Moisture Inspection Report

For the Property Located At:
1234 EIFS Drive

Report Prepared For:
Ms. EIFS Client
## Project Information

<table>
<thead>
<tr>
<th>OWNER INFORMATION</th>
<th>BUYER INFORMATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owners</td>
<td>Buyers</td>
</tr>
<tr>
<td>Property Address</td>
<td>Property Address</td>
</tr>
<tr>
<td>City, State, ZIP</td>
<td>City, State, ZIP</td>
</tr>
<tr>
<td>Phone</td>
<td>Phone</td>
</tr>
<tr>
<td>FAX</td>
<td>FAX</td>
</tr>
<tr>
<td>Owners Realtor</td>
<td>Buyers Realtor</td>
</tr>
<tr>
<td>Realty Company</td>
<td>Realty Company</td>
</tr>
<tr>
<td>Phone</td>
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<tr>
<td>FAX</td>
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</table>

<table>
<thead>
<tr>
<th>PROPERTY INFORMATION</th>
<th>INSPECTION INFORMATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of Exterior Cladding</td>
<td>EIFS and Stone Veneer</td>
</tr>
<tr>
<td>System Manufacturer</td>
<td>Undetermined</td>
</tr>
<tr>
<td>Mesh Color</td>
<td>Red</td>
</tr>
<tr>
<td>Underlying Substrate</td>
<td>Oriented Strand Board</td>
</tr>
<tr>
<td>Age of Property</td>
<td>19 Years</td>
</tr>
<tr>
<td>Square Footage</td>
<td>4757 s.f.</td>
</tr>
<tr>
<td>Date of Inspection</td>
<td>1/22/13</td>
</tr>
<tr>
<td>Inspector</td>
<td>Aaron D. Miller</td>
</tr>
<tr>
<td>Present at Inspection</td>
<td>Owner and Inspector</td>
</tr>
<tr>
<td>Temperature / Humidity</td>
<td>61° F. / 48% RH</td>
</tr>
<tr>
<td>Weather</td>
<td>Partly sunny</td>
</tr>
<tr>
<td>Last Rain</td>
<td>None within 48 hours</td>
</tr>
</tbody>
</table>

### Window Data

<table>
<thead>
<tr>
<th>Type of Windows</th>
<th>Quantity</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum Fixed and Single Hung</td>
<td>N/A</td>
<td>Seal all drilled security contact holes.</td>
</tr>
</tbody>
</table>

| Total Number of Window Units | N/A |

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## Summary Checklist

<table>
<thead>
<tr>
<th>Caulking</th>
<th>Good</th>
<th>Not Adequate</th>
<th>N/A</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caulking Around Window Frame</td>
<td>X</td>
<td></td>
<td></td>
<td>Existing caulk is too thin or inadequate to protect against moisture intrusion. Need to re-caulk.</td>
</tr>
<tr>
<td>Caulking At Window Joints / Miters</td>
<td></td>
<td>X</td>
<td></td>
<td>Sealant is showing signs of age. Touch-up or re-caulk as needed.</td>
</tr>
<tr>
<td>Caulking Around Door Frame</td>
<td>X</td>
<td></td>
<td></td>
<td>Caulk all door joints or miter joints, including thresholds.</td>
</tr>
<tr>
<td>Caulking At Door Joints / Miters</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caulking Around Other Breaches</td>
<td>X</td>
<td></td>
<td></td>
<td>All utility breaches, including hose bibs, light fixtures and vents, need to be caulked or re-caulked.</td>
</tr>
<tr>
<td>Flat Accents Caulked or Angled</td>
<td></td>
<td>X</td>
<td></td>
<td>Flat accents and/or quoins (corner accents) need to be caulked.</td>
</tr>
<tr>
<td>Soffit, Frieze &amp; Facia Boards Caulked</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Flashings / Diverters</th>
<th>Good</th>
<th>Not Adequate</th>
<th>N/A</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kickout Flashings / Roof / Wall</td>
<td>X</td>
<td></td>
<td></td>
<td>Elevated moisture detected below kickout(s). Kickout(s) appears to be failing and should be assessed by a qualified waterproofing contractor.</td>
</tr>
<tr>
<td>Deck Flashings</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other Attachment Flashings</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Porches / Stoop Flashing</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chimney Cap</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chimney Cricket</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Window Head Flashing</td>
<td>X</td>
<td></td>
<td></td>
<td>Window head flashing is not installed.</td>
</tr>
<tr>
<td>Door Head Flashing</td>
<td>X</td>
<td></td>
<td></td>
<td>Door head flashing is not installed.</td>
</tr>
<tr>
<td>Column Flashing</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Terminations</th>
<th>Yes</th>
<th>No</th>
<th>N/A</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>EIFS Is Terminated Above Grade</td>
<td>X</td>
<td></td>
<td></td>
<td>Foam insulation appears to terminate at or below grade and needs to be modified to protect against insect infestations.</td>
</tr>
<tr>
<td>EIFS Is Sealed At Bottom</td>
<td></td>
<td>X</td>
<td></td>
<td>Lower edge of system is exposed to the elements and needs to be properly backwrapped and sealed.</td>
</tr>
<tr>
<td>EIFS Is Terminated At Porches</td>
<td>X</td>
<td></td>
<td></td>
<td>Foam insulation is in direct contact with masonry porches and patios.</td>
</tr>
</tbody>
</table>
### Summary Checklist Continued ....

<table>
<thead>
<tr>
<th>Miscellaneous</th>
<th>Yes</th>
<th>No</th>
<th>N/A</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evidence Of Sprinkler Overspray</td>
<td>X</td>
<td></td>
<td></td>
<td>Redirect all sprinkler heads to spray away from windows and walls.</td>
</tr>
<tr>
<td>Gutters Clean &amp; Functioning</td>
<td></td>
<td>X</td>
<td></td>
<td>Downspout at NE has become detached and needs to be repaired.</td>
</tr>
<tr>
<td>Down Spout Fasteners Sealed</td>
<td></td>
<td>X</td>
<td></td>
<td>All downspout fasteners need to be sealed.</td>
</tr>
<tr>
<td>Cracks Or Impact Damage</td>
<td>X</td>
<td></td>
<td></td>
<td>Exposed cracks or impact damage need to be sealed or repaired.</td>
</tr>
<tr>
<td>Delaminating At Foam / Substrate</td>
<td>X</td>
<td></td>
<td></td>
<td>Delamination is occurring at an area or areas as noted in the report.</td>
</tr>
<tr>
<td>Exterior Evidence Of Pest Infestation</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adequate Slope Of Grade Away</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crawlspace Inspection Made</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Property Located Near Body of Water If Yes, Describe</td>
<td>X</td>
<td></td>
<td></td>
<td>Pool and creek adjacent to lot.</td>
</tr>
</tbody>
</table>
Moisture Inspection Summary

The barrier EIFS and stone veneer cladding on this house have not been installed in strict accordance with any manufacturer's installation instructions, industry standards, or good building practices. While the system appears to be in fair condition when viewed from afar, a closer look reveals many significant flaws.

The system has been installed too close to, and in some instances below, grade. The bottom edge of the foam insulation board has not been backwrapped or sealed to the foundation edge. The system has not been properly spaced and sealed at dissimilar materials such as window and door frames, glass block inserts, stone veneer, utility penetrations, et al. The system has been installed in direct contact with the roof surfaces, front porch, and patio.

Kickout flashings are either undersized or have not been installed where the roof surface terminated in the plane of the cladding. No header flashings were observed above windows, doors, and glass block inserts.

No horizontal band has been installed between the first and second storeys. The top edges of other horizontal bands have not been canted to promote drainage.

The system is obviously delaminating at the east exterior of the front porch and below the windows at the north side of the patio.

Elevated moisture readings were observed using a Tramex Wet Wall Detector meter under most of the window locations, above horizontal bands, and where the system is in contact with or below grade.

Given the vast number of repairs needed and the fact that barrier EIFS is know to be an inherently defective product which cannot be made to resist moisture penetration, it is this inspector's considered opinion that the EIFS and stone veneer claddings should be removed from this house and replaced with a more durable and proven cladding such as Portland Cement stucco, stone or brick veneer.

Removal of the existing claddings will almost certainly require the removal of the existing sheathing. At that time all moisture damage to the underlying
structure must be repaired. Any insulation that has been exposed to moisture must be replaced. Prior to the replacement of the insulation or sheathing it is recommended that all framing be treated with a borate solution such as Boracare®.

All work should be performed by a licensed, bonded, and insured general contractor with significant experience replacing exterior claddings and in strict accordance with the cladding manufacturer's installation instructions, the 2006 International Residential Code with Dallas amendments, and all industry standards e.g. all applicable Brick Industry Association Technical Notes, the Portland Cement Association's Plaster/Stucco Manual and all pertinent ASTM standards.

Aaron D. Miller, ACI, CEI, CMI, CPI, CRI, MTI, RCI
Exterior Design Institute (EDI/EIMA) EIFS Third Party Inspector and Moisture Analyst (CEI) MA TX-29
Photo Observations

System not backwrapped or sealed to foundation edge.

System not backwrapped or sealed to foundation edge.
Photo Observations

System not backwrapped or sealed to foundation edge.

System not backwrapped or sealed to foundation edge.
Photo Observations

System and banding not backwrapped or sealed to foundation edge.
Photo Observations

Kickout flashing not installed above patio.

System installed in direct contact with roof surface.
Photo Observations

Horizontal band top edge not canted to promote drainage.

Southwest band damaged.
Photo Observations

Utility penetration not sealed.

Utility penetration not sealed.
Photo Observations

Utility penetration not sealed.

Window header flashing missing.
Photo Observations

Glass block insert header flashing missing.

EIFS below grade.
Photo Observations

Stone veneer improperly installed with no air gap and no weep holes.

System waterlogged from ground contact at southwest corner.
What Experts Think About EIFS

US Gypsum Co., a major EIFS manufacturer, discontinued the sale of barrier EIFS for one and two-story residential homes in 1996, stating that "these systems could not adequately accommodate water penetration."

Senergy, another major EIFS manufacturer, withdrew from the EIFS Industry Manufacturer's Association (EIMA), concluding that barrier EIFS cannot be used on one and two-family residential construction.

The National Research Council of Canada identified many design deficiencies in barrier EIFS. For example, even when EIFS is installed around windows in "textbook fashion," "water can migrate through the interface with the [EIFS] cladding under simulated storm conditions." Moreover, the Council concluded that EIFS's "in-service performance is unpredictable and unreliable."

In 1985 the Massachusetts Executive Office of Communities and Development undertook a study of 17 EIFS-clad homes in that state. It found that "all projects had some cracks large enough to allow some water penetration, and buildings with only minor cracks have sufficient water penetration to cause internal damage, including damage to wood studs." (See Kenney, Russell J. and Richard Piper, "Proposed Materials and Application Standards for More Durable Exterior Insulation and Finish Systems," in Development, Use, and Performance of Exterior Insulation and Finish Systems (EIFS), ASTM STP 1187.

In 1998, the Director of the Department of Inspections in New Hanover County, North Carolina, Jay Graham, issued a report comparing what inspectors found when they compared EIFS and non-EIFS homes of identical age built on adjacent lots by the same 19 builders. The EIFS-clad homes "showed elevated moisture readings and had substantial damage," while the siding homes, although "expected to be wet," were "bone dry." Jay Graham, "Stucco Litigation - A Complete Perspective," North Carolina Bar Foundation Continuing Legal Education (CLE), 17 April, 1998, Greensboro, North Carolina. Or as another New Hanover inspector, Allen Golden, put it, "The problem is that the [EIFS] product design concept is inherently flawed, period."

Charles Graham, a professor of construction science at Texas A&M, studied 17 EIFS-clad homes in Texas, Illinois, and Colorado, and found that all had moisture leakage problems. Graham wrote that it is "a statistical probability" that "every house clad with synthetic stucco is going to incur water damage." Graham's summary of the problems were quoted in a news article: "Every house that I've ever looked at that was constructed [with synthetic stucco] is leaking with water. I have found a few that were not leaking as badly, but the problem with these homes is they all have places where they tend to leak, and you can't afford leakage in these homes." See "Who's Getting Stucco-ed," by Susan Harte and Virginia Anderson, in The Atlanta Constitution, Nov. 10, 1997.

The National Association of Home Builders (NAHB) has warned its members against EIFS. In a 1998 publication, it wrote that "Members who are installing barrier EIFS products on their homes are being strongly cautioned by NAHB that the design of the EIFS system, unlike other cladding, does not allow water penetrating the external surface of the system to drain." The publication added that "In NAHB's opinion, the barrier EIFS system have proven to be incompatible with the existing wood frame construction method typically used in residential construction in the United States, and has resulted in significant problems." See "Caution Advised in Using EIFS Sytems," in Nation's Building News, November 30, 1998, vol. 34, no. 14.

The U.S. Department of Housing and Urban Development does not use EIFS on its projects. As early as 1982, HUD issued a General Condition for existing EIFS-clad structures stating that "all
joints shall be designed and constructed on the assumption that a leak can occur in the primary seal, and a secondary seal or other defense against leaks shall be provided, together with a built-in means for disposing of the leakage." U.S. Dept. of Housing and Urban Development, Materials Release No. 883b, Nov. 1982.
The Problem Defined
Exterior insulation and finishing systems (EIFS) are inherently defective and unfit for use as an exterior cladding system where moisture sensitive components are used without a provision for drainage or in locations and assemblies without adequate drying. Their use should be limited to hot-dry climates (Fig.1). A hot-dry climate is defined as a region that receives less than 20 inches of annual precipitation and where the monthly average outdoor temperature remains above 45° F throughout the year.

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**Figure 1**
**Hygro-Thermal Regions**

**Legend**

- **Severe-Cold**: A severe-cold climate is defined as a region with approximately 8,000 heating degree days or greater.

- **Cold**: A cold climate is defined as a region with approximately 4,500 heating degree days or greater and less than approximately 8,000 heating degree days.

- **Mixed-Humid**: A mixed-humid climate is defined as a region that receives more than 20 inches of annual precipitation, has approximately 4,500 heating degree days or greater or less and where the monthly average outdoor temperature drops below 45° F during the winter months.

- **Hot-Humid**: A hot-humid climate is defined as a region that receives more than 20 inches of annual precipitation and where the monthly average outdoor temperature remains above 45° F throughout the year.*

- **Hot-Dry/Mixed-Dry**: A hot-dry climate is defined as a region that receives less than 20 inches of annual precipitation and where the monthly average outdoor temperature remains above 45°F throughout the year; A mixed-dry climate is defined as a region that receives less than 20 inches of annual precipitation, has approximately 4,500 heating degree days or less and where the monthly average outdoor temperature drops below 45°F during the winter months.

* This definition characterized a region that is almost identical to the ASHRAE definition of hot-humid where one or both of the following occur:
  - a 67°F or higher wet bulb temperature for 3,000 or more hours during the warmest six consecutive months of the year; or
  - a 73°F or higher wet bulb temperature for 1,500 or more hours during the warmest six consecutive months of the year.
Typical EIFS are barrier or face-sealed systems that by definition have no provision for drainage. The typical system also contains moisture sensitive materials. Specifically, the following moisture sensitive components are used: exterior gypsum board, oriented strand board (OSB) or plywood sheathing, metal or wood studs, fiberglass cavity insulation and interior gypsum board sheathing (Fig. 2).

![Figure 2](image)

**Face-Sealed EIFS**

Drainable EIFS are significantly different from face-sealed or barrier systems in that by definition they have a provision for drainage (Fig. 3). Unlike face-sealed or barrier systems – except where they are used in hot-dry climates, drainable EIFS are **not** inherently defective and therefore are fit for use as an exterior cladding system in most climates. Drainable EIFS are not subject to the same limitations of use of face-sealed or barrier systems. In fact, drainable EIFS are among the most robust and advanced moisture control assemblies available.

![Figure 3](image)

**Drainable EIFS**

**Effects of Climate**

The exterior and interior climates in many regions throughout North America provide limited drying potentials due to high relative humidities throughout the year. This is particularly a problem in hot-humid and mixed-humid climates. This limited drying
potential provides inadequate drying for EIFS where moisture sensitive components are used without a provision for drainage. This is exacerbated with the installation of interior vapor barriers or impermeable interior finishes such as vinyl wall coverings.

Moisture damage is in essence a rate question. When the rate of wetting is greater than the rate of drying, accumulation occurs. When the quantity of accumulated moisture exceeds the moisture storage capacity of a material, deterioration occurs.

The typical moisture damage in an EIFS assembly is deterioration due to mold, wood decay fungi and corrosion leading to decay, loss of strength and discoloration. The components principally affected are the interior and exterior gypsum sheathing, the metal or wood studs and the fiberglass cavity insulation. Less affected are the EIFS lamina and sealants.

The rate of wetting of a building assembly is a function of exposure, design, construction and operation/maintenance. The rate of drying of a building is a function of the same parameters. Exposure is substantially dominated by climate, but can be influenced by design factors such as building height, orientation, massing, overhangs, etc.

The principal wetting mechanism for EIFS assemblies is rain. As are all cladding systems, EIFS are sensitive to the frequency and severity of rain. The amount of rainfall deposited on a surface determines the type of approach necessary to control rain.

Figure 4 is a map of annual rainfall for North America. This map defines four rain exposure regions based on annual rainfall: extreme, high, moderate and low. In all but low rain exposure regions, face-sealed or barrier systems used with moisture sensitive components should be avoided.

Rain Control Strategies
Two broad types of rain control strategies are prevalent in building construction:

- barrier approaches
- water managed approaches

The barrier approach is traditionally used with heavy, massive, solid non-water sensitive construction such as stone, brick, masonry and concrete structures. The water managed approach is traditionally used with light, hollow, water sensitive construction such as wood frame, curtain wall and steel frame structures.

The barrier approach assumes that some rain water will pass through the cladding system into the wall assembly. In general, this rain water is stored in the mass of the wall assembly until drying by diffusion, capillarity and air flow occurs to either the exterior or interior. The barrier approach relies on water resistant materials, a significant reservoir or storage capacity, low wetting potentials and high drying potentials. Historically speaking this is the oldest technology used for rain control.

The water managed approach also assumes that some rain water will pass through the cladding or face of the wall assembly. However, the majority of this rain water is drained back to the exterior. A drainage plane is installed behind the exterior cladding to facilitate this drainage. This drainage plane requires a drainage space (air gap) and weep
openings to function. The drainage space allows rain water to drain between the drainage plane and the exterior cladding and the weep openings direct the draining rain water to the exterior out of the wall assembly. The small amount of rain water that does not drain back to the exterior, dries by diffusion, capillarity and air flow to either the exterior or the interior as in the barrier approach.

Over 60”
Pressure Equalized Rain Screen/Pressure Moderated Screen

40” - 60”
Rain Screen/Vented Cladding/Vented Drainage Space

20” - 40”
Drainage Plane/Drainage Space

Under 20”
Face Seal

Figure 4
Rain Exposure Zones

Traditional Stucco

Traditional stucco claddings have successfully employed both the barrier approach and the water managed approach. Traditional stucco using the barrier approach is common to masonry walls that are rendered on the exterior with a Portland cement based stucco. A vapor permeable paint is often used over the stucco rendering to reduce rain water
absorption while still allowing drying to the exterior. Interior finishes are typically vapor permeable and held away from the interior masonry surface to promote drying to the interior. The rain water that enters through the stucco face is harmlessly stored in the masonry wall until it can dry to either the interior or to the exterior.

Traditional stucco using the water managed approach (Fig. 5) is common to wood frame or steel stud walls that are sheathed with plywood or gypsum board. Two layers of building paper and metal lath are installed shingle fashion over the exterior sheathing. A Portland cement based stucco is then rendered over the metal lath and building papers. The building papers absorb water, swell and wrinkle. After application, the building papers dry, shrink and the stucco rendering debonds from the building papers creating a drainage space. The drainage space is connected to weep screeds or flashings completing the system. The water that enters through the stucco face is drained back to the exterior by the drainage plane and the weep screeds or flashing system.

![Figure 5](Image)

**Traditional Stucco**

Traditional stucco systems recognize the obvious – stucco cracks. Furthermore, since traditional stucco cracks, traditional stucco systems leak. Since traditional stucco systems leak, the leaking rain water must be addressed. This is done either by constructing assemblies from water resistant materials such as masonry and relying on high drying potentials or by using water management – drainage planes, drainage spaces and flashing systems.

**Traditional Cladding**

Traditional cladding systems also recognize the obvious – cladding systems leak. Brick leaks, wood siding leaks, vinyl siding leaks, stone leaks, granite leaks, stucco leaks, hardboard siding leaks, precast concrete leaks, curtain wall assemblies leak – everything leaks. Since everything leaks, assemblies are constructed out of water resistant materials or they are drained. This is a fundamental rule of design and construction.

There is only one exception to this almost universal rule. The exception occurs in places where it doesn’t rain very much and where the outside air is dry almost year round. In dry climates, with less than 20 inches of annual precipitation, almost anything can be built using any type of material. In these climates, walls don’t get very wet and they dry out quickly. The rate of wetting is low while the rate of drying is high – accumulation rarely occurs and moisture sensitive materials can be used in the barrier approach.
Traditional construction recognizes something else that is also obvious – it is not possible to rely on perfect workmanship and perfect materials. People are imperfect and materials are imperfect. There are limitations to what can be expected of individuals in the field and there is variation in the quality of materials – from sealants to the grade of wood, from the density of foam sheathing to the permeability of paint.

Where it rains, rain will enter. Period. How much rain enters is a function of exposure, design, workmanship and operation/maintenance. But make no mistake, rain will enter. That is why the rain must be let out after it enters, or the wall must be built in such a way that the rain entry doesn’t matter.

**Face-Sealed EIFS**

Relying on perfect workmanship and perfect materials to keep rain out, in a location where it rains, is a fundamental flaw in logic. It is contrary to historical experience and contrary to human nature. This is why EIFS are inherently defective and unfit for use as exterior cladding systems where moisture sensitive components are used without a provision for drainage or in locations without adequate drying. Adequate drying will occur in locations with high drying potentials – locations where, in essence, it does not rain much.

Rain water enters EIFS through cracks in the EIFS, between the EIFS lamina and windows, through balcony elements, through railings, through windows, through sliding doors, through service penetrations and through the roof system. That rain water enters should not be a surprise since, for all practical purposes, rain water entry is impossible to prevent.

**Sealants and Joints**

Relying on sealants to prevent rain water entry by eliminating openings is one of the key fundamental flaws in the logic of the EIFS – since the sealant material must be perfect and the installation of the sealant must be perfect.

It may be possible to install sealant in one joint perfectly – if the surfaces are clean, dry, dust free and the correct sealant, backer rod and gap are provided. Let us also assume good weather, not too cold, not too hot, not raining. But how about installing sealant perfectly in 10 joints?

Is it possible for a technician to install sealant perfectly in 10 joints in a row? Let us assume perfectly prepared joints: joints that are “backwrapped” properly, with the correct gap. It is probably possible – a conscientious, properly trained, supervised technician could do 10 perfect joints in a row.

Now how about 100 joints? Recall, that the joints must be perfectly prepared and that this preparation is dependent on other trades and technicians: the window installation contractor and the foam and lamina application technician. I think most rational people would have a problem with 100 perfect joints. But the requirement for 100 perfect joints is nothing – a drop in the bucket for what is required. How about 1,000 perfect joints? Or 10,000 perfect joints? Now we are getting just a little bit outrageous. Yet, this is what is required of EIFS constructed with moisture sensitive components without a provision for drainage or in location without adequate drying.
But on the subject of joints, we are just beginning. How do you select the sealant? Well, the material must adhere to the lamina, must be resistant to ultra-violet light; the base coat bond strength to the rigid insulation (EPS) must be greater than the sealant bond; and the material also has to be affordable. Does such a sealant exist? In short, no. But let’s assume that such a material does exist – and ask the next important questions.

How long should this joint last? How can you tell when the sealant in the joint needs to be replaced or how can you tell when the joint needs to be rehabilitated? How do you replace sealant in joints? How do you rehabilitate sealant joints? Can in fact any of this be done? It is the new millennium and the arguments around these questions continue to rage – no consensus exists within the EIFS industry – consensus certainly does not exist among consultants engaged in the rehabilitation of EIFS. Certainly no one even had a clue in the 1980s when face-sealed EIFS began to be marketed – except that it couldn’t be done. How could a system be marketed in the 1980s with such an overwhelming performance requirement on sealant joints when the question of sealant joint longevity, replacement and rehabilitation had not been adequately addressed?

To put this into perspective, there are more than 1,000 sealant joints per building in most commercial EIFS buildings. Most of the joints leak from day one. More joints leak as the building age. Many EIFS buildings are now over 10 years old. It is time to replace the joints? What to do? That’s easy, remove all existing sealant and rehabilitate the joints. How do you do that? How do you prepare the surfaces to take new sealant? You think installing the sealant perfectly the first time was difficult – how about after the building has aged a decade? Oh, by the way, all the windows leak. Now what? What indeed. A system that relies on perfect joints, sealed perfectly, with perfect windows is fundamentally, inherently defective. The system, if it is constructed with moisture sensitive materials in a climate where it rains and has a high humidity, is unfit for the intended use.

**Cracking**

Traditional stucco cracks due to drying shrinkage or hygric stresses, embrittlement due to aging, and building movement. EIFS laminas do the same thing for essentially the same reasons. It is not possible to prevent traditional stucco from cracking. The same holds true for EIFS laminas. If there are cracks, there will be rain entry – and there will be cracks because it is impossible not to have them.

If drying shrinkage or hygric stress were not an issue in EIFS laminas, mesh reinforcing would not be necessary. The function of mesh reinforcing is to distribute the hygric stresses throughout the lamina rather than allowing stress relief to occur at a single location such as a crack. In the most fundamental sense a crack is stress relief. When cracking begins to occur, an additional function of the mesh reinforcing is to promote micro-cracking – many tiny cracks rather than fewer larger cracks, and to limit crack propagation – short cracks rather than long ones. More mesh reinforcing provides more effective distribution of hygric stresses, effectively promotes micro-cracking and limits crack propagation.

Unfortunately, the use of fiberglass mesh in an alkaline environment leads to the deterioration of the fiberglass mesh. To compensate for this, the mesh is coated and the alkaline environment is buffered chemically. However, prolonged exposure of the lamina
to moisture leads to a loss of strength of the fiberglass mesh. This mechanism of
deterioration can only be slowed, not stopped or prevented. There is no known solution to
this problem. To further compensate for this problem, more mesh reinforcing and thicker
mesh reinforcing is used. The logic being: if it’s going to get weaker, make it stronger
than you need initially, so that later it will still be strong enough. The flaw in this logic is
the definition of “later.” Does later mean 1 year, 3 years, 5 years, 10 years, 25 years or 50
years? “Later” also depends on exposure. Ten years in Las Vegas is very different from
10 years in Columbia, SC. It appears that after 10 years in a moderate rain exposure
region, significant deterioration of fiberglass mesh occurs.

Unfortunately, more mesh reinforcing leads to a thicker lamina, which decreases
the elasticity of the system. To compensate for this problem, the elasticity of the system is
increased by increasing the acrylic content. However, as the acrylic content is increased
the permeability of the lamina is decreased while the sensitivity of the lamina to ultra-
violet light (solar radiation) is increased. A decrease in permeability, of course, leads to a
reduction in drying to the exterior.

The exposure to ultra-violet light leads to embrittlement and a decrease in elasticity
of the system. The acrylic content also interferes with hydration and makes the lamina
more sensitive to carbonation – a reaction with atmospheric carbon dioxide – that leads to
embrittlement and a decrease in elasticity.

In other words, as the system ages, the lamina becomes more brittle and subject to
cracking.

Taking into account hygric stresses and embrittlement due to aging is one thing.
Building movement is an entirely different – and serious matter. In the realm of the
obvious, building movement is another given: buildings move. All buildings move. Tall
buildings move more than short buildings – especially tall concrete frame buildings. Since
all buildings move, control joints are necessary. If control joints are not provided, the
building provides its own in the form of cracks. Arguing that control joints are not
necessary in buildings is another fundamental flaw in logic that is contrary to experience
and the laws of physics.

Tall concrete frame buildings are subject to frame shortening due to the mechanism
of concrete creep, a fundamental characteristic of concrete experiencing loading over an
extended period of time. The weight of a tall concrete building causes the columns to
shorten by swelling. In order to take this into account, control joints are typically provided
through the cladding system at every floor. It is inconceivable to argue rationally that this
does not happen and that exterior cladding systems are flexible enough to take into account
this movement.

EIFS laminas crack – every one of them. Some EIFS laminas crack sooner than
others, but they all eventually crack. The cracks are due to hygric stresses, embrittlement
due to aging and building movement. The cracks in EIFS laminas are often found initially
at reveals and at window openings. The hygric stresses and building movement stresses
typically concentrate at locations where there is a change in thickness, a change in
direction or at a termination such as an opening.

As mentioned earlier, rain water entry occurs through cracks in the EIFS lamina,
between the EIFS lamina and windows, through balcony elements, through railings,
through windows, through sliding doors, through service penetrations and through the roof system leads to moisture damage.

**Moisture Damage**

Moisture damage is defined as deterioration due to mold, decay, corrosion, loss of strength, dimensional instability, freeze-thaw action, mineral or soluble salt spalling, deterioration of surfaces and volatile organic compound (v.o.c.) or odor emission.

The sensitivity of material to moisture is described by a damage function – typically a time, temperature and moisture content relationship specific to a particular deterioration mechanism such as mold, decay or corrosion.

The moisture damage typically observed with EIFS includes the following:

- mold growth on gypsum board and fiberglass cavity insulation surfaces
- loss of cohesive strength of gypsum board or OSB sheathing
- corrosion of metal studs
- discoloration of interior and exterior surfaces
- volatile organic compound (v.o.c.) or odor emission
- water damage to interior furnishings such as carpet
- dimensional instability – loss of cohesive and adhesive properties of sealant-lamina interfaces

Gypsum board is an extremely moisture sensitive material and has an extremely low moisture storage capacity. It must be protected from water in both the liquid and vapor forms. Paper faced gypsum board is particularly sensitive to mold growth and loss of strength when exposed to water. OSB sheathing is not much better.

The moisture storage capacity of hygroscopic materials such as gypsum board is time and temperature dependent. The acceptable hygroscopic performance limits for gypsum board are typically established by mold growth rather than loss of strength.

Mold growth on gypsum board can occur due to elevated relative humidity. The presence of liquid water from rain water leakage, ground water leakage, condensation or plumbing leaks is not necessary.

Mold growth occurs on gypsum board when the water activity of the gypsum surfaces exceeds 0.7 for more than two weeks at a temperature greater than 45 degrees F. and less than 100 degrees F. As the temperature (within this range) and relative humidity rise, the time period for mold establishment and amplification shortens. Mold growth will appear on gypsum board within 48 hours at a water activity of 0.9 at 75 degrees F.

In general, water activity is directly related to relative humidity. For example, a water activity of 0.7 is achieved when a hygroscopic material is in moisture equilibrium with air at a relative humidity of 70 per cent. Water activity should not be confused with moisture content. The moisture content of gypsum sheathing when it is at equilibrium with air at a relative humidity of 70 percent is approximately 0.5 percent by weight.

Loss of cohesive strength in gypsum sheathing occurs at moisture contents of 2 to 3 percent by weight or greater and requires the presence of liquid water. Loss of cohesive
strength of gypsum sheathing cannot be attributed to high relative humidities alone – liquid water due to water leakage or due to condensation is necessary.

Metal studs are also moisture sensitive and are subject to corrosion. Metal studs begin to corrode in air at a relative humidity of 70 percent or more. The rate of corrosion is dependent on temperature and available moisture. The time required for corrosion to become initiated depends on the degree of protection. For example, steel studs are galvanized to protect the steel from corrosion.

However, the zinc galvanic coating is sacrificial – it disappears over time as it protects the steel. Thicker galvanization provides a great time period or protection before corrosion occurs. Additionally, the coating must be continuous. Where steel studs are cut, where screws penetrate or where scratches occur, the coating is breached and corrosion can begin if sufficient moisture is available.

Steel studs are typically galvanized only to the extent necessary to protect the steel from water and humidity during the construction process. Galvanization is not relied upon to provide long term protection for the assembly. It is for this reason that galvanized steel studs are considered to be a moisture sensitive component. Long term protection for steel studs is typically provided by keeping the assembly dry.

Wood studs and wood based sheathings such as OSB and plywood are also moisture sensitive and are subject to decay and surface mold growth. When wood studs, OSB and plywood are exposed to relative humidities of 80 percent or more, mold can colonize the surfaces. These conditions approximate an equilibrium moisture content of 16 percent by weight in the wood or a water activity of 0.8 at wood surfaces. When moisture content by weight exceeds fiber saturation – typically 28 percent – decay can occur. Once decay is initiated, it will continue until moisture content by weight is dropped below 20 percent. Long term protection for wood studs and wood based sheathings is typically by keeping the assembly dry. Treating wood with biocides is not considered long term protection – they are considered sacrificial and therefore temporary.

Fiberglass cavity insulation is composed of glass fibers coated with a binder. The binder provides stiffness and binds the fiberglass layers to one another creating a mat. The glass fiber mat is covered on one side with a draft paper impregnated with bitumen. The binder is principally phenol-formaldehyde, with urea formaldehyde as an extender.

When relative humidities exceed 70 percent, the urea binder off-gasses, leading to a distinct urine odor. Mold growth also occurs on both the fiberglass and the kraft paper surfaces. Fiberglass fibers themselves do not rot; however, the kraft facing does when it becomes saturated with water.

The moisture sensitivity of the gypsum board or OSB exterior sheathing, the metal or wood studs and the fiberglass wall cavity insulation make them unsuitable for use with a barrier system in all but dry climates. The use of such moisture sensitive materials makes the EIFS inherently defective and unfit for use as an exterior cladding system in much of North America – with the exception of hot-dry climates or regions with less than 20 inches of annual precipitation.

To use EIFS safely in regions with more than 20 inches of annual precipitation it must be used with a wall assembly that manages rain water. Such assemblies also must not
contain interior vapor barriers or impermeable interior finishes. An exception to this requirement is where the drainage plane is a membrane that is also a vapor barrier and an air barrier and the interior framing cavities are uninsulated (Fig. 6).

Figure 6
Drainable EIFS with Membrane Drainage Plane
**Fig. 1 STEEL OR WOOD FRAMING**

EIFS may be attached by mechanical fasteners (as shown) or by adhesive (as shown below).

**Fig. 2 CONCRETE AND MASONRY**

EIFS attached to concrete or masonry using adhesive. Mechanical fasteners may also be used.
Insulation Board Applied In a Running Bond Pattern

Starter Row of Insulation Board At Corners

Interlock Edges of Insulation Board At Corners

Insulation Board “L” Cut At Corners of Wall Penetrations

Encapsulate Insulation Board Edge With Reinforcing Mesh And Base Coat.

Strips of Reinforcing Mesh Placed Diagonally At Opening Corners

NOTE: Window flashings, not shown, are placed at the head and sill.

Fig. 1 EPS BOARD LAYOUT

The Expanded Polystyrene Board (EPS) is placed on the wall in a running-bond pattern. The first row is generally half width to minimize EPS board joints from lining up with sheathing joints. To decrease base coat stress at corners of wall openings, EPS boards are “L” cut.

Fig. 2 MESH TREATMENT AT FENESTRATION

To further guard against cracking, diagonal pieces of mesh called butterflies are placed over the wrapped mesh at corners of the opening.
Wrap Reinforcing Mesh

Terminate EIFS Above Grade According To Local Building Code

Finished Grade - Sloped Away From Wall

Fig. 1 WRAPPING - Alternate 1
Fiber mesh located between substrate and insulation is attached either by base coat, adhesive, or mechanical anchorage.

Fig. 2 WRAPPING - Alternate 2
To give the foundation the appearance of EIFS, the reinforced base coat and finish may be lapped onto the foundation.
Refer to the sealant manufacturer’s guidelines for specific installation requirements.

**Fig. 1 FILLET JOINT**
Fillet beads may be used for weather seal joints, such as at window and door perimeter. Note that sealant is applied to the reinforced base coat and not to the finish coat.

**Fig. 2 BUTT JOINT**
Expansion joints should be designed for a minimum of four times the anticipated movement, but not less than 3/4” (19 mm). For joints where movement has been determined to be negligible, the minimum butt joint size is 1/2” (13 mm). Note that sealant is applied to the reinforced base coat and not to the finish coat.
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Refer to the window manufacturer’s guidelines for specific installation requirements.

**Fig. 1 WINDOW HEAD**

Even with the use of head flashing, sealant is still required, as indicated, and serves to complement the flashing in establishing a water tight, continuous weather seal between the EIFS and the window frame.

**Fig. 2 WINDOW SILL AND JAMB**

The purpose of a sill pan flashing is to catch water that may breach the window’s barrier or pass beyond the sealant. The flashing should extend between the framing members of the rough opening and be sloped to allow water to drain to the outside of the EIFS. Also, sill pan flashing end dams should extend 1/8” to 3/16” beyond outer plane of window frame. Exposed end dam edge may be covered with sealant if desired for improved appearance. To properly fabricate this detail, the EIFS should be installed before the pan flashing is set in place. This detail reflects an exposed sill pan. However, this type of window may also be installed with a concealed sill pan as depicted in figure 2 of drawings 6 and 7.

**Refer to the window manufacturer’s guidelines for specific installation requirements.**
Some finned windows are considered "self-flashed". However, a careful examination should be made of the joinery between the head, jamb and sill fins to ensure continuous protection against air and water passage. Any breach in the window’s outer cladding should be resolved with additional flashing and/or sealant. Consult the window manufacturer for installation recommendations.

The purpose of a sill pan flashing is to catch water that may breach the window’s barrier or pass beyond the sealant. The flashing should extend between the framing members of the rough opening and be sloped to allow water to drain to the outside of the EIFS. The spacer material should hold the nailing fin off of the sill pan extension by at least 1/8" (3 mm) to form drainage channels.

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The purpose of a sill pan flashing is to catch water that may breach the window's barrier or pass beyond the sealant. The flashing should extend between the framing members of the rough opening and be sloped to allow water to drain to the outside of the EIFS. The drainage medium should hold the EPS insulation board off of the sill pan extension by at least 1/8" (3 mm). This detail depicts a concealed sill pan. However, this type of window may also be installed with an exposed sill pan as depicted in figure 2 of drawing 5.

Refer to the window manufacturer’s guidelines for specific installation requirements.

Even with the use of head flashing, sealant is still required, as indicated, and serves to complement the flashing in establishing a water tight, continuous weather seal between the EIFS and the window frame.
For accessories subjected to handling, such as hose bibs and railing supports, wood blocking offers protection to the EIFS while providing a base for rigid attachment. The wood blocking may be painted or encapsulated in flashing.

Electrical box installations, whether for light fixtures or outlets, may be shimmed back to the sheathing to allow for flush mounting of the electrical accessory.
SLEEVED ATTACHMENTS

Substrate
Insulation Board
Adhesively or Mechanically Attached To Wall
Corrosion Resistant Fastener and Sleeve
Set In Sealant
Before Inserting Fastener
Sealant Placed Around Sleeve
Reinforcing Mesh Embedded In Base Coat
Shutter

1/4" (6 mm) Min

Fig. 1 SHUTTER ATTACHMENT
Sleeve and fastener attachment is adequate for most accessories. Downspouts, mail boxes, awnings, and other lightweight accessories may be mounted using the procedure shown. For non-structural sheathing such as gypsum board, ensure fastener(s) is placed in framing or blocking to provide rigid attachment.

Fig. 2 WIRING PENETRATIONS
Phone lines, cable lines, outdoor speaker wire and the like may penetrate the EIFS with the use of a sleeved grommet sized to fit snugly around the wire. The grommet flange provides an area for sealant application.

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DECK SECTION
The EIF System is held off of deck surface to allow for installation and maintenance of sealant, facilitate removal of foreign matter which may cause water retention, and to decrease exposure of wall system to precipitation, particularly snow and ice.
expansion joints and reveals

Fig. 1 FLOOR LINE EXPANSION JOINT
Expansion joints shall be installed in the EIF System as per manufacturers' recommendations but as a minimum where changes in substrate occur, where a joint exists in the substrate, and at floor lines in wood framed construction.

Fig. 2 AESTHETIC REVEALS
Reveals cut into the insulation board serve an aesthetic function by offering the look of joints without having to terminate the system. Grooves can also serve as a drip edge at soffits or head locations of fenestrations.

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**CHIMNEY FLASHING**

**Fig. 1 PROPER FLASHING**
The flashing located on the high side of the chimney shall divert water away from the EIFS System running down the side of the chimney. Turned out flashing ensures proper diversion of water.

**Fig. 2 CHIMNEY WITH EIFS INSTALLED**
With the EIFS System terminating at the top of the turned out flashing leg and a fillet bead of sealant applied to the flashing/EIFS interface, water is diverted around the chimney.

**Fig. 3 EIFS CHIMNEY WITH CRICKET**
Cricket detailing helps divert water around the chimney and alleviates snow and ice buildup. Diverter flashing is used anywhere an area of water shed terminates into a vertical wall.

**NOTE:** Flashing shall have watertight joints. Refer to the Sheet Metal and Air Conditioning Contractors National Association (SMACNA) for Flashing Configurations.
Fig. 1 GABLE END
The frieze board should extend over the EIFS face approximately 1 1/2" (38 mm). For less of an overlap it is advisable to terminate the EPS board 1/2" (13 mm) from the wood blocking and apply sealant with closed cell backer rod.

Fig. 2 NON EIFS SOFFIT
Refer to the note for Figure 1.

Fig. 3 EIFS SOFFIT
As with all inside corners, the reinforcing mesh from both legs of the corner should lap onto the adjacent leg 8" (200 mm). Under certain circumstances, an expansion joint may be required at the inside corner. Refer to the manufacturer’s specifications for guidelines.

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**Guide to EIFS Construction**

**ROOF AND WALL INTERSECTION**

**Fig. 1 FLASHING**
Flashing should extend up behind EIF system. A diverter flashing should be used wherever a water shed terminates into a vertical wall (as shown).

**Fig. 2 EIFS INSTALLED**
The EIF system should be terminated above the roof line to facilitate roof repairs and treatment of EIFS termination. In addition, the clearance allows for free-flow of water and minimizes accumulation of debris. Set the diverter flashing in a full bed of roof cement between the roof sheathing and underlayment.

**NOTE:** Flashing shall have watertight joints.