Revised Proposal

The Apartment Building
East Coast, USA

B. Kerem Demirci | Construction Option | Advisor: Dr. Messner | 1.16.15

Source: JMAV

EXECUTIVE SUMMARY

The Apartment Building is a high-end apartment building located in a historic metropolitan city on the East Coast. It consist of ten stories above grade, amounting to 151,158 SF. The building also has a two story, 62,250 SF underground parking garage. This proposal identifies key problematic areas of The Apartment Building and describes various analyses that the will be completed to address these problems. Below is a summary of the main analyses.

Analysis 1: Effects of Green Building on Marketability

The critical industry research for this course will focus on the effect of green building on the marketability of residential apartment buildings. This research will be accompanied by a survey of students and young professionals that would be likely tenants of the building, to determine their perceptions on green apartment buildings. The goal of this research is to determine if the marketability of The Apartment Building can be improved by altering the current LEED plan.

Analysis 2: Exterior Enclosure Acceleration

Analysis 2 looks into methods of accelerating the exterior enclosure that was behind schedule due to a harsh winter. In this analysis will focus on the use of prefabricated brick and masonry panels as opposed to the traditional stick-build system that is being used. An appropriate system will be designed and the cost and schedule impact will be analyzed. In addition a structural and mechanical breadth will be done on the new prefabricated enclosure. A structural analysis will determine if any changes will need to be done to the structure to support the panels and the interface between the panels and structure will be detailed. A mechanical analysis will be done to ensure the new building enclosure is not compromising mechanical performance.

Analysis 3: SIPS Implementation for Interior Fit-out

Due to the stringent schedule dictated by the phased turnover of the building, high level of quality and the repetitive nature of the apartment units, short interval production scheduling will be implemented for interior fit out. An implementation guide will be developed for best practices for SIPS for interior fit out. SIPS will then be implemented on The Apartment Building.

Analysis 4: Tools to Support SIPS Implementation

Building of SIPS implementation and the BIM execution guide developed in Technical Report 3, Analysis 4 will look into potential BIM uses that can be used to support the implementation of SIPS on interior fit out.

CONTENTS

PROJECT BACKGROUND

The Apartment Building is a new high end residential building. The Apartment Building is primarily a post tensioned cast-in-place concrete structure enclosed by stone and brick veneer. The building extends ten stories above grade, reaching a height of 99 feet and totaling approximately 151,000 SF. This space provides room for 165 high quality apartment units that average 767 SF per unit. Ten of the units are designated affordable housing for 40 years which allows the maximum zoning height restriction to increase from 77 feet to 99 feet. Below grade, lie two garage levels that provide 153 parking spaces for the building tenants. A 10,000 SF public pedestrian park along with an outdoor pool is located outside the south face of the building. The ground floor houses amenities such as a lounge, business center, and fitness room. An additional club room is located on the fifth floor. Accessible terraces are located on the fifth and eighth floor and include gas grills, gas fire pits, and water/gas features. The total contract value of the negotiated GMP contract is $32,752,717, or $216.75 per SF.

Figure 1: Rendering of the Apartment Building (JMAV)

Figure 2: Site photo during construction

The client for The Apartment Building is BMPI. BMPI is a partnership between three main investors of which one is the owner of the general contractor of this project, John Moriarty & Associates (JMA). The other two partners are a developer out of Boston and a local developer. The goal of BMPI is to promote the growth of an up and coming metro accessible area. The Apartment Building received the notice to proceed on February 11th, 2013 and will reach substantial completion on February 13, 2015, resulting in a duration of roughly 24 months. The post-tensioned concrete structure was completed in June, 2014, roughly 16 months after notice to proceed. Turnover of this building will be done in phases, allowing early revenue for the owner. The first phase of turnover is planned for December 10th, 2014 and includes the garage through the 2nd floor. From this point on the schedule dictates a turnover rate of a floor per week.

ANALYSIS 1: EFFECTS OF GREEN BUILDING ON MARKETABILITY

*CRITICAL INDUSTRY ISSUE

PROBLEM IDENTIFICATION

As an owner-builder, the ultimate goal for the owner is to maximize the rentability of the apartment units. Decisions made in the planning, design and construction phase of the project can all have an effect on the marketability of the apartment. Interest in green building has increased in recent years. BMPI is aiming for a LEED Certified status for The Apartment Building under LEED 2009 for New Construction. From the LEED scorecard, provided by JMAV, the project is pursuing a total of 47 points, out of the possible 110, which puts the project in the LEED Certified category. From a general economic impact, can increased sustainability practices improve the overall marketability of the building? Should BMPI pursue a higher LEED rating to increase value from the perspective of the tenants?

BACKGROUND RESEARCH

Research on the economic impact of green building is relatively new. A recent paper written by Jiro Yoshida and Ayako Sugiura analyzes the rent prices of condominiums based on various green factors. They discovered that that people will pay more for a design that has a longer life span but the use of renewable energy and recycled materials are associated with price discounts. This papers shows that green building can have a positive and negative effect on perceived value. This perceived value translates directly into marketability of the building.

POTENTIAL SOLUTION

As an academic research study, various papers, journals and literature will be researched in order to determine the general economic impact of green building. This research will guide the decision whether or not any changes to the sustainability plan at The Apartment Building should be made in order to improve the marketability from an economic standpoint. This final recommendation will incorporate the owner's goals while meeting the demand of the market.

ANALYSIS PROCEDURE

1. Conduct research on the economic impact of green building
    a. Literature reviews
    b. Interview Institute for Real Estate Studies (IRES) faculty at Penn State

2. Summarize key economic impact findings
3. Survey students and young professionals on green building perceptions
4. Apply research and survey data to the Apartment Building and make final recommendation

EXPECTED OUTCOME

It is expected overall by implementing proper green building strategies to The Apartment Building, the marketability of the building can be improved which is the owner's ultimate goal.

RESOURCES

- Literature
    1. The Journal of Sustainable Real Estate (JOSRE)
    2. " The Effects of Multiple Green Factors on Condominium Prices" (Yoshida, Sugiura)
    3. "Green Noise of Green Value? Measuring the Effects of Environmental Certification on Office Property Value" (Fuerst, McAllister)
    4. "New Evidence on the Green Building Rent and Price Premium" (Fuerst, McAllister)
- Professional Resources
    1. United State Green Building Council
    2. John O'Keefe, President of Atkinson Construction
    3. MacWilliams Ballard
    4. Cassidy Turley
    5. Construction thesis board
- Academic Resources
    1. Institute for Real Estate Studies (IRES) at Penn State
    2. Georgetown University Real Estate faculty
    3. Phil Fogarty, Master of Professional Studies in Real Estate student at Georgetown University
    4. Social Science Research Network (SSRN)

ANALYSIS 2: EXTERIOR ENCLOSURE ACCELERATION

PROBLEM IDENTIFICATION

According to the baseline schedule, exterior masonry work was set to begin during the winter. However, a harsh winter affected 26 days of construction which had a negative impact on the schedule. This weather delayed the concrete structure and ultimately the exterior enclosure that was planned to begin in the winter. The exterior masonry is a vital component of the building enclosure system which puts it on the critical path making it an essential activity of the overall schedule. The enclosure for The Apartment Building is complex in that it uses a multitude of different materials: brick, architectural masonry units, metal cladding and cast stone. Many types of each material are also used. The Apartment Building uses four types of brick, 3 types of mortar, 6 types of ACMU and 3 types of cast stone. In addition multiple materials are used on each floor of the buildings as opposed to just one. In a previous interview with the project manager, he mentioned that it was very difficult to get into a productive flow due to the many different material types. This is not ideal especially after the schedule has already been pushed due to weather delays.

BACKGROUND RESEARCH

Prefabrication is the process of assembling certain components of a larger product offsite then transporting these assemblies to the jobsite for installation. Prefabrication can apply to almost any trade in construction. Prefabricated masonry and brick panels have many benefits.

- Decreased site congestion
- Schedule acceleration
- Safer work environment
- Increased quality control
- Less onsite scaffolding
- Prefabrication can be done in any weather

With the benefits come some disadvantages

- Size of the panels are limited by transportation and erection limitations
- Joints between panels may not be desired

There are two common ways of prefabricating brick masonry panels: hand-laying and casting. Once the panels are made they are transported to the job site then installed using a crane.

POTENTIAL SOLUTIONS

This analysis will look into various opportunities to reduce the schedule for the exterior work. Traditional brick installation practices were used. This process is very labor intensive and ultimately inefficient. A possible solution is the use of prefabrication of the exterior masonry into modular panels. An analysis will be completed to study the implementation of prefabricated masonry panels as well as resequencing the installation process. Construction means and methods will also be analyzed. Currently, standard pump swing system were used for exterior work. Although a higher front end cost, a Fraco system may be a possible solution to increase production.

ANALYSIS PROCEDURE

1. Research various prefabrication systems
    a. Hand-laying vs. casting
    b. Subcontractor interviews
    c. Product reviews
    d. Academic research journals
2. Design an appropriate prefabricated masonry system
    a. Determine transportation and hoisting restrictions
3. Identify advantages and disadvantages of prefabricated brick system
    a. Cost, feasibility, design, schedule, etc.
4. Create sequencing plan for installation and site utilization plan
5. Perform schedule analysis
6. Perform cost impact analysis
7. Structural analysis
    a. Calculate panel load
    b. Compare to the existing building
    c. If existing structure sufficiently supports the new system, proceed to step 5
    d. If existing structure is insufficient, resize a typical bay from the roof to footing to accommodate the calculated panel loads
    e. Indicate and detail anchorage/bearing/ attachment system
8. Mechanical analysis
    a. Review building science studies completed by Liang, Memari and Kuczynski
    b. Use WUFI software to complete various analysis for the original stick built brick envelope and the precast panel system
        i. Condensation analysis

ii. Hydrothermal analysis
iii. R Value and thermal analysis

9. Final recommendation based on mechanical properties
10. Final evaluation

EXPECTED OUTCOME

It is expected that implementing prefabricated masonry panels, the overall schedule of the project will be accelerated. This will result reaching water tight status faster and beginning interior work sooner.

RESOURCES

- Literature
  - "Introduction of a Panelized Brick Veneer Wall System and Its Building Science Evaluation" (Liang, Memari)
  - "Experimental evaluation of the enchanced panelized brick veneer over steel stud wall system for out-of-plane loading" (Kuczynski, Memari)
  - "Performance of a Panelized Brick Veneer Wall System under Lateral Loads" (Liang, Memari)
- Professional Resources
  - The Brick Industry Association
  - Precast brick and masonry fabricators
- Academic Resources
  - AE 542: Building Enclosure Science and Design
  - AE 404: Building Structural Systems in Steel and Concrete course material
  - AE 308: Introduction to Structural Analysis course material
  - Dr. Boothby, Professor of Architectural Engineering
  - Dr. Hanagan, Associate Professor of Architectural Engineering

ANALYSIS 3: SIPS IMPLEMENTATION FOR INTERIOR FIT-OUT

PROBLEM IDENTIFICATION

As part of the owner's investment strategy, The Apartment Building is being turned over in phases in order to bring in revenue before the building is entirely complete. With a phased turnover comes many caveats, quality and phasing are critical. If proper quality control measures are not taken, the extended punchlist and project closeout can result in late turnover which ultimately will impact the owner's financial model. During a phased turnover project, construction and occupancy are occurring concurrently and there are many factors that can impact the experience of the occupant and ultimately their health and safety. It is vital that each floor is turned over on time and at the proper level of quality. The current CPM schedule is on detailed down to the trades per floor. Without further detailed scheduling it is common for the deadlines to not be met.

BACKGROUND RESEARCH

The main idea behind a successful schedule is the lean concept of flow. As defined in, "Lean Thinking," flow is the process of making value without interruption by eliminating wasteful activities and creating sequential arrangements. In this case, value would be defined as timely turnover of each floor and high quality of work so rework is not necessary. The main principles of flow include lining up the essential steps to get the job done without any waste, interruptions, and batching and queuing. This basic lean concept can be applied to any process.

Short interval production scheduling or SIPS, is a method of scheduling that envelops the concept of flow. SIPS is a whole system of production management that focuses on the interconnections between trades and the flow of trades through the building. SIPS focus down to the trade level and takes into account material, labor and other resources of each trade. There are many benefits to using SIPS. Some included: eliminating the stacking of trades, predictability, minimizing learning curve, leveling resources, and quality control becomes an inherent part of the process. SIPS is an iterative process that requires more than a single matrix schedule, which is often confused as a SIPS. The process of implementing SIPS requires full team buy in, continuous communication between trades, and room for buffers.

Hensel Phelps pioneered SIPS to construct the structure of the Tabor Center. Alvin Burkhart, who worked for Hensel Phelps, documented the process and created a guide for successful SIPS implementation. According to the guidelines the SIPS process can be broken up into three main phases.

Phase 1 – Operation, Schedule, Budget, Goals
Phase 2 – Physical Constraints, Resource Requirements, Sequence/Coordination/Balance
Phase 3: Communicate the Plan, Feedback, Follow-through

POTENTIAL SOLUTIONS

Due to the repetitive nature of The Apartment Building, a need for stringent quality control, and the tight schedule constrained by the phased turnover a possible solution is to implement short interval production scheduling as well as and matrix scheduling for interior fit out. SIPS is often confused with matrix scheduling. SIPS is focused at the trade level and the process associated with completing the work. Matrix scheduling is a tool that is used within SIPS to manage the flow of various trades throughout the building. Currently a guide that focuses on SIPS for interior fit out does not exist.

In this analysis, a SIPS planning guide will be created for interior fit out. This guide will include best practices for implementing the SIPS process for interior fit out at the trade level. This guide will include the steps each trade would need to take to create a detailed, resource loaded schedule in order to meet a set interval. The guide will also include how to implement matrix schedules to coordinate the flow of trades through spaces. This SIPS implementation guide will then be used on The Apartment Building.

ANALYSIS PROCEDURE

1. Research projects that have implemented SIPS (Tabor Center, Pentagon, MGM Grand)
    a. Review documents
    b. Read case reports
    c. Interview project managers and/or superintendents with experience
2. Develop SIPS Implementation Guide for interior fit out
    a. Process of creating the schedule
        i. Setting the interval
        ii. Breaking down the activities
        iii. Determining prerequisite activities
        iv. Calculating production
        v. Creating a schedule
        vi. Leveling resources
        vii. Creating buffers
        viii. Creating a matrix schedule and various visual tools

b. Best practices for Implementing the schedule
    i. Achieving team buy in
    ii. Methods for continual improvement
    iii. Tools for production tracking
    iv. Methods for quality control
3. Distribute guide to industry professionals and faculty for feedback
4. Apply the SIPS Implementation Guide to interior fit out work on The Apartment Building as an educational exercise.

EXPECTED OUTCOME

Through creating a guide and implementing SIPS to interior fit out activities on The Apartment Building, it is expected that the flow of work will be improved and waste will be mitigated. The work flow will be more predictable and easier to manage resulting in timely turnover of floors and increased quality control.

RESOURCES

- Literature
    - "Lean Thinking" (Womack, Jones)
    - "Improving Productivity with Short-Interval Scheduling" (Strutt)
    - "The Secret to Short-Interval Scheduling" (Daneshgari, Moore)
- Case Studies
    - Tabor Center chimney wall
    - MGM Grand precast
    - Pentagon Renovation
- Professional Resources
    - Adam Harrison, Project Manager on The Apartment Building
    - Rob Soper , Superintendent at Grunley Construction
- Academic Resources
    - Dr. Rob Leicht, AE 570:Production Management in Construction

ANALYSIS 4: TOOLS TO SUPPORT SIPS IMPLEMENTATION

PROBLEM IDENTIFICATION

As mentioned in Analysis 3, The Apartment Building is being turned over in phases. With a phased turnover, quality control is of higher importance in order to prevent rework in occupied spaced. During the construction of The Apartment Building, many coordination issue arose. For example, sleeves were missed or incorrectly placed during the placement of the concrete floors. Missed sleeves pose a major issue in a post-tensioned concrete slab. The only solution for a missed sleeve is to core drill through the slab, which is extremely risky. If a steel tendon is hit, the tendon could snap and whip through the concrete slab and cause structural damage and become a safety hazard.

On The Apartment Building, Building Information Modeling (BIM) was primarily used only in the design phase by the architect to create the model in 3D. This 3D model was strictly used for design purposes and was not transferred over to the contractor for use during construction. There is a large spectrum of BIM uses that can be applied to the planning, design, construction, and operation phase of the project. There are a multitude of BIM uses that can benefit the construction phase of the project and support the SIPS implementation discussed in Analysis 3.

BACKGROUND RESEARCH

As defined by the National Building Information Modeling Standards Committee, Building Information Modeling (BIM) is a, "digital representation of a physical and functional characteristics. A BIM is a shared knowledge resources for information about a facility forming a reliable basis for decisions during its life-cycle; defined as existing from earliest conception to demolition." BIM is a process, not just a tool. It is the processes of effectively exchanging information between all disciplines to help proctor planning, design, construction and operation decisions.

BIM uses are only as effective as the plan used to implement the information exchanges. The BIM Project Execution Planning Guide (BIMex), is a guide developed by Penn State to provide a structured procedure for implementing BIM on a project.

According to Penn State's BIM Execution Planning website, the five most frequently used BIM uses are 3D coordination, design reviews, design authoring, construction system design, existing conditions modeling. There are roughly 25 various BIM uses that are identified in the BIM Execution Planning website.

POTENTIAL SOLUTIONS

In Analysis 3, SIPS processes will be implemented on interior fit out for the Apartment Building. Building off this, Analysis 4 will look into supplementing the SIPS process with BIM tools that will improve the predictability, quality control, and production control of the SIPS implementation. The BIM Execution Plan that was developed in Technical Report 3 will be revisited and the BIM Uses that can could aid the SIPS implementation will be determined. Once again, QFD tools such as House of Quality will be used when selecting BIM uses to ensure the client's goals are respected. Once BIM uses that support SIPS are identified each BIM use will be further researched and an analysis on the benefits and feasibility will be conducted.

ANALYSIS PROCEDURE

1. Attempt to obtain 3D model from architect
2. Review BIM Execution plan from Technical Report 3 and
3. Identify BIM uses that would support SIPS implementation
4. Conduct House of Quality analysis when selecting BIM uses
5. Implement BIM uses
6. Conduct a feasibility analysis of implementing each BIM use
7. Assuming SIPS is being implemented, make a final recommendation of which BIM uses should be used.

EXPECTED OUTCOME

It is expected that the quality, predictability and management of the SIPS implementation can be benefitted by applying some BIM uses. Some potential BIM uses are phase planning, clash detection, and site utilization planning.

RESOURCES

- Literature
    - "Implementing Successful Building Information Modeling" (Epstein)
    - "Building Information Modeling: BIM in Current and Future Practice" (Kensek, Noble)
- Professional Resources
    - Adam Harrison, Project Manager on The Apartment Building
    - Moez Jaffer, BIM Manager at Grunley Construction

    - Greg McHugh, Senior Project Manager at Grunley Construction
    - Jason Kincaid, BIM Engineer Architect at Grunley Construction
- Academic Resources
    - Dr. John Messner
    - Computer Integrated Construction (CIC) at Penn State
    - BIM Wiki
    - Integrative Collaborative Studio materials

APPENDIX 1 – BREADTH STUDIES

STRUCTURAL BREADTH

Building on Analysis 2, implementing prefabricated panels systems will have an impact on the structures. A structural analysis will have to be performed to ensure the load of the panels can be supported by the concrete structure. In addition, the interface between the prefabricated panels and the structure will be designed and detailed.

Breadth Procedure

1. Calculate panel load
2. Compare to the existing building
3. If existing structure sufficiently supports the new system, proceed to step 5
4. If existing structure is insufficient, resize a typical bay from the roof to footing to accommodate the calculated panel loads
5. Indicate and detail anchorage/bearing/ attachment system

Resources

- "Experimental evaluation of the enchanced panelized brick veneer over steel stud wall system for out-of-plane loading" (Kuczynski, Memari)
- "Performance of a Panelized Brick Veneer Wall System under Lateral Loads" (Liang, Memari)
- Penn State AE structural faculty and students
- AE 308 and AE 404 course notes

MECHANICAL BREADTH

The building enclosure has a large impact on the mechanical system of the building. The prefabricated panel system designed in Analysis 2, will have to be analyzed to ensure the new building enclosure is not compromising mechanical performance.

Breadth Procedure

1. Review building science studies completed by Liang, Memari and Kuczynski
2. Use WUFI software to complete various analysis for the original stick built brick envelope and the precast panel system
    a. Condensation analysis

   b. Hydrothermal analysis
   c. R Value and thermal analysis
3. Final recommendation based on mechanical properties

Resources

- "Introduction of a Panelized Brick Veneer Wall System and Its Building Science Evaluation" (Liang, Memari)
- Dr. Ali Memari, Director of the Building Envelopes Research Laboratory and the Pennsylvania Housing Research Center at Penn State
- Penn State AE mechanical faculty and students
- AE 303 and AE 542 course notes

The Apartment Building
Spring 2015 Proposed Schedule
B. Kerem Demirci
Advisor: Dr. Messner

		Task	January				February				March				April				May			
			1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
			1/5	1/12	1/19	1/26	2/2	2/9	2/16	2/23	3/2	3/9	3/16	3/23	3/30	4/6	4/13	4/20	4/27	5/4	5/11	5/18
Analysis 1	Effects of Green Building on Marketability	Literature Reviews										Spring Break			Compile Final Report and Presentation		Final Presentations		AE Banquet			
		Interview faculty and conduct survey																				
		Summarize key findings																				
		Make recommendation to the owner																				
Analysis 2	Exterior Enclosure Acceleration	Research prefabricated systems																				
		Design appropriate system																				
		Create sequence and installation plan																				
		Perform schedule analysis																				
		Perform cost impact analysis																				
		Conduct structural analysis and detailing																				
		Conduct mechanical analysis																				
Analysis 3	SIPS for Interior Fit-out	Research SIPS case studies																				
		Develop Implementation Guide																				
		Distribute to industry professional for feedback																				
		Apply SIPS to The Apartment Building																				
Analysis 4	Tools to Support SIPS	Obtain 3D model from Architect (if possible)																				
		Identify supporting BIM uses																				
		Research and implement BIM uses																				
		Make final recommendations to owner																				

Milestones	Date
Analysis 1 Complete	2/2/2015
Analysis 2 Complete	3/2/2015
Analysis 3 Complete	3/23/2015
Analysis 4 Complete	3/23/2015

APPENDIX 3 – ANALYSIS WEIGHT BREAKDOWN

Table 1 shows the weighting of each analysis as it relates to the overall grade.

Table 1: Grade Breakdown

Analysis	Description	Grade Breakdown
1	Apartment Market Demand Evaluation	25%
2	Exterior Enclosure Acceleration	25%
3	SIPS Implementation for Interior Fit-out	30%
4	Tools to Support SIPS Implementation	20%
	Total	100%

APPENDIX 4 – MAE REQUIREMENTS

Many of the analysis identified in this proposal will incorporate various tools and knowledge that has been obtained in the MAE courses at Penn State. Some of the MAE classes have already been completed while others will be taken concurrently in the spring. Below is a list of some of the courses and the relevant material from these courses that will be used various analysis.

AE 542: Building Enclosure Science and Design

This course will be taken in the spring. This course should provide good information regarding the new prefabricated panel system that is being proposed in Analysis 2. Relevant topics will include structural considerations, control considerations, and thermal property analysis.

AE 570: Production Management in Construction

Core concepts from this course such as production management tools, lean concepts and QFD decision making tools will be utilized in Analysis 1 and Analysis 3. Analysis 1, the apartment market demand evaluation will use the House of Quality to ensure decisions made take the owner and tenant requirements into account. In the SIPS Implementation Guide that will be developed as a part of Analysis 3, various production tracking tools will be identified and suggested to help monitor and control the SIPS process.