Analysis 1: Prefabrication of the Exterior wall (Depth Study)

Problem

Hand laid brick is the most common method when building the façade of a building. However, this method is slow and takes a lot of time of the schedule.

Goal

On a project that has a big façade; it is worth studying how a prefabricated façade would affect the project. The use of pre-cast brick façade panels rather than hand laid brick could reduce the schedule duration significantly. The goal of this analysis is to see if replacing the bricks with precast brick panels could reduce the schedule duration and cost of the project.

Background

The current façade design calls for stick built 4" masonry on a 7-5/8" metal stud back-up with exterior sheathing board, 1" cavity board insulation and sheet membrane air barrier. Masonry is attached to the structure using masonry ties that are screwed to the metal studs.

Steps for the Analysis

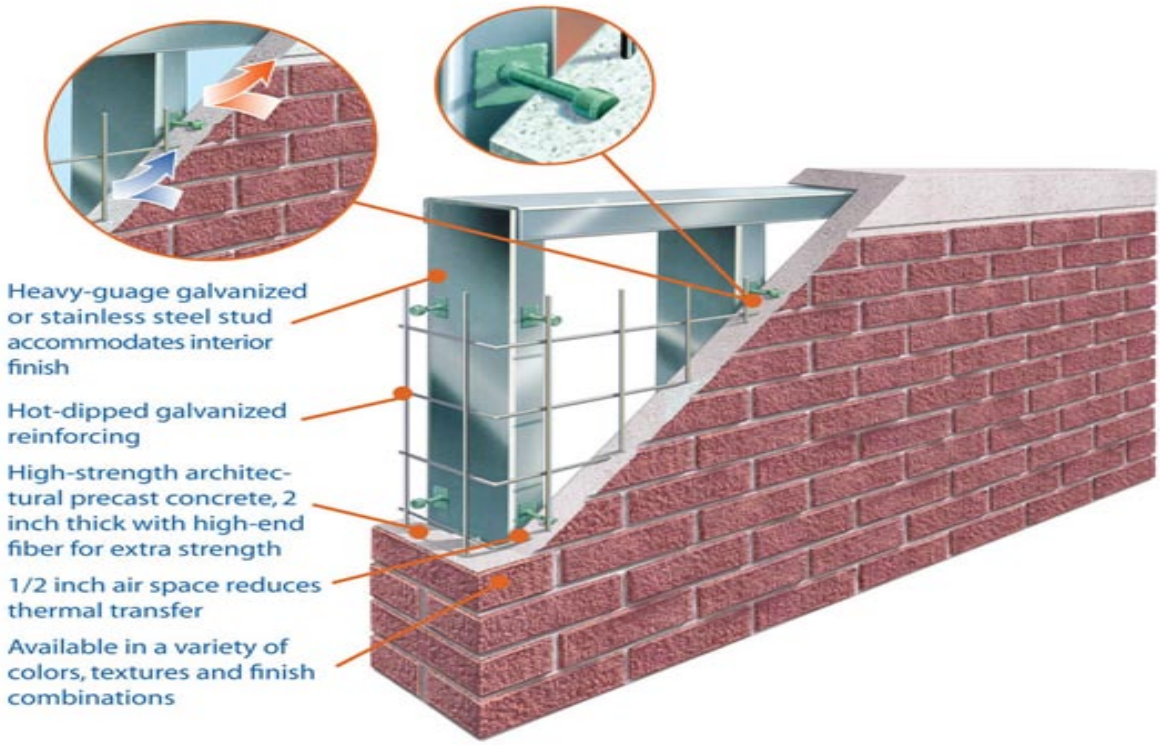
- Perform a Quantity Take-Off of the Existing Façade
- Select an Architectural Precast Brick Panel system to replace the current system.
- Contact the panel manufacturer to determine number of panels, erection costs, and installation costs.
- Investigate typical erection time for each panel.
- Perform a Cost & Schedule Comparison of both Systems
- Perform Structural Analysis to determine if the structure need to be changed

Resources

- Clark Construction Company
- Architectural Engineering Faculty
- EASI-SET® Industries
- RS-Means

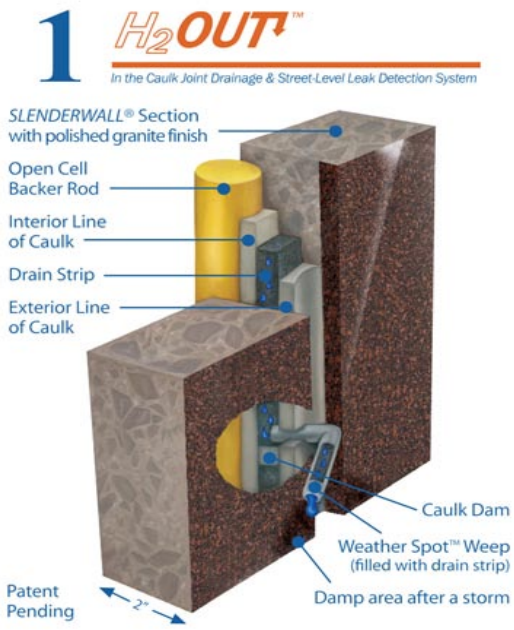
Proposed System

After analyzing many solid precast panels, I realized that the ordinary precast panels weigh significantly more that the existing brick façade, which means that the structure would have to be modified. After further research I found a system called ThermaGuard SlenderWall System, which is an architectural precast concrete system that is much lighter and less expensive than the ordinary solid precast panel system. The Slenderwall consists on a two inch reinforced high-strength architectural precast concrete exterior layer with hot-dipped galvanized reinforcing, and an interior formed by 16 gauge, six inch galvanized steel studs spaced vertically at two foot center. The concrete is securely connected to the steel stud frame with a epoxy-coated stainless-steel welded Nelson anchors. There is also a1/2-inch air space between the concrete panel and metal studs for greater thermal protection. The patented connection prevents corrosion and reduces thermal transfer by as much as 25%, which reduced heating and cooling costs especially during winter and summer.



The Slenderwall system is the only wall system that combines high-strength architectural precast concrete, hot-dipped galvanized welded-wire-fabric reinforcing steel, insulated epoxy-coated stainless- steel Nelson® anchors, and heavy-gauge galvanized or stainless-steel studs. The slenderwall panels weight about 30lbs per square foot, which is about two-thirds less than conventional architectural precast or brick. Moreover, this system offers many combinations of architectural precast textures, colors, shapes and finishes.

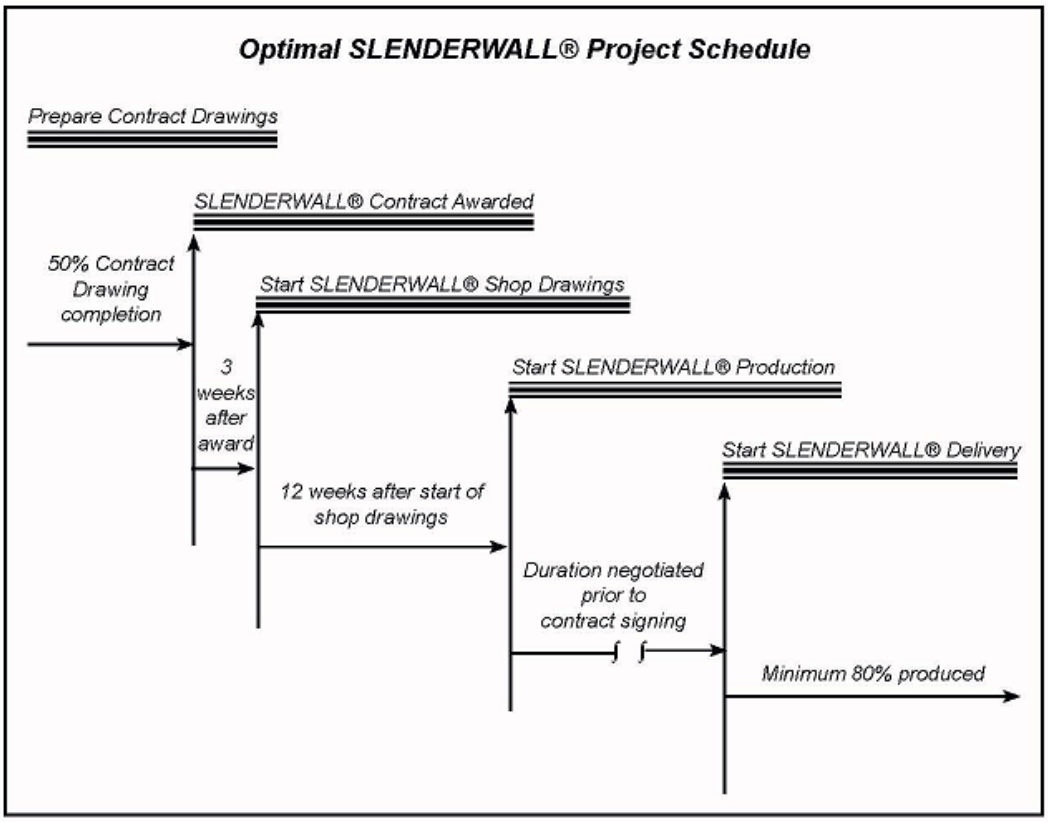
The Slenderwall system has many advantages over the actual hand-laid brick system. It has a drainage system called H2Out, which is the only secondary drainage, street-level, caulk joint leak detection system. As opposed to other system, with the H2Out system, if caulk joints ever fail, they can be easily detected. Another advantage of the Slenderwall system is the precast to stud frame connection called DuraFlex 360. As its name shows, this connection allows a 360° movement to isolate the precast concrete from the structural stresses that can be caused by wind loads, frame movement, expansion, or contraction. DuraFlex 360 allows the structure to maintain its integrity and to maintain the water tightness.



Another advantage of the Slenderwall system, which I think is the most valuable advantage, is the fact that this system has a “Lift-and-Release” mechanism that makes the installation process faster and easier (19 minutes per panel). This mechanism increases panel installation rates by 50% reducing the schedule duration significantly. There are however some implications to the prefabricated panels. The precast panels must be erected with a crane and therefore there is a significant impact to the site planning. In addition, the precast panels are much more expensive than the brick veneer. However After a full analysis that addressed the impacts to cost, schedule, structural loads, and mechanical loads, the Slenderwall system fits better to the project. The sections on the following pages will give a more detailed analysis on each aspect.

Schedule Comparison

Masonry construction is very slow and requires a lot of man-hours. The SlenderWall system provides very significant schedule savings. With the prefabricated system the duration of the wall assembly is reduced 87% from 166 days to 21 days. A production rate of 16 panels per day was used to calculate the schedule. It is important to mention that the prefabricated systems needs contract documents as well as shop drawings. Usually the design of these shop drawings take 12 weeks. Moreover, there should be three weeks between the contract award and the shop drawings deign. However, even with the 15 weeks that have to be added to the schedule, with the prefabricated panels the completion of the exterior wall is still reduced by 14 weeks, which is a significant amount of time.



Item	Quantity	Total Days
Brick/EIFS/CMU	64,000 SF	166 days
SlenderWall Panels	324 Panels	21 days

Even though the wall assembly is not on the critical path, other activities that are on the critical path can start earlier. The prefabricated panels allow interior finishes to start three months earlier reducing the construction duration significantly. The general condition savings as well as all the other cost related analysis are shown on the following section.

Cost Comparison

Apartment Complex has a building envelope system that involves many different elements. The building façade incorporates five major materials: Norman brick veneer, EIFS, CMU, windows, and doors. The envelope estimate was approximately $2,155,913, which is about 5% of the total cost of the building. The Envelope without windows and doors costs $1,878,050, which is 4.3% of the total cost. The Assemblies Estimate was calculated using *RSMeans Assemblies Cost Data 2007*.

Detailed building envelope estimate

Category	CSI	Type	Quantity	Unit	Material	Labor	Tot. Unit Price	Total Cost
Masonry	5350	EIFS	14,000	SF	5.7	14.40	20.1	$281,400
	1400	Brick	47,000	SF	15.05	18.35	33.40	$1,569,800
	2750	CMU	3,000	SF	3.05	5.9	8.95	$26,850
Doors	5100	Overhead door	32	EA	1752	703	$2,455	$78,560
	1980	Storefronts	32	EA	743	351	$1,694	$54,208
Windows	5850	Type 1	250	EA	1400	294	1694	$423,500
	5500	Type 2	115	EA	975	243	1218	$140,070
	5250	Type 3	75	EA	535	120	655	$49,125
							Total	**$2,632,513**

Prefabricated panel cost

Item	SF	Cost/SF	Total Cost
Slenderwall Panels	64,000	$36	$2,304,000

Cost Comparison

Item	Cost
Slenderwall Panels	2,304,000
Crane Usage	29,904
General Condition savings	-184,241
Cost of Previous system	-1,878,050
Additional cost of new System	**$271,613**

The Slenderwall system costs $271,613 more. It is true that with the new system there will be more planning and more coordination needed. However the advantages that this system brings to the project overcome the extra cost.

Site Planning Implications

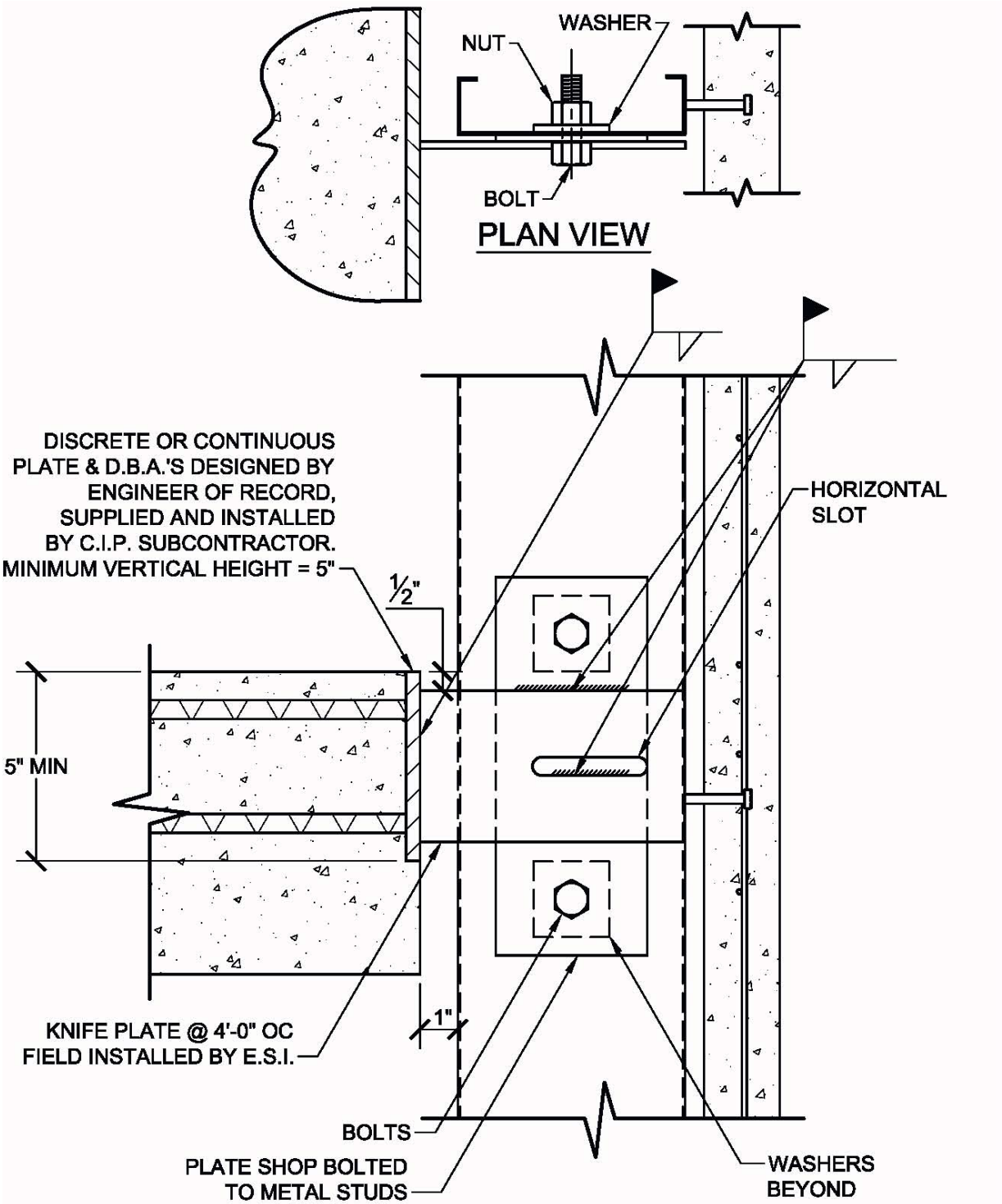
The process of building a prefabricated façade is very different from the process of building a hand laid brick façade. With the prefabricated system, there are many steps that have to be coordinated. Masonry construction requires a lot of man-hours and many scaffolds. The prefabricated system only requires a crane and few workers. Every time that an activity requires the use of a crane, many steps need to be coordinated. Delivery area, stage location, pick-up points, and safety gear are some of the aspects that have to be considered with the new prefabricated system.

The jobsite is congested as it is, and with the delivery and staging of the prefabricated panels it will be even more congested. That is why coordination will be key in the success of this process. The best way to erect the façade is to pick the panels directly from the delivery trucks. That way there will be no need to store any material. However, in order to do so it is necessary to calculate the exact amount of panels that will be erected each day so that the exact amount of panels are delivered. The fact is that the advantages that this system brings to the project are worth all the extra coordination and extra planning.

Connection Details

Another advantage of the SlenderWall system is that weights two thirds less than the average precast panel. The SlenderWall panels weight 30 psf, which means that the structural system does not have to change. The current system is able to support the panels as long as the necessary connection angles are installed. The SlenderWall panels are attached to the building perimeter by gravity and lateral connection at the floor slab. The current system calls for 12 gage galvanized masonry straps with 3/16” diameter ties @ 24” a/c horizontally and 16” 0.C. vertically between veneer walls and back-up wall. The masonry ties are screwed to the metals studs. The masonry assembly rests on 1/2”x 3 1/2x 5/16” continuous angles welded to the pour stops.

See Connection details on the next page.



GRAVITY CONNECTION @ CAST-IN-PLACE SLAB

S-1

SCALE	DN.BY	DATE
3" = 1'-0"	CEK	5/1/06

Conclusion

As with every system, there are always advantages and disadvantages. In order to decide whether or not a system is worth using, the only thing we need to see is if the advantages are greater than the disadvantages. That is how I approached this analysis. I compare advantages and disadvantages and then decided that the prefabricated system was worth using. In first place, the system reduces the schedule significantly, which means that the construction process can be done faster and cheaper. Moreover the Slenderwall system has better performance than the regular brick façade in the sense that isolates the building more. This means that there is less heat loss in the building, and less energy is required to maintain the building's desired temperature. Another advantage of using prefabricated panels is that since they are built indoors, weather is not a factor and it can never delay the project.

On the other side, using a prefabricated system means that there will be additional costs. Since the panels are made off site, they need to be stored and transported to the jobsite. Transportation and storage are very costly. Moreover, when using prefabricated panels, there is the need of additional designing since connection and installation details are needed. Furthermore, the design process needs to be done ahead of time meaning that more coordination and early planning is necessary. Another disadvantage of using the Slenderwall precast panels is that additional crane picks are needed, which means that there will be additional cost and additional crane coordination.

After analyzing the advantages and disadvantages of the prefabricated system, I got to the conclusion that the Slenderwall system is a very good alternative for the hand laid masonry system currently being used in the project. The prefabricated system helps the project in many areas such as schedule, cost, and performance. In my opinion, cost, schedule, and performance are the most important aspect of a project. A project that has low cost, good performance, and it was done in less time than it was expected, it becomes automatically on a successful project. That is why I think that the implementation of the Slendewall system is a good idea and it will benefit the project significantly.