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Technical Report 3

The Woodley

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Executive Summary

The following technical report investigates the construction of The Woodley, an $85 million dollar 8-story luxury apartment building located in Woodley Park, Northwest Washington, DC. This report includes in depth analysis of the project's schedule, value engineering implemented, critical industry issues, and potential technical analysis options.

The critical path of The Woodley's construction schedule starts with obtaining all required zoning and building permits required for construction then follows with Phase 1 of construction, the demolition and construction of the pedestrian/vehicular tunnel. After Phase 1, excavation and foundations for Phase 2 of residential construction falls on the critical path in anticipation of the buildings below and above grade concrete structure. Once the concrete structure of the building is complete the next critical phase of construction is the exterior skin of the building followed by unit and lobby build out and finishes.

Brick exterior skin masonry construction and sitework during winter weather conditions are examined in this report as major risks to project completion. Brick masonry is typically a lagging activity on any project and The Woodley is no exception with the intricate brick skin design intended for the building's facade. Sitework scheduled to take place during the winter months of 2013 is also a potential risk to project completion with unforeseen adverse weather conditions such as rain, muddy soil, frozen earth and snowfall. To combat these risks certain schedule acceleration techniques could potentially be utilized. To accelerate exterior brick masonry construction manpower, multiple shifts, an increased number of FRACO scaffolds and more mortar mix stations could be implemented. Although delays in sitework during winter months is often unavoidable, certain measures could be taken to reduce as much risk the construction schedule as possible, for instance, rescheduling activities to commence earlier and value engineering for access roads to change from asphalt to concrete.

The Woodley was very healthily financed due to the high level of quality and luxury expected by owner JBG. To not detract from the high level of quality required, Clark implemented value engineering techniques that only lowered cost, while maintained the original material and ascetic characteristics through using different manufacturers. Also, for unit build out and finishes VE items, the interior designer specified obscure manufacturers that had extremely marked up prices for their products. These original manufacturers also did not have the capabilities to supply their product for such a large scale residential project as The Woodley. If a material was changed, it was made sure that the ascetic look of the new material was close to identical to that of the original material, such as the bath tubs being changed from a cast iron tub to an acrylic tub of the same color. Through value engineering implemented for the building's site, mechanical and unit build out and finishes construction, a total of $800,000 was saved, while maintaining the intended high quality of the building's design.

Critical industry trends and feedback from the annual PACE Roundtable are also examined in this report. Two break sessions were attended on prevention through design and multi-trade prefabrication or modularization, in addition to a one on one session with an industry member, to develop potential areas for research for technical analyses. The potential topics developed from the feedback given during the event are contractor designed safety solutions, prefabrication/modularization specific safety plans, prefabricated brick panels and/or sections and modularization of kitchen and/or bathroom units.

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Schedule Acceleration

Critical Path

The critical path of the schedule for the construction of The Woodley is initiated by obtaining all the required permits from the city needed for zoning, demolition, sitework and building construction. It was essential to anticipate lead times into the schedule for these required permits so their respected work was not delayed. Knowing that The Woodley is located in Northwest Washington, DC and in the historic area of Woodley Park it was even more prudent to coordinate as early as possible with local jurisdiction to apply for permits due to the strict restrictions the city has in place for zoning and building permits. Zoning permits were especially important considering that the building's construction site was so closely located next to the existing Marriot Hotel and the construction of the pedestrian and vehicular tunnel to the hotel during Phase 1 would require these permits before proceeding with any construction. Zoning permits were also vital to gaining the needed access along Woodley Road for material deliveries and staging.

Following permits the demolition of the existing parking garage on site and the noted construction of the tunnel of Phase 1 of construction was next to fall on the schedule's critical path. Likewise to any demolition, existing utility lines needed to be located and then later reconnected to the building during the appropriate point of construction. After demolition and the tunnel construction was complete, excavation and foundations were a critical phase to allow the below and above grade concrete structure to be built. The building's concrete structure consists of three below grade levels, two of which are for parking, and eight above grade levels made of cast-in-place concrete and two-way post-tensioned concrete slabs with a total duration of approximately 16 months. Once the concrete structure was in place the exterior skin of the building was the next critical path phase to complete. The building's façade calls for a combination of intricate hand laid brick, limestone and cast stone. Brick was a lagging activity and a risk to project completion, which is later explained in more depth. Therefore, to take brick masonry construction off the critical path Clark installed all windows prior to commencing masonry construction to allow for the next critical path phase of interior unit build out and finish construction to start.

With the windows, exterior sheathing and waterproofing installed allowing the building to be water tight, approximately taking 12 months to finish, the schedule's critical path was followed with residential unit construction. The 212 residential apartment units within the building called for high-end finishes that required continual mock-up and approvals as floors were being turned over. Clark punchlist activities were especially vital to obtaining owner approval for the first floor, which also consisted of the addition lobby, clubroom and library spaces. Completion of the first floor was also important when considering the repetitious natural of residential construction. Once interior trades completed work on the first floor is was easier to maintain quality control and turnover units at a faster rate with the know inefficiencies experienced during the first floor's interior construction. The build out and finishes out interior residential units took approximately 15 months to complete.

Risks to Project Completion

As mentioned earlier brick masonry construction was a lagging activity that fell behind schedule during the construction of the Woodley and was a significant risk to the project's substantial completion in March 2014. Brick masonry construction is typically a slow moving activity due to the intense labor and high level of craftsmanship involved. Brick veneer and wall construction usually requires mason's to work in very tight quarters on scaffolding when working on a building's exterior façade.

To compound the problem of a known slow moving activity the brick mason subcontractor under contract by Clark Construction was somewhat inexperienced in the installing the high level of craftsmanship involved in design of the brick exterior skin. The brick masonry subcontractor typically performed projects with much simpler brick exterior skin designs compared to the luxurious design of The Woodley. Clark combated these issues with early mock-ups and the use of FRACO hydraulic mast-climbing platforms to work on different floors of the same elevation simultaneously. Nevertheless, brick exterior skin continued to lag during construction and was a risk to project completion.

Various sitework scheduled to be completed during the winter months of 2013 was a potential risk to project completion. Sitework can easily be delayed with the risk of frost, rain/muddy conditions and snow. The construction of pavement and curbs surrounding the buildings perimeter, as well as the final stages of building the country club style infinity swimming pool fell within these adverse winter weather conditions. Pavement for the sites various access roads not only were at high risk due to the unpredictable conditions of the soil for grading, but often asphalt plants shut down before January annual and do not open again until early spring. Consequently, building the asphalt access roads as early as possible was essential to avoid the risk of running behind schedule.

Areas for Potential Schedule Acceleration

Knowing that brick masonry lagged and ran behind schedule, Clark could have used several possible techniques to accelerate the speed at which the brick exterior skin was installed. From a general contractor's standpoint increasing manpower would be the easiest potential solution. Financially Clark would not incur additional cost to increase manpower but would rather need to convince the masonry subcontractor to supply more masons. However, influencing a subcontractor to increase manpower is not always an easy task knowing that the subcontractor will not be willing to pay to additional labor if the added masons are not all efficiently working. Due to tight spaces on scaffolding the addition of extra manpower could potentially congest workflow and actually have the reverse effect of its intent to accelerate work. Another factor to consider when increasing manpower are the limitations on the number of masons allowed to safely work on one scaffold at a time.

Instead of increases manpower brick masonry could also be accelerated by splitting manpower into two shifts to increase the amount of work put in place in one work day. This not only increases the amount of time the masons have to lay brick but also helps to maintain quality control by having two shifts to ensure that they are not over worked which would be detrimental to the quality of their work.

Additionally, the amount of FRACO hydraulic climbing lifts could be increased to allow for more levels to be worked on for a given elevation at one time. In combination with the additional FRACO's, additional mix stations for mortar could also be implemented. Having a mix station for each elevation could increase the rate at which the brick is laid and would not add a significant increase in cost of the additional labor.

Because forces of nature and the winter season in unavoidable the risk of prolonged sitework is just a risk that Clark must carry and try to avoid as much as possible. However, certain measures can be taken to avoid the harshest months of winter by accelerating sitework that requires the most earthwork and relocating staging areas to open out site space to perform these activities. Additionally, value engineering potentially could be implemented to eliminate as much asphalt work as possible by changing to concrete access roads. Techniques such as cover blankets and temporary heaters can be used to maintain the needed harm to pour and cure the concrete, whereas, asphalt is difficult to control is extremely cold conditions, as well as, combating the problem of asphalt plants shutting down during the coldest winter months.

Value Engineering

Sitework

The many pavers called for in the hardscape design of the building resulted in a very high cost that Clark targeted to value engineer. The owner would not approve a material or manufacturer change for site pavers in the community courtyard; however, they did approve to reduce the thickness of the pavers. This resulted in a slight decrease in cost, all in all, saving $40,000.

Mechanical

The original mechanical design of the building called for water source heat pumps to be located in all corridors. However, Clark proposed to JBG that eliminating these corridor heat pumps and relying on the two MAHU's to supply heating and cooling to the corridor spaces. Because the corridors have a significantly lower required heating and cooling load relative to the apartments units, being that they are interior spaces, it was decided a cost effective change that did not negatively effect the heating and cooling demand of the buildings mechanical equipment. The value engineering change to eliminate corridor heat pumps resulted in slight decrease in cost at $18,000.

In addition to corridor heat pumps, it was decided that major cost savings were possible if the building's fire pump was built in field instead of in a manufacturer's factory. This provided a savings of approximately $22,000 and greatly reduced the lead time of parts needed for its construction, relative to the long lead time originally anticipated with a factory built product.

Unit Build out / Finishes

With all the high-end finishes being installed in the residential units of the building there was opportunity for the implementation of value engineering as long as the high level of luxury was materialistically and ascetically maintained. Also, for all of the following unit build out and finish VE items, excluded the original Kohler cast iron tubs) the interior designer specified obscure manufacturers that had extremely marked up prices for their products. These original manufacturers also did not have the capabilities to supply their product for such a large scale residential project as The Woodley. Watson Smith, the original wood flooring manufacturer, and Nanz, the original cabinet hardware manufacturer, in particular are more of boutique manufacturers for smaller high-end condo work.

Kitchen and bathroom hardware, specifically cabinet knobs and pulls, were targeted to be purchased through a cheaper manufacturer going from Nanz to Omnia that resulted in a savings of $265,000. Tubs in all the residential unit bathrooms were changed from the original cast iron design to an acrylic tub by the same manufacturer. Although Clark tried to avoid changing any materials for finishes when implementing value engineering, JBG approved this change because the ascetic integrity of the tubs was not affected by the new material and it yielding significant cost savings at $220,000. The buildings corridor carpet and unit wood flooring manufacturers were also changed for value engineering purposes. The original engineering veneered walnut by Watson Smith was changed to a Wego American

walnut adding $170,000 to total savings and the carpets were changed from an Atelier Lapchi, Andre Arbus Arabesque interpretation series to a Shaw custom carpet that saved $65,000.

Table 1 below shows the cost breakdown for all VE items, including their original manufacturers and/or materials, their revised VE manufactures and/or material and the savings produced.

Table 1. Value Engineering Cost Breakdown

Value Engineering Cost Breakdown			
Material	**Original Manufacturer/Mat.**	**VE/Revised Manufacturer/Mat.**	**Cost Savings**
Site Pavers	-	Reduced Thickness	**$40,000**
Corridor Heat Pumps	-	Eliminated	**$18,000**
Fire Pump	Factory Built	Field Built	**$22,000**
Wood Flooring	Watson Smith engineered veneer walnut	Wego American walnut	**$170,000**
Carpet	Atelier Lapchi, Andre Arbus interpretation series, Arabesque	Shaw L87ZR5X custom carpet	**$65,000**
Cabinet Pulls/Knobs	Nanz 8618 pull, 8495 knob	Omnia 9441 pull, 9141 knob	**$265,000**
Bathroom Tubs	Kohler Tea for Two K-850 (cast iron)	Kohler Tea for Two K-850 (cast iron)	**$220,000**
Total			**$800,000**

Correlation or Detraction from Owner's Goals

The Woodley was very healthily financed due to the high level of quality and luxury expected by owner JBG. To not detract from the high level of quality required, Clark implemented value engineering techniques that only lowered cost, while maintained the original material and ascetic characteristics through using different manufacturers. If a material was changed, it was made sure that the ascetic look of the new material was close to identical to that of the original material, such as the bath tubs being changed from a cast iron tub to an acrylic tub of the same color.

VE Considered but NOT Implemented

Before the change in thickness was decided to be implemented Clark proposed that the site pavers be changed to a cheaper material. However, knowing the high-level of quality and luxury expected by JBG not only for the building construction but also the landscaping and hardscaping as well, it was deemed to be change that would detract from the ascetic look of the pavers.

Bathroom floor and wall tile was also considered for value engineering but in the end not approved. Using travertine tile instead of the specified ceramic tile was proposed, but like the courtyard pavers it would have taken away from the ascetic quality of the tile.

Critical Industry Trends

PACE Roundtable

During the annual PACE Roundtable Event several break sessions were attended to further develop research topic's to analyze for the construction of The Woodley. During these sessions both students and industry members discussed new areas of research currently being explored in the design and construction community. The summaries below of the feedback gathered from the two sessions attended will later be used to develop research topics to perform a detailed technical analysis.

Prevention through Design:

The first of the two break sessions attended was focused on how safety can be implemented earlier on in a building's project lifecycle during design and the possible impacts it would have on the design and construction community as a whole. It was established that although safety is built into design code architects and engineers do not proactively put safety at the forefront of a building's design conception. Currently safety is not being stressed as early on as it should. Designer's avoid any contractual obligation and risk and prefer to put responsibility on the builder or contractor. It was brought forth that safety also needs to become more of a culture in the design community like it has become in the building industry to help establish more implementation into not only safe design criteria but also design solutions to eliminate potential unseen safety problems found during the construction process.

It was mutually agreed that some form of contractual obligation needs to be established to bind architects and engineers to activity design with safety in mind. Solutions such as having owners incorporating safety requirements for design RFP's and insurance programs to include designers into saving sharing programs with owners and contractors to add incentive to more proactively implement design safety were discussed. In addition to the need for contractual obligation, some form of target value design safety evaluation or point system similar to LEED is needed to establish a standard form of criteria for the design community to follow. Without any fine line to divide design safety and construction safety the root problem of which player takes on obligation and risk will continue to be a gray area. If a point system is established for a required design safety evaluation there will need to be a database created for major ticket items that should be targeted during design that have the most significant impact on construction. Research to establish this database of major design safety areas is potentially a topic that can be analyzed for the construction of the Woodley, especially design safety criteria for residential construction. Additionally, continual safety reviews for an established criteria or point system would need to be performed receptively throughout the design process, at least starting at the 30% completion point of a building's design.

Multi-trade Prefabrication:

The second breakout session attended focused on the use of multi-trade prefabrication and modularization for scopes of a buildings construction. Much of the topics discussed were built around industry members' personal experiences with the successes and failures of prefabrication and modularization used on past projects. The major building and infrastructure areas found most effective for the use of prefabrication and modularization included MEP for hospitals, structural prefabrication for bridges, precast parking garages and volumetric modules for residential projects. Exterior envelope prefabrication was also discussed but it was established that a multi-trade approach is often less effective for this scope of construction with the difficulty of coordinating all the different trades incorporated into an exterior enclosure system. The coordination of combining work with multiple trades was also discussed, particularly the difficulties with managing of bringing together Union tradesman with the known restrictions of Unions. Feedback from industry members actually resulted in a mostly mutual consensus that Union trades are more often accepting of coordinating with other Union trades to perform prefabrication or modularization.

From a cost standpoint prefabrication and modularization has its advantages and disadvantages when considering transportation and quality control. As far as transportation, financing can escalate with acquiring local staging areas off site, obtaining permits for logistics and the cost of off hours and weekend deliveries. Yet, money can be saved through shipping in comparison to the labor of on-site construction as well as the advantage of using local subcontractors to perform prefabrication. When considering quality, prefabrication and modularization are quite advantageous. The elimination of weather and working around other trades in a sheltered off-site fabrication structure allows laborers to construct work at a much higher level of quality. Also, off-site fabrication allows subcontractors and general contractors can more effective maintain inventory control.

Through all of the different examples of prefabrication and modularization being used my industry members on former projects the following major factors for implementation to a project should be considered:

1. Trade Coordination
2. Prefabrication Location & Distance
3. Onsite Staging
4. Transportation Requirements
5. Equipment Logistics
6. Inspection Limitations
7. Structural Tolerances
8. Lending Limitations for Financing
9. Possibility for Onsite Prefabrication

A project team should also strive to implement either prefabrication or modularization as early as possible in the design and construction process. It is especially prudent that the general contractor acts as the driving force during early implementation to successfully reduce potential problems occurring

later on during the construction process. It should also be noted that the effective use of prefabrication and modularization does not always need be implemented on a macro scale. Keeping their use to a micro scale for a certain scope of work more often will result in schedule acceleration and cost savings from the standpoint of less complications and risk.

Feedback from Industry

Following the two breakout sessions at the PACE Roundtable Event, a one on one feedback session with an industry member occurred to further develop research topics catalyzed during the breakout sessions. John O'Keefe, president of Atkinson Construction and former vice president of Clark Construction, provided input to develop the following research topics for prevention through design and prefabrication and modularization for The Woodley.

Safety

Construction Safety Design:

The most common accidents associated with prefabricated and/or modularized construction can be addressed through contractor designed solutions. For instance, although not specific to prefabrication or modularization, Clark Construction has designed a nylon mesh safety net system that anchors into a concrete slabs at duct and chase opening to provide fall protection.

Prefabrication/Modularization Specific Safety Plans:

In anticipation of the implementation of prefabrication and/or modularization for The Woodley a safety plan should be developed to address staging, transportation, erection and installation.

Prefabrication and/or Modularization

Prefabricated Brick Panels or Sections:

To accelerate the lagging Brick exterior skin construction for The Woodley either prefabricated brick panels or a combination of hand laid brick and prefabricated brick sections can be used for a potential area of analysis.

Modularization of Bathroom/Kitchen Units:

The modularization of kitchen and/or bathroom units could be potentially yield significant increases in quality and ease of coordination, while saving time and overall cost. Modules would include all MEP and interior framing per respected apartment unit.