BUILDING FAÇADE DESIGN

Executive Summary

The existing façade design for Frederick Memorial Hospital calls for a brick veneer wall to be placed in front of the old façade. This analysis proposes the use of precast masonry panels instead. The panels will utilize the Brick Snap© system patented by Scott System, Inc. This system consists of thin brick veneers that are attached to a concrete panel. The heat and moisture transfer properties of these panels are analyzed in the German program WUFI and via a U value analysis. The precast panels are shown to provide the same level of moisture and heat resistance as a brick veneer wall. There are several implications of using the precast panels. The panels weigh twice as much as the brick veneer system. As a result the existing foundation will have to be upsized. The precast panels must be erected with a crane; as a result there is a significant impact upon the site planning. In addition, the precast panels are much more expensive than a brick veneer. Contributing to the extra cost is the fact that a crane is needed for erection. Even with general conditions savings from the decreased construction time, the panels are more expensive. Because brick veneer wall construction is very slow, the precast panels can be installed much faster comparatively. The schedule is positively impacted, allowing for less general conditions time and for the building to be dried in faster. Weighing the advantages and disadvantages, the precast panel construction is better than the standard brick veneer façade method.

Façade Design

The current construction of the G wing at Frederick Memorial Hospital is cast-in-place concrete slabs and columns with brick masonry walls constructed over 50 years ago. The walls are just 2 layers of brick separated by a layer of grout. The existing façade design entails constructing a brick veneer wall in front of the old façade. The designed façade consists of standard 3-5/8" brick, a 2" airspace, 2" of rigid insulation, and damproofing sprayed on the exterior of the old façade.

The proposed design for the façade consists of manufactured precast masonry panels instead of hand laid brick veneer. The panels are 5 ¼" thick concrete with ¾" thick thin bricks attached to the concrete. The panels being used are Scott System Inc. Brick Snap© panels. With this system the thin bricks are placed on a flat concrete surface in a running bond and each brick is "snapped" together. An example of this procedure is shown in figures 1 and 2. Formwork is then placed around the edges and reinforcing is situated on chairs on top of the brick in the form. Concrete is then poured and vibrated as it would be in any typical form. After the concrete has cured, the panel is lifted and placed upright exposing the brick. The brick snaps are then removed by hand. The snaps are designed so that when the concrete is poured a tooled joint shape forms at the snap connections. Therefore, when the snaps are removed there appears to be a tooled joint between the courses exactly how a hand laid masonry wall would look. The end result is a panel that appears to be a very carefully handcrafted masonry wall.

Figure 1: Laying the thin bricks

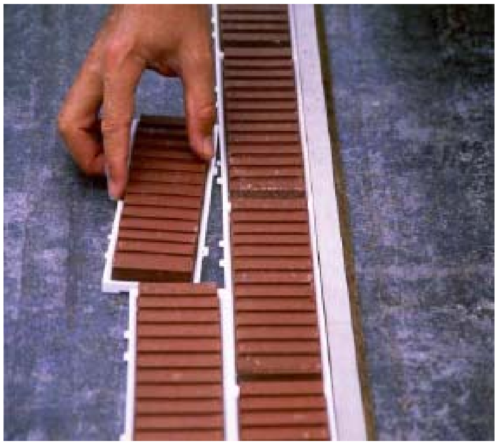


Figure 2: Snapping the bricks together

For Frederick Memorial Hospital the panels have been designed to each be one story high, by 20' long. This will match the existing column to column spacing of the wing. The panels will stack directly on top of each other from the basement to the roof. 4

panels will span this vertical distance. Each panel will be 6" thick and reinforced in both the long and short direction. To transfer lateral load, each panel will tie into the existing structure at the existing floor level. On each side the panels connect to each other with a plate bolted to each panel. On the top and bottom the panels bear on each other. Sealant is caulked around all of the edges to minimize water infiltration. Figure 3 below shows a comparison between the cross section of the existing design, and the proposed design.

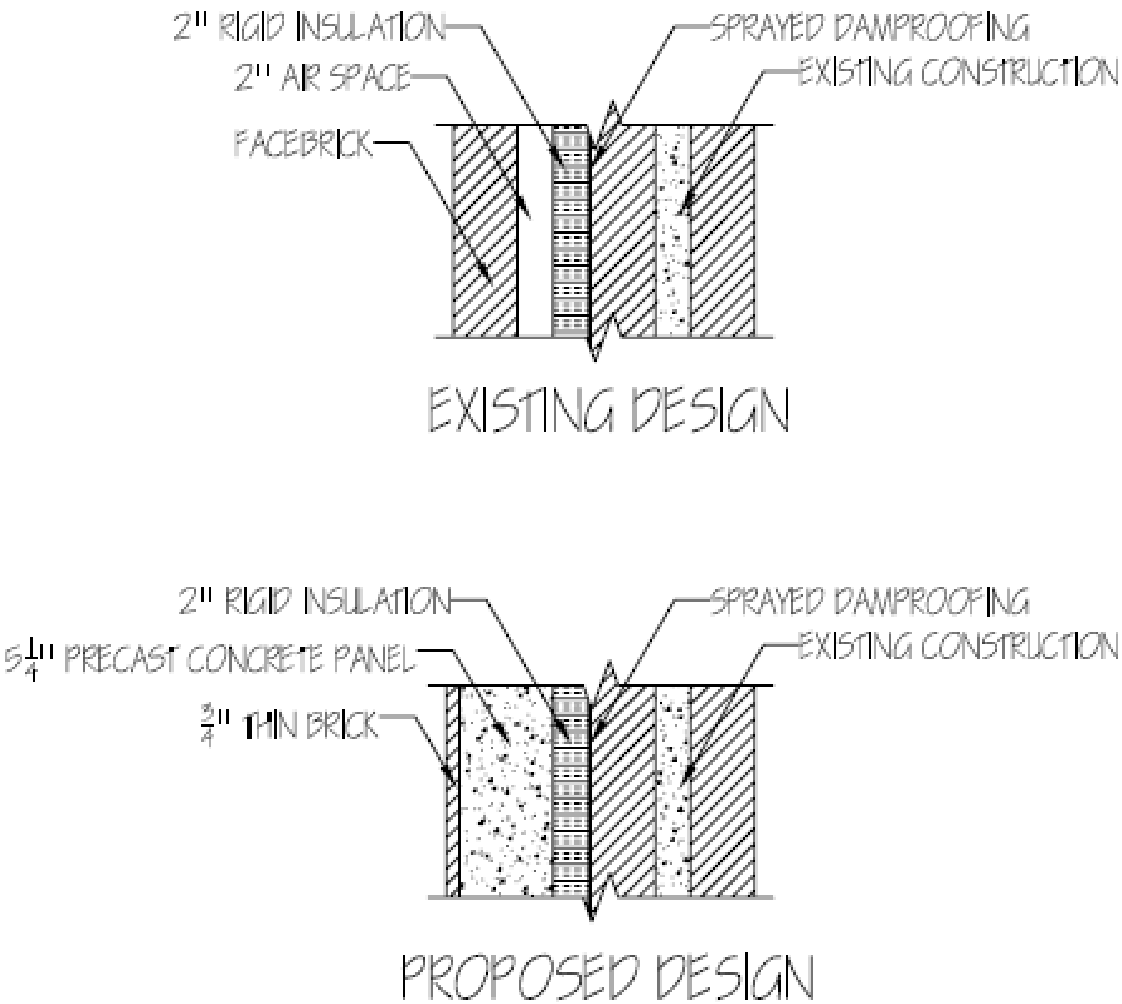


Figure 3: Proposed v. Existing Cross-Sections

Introduction to WUFI

The existing hand laid masonry design and the proposed precast concrete and masonry panel design were both tested for heat and moisture transfer in a program titled WUFI. WUFI is the acronym for Wärme- und Feuchtetransport Instationär, which translates from German to transient heat and moisture transport in English. The program calculates simultaneous heat and moisture transport through building envelopes. WUFI takes the following into account for the calculations:

- thermal conduction
- enthalpy flows through moisture movement with phase change
- short-wave solar radiation
- nighttime long-wave radiation cooling
- vapor diffusion
- solution diffusion
- capillary conduction
- surface diffusion

The first step in the analysis is inputting the envelope materials and thicknesses. WUFI has an extensive database of construction materials that contains all of the thermal and moisture properties necessary for the analysis. For each case to be analyzed the cross section of the envelope is created with the associated materials from the WUFI database. Three primary cases were analyzed through WUFI:

1. The old G wing façade
2. The brick veneer existing design
3. The precast panel proposed design

Besides those cases, 4 additional cases for the precast panel were analyzed to determine the impact of the insulation, airspace, and damproofing membrane on the thermal and moisture properties of the wall:

1. Airspace instead of insulation, with damproofing
2. Airspace instead of insulation without damproofing
3. No airspace, no insulation, with damproofing
4. No airspace, no insulation, without damproofing

The following pages contain graphical data from the tests in figures 4 through 8.

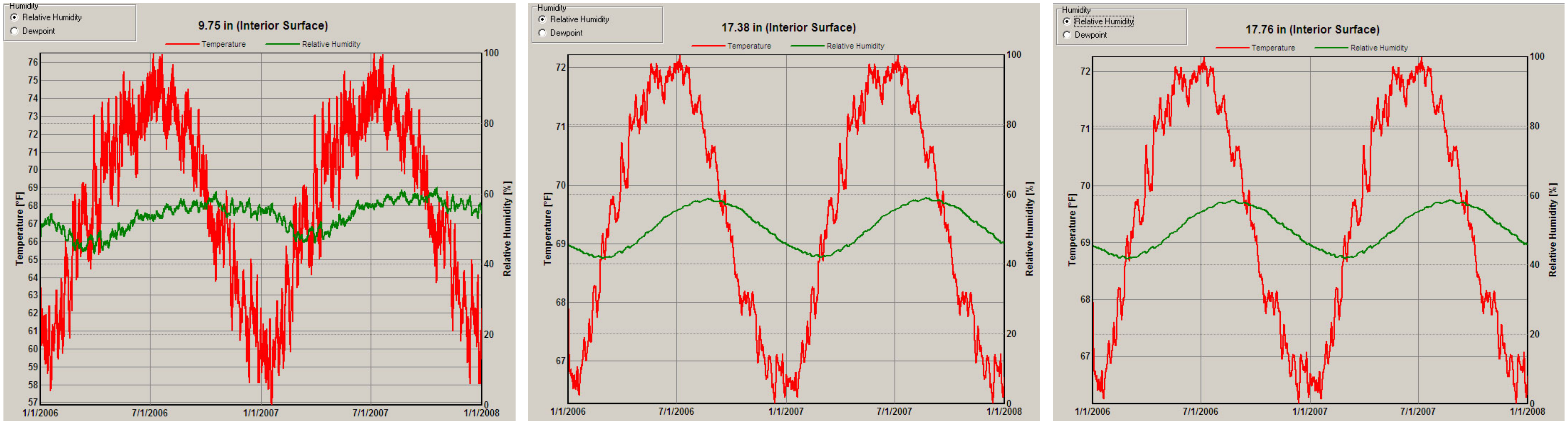


Figure 4: Temperature on interior wall during 2 year period for old façade, existing veneer design, and proposed panel design

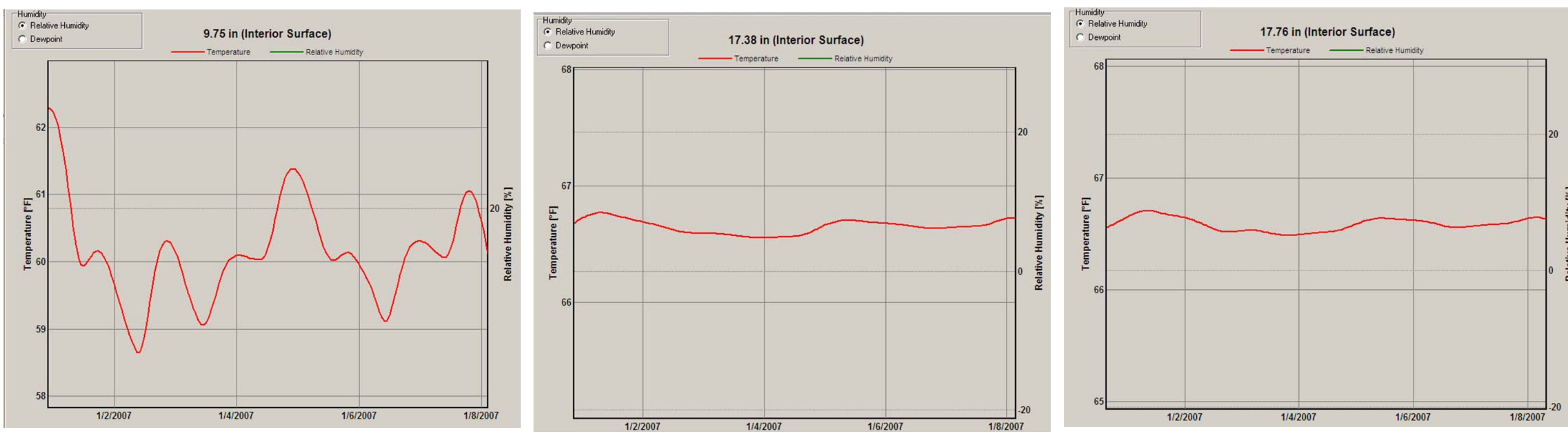


Figure 5: Temperature on interior wall during 1 week period in January for old façade, existing veneer design, and proposed panel design

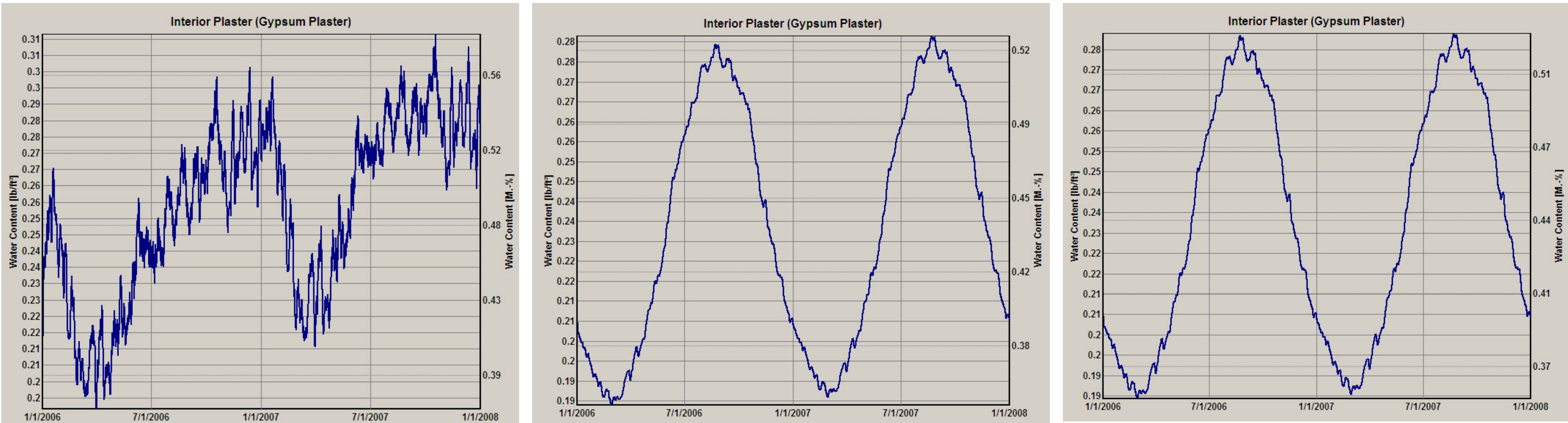


Figure 6: Water content of the interior during a 2 year period surface for old façade, existing veneer design, and proposed panel design

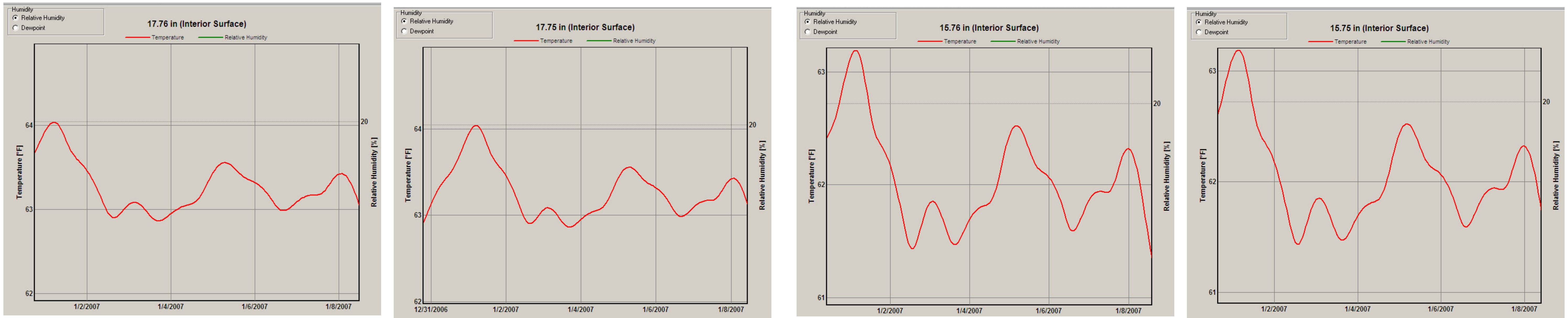


Figure 7: Temperature on interior wall during 1 week period in January for panel with airspace with dampproofing, panel with airspace without dampproofing, panel without airspace with dampproofing, panel without airspace without dampproofing

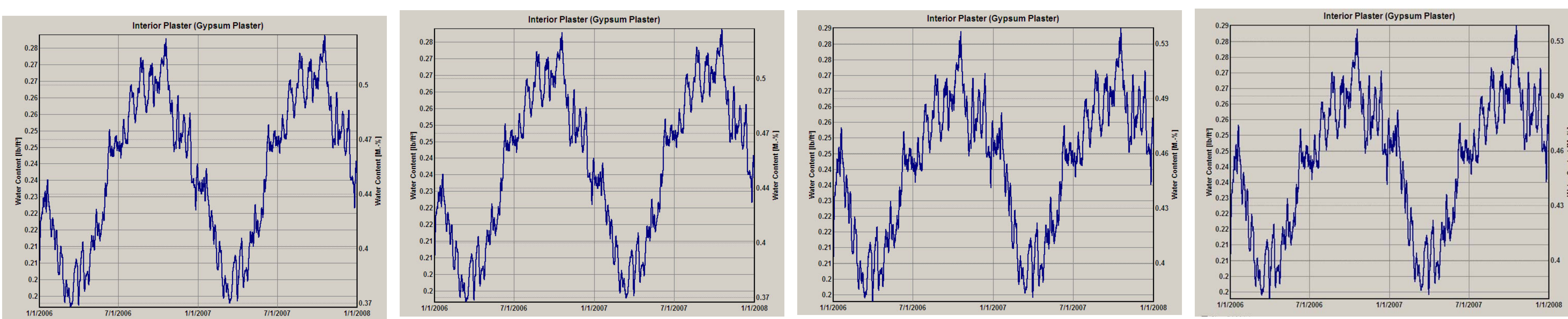


Figure 8: Water content of the interior surface during a 2 year period for panel with airspace with dampproofing, panel with airspace without dampproofing, panel without airspace with dampproofing, panel without airspace without dampproofing

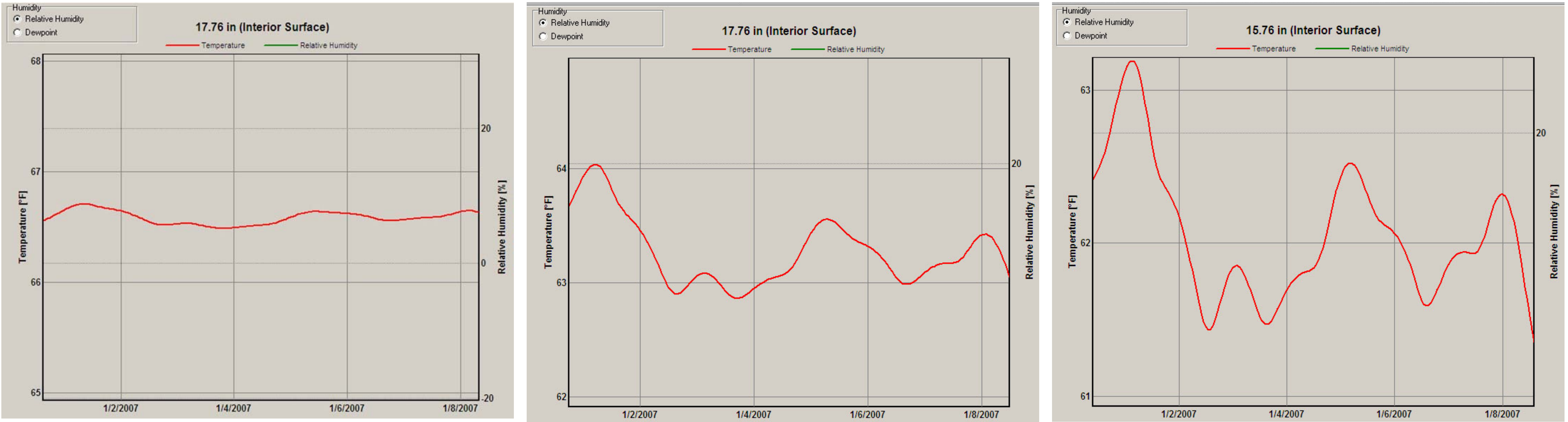


Figure 9: Temperature on interior wall during 1 week period in January for panel with insulation, panel without insulation with airspace, panel without insulation without airspace

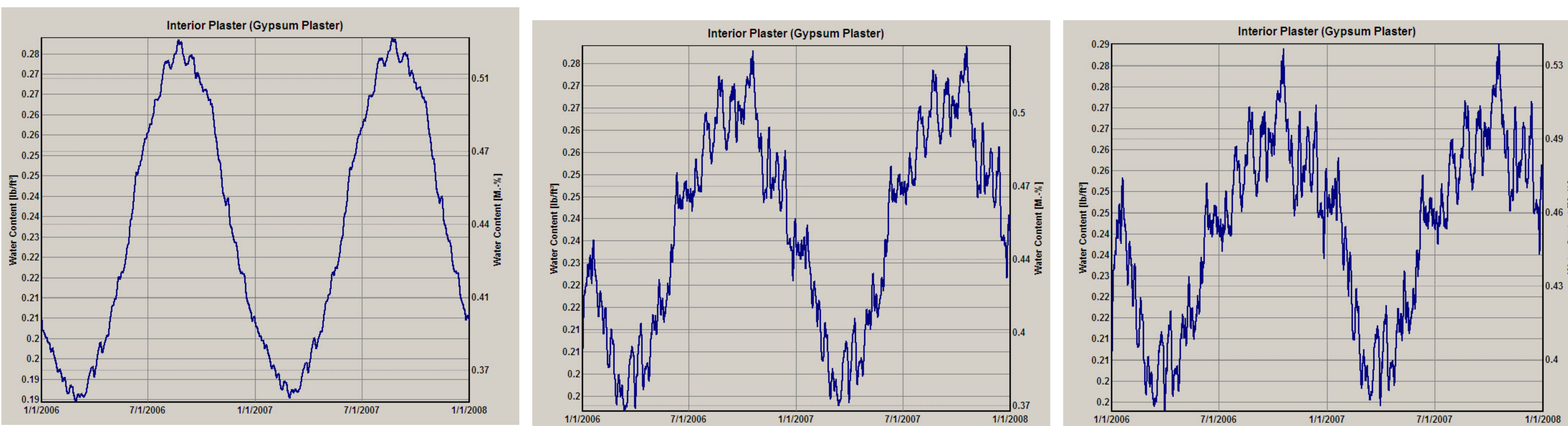


Figure 10: Water content of the interior surface during a 2 year period for panel with insulation, panel without insulation with airspace, panel without insulation without airspace

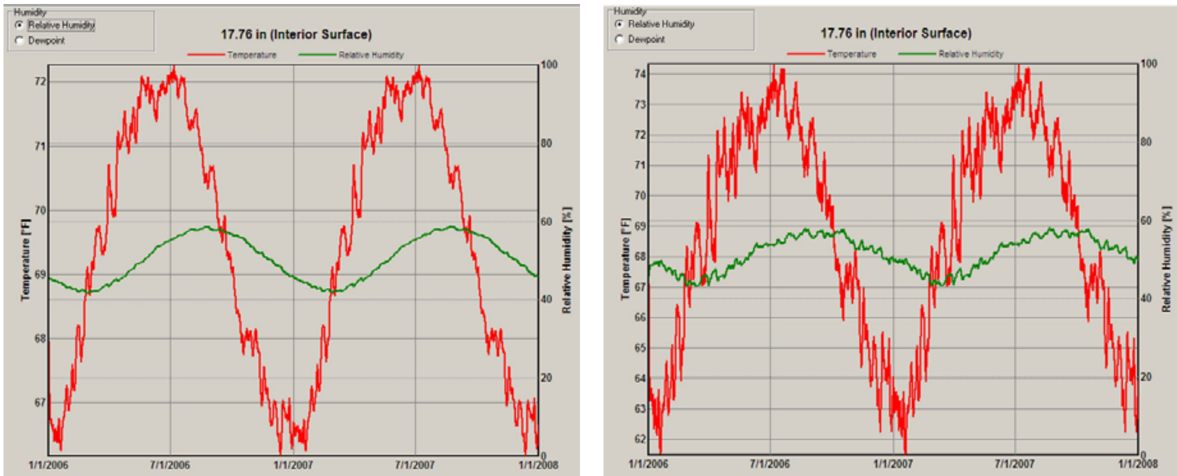


Figure 11: Relative humidity shown in green of precast panel with and without insulation

Transient Heat & Moisture Transport Analysis

The goal of this analysis was to determine if the precast Brick Snap© panels would perform the same or better when compared to the hand laid brick veneer. In terms of the temperature on the inside surface of the building the precast panel performed essentially exactly the same as the brick veneer. Both the veneer and the panel were marked a marked improvement over the existing construction. The inside temperature for the veneer and the panel virtually did not vary from day to day, whereas in the existing condition the temperature fluctuated around 3 degrees daily. In terms of moisture content on the inner surface the panel performed almost identically as the brick veneer. And again both the panel and the veneer showed visible improvement over the existing construction. In terms of fluctuation range the panel, veneer and existing construction varied the same; however the existing construction had moisture content variation on a daily and weekly basis, whereas the panel and the veneer fluctuated from season to season because of the increased humidity during the warm months, but barely fluctuated on a daily or weekly basis. Additionally, the existing construction showed a significant trend of the moisture content increasing each year. This trend could result in failure of the building materials if a certain critical water content level was reached, or could result in moisture appearing on the inside surface of the building. The brick veneer and the precast panel both did not exhibit any increasing water content trend.

When looking at just the precast panel to see impact of the insulation, airspace, and dampproofing membrane there were some consistent trends visible. First, it appeared to make no difference if there was damproofing present or not. The panel with an airspace showed no discrepancy in interior surface temperature and moisture content whether or not there was damproofing. The panel with no airspace had the same results. This can most likely be attributed to the fact that brick is about 20 times more permeable than concrete. Typical brick veneer construction dictates having damproofing, but since concrete allows much less water through it becomes unnecessary. There only a slight difference between the panel with and airspace and the one without an airspace, but there seemed to be a fairly significant difference between those two and the panel with insulation. The panel with insulation barely fluctuated inside temperature, where as the other two panels fluctuated about 2 degrees a day, and the average was about 4 degrees colder with the non insulated panels during the winter. Additionally, whereas the panel with insulation did not fluctuate daily and weekly with respect to moisture content, the panels without insulation did. The interior moisture content can be correlated to the insulation because as seen above in figure 11, the relative humidity varies much more with the panel without insulation. As a result of the relative humidity being more variable, the moisture content is more variable.

U Value Analysis

Another good metric to determine the heat transfer properties of a wall is the U value. The U value defines the number of BTUs flowing through an assembly per square foot per hour per temperature degree difference. A lower U value is preferred because it means that less heat is being lost through the wall during the winter, and less heat is transmitted through the wall into the building during the summer. Tables 1 through 4 show the U values for the various wall assemblies. The U value including windows is calculated as 25% of wall area containing double glazed windows.

Existing Construction	
	R value
air film	0.17
brick	0.385
grout	0.2
brick	0.385
plaster	0.32
inside air	0.68
sum (R Value)	2.14
U Value	0.4673
U incl. windows	0.4755

Hand Laid Brick Veneer	
	R value
air film	0.17
brick	0.385
2" air space	0.9
2" rigid ins.	10
brick	0.385
grout	0.2
brick	0.385
plaster	0.32
inside air	0.68
sum (R Value)	13.425
U Value	0.0745
U incl. windows	0.1809

Table 1: U values for Existing Construction and Brick Veneer

Precast Panels, no insulation	
	R value
air film	0.17
brick	0.385
concrete	0.6
air space	0.9
brick	0.385
grout	0.2
brick	0.385
plaster	0.32
inside air	0.68
sum (R Value)	4.025
U value	0.248447
U incl. windows	0.311335

Precast Panels with insulation	
	R value
air film	0.17
brick	0.385
concrete	0.6
rigid ins.	10
brick	0.385
grout	0.2
brick	0.385
plaster	0.32
inside air	0.68
sum (R Value)	13.125
U Value	0.07619
U incl. windows	0.182143

Table 2: U values for Precast Panel without insulation and Panel with insulation

For Frederick Maryland, with 5000 heating degree days, ASHRAE standards dictate that a non-residential facility should have a minimum 0.3 U value for the exterior walls. The existing construction of the walls is definitely inadequate. The brick veneer and the precast panel with insulation are both meet the standards and are more than adequate. However the precast panel without insulation does not meet ASHRAE standards. This is evidence that in order to use the precast masonry panels there must be insulation in the wall assembly.

Structural Implications

By changing the new façade from a brick veneer system to a precast concrete and masonry system there are several impacts. The precast panels are significantly heavier than typical brick veneer. The following table 3 shows the calculated weight difference of the two construction systems.

Brick Veneer	
120	lb/cf
0.30208	ft
11	ft
398.75	lb/ft

Precast Panel			
Brick		Concrete	
120	lb/cf	150	lb/cf
0.0625	ft	0.4375	ft
11	ft	11	ft
82.5	lb/ft	721.875	lb/ft
Total		804.38	lb/ft

Equivalent 20' wide by 11' high area			
Brick Veneer		Precast Panel	
7975	lbs	16088	lbs

Table 3: Weight Comparison of Brick Veneer v. Precast Panels

Because of the panels weighing twice as much as the brick veneer changes must be made to the foundation so that it can bear the weight of the panels. The existing design of the brick veneer façade calls for the brick to bear on the existing foundation built over 50 years ago. This is no longer acceptable, and the foundation must be retrofitted. Figure 12 below shows a schematic design of the retrofitted foundation. As well as the additional bearing requirements, connections between the panels and the existing façade must be designed to be able to transfer the lateral load of the panels to the existing structure. However, because the panels bear on top of each other, the bearing angles that supported the brick can be eliminated.

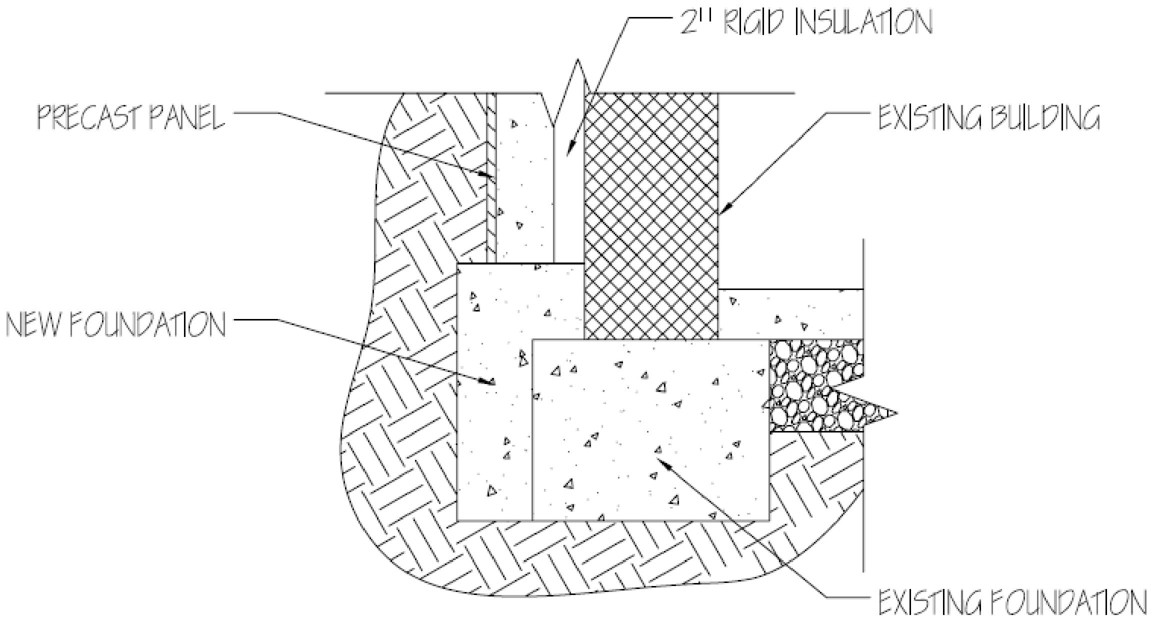
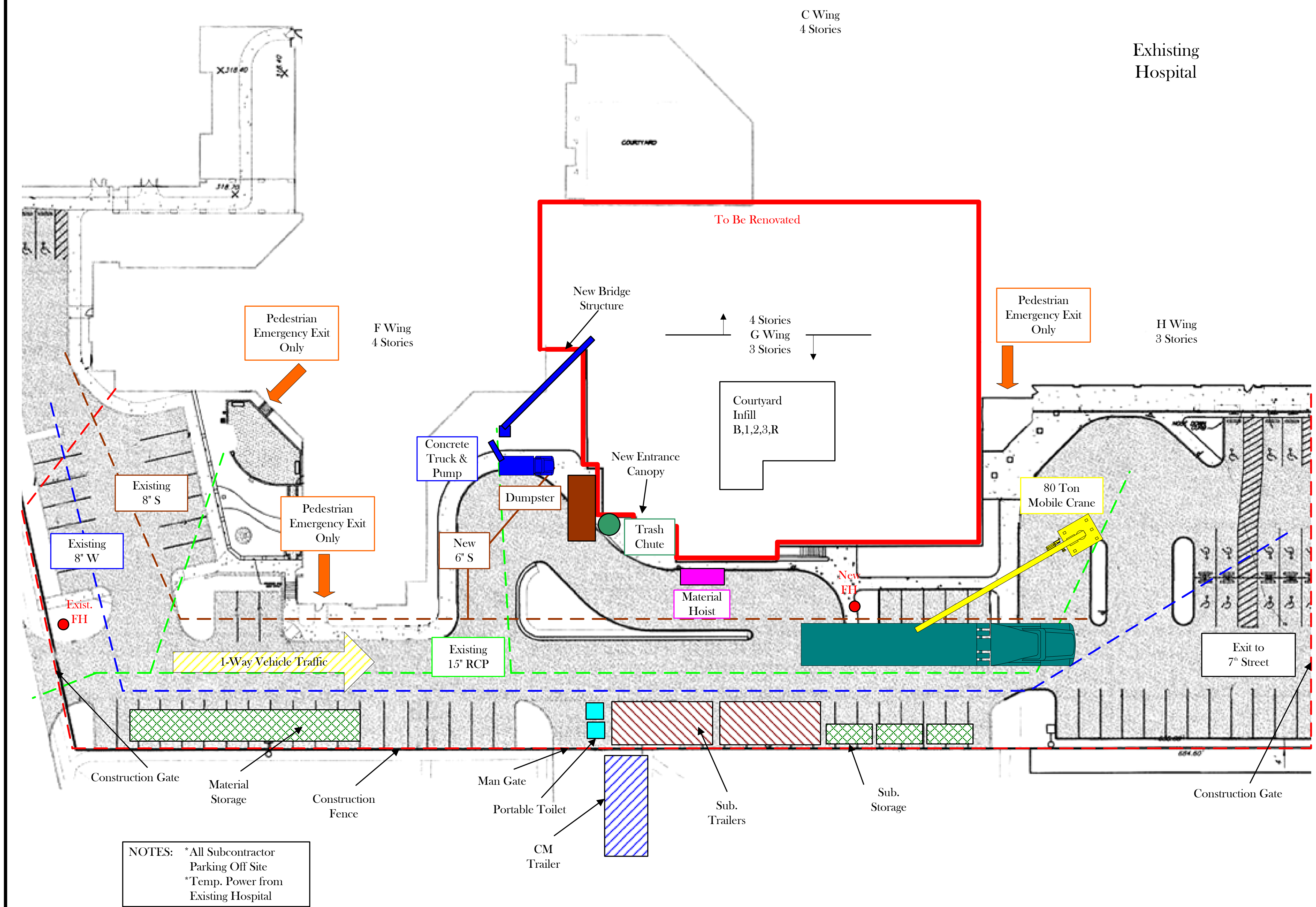


Figure 12: Schematic Design of New Foundation

Site Planning Implications

The construction of a brick veneer façade is very different from the construction of a precast concrete façade; as a result there are some site planning implications from using precast. Masonry construction requires a lot of scaffolding which can clog up the site; by using precast this eliminates the need for scaffolding. However, precast members must be erected with a crane, so the scaffolding has been eliminated but there is a crane on site instead. Additionally, there is very little to no lay down area on the site, therefore the precast panels must be trucked in and lifted right off of the truck. This adds more congestion to the site. Two site plans are shown on the following pages for the construction of the precast panel façade.



FREDERICK MEMORIAL HEALTHCARE SYSTEM

Frederick Memorial Hospital

Project 2000
Phase 4
Additions
&
Renovations

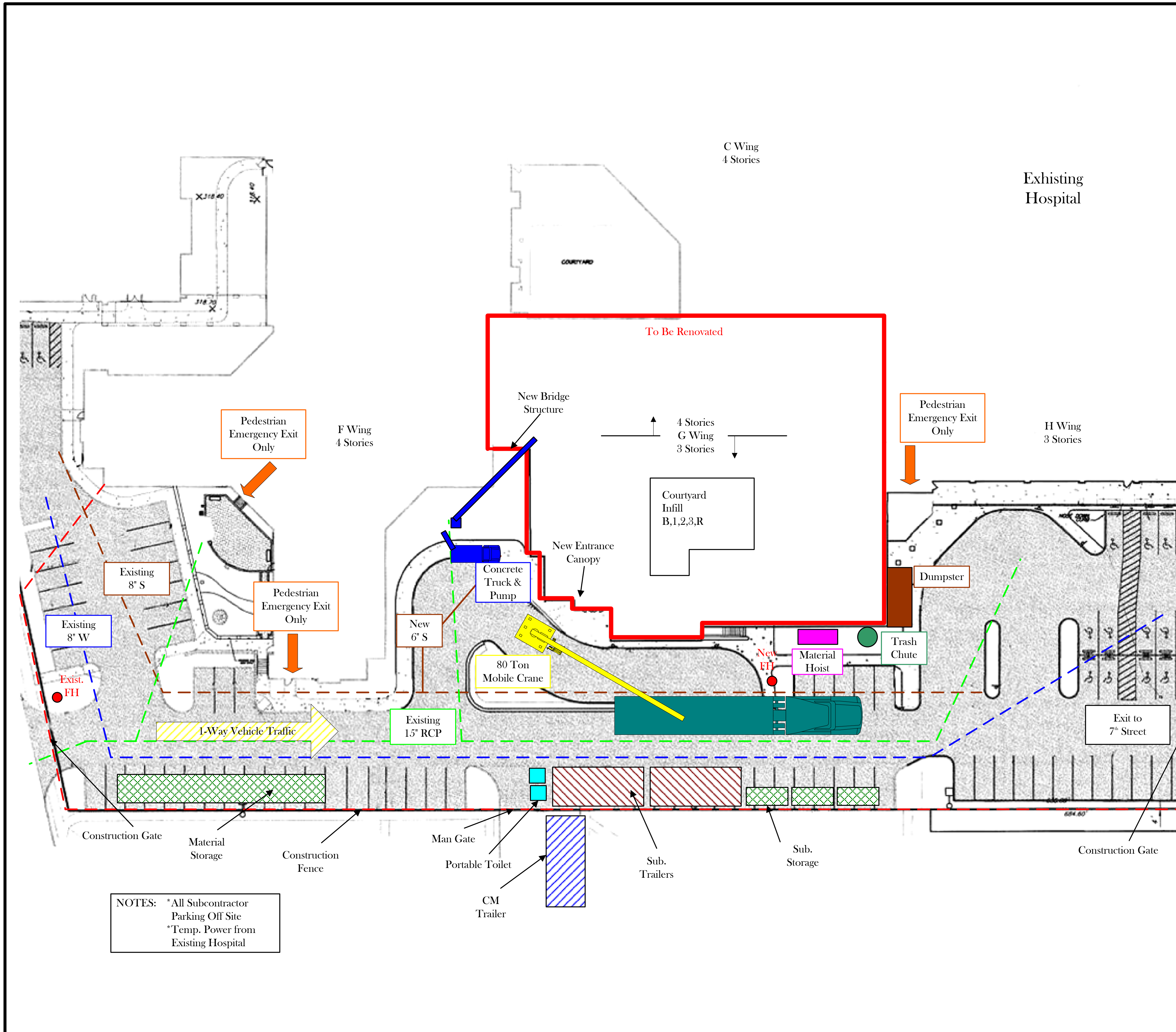
N

NAME

Abe Vogel
4.03.06

TITLE

NE PANEL ERECTION



FREDERICK MEMORIAL
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TITLE

SE PANEL
ERECTION

Cost Implications

Being two very different systems there is a cost difference between brick veneer and precast panel construction. The following table shows the estimate of each method.

Description	Quantity	Unit Price	Cost
Brick Veneer, 4" standard brick with polystyrene cavity insulation	15,772 SF	26.8 /SF	$422,690
Location Modifier – Hagerstown		0.89	-$58,304
Estimate Total			$364,386

Description	Quantity	Unit Price	Cost
Manufacture and Deliver Precast Panels	15772 SF	35 /SF	$552,020
Crane for Panel Erection	20 DAY	1513 /DAY	$30,260
Less General Conditions	4 WK	12837 /WK	-$51,348
Location Modifier - Hagerstown		0.89	-$64,051
Estimate Total			$466,881

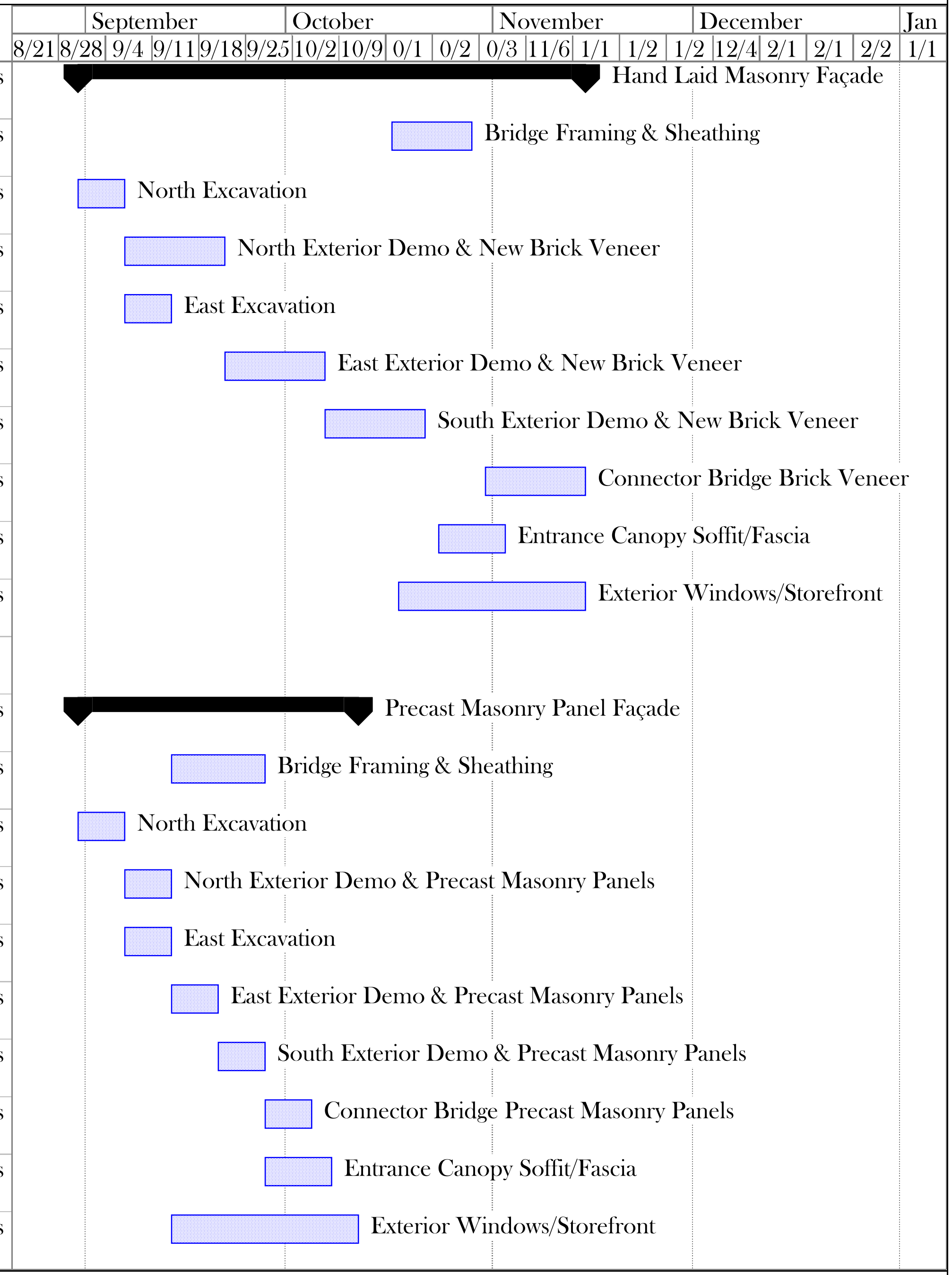
Table 4: Cost Comparison of Brick Veneer v. Precast Panels

Cost for the manufacture and deliver precast panels activity was quoted from Mark Taylor of Nitterhouse Concrete Products Inc. Precast panel erection is less labor intensive than masonry construction; however the labor hours required to manufacture the panels must be taken into consideration. A major cost difference is that the precast panels require a crane to be rented. A somewhat equalizing factor is that the precast panels can be erected much more rapidly than brick veneer walls can be built. This saves a significant amount of time on general conditions.

Schedule Implications

Because masonry construction is very slow and requires a lot of man hours, the precast panel erection saves a significant amount of time on the schedule. The brick veneer will take 54 work days, whereas the precast panels will take 30 work days. One aspect that must be considered is the lead time on the precast panels. The design of the façade must be 100% complete before the manufacturer can begin constructing the panels. Because once the panel is made, there is not possible way to change a window size or window placement without making another panel. However, the biggest positive impact in saving a month on the schedule is that the building is dried in faster. This is extremely important from an infection control standpoint. As long as the building is opened up the risk for bacteria infiltrating the building is extremely high. With this project being a hospital project infection risks must be minimized. The shortened schedule for the building envelope is a big help towards this goal. The comparison schedule is shown on the next page.

ID	Task Name	Duration
1	Hand Laid Masonry Façade	54 days
2	Bridge Framing & Sheathing	10 days
3	North Excavation	5 days
4	North Exterior Demo & New Brick Veneer	11 days
5	East Excavation	5 days
6	East Exterior Demo & New Brick Veneer	11 days
7	South Exterior Demo & New Brick Veneer	11 days
8	Connector Bridge Brick Veneer	11 days
9	Entrance Canopy Soffit/Fascia	8 days
10	Exterior Windows/Storefront	20 days
11		
12	Precast Masonry Panel Façade	30 days
13	Bridge Framing & Sheathing	10 days
14	North Excavation	5 days
15	North Exterior Demo & Precast Masonry Panels	5 days
16	East Excavation	5 days
17	East Exterior Demo & Precast Masonry Panels	5 days
18	South Exterior Demo & Precast Masonry Panels	5 days
19	Connector Bridge Precast Masonry Panels	5 days
20	Entrance Canopy Soffit/Fascia	8 days
21	Exterior Windows/Storefront	20 days



Conclusion

The Brick Snap© panels provide an effective alternative to hand laid masonry for Frederick Memorial Hospital. In terms of heat and moisture transport a system of precast panels with rigid insulation performs just as well as a brick veneer façade. The precast panels are also shown to be just as good as masonry veneer when it comes to thermal transmission. However it was apparent that the panels need the rigid insulation in order to meet ASHRAE standards. The precast panels do have some significant implications, both positive and negative, on the project. Structurally, the panels require a new foundation to be constructed to support the extra weight that the panels have versus the brick veneer, as well as connections to the structure to transfer the lateral load from the panels. The panels do affect the site plan. Although there no longer needs to be scaffolding set up, a crane must be used to erect the panels and truck deliveries must be scheduled to bring in the panels. And due to the tight sight, the panels must be lifted right off the trucks because there is no laydown area. The precast panel system is more expensive than a brick veneer system. However, one month is saved on the schedule by going to a precast panel façade allowing the building to be dried in faster greatly reducing infection risk. Weighing the advantages and disadvantages, the precast panel construction is better than the standard brick veneer façade method.