Breadth Analysis II: Building Façade System

Executive Summary of Analysis

The purpose of this analysis is to find a more economic material to use for the façade of the building, especially in place of the brick veneer. The location of the brick on the building is such that most of the area covered is far away from street level and other areas where it can be easily seen. Ventana is situated between two other tall buildings and there is a considerable amount of brick that is used above these buildings up to Ventana’s roof. The brick on the street side is also set far back from the street and begins several stories high due to the historic buildings at the front of the property. The rear façade contains a lot of brick on all stories, but is in an enclosed alley with minimal traffic. The brick veneer is a prime target for value engineering because there are less expensive materials available that will not diminish from the overall appearance of the building, especially due to the locations where they will be applied.

After analyzing the existing façade conditions and doing a takeoff of the area of different key façade materials, RS Means was consulted to narrow down the list of materials that could replace the brick based on cost. These items were then thoroughly researched to determine their constructability in order to realistically determine whether or not they would be a viable alternative. The Exterior Insulation Finish System (EIFS) was the only material to make it through these stages.

More research was then conducted to determine the risks of EIFS construction and methods of controlling these risks during the design and construction processes. After determining that EIFS was indeed a good candidate for an alternative to the brick veneer, initial and life cycle costs were compared. Productivity was then analyzed to determine any effect on project schedule. Finally, a list of quality control procedures for the design and construction of the EIFS was compiled in order to ensure a successful project.
Overview

The primary reason for performing this analysis was to find a more economic building façade material to replace the brick veneer on the building without compromising the building’s overall aesthetic appeal. The ideal project came in over budget for several reasons, among which are the redesign of the project from apartments to condominiums, downturns in the market, and an initial design that exceeded the developer’s resources. Because of these factors, numerous areas were targeted for value engineering, especially with finishes in the building’s interior. This resulted in a delay in the start of construction. Any money that is saved by a change of building materials would help make the beginning of construction start earlier, or the money could be put back into the building making the units more attractive to potential buyers.

In addition to initial cost, life cycle costs are also important to consider and will be discussed later. Cost was not the only factor under consideration during this analysis, however. Constructability was equally as important due to the limited amount of space available in the urban environment of Washington, D.C. Space needed and necessary equipment, as well as the availability of qualified labor in the area were all taken into consideration while analyzing materials.

Cost Analysis

After performing a takeoff of the building’s façade systems, an RS Means Assemblies guide was consulted to narrow down the large list of possible alternate materials based on cost per square foot. The list of materials was shortened to precast concrete panels, EIFS, and wood, aluminum, or vinyl siding. The sidings were taken out of consideration because of the quality and aesthetics of the material as well as their limited application on high rise buildings in an urban environment. The concrete panels were also eliminated due to schedule and constructability issues. A crane would be needed to lift the panels into place, and the tower crane used for construction is scheduled to be removed well before the façade is going to be finished. Another crane would have to be brought in so that the infills and exterior framing could be completed without schedule delay, resulting in extra costs, a congested site, and nearly impossible construction conditions. EIFS quickly became the only practical alternative. This system was compared side by side with the brick system for initial cost. A summary of the cost results are on the following page based on a 2” insulation thickness.
The initial savings of $103,854.32 indicated that the system was worth investigating further to determine if the additional risks of using EIFS overcome the benefits of the cost savings. The first comparison made was the life cycle cost of the building, including maintenance and energy savings costs.

A case study was done by William Egan and Jason Iacovelli concerning the life cycle costs of different façade materials over 30 years. Costs considered with an EIFS system included cleaning the entire system once every 15 years and recoating the system at year 30. Brick was assumed to need to be cleaned and repointed at year 30. The costs that were realized during their study were converted to the cost per square foot and then applied to Ventana. The façade area in the case study was very similar to that in Ventana, making the comparison fairly accurate. The present value of money from the study was used, and the costs were adjusted from 1996 dollars to 2005 dollars.

An energy analysis of the savings that could be achieved using an EIFS system was then performed. Since EIFS has a higher resistance to conductivity than brick, the heating and cooling costs of the building can be reduced. EIFS can also reduce unwanted air infiltration into the building by up to 55%, further reducing building loads. Energy savings calculations can be seen in Appendix K. The comparison of the total life cycle costs are as follows.

<table>
<thead>
<tr>
<th>Area</th>
<th>Brick $ / SF</th>
<th>Total</th>
<th>EIFS $ / SF</th>
<th>Total</th>
<th>Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>18530</td>
<td>$19.36</td>
<td>$358,732.92</td>
<td>$13.75</td>
<td>$254,878.60</td>
<td>$103,854.32</td>
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With 30 year life cycle for maintenance and energy savings

<table>
<thead>
<tr>
<th></th>
<th>Installation</th>
<th>Maintenance</th>
<th>Energy</th>
<th>30 year total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brick</td>
<td>$358,733</td>
<td>$10,562</td>
<td></td>
<td>$369,295</td>
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<tr>
<td>EIFS</td>
<td>$254,879</td>
<td>$20,754</td>
<td></td>
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<tr>
<td>Savings</td>
<td>$103,854</td>
<td>($10,192)</td>
<td>$34,680</td>
<td>$128,343</td>
</tr>
</tbody>
</table>

Figure 10. Façade Change Cost Savings

The cost of repairs would also narrow the cost gap some, although there are many steps that can be taken to minimize the number of problems with the system, which will be discussed later. With a life cycle cost savings of $128,343 the effects of a change of building systems on the projects schedule were then analyzed.

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Schedule Impact

The current project schedule allows 5 days each for framing the exterior walls, applying the exterior sheathing, and installing the masonry for each floor. This allows for an even flow of work and no down time for the different trades. The work rate assumed on the masonry work is a little ambitious for one crew, with a productivity rate of 247 square feet per day needed to finish in the time allotted while RS Means states that the average productivity rate is 222 square feet per day. At the end of the project, this would result in the equivalent of 8 extra days of work needed to meet the proposed schedule.

The proposed EIFS system can be placed by one crew at an average of 295 square feet per day, which easily keeps up with the productivity rate needed to keep the project on schedule. If all other systems were able to be equally accelerated, the EIFS could actually be finished 12 days ahead of the schedule that the brick is currently on. Because there are other constraints on the system, however, these areas had to be analyzed to see if any impact whatsoever could be made on the schedule. Even adding personnel to the supporting systems such as framing the exterior walls and applying exterior sheathing would not accelerate the schedule, however, as other critical path items prevent the overall reduction of the schedule.

The benefit of the increased productivity then becomes an extra 12 days with which to apply the EIFS. Float time would be available, which can be used in a number of different ways. First, the proper quality control measures can be taken and installation can be done correctly without worrying about the pace of construction. Weather will also play a factor with the installation of the EIFS, so there is extra time to use in case the conditions become unfavorable. This will allow the applicator to work during more ideal construction conditions and will lead to better overall quality in the end.

Exterior Insulation and Finish Systems (EIFS)

An EIFS system consists of 3 layers of materials. The first is an insulating board which can come in numerous shapes and thicknesses. The second layer is a base coat which consists of wire mesh and a coat of adhesive. Finally, a plaster finish layer is applied which can consist of a variety of colors and textures.
There are many pros and cons in EIFS construction. Some of the primary advantages have already been seen in the system’s low cost and relatively quick erection speed. Additional advantages that make EIFS attractive in this application are its design versatility, which enables the architect to create a wide variety of possible looks as explained above. EIFS is also a very light weight cladding, reducing the forces on the rest of the building. By switching from a brick to an EIFS façade, the total building weight is decreased nearly 360 tons. Finally, this system has good insulating properties. A fairly high R value can be obtained with an EIFS system, and since the insulation is located on the outside of the wall system, the structural members stay at a more constant temperature and do not expand and contract as much as they would with many other systems.

Unfortunately, there are also numerous drawbacks to an EIFS system. Most of these, however, can be avoided with proper design and installation procedures. The biggest problem with this system is that it is a barrier system designed to keep water completely out, but it does not always have that capability. Once water gets into the system, it is also very hard to get it out. Water infiltration may result in delamination, or the separation of the base coat and finish coat from the insulation. Water can also result in discoloration of the finish, cracking, the damage of interior finishes, and in the worst case, the EIFS detaching from the building.

The first area where water can enter in to the system is at failed joints. These include expansion joints as well as areas where the EIFS meets other façade materials, most notably the glass curtain wall on this project. There are many ways in which to minimize the possibility of water entering into these joints. The biggest is to have architectural input on the design of these joints as well as precise joint details included in the drawings. The second key is to have a sealant contractor that is well versed in EIFS construction in order to have proper initial installation. Qualified inspectors are also important to ensure that the joints have been properly installed and may be a member of the company that manufactures the EIFS or a third party. Finally, the choice of sealants is very important. The sealant must be able to resist the weather and also must be compatible with the other systems that it comes into contact with, such as the windows.

Another potential point for water entry is cracks that may develop in the system. Besides being an eyesore, these cracks can let a large volume of water in which puts the interior finishes of the building in jeopardy. In no place is that more crucial than in a condominium
building, such as Ventana. The possibility for litigation is high and the tenants may band together and sue the owner if damages occur. Because of this, a number of steps need to be taken to minimize the potential for cracks to appear.

The first and most important way to prevent cracking is proper design and installation of the system. Specifically, reinforcement should be lapped at its edges to ensure that there are no weak spots and diagonal reinforcement should be used at the corners of all openings. In addition, expansion joints should be used wherever there is a change in the underlying material, such as at the base of each floor. These areas are where most of the cracks in the system can occur, and these simple design features will greatly reduce the ability of cracks to form.

Additionally, proper installation is just as important as design. Insulation joints should be kept away from the corners of the building and windows. The different layers also need to properly cure before the next layer is placed on top of them, which usually takes 24 hours. Proper steps need to be taken to protect these materials while they are curing, especially from the sun, water, dirt, and freezing. The application of the façade system is to take place over the winter months, so heat will have to be taken into account at certain times. A proper base coat thickness will also lessen the chance that cracks will occur. From a quality control standpoint, the insulation should be kept dry and out of the sun prior to its installation. The perimeter of the system should also be properly caulked to minimize water intrusion.

The application is to begin in the month of November and continue through the following June, so cold weather will be a factor. The adhesive that attaches the insulation to the exterior sheathing will not hold if the temperature is below freezing. The temperature in the DC area averages 42 degrees or higher for a daytime high even during the coldest portions of winter, but there is still a chance for freezing temperatures. Either the portion of the building that is being worked on needs to be heated, or mechanical fastening needs to be used.

This method may result in more expense and also has the disadvantages of potentially creating uneven portions in the surface of the system as well as points at which heat can escape, minimizing the insulating effect of the wall. Mechanical fastening should be avoided but is a possibility if necessitated by weather. Fortunately some float is built in and the weather can be worked around to a certain extent.
Other steps that can be taken to minimize the chance of water entering the system include properly using flashing thru the walls at sealant joints, windows, and other wall penetrations. This often requires design coordination, especially with the window contractor, as the flashing and EIFS often have to be put in place prior to window installation. Fortunately, that is already the case on Ventana, and no change in schedule or additional coordination would need to take place. It is also possible to install a water barrier over the exterior sheathing with a drainage channel to try to move some of the water that does get in down through the channel and out at the flashings at joints. Snow or ice accumulation against the building is also a concern, especially in the areas where the roofs of adjacent buildings meet Ventana. In these areas, special considerations will have to be made on how to keep this from happening.

Another problem with EIFS is its susceptibility to impact damage. Again, the key minimizing damage is proper design and installation. Heavy duty mesh should be used in high traffic areas. Fortunately, the design of the building is such that windows span the entire balcony and regular mesh can be used outside these locations between the windows. Heavy duty mesh should be used along the rear of the building at the entrance to the parking garage and on the balcony above. Both of these areas are trouble spots, although the EIFS application here will be applied directly onto a CMU block wall, resulting in a tougher overall system. Another measure that can be taken is to use a base coat with high resin levels, which increases its strength. As was the case in preventing water, the base coat is the most important in resisting impact damage, and proper installation is of the utmost importance.

If impact damage does occur, it will not spread. The initial damage will not get any worse from an aesthetic perspective, however it should be repaired immediately as water may enter the damaged area. As stated previously, those areas susceptible to the most damage are also those where water entry does not matter, since they are the block walls of the parking garage. Repairs are generally easy to do and can be done quickly and with simple tools, but they do represent a cost that would not be associated with a similar brick veneer façade.

The final big problem with EIFS is maintaining its appearance, more specifically cleaning the system. The finish coat is fairly sensitive and cannot be cleaned with traditional machinery such as pressure washers or sandblasters, as well as many cleaning products. A mild detergent should be used whenever necessary. There are ways to reduce the
number of times the system needs to be cleaned, however. Acrylic finishes can be used which reduce the finish’s ability to pick up dirt. These finishes also help maintain the colorfastness of the system, which can be a problem due to exposure to the elements, especially the sun.

In general, many of the problems inherent in EIFS can be avoided with proper design and quality control during construction. Residents should also be educated as to the nature of the system, since it appears to be a much more durable material, like stone. An EIFS manufacturer should also be able to review the construction details and installation processes to ensure that they are done properly. Finally, and perhaps most importantly, an applicator should be found who is qualified and is established as a quality EIFS contractor. If these safeguards are in place, there is no reason that a properly installed EIFS could not perform as well as any other type of façade material.

**Conclusion and Recommendations**

A fairly sizable cost savings was realized when comparing an EIFS to the brick veneer system which the building was designed for. Over a 30 year period, the savings is over $128,000 including potential energy savings that residents will be able to realize due to the insulating value of the EIFS. The schedule was not able to be reduced because of the constraints of other building systems, but there is a better chance that the EIFS system can be completed in the time scheduled than that of the brick veneer with some float time available.

The aesthetics of an EIFS system does not depart significantly from that of the original brick system, especially considering the wide variety of looks that the system can attain and the fact that there is very little façade area that can be seen up close due to the building’s layout.

Based on the cost savings and with the intention of placing a quality control system in place for design and construction of the system, it is recommended that the current system be changed to an EIFS system. The money that is saved could be put back into the building in a number of different places, or could be saved by the owner outright. In order to maximize savings, the system should be applied on site as opposed to being prefabricated in panels and shipped to the site.
Qualified applicators should be sought to work on the project and the chosen EIFS manufacturer should be able to have input on design and construction. The construction process changes very little from brick to EIFS in terms of staging scaffolding and moving materials vertically through the building by means of a materials hoist to the point of application, and there is no additional machinery required to apply the system.

With a quality control process in place and a good EIFS contractor on the job, the risks inherent in the EIFS system will be very minimal and there will be a significant cost savings on the portion of the façade system that is currently designed as a brick veneer.