Pershing Hill Elementary School

Fort Meade, MD

Revised Proposal for Spring Thesis Project

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Executive Summary

Pershing Hill Elementary School Replacement Project is the replacement of the existing school, with a new school of 87,160 square feet and $13.3 million in construction costs. Pershing Hill Elementary School is being delivered using a traditional design-bid-build approach with a multiple prime contract structure in which Jacobs Facilities, Inc. is acting as the construction manager. Pershing Hill Elementary School is located entirely within an US army base (Fort Meade), and part of the site is within a “Critical Wetlands Area”

Four analysis activities are proposed in this paper; replacing the traditional roof with a green roof, installing a geothermal mechanical system, replacing all or a portion of the masonry façade with a precast system, and pursuing LEED certification. These green roof would address problems associated with storm water management, but would also provide additional load which will likely result in needing to redesign the structural system of a typical bay. A geothermal system would provide alternative energy, but at an additional upfront cost. Lifecycle analysis will be used to weigh the additional upfront costs against the energy savings. A precast system would be less labor intensive than a masonry one, reducing the effects of site access difficulties, but would require analyzing how the site could accommodate the additional requirements associated with precast systems (additional crane use, and need to layout spaces). At the PACE Roundtable conference, it was discussed that many schools are moving towards LEED certification. This analysis will look at the costs associated with pursuing LEED certification.

Project Summary

General Building Data

Building Name: Pershing Hill Elementary School

Location: 7600 29th Division Road, Fort Meade, MD 20755

Owner/Occupant: Anne Arundel County Public Schools

Function Type: Primary Education

Project Delivery Method: Design-bid-build

Contract type: Multiple Prime

Number of Stories: 2

SqFt: 87,160

Construction Costs: $13,311,664

Estimated Completion: Feb. 2011

Architecture

Pershing Hill Elementary school is two stories. The first floor contains the spaces used by all students including: the gymnasium, cafeteria, media center, computer lab, music room, health room (also known as a nurse’s office), principal’s office, and classrooms. The second floor consists primarily of classrooms, but also contains the science room and faculty lounge. Outside of the entrance to the vestibule is a curved aluminum canopy, which is attached to the façade by a one inch hanger pipe assembly attached to embedded plates.

The first floor contains a large block to the North of the main hallway which contains the gymnasium and cafeteria (as well as the supporting facilities for these features. There is a stage in the cafeteria, which allows it to double as an auditorium. For presentations with a larger audience, the partition between the cafeteria and gym can be removed, allowing for additional seating.

The supporting facilities for the gymnasium and cafeteria are placed on the sides of these rooms opposite the main hallway. For the cafeteria this includes the food prep and food storage area, as well as the food serving area which is accessed by two doors on the north side of the cafeteria. By designating one door the entrance and the other as the exit; it is possible to move a large number of children through the food service area, as they do not need to turn around after receiving their food.

On the South side of the main hallway is the media center, which is attached to the computer lab. To the East and West of the media center are two wings which primarily contain classrooms, and closely follow the plan of the second floor wings. Because the entrance is to the West, the base of the west wing also contains the administrative offices. This allows the receptionist to see who is entering and exiting the school, and ensures that any visitors are reminded to sign in.

The second floor consists of two wings and a hallway connecting them. The second floor hallway lies on top of the main hallway on the first floor, but there are no rooms to the north of it. This allows the gymnasium ceiling to rise in order to accommodate basketball games.

Both wings are largely composed of classrooms on either side of the hallway. Four stairwells in total are located at the end of the hallway, as well as where it turns. The teacher’s lounge and resource rooms are stationed between the two wings. The classroom bathrooms are placed along either the North or South wall, and are placed so they share a wall with the bathroom for the adjacent classroom. The classrooms are on both sides of the hallway, and because they are along the wings of the building every classroom is open to natural light.

Building Enclosure

The exterior wall typically consists of a 4” brick veneer, 1¾” air space, 2” of extruded polystyrene insulation, and 8” CMU with a vapor retarder. Veneer ties are placed at a maximum of 16” on center, as are the weep holes. This is the typical system for the exterior walls, although it varies slightly at certain locations and the color of the brick changes throughout the building. The exterior brick comes in three different colors, with a lighter color being used on the second floor, and a darker decorative band running along the top of the walls on the second floor and gymnasium as well as along the top of the windows on the first floor. The building windows are made with aluminum frames and 1” insulated glazing.

The gymnasium and cafeteria wall are composed of the same system, but with minor modifications. The CMU in the gymnasium and cafeteria is 12” (as opposed to 8”) and the vapor retarder is replaced with a mastic vapor barrier.

The walls for the music room follow the typical construction, with the addition of fabric covered fiberglass acoustic wall panels on the inside. The fabric covered panels absorb sound much better than exposed CMU, which decreases the reverberation time for the room.

The walls for the exterior mechanical courtyard do not contain insulation, as both sides are exposed. Instead the wall is composed of 8” CMU with a solid grouted collar joint and brick façade on each side.

Built-up asphalt roofing is used on top of the roofing insulation throughout the building. The insulation rests on topof the steel deck, and is made of two layers. The top layer slopes, in order to direct the water on the roof to the drains.

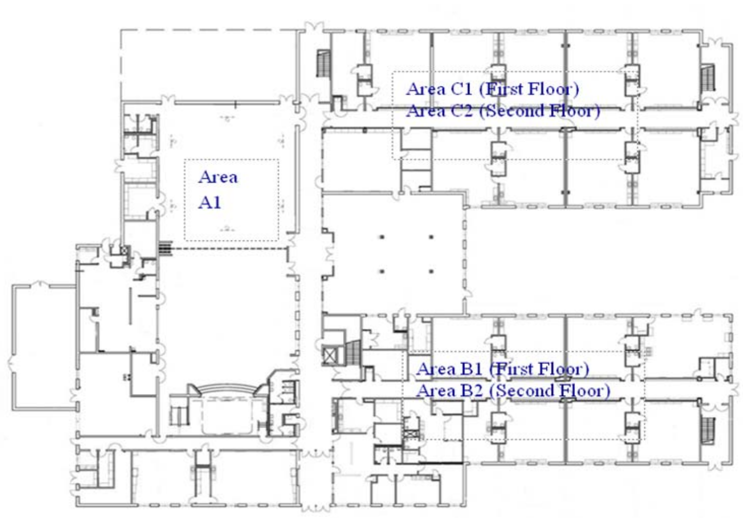
Construction

Pershing Hill Elementary School is being delivered using a traditional design-bid-build approach with a multiple prime contract structure in which Jacobs Facilities, Inc. is acting as the construction manager. Because it is a public school project, the multiple prime approach is mandated by law. The owner holds 15 lump sum contracts with the specialty contractors, in addition to the contracts with the architect and construction manager. The specialty contractors won their contracts in a public bid, where the contract is awarded to the lowest qualified (defined as a company that has been in business for at least three years, and has completed at least three jobs of similar size and scope) bidder.

Pershing Hill Elementary School is located entirely within an US army base (Fort Meade). This results in challenges: for access for personnel, materials and equipment; coordinating with permitting authorities, as well as the authorities which have jurisdiction at the county level; and meeting additional contract requirements (e.g. in the event of a base lockdown). Anne Arundel County is very concerned with possible storm water runoff from construction sites. As such, two sediment control ponds are installed which will collect and trap the runoff.

Demolition of the existing building was required, as the new school will be built on the same site. The existing building contained hazardous materials including lead paint, mercury in the thermostats, and asbestos between the face brick and CMU walls. The abatement was performed by the abatement prime contractor, Delaware Cornerstone Builders, and the other demolition by the demolition prime contractor, Pleasants Construction. During construction, the students from Pershing Hill ES will be relocated to Meade Heights ES.

The reinforced concrete footings will be poured in area B first, followed by area A and area C last. Erection of the structural steel will begin in area A, followed by areas B and C. The finish sequences will follow the sequence A1, B1, C1, B2, C2 where the first floor is completed before work starts on the second floor. A graphic display of the various areas of the building is shown below.



There are several problematic features of the Pershing Hill Elementary School Replacement Project that could be pursued through a detailed analysis of the technical building systems and construction methods. These include restricted site access, masonry construction is a labor intensive process; buildings have to become more energy efficient, and less attention is paid to storm water runoff after construction.

Because the project is entirely within a US Army Base all contractors working on the site need low level security clearance in order to get access for themselves and their vehicles. Typically this process takes around 30 days, during which time the workers can obtain a temporary badge. If the vehicle that the person is driving is not registered to them, or is a company vehicle, the driver must have an original power of attorney or letter from the vehicle's owner stating the operators' name, dates that permission to use the vehicle is granted, and all vehicle information. It would be interesting to see if this process causes any significant access problems or if the contractors are able to easily follow the process and obtain their security clearance. The additional time spent on this process represents a potential loss of labor for each worker who must complete this process.

Masonry construction is a labor intensive process. This project contains a large amount of masonry work (the masonry bid package was over $1.7 million), which necessitates a large number of workers. Site access problems have already been discussed, and a large number of workers would exacerbate any problems with obtaining security clearance. Alternate systems to the masonry walls that are less labor intensive would require fewer workers and would minimize any problems with the security clearance process.

Many buildings are becoming more sustainable, due to increased awareness of owners. The air handling units with energy recovery that are used in this project are an example of how the owner is addressing this concern. However, there are other school projects where the owners are pursuing alternate energy sources, including geothermal, to make the building even more environmentally friendly. Geothermal systems also help schools that are seeking to achieve LEED certification, which this project is not.

Storm water runoff is monitored carefully during construction, and for this project two sediment control ponds have been installed. However, little attention is paid to storm water management once construction is complete. The Pershing Hill Elementary School Replacement Project requires additional sediment controls during construction, because of its proximity to a "critical wetlands area." The "critical wetlands area" will be preserved through construction, but following construction of the building one of the sediment control ponds will be demolished to build the parking lot. The parking lot, and the school, will reduce the amount of green space, which will increase the amount of storm water runoff after construction.

Electrical

The electrical system includes both 277/480V and 120/208V distribution. Both are three phase with four wires. There is an electrical room located on the first floor across the hall from the mechanical room, and four other electrical closets throughout the building. The main switchboard carries a connected load of 1592.7 KVA and a demand load of 1276.7 KVA. An emergency intercom is available in each classroom.

Lighting

There are 52 different lighting fixture types on this project. Most are 277 volt; however there are also some that run on 120 volts. Fluorescent fixtures are primarily used, but there are also HID, incandescent, and LED lights used for specific purposes. All interior lighting must comply with local codes and zoning requirements as well as NFPA 70 and NFPA 101.

Mechanical

The building is divided into 11 zones in which the temperature can be controlled. The mechanical room is located on the first floor, adjacent to the cafeteria. The mechanical system included 2 boilers, 46 fan coil units, 6 ductless split system AC units, 6 rooftop air handling units and 2 rooftop air handling units with energy recovery. All rooftop air handling units run on 480V-3 phase power.

Structural

The foundation system on this project is cast in place concrete. The slab on grade is typically 5” thick concrete reinforced with welded wire fabric over a vapor barrier and 4” of washed gravel, however it is 6” thick concrete at the mechanical room. The top of the footings typically lie 2’ below the slab. The footings are reinforced and vary widely in size (from 11 to 99 sqft in area), but only vary between 1’ and 1’-6” in thickness. The concrete on this project typically must have a compressive strength of 3000psi at 28 days, but all concrete exposed to weather must have 4500psi and be air entrained.

A composite slab is used where the second floor slab is 3” thick normal weight concrete reinforced with welded wire fabric over galvanized form deck. W16X26 joists are used in areas B and C with W10x15 joists used along the corridors on the second floor and 18KCS2 joists are used with W5X16 joists to support the roof. The roof deck is 1 ½” type ‘B’ galvanized metal roof deck. Seven different sizes of HSS shaped columns are used

The concrete masonry shall have a minimum compressive strength of 1900 psi on the net area, and the brick shall have a minimum compressive strength of 3350 psi on the net area. Temporary scaffolding is used during the installation of the masonry. Masonry piers with vertical reinforcement are used which vary in size from 8”x16” to 19”x32” All piers are 100% solid (either solid block, or hollow block filled with 3000 psi grout).

Analysis 1: Green Roof

Problem Statement

Storm water management is an important issue. The Pershing Hill Elementary School Replacement Project requires additional sediment controls during construction, because of its proximity to a “critical wetlands area.” The “critical wetlands area” will be preserved through construction. Following construction of the building, one of the sediment control ponds will be demolished to build the parking lot. The parking lot, and the school, will reduce the amount of green space, which will increase the amount of storm water runoff after construction.

Proposed Solution

A green roof would help manage storm water runoff after construction, but would weigh significantly more than a traditional roof, resulting in increased building loads. A green roof will also require adjusting the project schedule to accommodate its construction.

Methodology

- Research types of green roofs paying special attention to: benefits related to storm water management, structural implications, and effects on the construction schedule. Research will be done through keyword searches on the Compendex (Ei Village 2) database accessed through the Penn State University Libraries website and the CAT, also accessed through the Penn State University Libraries.

- Determine an appropriate choice for Pershing Hill Elementary School based on the different types of green roofs found in the research
- Select a green roof system from the systems researched
- Calculate additional structural loads of green roof, and determine suitability of current structural system. If the current system is not sufficient, redesign a typical bay to accommodate green roof.
- Adjust construction sequence and schedule to accommodate green roof.

Expected Outcome

I expect to find that a green roof will aid in storm water management. There are two types of green roofs; extensive and intensive. Intensive green roofs often are thicker which I expect will aid further in storm water management, but will also necessitate a structural redesign. I expect a green roof will take longer to construct than a conventional roof, unless a preassembled system is available, which will result in schedule implications that will need to be addressed by adjusting the construction sequence to allow the roof construction to start earlier.

Analysis 2: Geothermal Mechanical System

Problem Statement

As was discussed in the PACE Roundtable conference earlier this semester, new standards for energy performance are emerging and clients are becoming more aware of the energy impacts in their buildings. This is a critical industry issue. It was also discussed that builders are seeing more geothermal systems being implemented in schools, as a way to meet these energy demands, and alternative energy sources are becoming more popular due to government incentives.

Proposed Solution

A geothermal mechanical system will provide alternative energy, and reduce the building's demand for outside energy. However, there are significant upfront costs associated with alternative energy systems.

Methodology

- Research Geothermal Systems, paying attention to constructability challenges, additional costs, and government incentives. http://www.dsireusa.org will be used to research government incenives, as it was mentioned at Pace Roundtable as a good website for finding the applicable incentives for a particular state. Research on the geothermal systems will be done through keyword searches on the Compendex (Ei Village 2) database accessed through the Penn State University Libraries website and the CAT, also accessed through the Penn State University Libraries.

- Select a geothermal system from the systems researched, and modify it for Pershing Hill Elementary School.
- Provide plan to address additional time associated with installation of a geothermal system, by accelerating other activities on the critical path.
- Perform life cycle analysis to determine if a geothermal system is appropriate for Pershing Hill Elementary School.

Expected Outcome

I expect a geothermal system will result in increased initial costs, for both the system and the schedule reduction. Because excavation is on the critical path of the project, the schedule will need to be compressed to accommodate the additional time involved in installing the geothermal system. I expect the geothermal system will reduce yearly energy costs which, when combined with government incentives, will offset the initial costs over the building's life.

Analysis 3: Alternative to Masonry Construction

Problem Statement

Masonry construction is a labor intensive process. This project contains a large amount of masonry work, which necessitates a large number of workers. Site access problems are a construction challenge because of Pershing Hill Elementary School's location, and a large number of workers would exacerbate any problems with obtaining security clearance. Because certain areas of masonry construction are on the critical path, any delays to the mason can delay the entire project.

Proposed Solution

A precast system would be less labor intensive than masonry construction. A precast system would require fewer workers and would minimize any problems with the security clearance process. A preconstructed system would require less labor on site, which would result in fewer workers while maintaining the masonry appearance.

Methodology

- Research precast systems and pre-constructed systems, paying attention to duration of activities and special requirements during construction (e.g. cranes, staging areas). Research will be done through keyword searches on the Compendex (Ei Village 2) database accessed through the Penn State University Libraries website and the CAT, also accessed through the Penn State University Libraries.

- Select an appropriate system for Pershing Hill Elementary School from those researched. Preconstructed systems will be favored, if available, followed by precast systems with the closest appearance to the masonry systems.
- Select appropriate areas to replace the masonry construction with a precast system. These will be areas of masonry construction that are on the critical path if the research shows that the precast/preconstructed system instillation is faster and areas off the critical path if research shows the precast/preconstructed system instillation is slower.
- Analyze effect of the selected system on the project schedule by comparing the construction durations of the critical path activities. The duration for the masonry activities will be those used by the construction team in scheduling the project. The durations for the precast/preconstructed system will be those found in the research.
- Perform constructability review analyzing any special requirements found in the research, and if changes to the site layout need to be made to accommodate them.

Expected Outcome

I expect to find that a precast/preconstructed system will reduce the schedule for construction of Pershing Hill Elementary School. I expect the precast/preconstructed system will be installed quicker which will result in the areas on the critical path being replaced for this activity. I expect the precast/preconstructed system to be less labor intensive, but have additional requirements in site layout which will require a constructability review and possibly changing the location of the crane, or including an additional crane.

Analysis 4: LEED Certification

Problem Statement

It was discussed at the PACE Roundtable conference that schools are moving towards LEED certification. There are many benefits to LEED certification; however Pershing Hill Elementary School chose not to peruse LEED certification.

Proposed Solution

Perform an analysis of the costs associated with pursuing LEED certification for Pershing Hill Elementary School.

Methodology

- Research Requirements for LEED certification from the LEED website
- Identify LEED requirements that are currently being met
- Identify additional requirements for design or construction that could be used to achieve LEED certification (paying attention to analysis activities 1 and 2).
- Determine costs associated with LEED certification

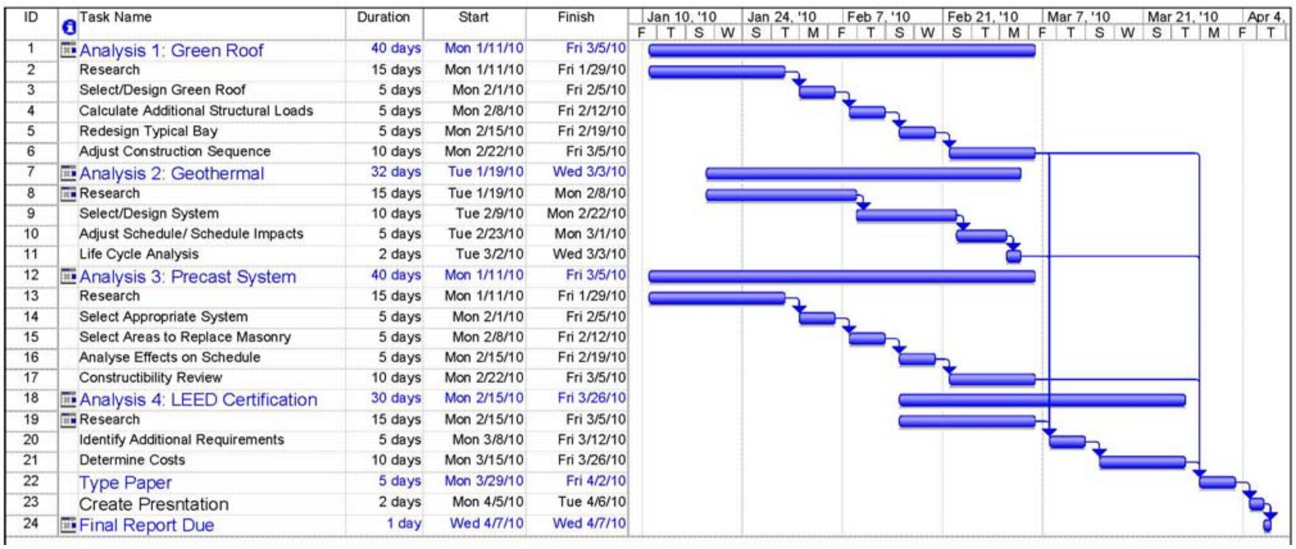
Expected Outcome

I expect to find that minimal costs would be associated with achieving LEED certification, and analysis activities 1 and 2 would contribute to achieving LEED certification.

Conclusions

My proposal includes four analysis activities; a green roof, geothermal mechanical system, precast system, and pursuing LEED certification. A schedule showing how I intend to complete these four activities is shown below, as is a weight matrix.

Schedule



ID	Task Name	Duration	Start	Finish
1	Analysis 1: Green Roof	40 days	Mon 1/11/10	Fri 3/5/10
2	Research	15 days	Mon 1/11/10	Fri 1/29/10
3	Select/Design Green Roof	5 days	Mon 2/1/10	Fri 2/5/10
4	Calculate Additional Structural Loads	5 days	Mon 2/8/10	Fri 2/12/10
5	Redesign Typical Bay	5 days	Mon 2/15/10	Fri 2/19/10
6	Adjust Construction Sequence	10 days	Mon 2/22/10	Fri 3/5/10
7	Analysis 2: Geothermal	32 days	Tue 1/19/10	Wed 3/3/10
8	Research	15 days	Tue 1/19/10	Mon 2/8/10
9	Select/Design System	10 days	Tue 2/9/10	Mon 2/22/10
10	Adjust Schedule/ Schedule Impacts	5 days	Tue 2/23/10	Mon 3/1/10
11	Life Cycle Analysis	2 days	Tue 3/2/10	Wed 3/3/10
12	Analysis 3: Precast System	40 days	Mon 1/11/10	Fri 3/5/10
13	Research	15 days	Mon 1/11/10	Fri 1/29/10
14	Select Appropriate System	5 days	Mon 2/1/10	Fri 2/5/10
15	Select Areas to Replace Masonry	5 days	Mon 2/8/10	Fri 2/12/10
16	Analyse Effects on Schedule	5 days	Mon 2/15/10	Fri 2/19/10
17	Constructibility Review	10 days	Mon 2/22/10	Fri 3/5/10
18	Analysis 4: LEED Certification	30 days	Mon 2/15/10	Fri 3/26/10
19	Research	15 days	Mon 2/15/10	Fri 3/5/10
20	Identify Additional Requirements	5 days	Mon 3/8/10	Fri 3/12/10
21	Determine Costs	10 days	Mon 3/15/10	Fri 3/26/10
22	Type Paper	5 days	Mon 3/29/10	Fri 4/2/10
23	Create Presntation	2 days	Mon 4/5/10	Tue 4/6/10
24	Final Report Due	1 day	Wed 4/7/10	Wed 4/7/10

Weight Matrix

Description of Analysis	Research	Value Eng.	Const. Rev.	Sched. Red.	Total
Analysis 1: Green Roof	10	10	10	10	**40**
Analysis 2: Geothermal	10	10		10	**30**
Analysis 3: Precast System		5	10	5	**20**
Analysis 4: LEED Certification	10				**10**
Total	**30**	**25**	**20**	**25**	**100%**

Appendix A

Breadth Studies and MAE Course Related Studies

Breadth studies in structural and mechanical options were integrated into this report as parts of analysis 1 and 2. Analysis 1 includes calculating the additional structural loads imposed by the green roof and redesigning a typical bay for these loads. Analysis 2 involves designing an appropriate geothermal mechanical system for Pershing Hill Elementary School.

Research methods learned in AE 597K (Research Methods in Architectural Engineering) will be used to perform research on green roofs, geothermal systems, and precast systems, as identified in analysis activities 1, 2, and 3. Life cycle analysis for the geothermal system in analysis 2 will follow the method used in AE 572 (Project Development and Delivery Planning) to determine if an option is economically advantageous. When assessing schedule impacts, and in particular the need to condense the schedule as in Analysis 2, information from CE 533 (Construction Productivity and Performance Analysis) will be used to determine the optimal way to accelerate the schedule and the effects of overtime, overlapping trades, and working multiple shifts on productivity.