or standards in the U.S. Until standards are developed it is necessary for companies to implement their own rules.

The goal of this analysis is to educate those who are unaware of the health risks involved in Hand Arm Vibration and to educate managers and foreman on how to avoid these risks.

3. Potential Solution

This analysis will be research intensive. Determining how far reaching this problem is will be done using ENR and online resources. The research will also attempt to find out if workers have made claims against companies in the past.

Once the facts are gathered, research into prevention will begin. Tips and rules of thumbs will be researched. Exposure limits will be developed and companies that manufacture lower vibration equipment will be advertised.

At the end the pamphlets and jobsite signage will be designed so industry can be informed of the problem and what kind of prevention steps they can follow.

D. Analysis IV – Prefabricated Columns

1. Problem (Opportunity)

As mentioned above, the driving force of the UMB Administration Building was the schedule. Speeding up construction without impacting the schedule will again be the focus of this analysis.

2. Potential Solution

Columns on the UMB Administration Building, like the slabs, were also split into two halves, North and South. The concrete crews could form, reinforce, and pour 15 columns in 3 days. This analysis will investigate the implications of using prefabricated columns in lieu of cast-in-place.

With durations and crews sizes already available, for cast-in-place columns, only the cost will need to be determined. Costs for the concrete, forming, and labor will be obtained by talking with the concrete contractor that was on the Administration Building, Miller Long & Arnold. After that, the cost of prefabrication, installation, and labor will be determined by a combination of looking through manufacturers’ manuals, obtaining manufacturers’ quotes, and talking with industry to find out other costs associated with prefabrication. Developing durations and crew sizes will be done through discussions with concrete contractors who have installed prefabricated columns. Once all these figures are collected a comparison of price, labor, and durations will take place and it will be seen if changing to prefabricated columns is logical.

One thing to consider is will the crane be able to make picks in between installations or will it be only working on the columns? Consulting subcontractors and developing a step by step process for installation will answer that question. This can also be assisted through research conducted online. Another issue that needs to be addressed is will there be room on an already tight site to store columns waiting to be installed? One solution is to have the columns delivered the day of installation, which takes careful planning. Another is storing them where the rebar cages for the columns were being made on-site. During the analysis these possibilities will be examined further.

3. Expected Outcome

It is expected that the prefabrication costs will be similar to the cast-in-place cost and so the determining factor will be effects on the schedule. Most likely the installation of prefabricated columns will be faster than the 3 days that is already associated with cast-in-place. Thus, if this is the case then changing the columns is a viable option.

E. Conclusions

Replace Slab Formwork: Determine if using unlimited use formwork for the elevated slabs will reduce the schedule. Evaluate the cost implications and determine if the schedule acceleration outweighs the cost.

Replace Façade Windows: Determine how much energy can be saved by replacing the windows. Compare this savings to the additional costs of more efficient windows. Examine if the additional loads applied by the new windows can be supported. Observe whether the savings, in the long run, will compensate for the initial cost.

Hand Arm Vibration: Develop literature (pamphlets, jobsite signage) to educate the industry of the long term health risks involved associated with the use of construction equipment.

Prefabricated Columns: Determine if exchanging prefabricated columns and cast-in-place columns will reduce the schedule. Compare material costs, labor costs and crew sizes to confirm that the change does not sacrifice anything to benefit the schedule.

F. Weight Matrix

Below is a matrix describing the distribution of time that will be spent on each Analysis.

Description	Research	Value Engineering	Constructability Review	Schedule Reduction	Total
Replace Slab Formwork	5		10	10	25
Replace Facade Windows (Mechanical and Structural Breadths)	10	10	10		30
Critical Industry Issue: Hand Arm Vibration	20				20
Prefabricated Columns	5		10	10	25
Total	40	10	30	20	100

G. Appendix 1: Breadth Studies

1. Mechanical Breadth

The mechanical breadth will be completed by determining the efficiency of the windows that were installed. Once this is completed a more efficient window will be chosen and analysis will take place considering material costs, energy savings, and installation costs. Comparisons will determine if this change is logical.

2. Structural Breadth

Stemming from the mechanical breadth a structural breadth will be completed based on the new properties of the windows. The current buildings bearing capacity will be analyzed with the current windows in place. Then it will be determined whether the new loads imposed by the alternate windows will exceed this bearing capacity. If so the structure will have to be altered so there is sufficient support for the new system.