Exterior Insulation Finish Systems: Designing EIFS (Clad Walls) for a Predictable Service Life

Kevin C. Day[1]

Abstract

The most common criticisms of exterior insulation finish systems (EIFS) cladding stem from the most common deficiencies:

- Detailing and construction of joints, junctures, & interfaces with windows, etc.
- Sensitivity of workmanship, as it affects performance
- Staining (moss, mildew, dirt accumulation)
- Water penetration
- Impact damage & cracking

The elements of an EIFS clad wall design must include flashing, and adequate interfacing components with fenestration, waterproofing, and other cladding systems. To design an EIFS clad wall that will last 30, 50, or even the possibility of 100 years, requires that one foresee the loads upon the wall assembly, and design the wall to ensure these loads will be sustained with minimal detrimental effect, keeping in mind the serviceability and maintenance.

Towards predicting the service life of EIFS, thus far over 25 years has been achieved by some EIFS clad buildings. The author identifies the key performance parameters that affect EIFS service life, and provides recommendations for designers to follow in designing the assembly of a given EIFS clad wall assembly. The most critical parameters include the moisture management of the EIFS (including substrate considerations), limitations of use and exposure, consistency of testing of components and proprietary systems with actual application, and designing for serviceability and maintenance.

The emphasis of this article shall be to educate design professionals on how to better ensure their expectations may be realised, thereby providing some assurance of performance.

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[1] Kevin C. Day is a Project Manager & Building Science Specialist, in the Building Engineering Division of Morrison Hershfield Limited.

Exterior Insulation Finish Systems:
Designing EIFS (Clad Walls) for a Predictable Service Life

Kevin C. Day

Introduction

The continued selection and use of EIFS in the North American construction marketplace should serve notice to all critics and advocates that it is a cladding system that is here to stay. Two simple questions (that precipitated this article) were, "*How long **should** EIFS last?*" and "*Where and when **should** EIFS be used?*" Some critics may suggest that EIFS *should* be relegated to low-rise commercial (mercantile) buildings, i.e., buildings that are not anticipated to have a long service life, nor expected to perform to the same life cycle longevity as other buildings. Conversely, advocates state that any building *should* be suitable for cladding with EIFS. Both the critics and the advocates can point to exemplary examples to support their respective points of view. Hence, this article endeavours to formalise the evaluation of EIFS with respect to its potential service life, giving due consideration to the complete wall assembly upon which the EIFS is to clad, and to identify the parameters that will influence such performance in a given project.

This article is not intended to be an introduction to EIFS. There are documents listed in the bibliography that would be of benefit to the reader before reading this article. Note: Not all of the documents cited in the bibliography necessarily reflect the viewpoints of this author.

The installation and design of EIFS clad wall assemblies will be described as these factors affect the service life. Both the installation and design greatly influence whether a given EIFS clad wall may provide acceptable service life. Secondary to the installation and design, the testing and material/system properties can serve as a baseline for anticipated performance.

Background

To better comprehend the effective performance of EIFS as a cladding, one must analyse the evidence of both satisfactory and unsatisfactory examples of EIFS clad buildings. It is not the intent of this article to provide case study evidence reviewing failures and successes of EIFS. In reports published by ASTM and CMHC (some of which are listed in the bibliography), the typical problems encountered with EIFS clad walls have been well documented. Although many different opinions permeate these articles, the most common deficiencies include (in no particular order):

- Detailing and construction of joints, junctures, & interfaces with windows, etc.
- Sensitivity of workmanship, as it affects performance
- Staining (moss, mildew, dirt accumulation)
- Water penetration
- Impact damage & cracking

The characteristic of EIFS that make it both advantageous and potentially problematic, is the skin which it forms, enveloping a building. By the very essence of its construction and performance, EIFS is a lamination comprised of boards of rigid thermal insulation attached to a substrate with adhesive and/or mechanical fasteners, upon which a polymer cement base coat is rendered and reinforced with glass fibre mesh, finished with a polymer based finish coat with integral colour and texture. EIFS are proprietary systems, whereby the components are all provided by an EIFS manufacturer. It is a system that has very different attributes than other cladding systems, and as such, cannot be compared as easily as some individuals may suggest. To better appreciate these differences, designers should resolve themselves to following some basic rules when considering a building to be clad with EIFS, rather than speculation:

> *"The basic rules for long service life of materials are (a) to design so as to impose the least critical function upon a material, (b) to select a material that can perform the function and be durable in its service environment, or, (c) to alter the environment to suit the properties of the material that must be used."* [1]

Applying Garden's rules forms the rationale by which this author will address EIFS cladding. This article will assume that option (c) is not feasible, hence, to ensure a predictable service life, the limitations of EIFS will be addressed (imposing the least critical function) and its characteristics through exposure (being durable in its service environment).

To ascertain the potential service life of a given EIFS installation, there is at least one document that purports a minimum service life that can be achieved through compliance to the respective document. It is the "ETAG 004: Guideline for European Technical Approval of External Thermal Insulation Composite Systems with Rendering," March, 2000, produced by the European Organisation for Technical Approvals (EOTA). It states the following:

> *"The provisions, test and assessment methods in this guideline… have been written based upon the assumed intended working life… of at least 25 years, provided that the (EIFS) is subject to appropriate use and maintenance"* [2]

The EOTA document does not address wall assemblies that comprise sheathing and framing as substrates, only concrete and masonry substrates are addressed. Further, the correlation of proprietary EIFS between North America versus Europe cannot be easily defined. Beyond the substrates, there are differences with respect to the lamina thickness, polymer content, cement content, insulation types, mechanical fasteners, and types of reinforcement and accessories. At this time, there is no authority known to this author that has established any guidelines upon which a minimum service life for could be accurately predicted, in terms of testing and evaluation. As such, we must refer to historical examples, and define the typical problems and determine the appropriate limitations for use of EIFS. Therefore, this article purports that EIFS should be designed to clad a wall assembly, giving proper consideration to available testing, and attention to details and quality workmanship. The severity and frequency of the loads imposed on EIFS clad wall assemblies may one day be correlated to a calculated service life.

Substrates & Moisture Management

Having stated that this is not an introduction to EIFS, the general issues pertaining to substrates and moisture management can be addressed directly, as follows:

1. The most important aspect of moisture management is the deflection of rain water away from ever entering the wall assembly, i.e., proper flashing, overhangs, etc.
2. In general, for wood and steel framed wall assemblies, the presence of water in a stud cavity and/or within the sheathing is unacceptable for the vast majority of building locales across North America. Any consideration for significant drying of the wall must be limited to wall components to the exterior of the sheathing layer, dissipating outward.

This author is of the conviction that the reliance of drying moisture to the building interior is insufficient to compensate for moderate to extreme moisture within the cavity of a given wall, especially for insulated stud framed walls with polyethylene vapour barriers [3]. An excellent condensation control strategy would be to design the dew point temperature outside of the stud cavity, irrespective of the time of year. In reference to Figure 1, it should be noted that the larger range of temperature that may exist within the stud cavity of a wall assembly is in proportion to the risk of condensation occurring. If the wall is uninsulated, and the vapour barrier (or retarder) is to the exterior of the sheathing, then any condensation that may occur within the stud cavity during extreme circumstance could then dry out to the interior. Note: the quantity of water that can evaporate and diffuse to the building interior is very small, and should not be considered a major component of the moisture management of an EIFS clad wall.

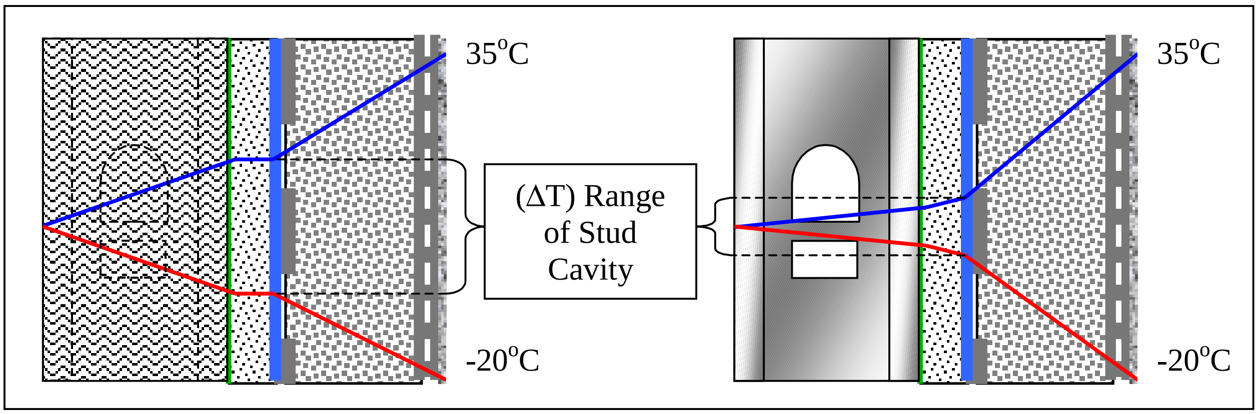

Figure 1 – Temperature Range of Stud Cavity, Insulated vs. Non-Insulated

3. Moisture-sensitive substrates, at the very least, should be protected with a moisture/weather barrier. In considering the longevity of the wall, one must not only consider the integrity of the sheathing, but also the attachment of that sheathing to the framing, i.e., screw fasteners. It is very reasonable to have all (or most) of the insulation to the exterior side of the sheathing (which is moisture protected) in all North American climate zones.

4. In general, for masonry, brick veneer, and reinforced concrete wall assemblies, which form a substrate for EIFS, moisture protection for the substrate is not necessarily required, except if a continuous plane of air-tightness and/or drainage may be required between the EIFS and the substrate. If no moisture barrier is incorporated into EIFS

applied over a mass wall, then one must assume that any incidental moisture that may penetrate the EIFS assembly, that the mass wall is capable of storing this moisture, without detriment to the assembly. Then over time, allow the moisture to dissipate in a manner that has little effect on the wall assembly.

5. The open rainscreen principle (pressure moderation) of EIFS should be considered tertiary to providing drainage of incidental moisture, and the protection of moisture-sensitive substrates. The pressure moderation attribute is only a benefit in high exposure applications, and should be considered as a supplementary moisture management strategy, not the primary.

System Selection

As a preamble to this discussion, the designations of class PB (polymer based) and PM (polymer modified) systems, known also as soft (thin) coat or hard (thick) coat respectively, are no longer applicable to many proprietary systems available on the market. This is further clarified by Bomberg, Kumaran, & Day [4].

EIFS are most typically proprietary systems, whereby the insulation, reinforcing mesh, adhesive/fasteners, base coat and finish coat are all provided by an EIFS manufacturer. Although some of the components may be supplied by 3rd party, it is crucial that a given EIFS be proprietary, and all of the aforementioned components be included in the material system warranty. Some municipal authorities in Canada also require that proprietary EIFS be listed with the Canadian Construction Materials Centre (CCMC), a division of the National Research Council of Canada. CCMC and relevant fire listings require that the proprietary EIFS components, specifically the insulation, mesh, and coatings, be audited and/or have a material fingerprint that is traceable as a method to ensure that the EIFS tested is the same as it is manufactured. It is very important to be cognizant of the specific information provided in both the fire listing and/or CCMC evaluation for a proprietary EIFS. Deviations from specified requirements, may contravene the intent and integrity of the listing. As an example, if a contractor or designer makes a change that is not supported by a manufacturer’s testing and specifications, nor supported by the fire and/or CCMC listing, it is likely that the material warranty would become invalid, and potentially the assembly may no longer be code compliant.

The necessity of a given EIFS being proprietary, as supplied by an EIFS manufacturer, is predicated on two major liability issues:

1. The manufacturer of the EIFS must be liable for the compatibility and suitability of the constituent components for its given system, insofar as material warranties, which typically state the materials shall be free of manufacturer defect, including aspects of cracking, crazing, delamination, peeling, etc.
2. The manufacturer of the EIFS must also maintain the continuity of the EIFS testing, and fire listings (where applicable), being representative of the systems sold in contrast to the systems tested.

As a reference point for the potential service life of EIFS, a cursory review of the general requirements that exist, insofar as standards and guidelines, are summarised in Table 1 to form the basis for qualifying a specific or series of proprietary systems.

Load Type	Load	Test Method(s)
General Exposure	Water Penetration	ASTM E 331 – Water Penetration ASTM E 1105 – Field Testing of Mock-Up EOTA ETAG 004 – 5.1.3.1 Water Penetration [5]
	Moisture Barrier	CCMC Tech. Guide for EIFS, 1999, A1 – Determining the Moisture Absorption Coefficient of a Moisture Barrier
	Hygrothermal	CCMC Tech. Guide for EIFS, 1999, A2 – Durability ETAG 004 – 5.1.3.2 Environmental Durability [6]
	Adhesion	CCMC Tech. Guide 5.2.1 – Wet & Dry State Adhesion
	Water Vapour	ASTM E 96 – Dry Cup for Lamina ASTM E 96 – Wet Cup for Moisture Barriers
	Alkali Resistance (Mesh)	EIMA 101.91 – Alkali Resistance of Reinforcing Mesh [7] CCMC Tech. Guide 5.3 – Tensile Strength/Alkali Resistance
	Salt Resistance	ASTM E 117 – Salt Spray (Fog) Resistance
	Fungus Resistance	MIL-STD-810E – Resistance to Fungal Growth
	Ultra-Violet Resistance	ASTM G23 – Carbon Arc Light ASTM G53 – Fluorescent UV & Water Condensation
Movement	Air Pressure and Structural Deflection	ASTM E 283 – Air Leakage ASTM E 330 – Positive & Negative Wind Load
	Kinetic (Impact) Forces	EIMA 101.86 – Kinetic Impact Test EOTA ETAG 004 – 5.1.3 – Puncture Testing
	Abrasion	ASTM D 968 – Abrasion Resistance of Coatings
Interface Elements	Sealant Adhesion	ASTM C 1382 – Sealant Tensile Adhesion – 5 Conditions ASTM C 920 – Sealant Classification

Table 1 – Basic Summary of Testing Requirements for EIFS

It is the opinion of this author that these tests provide only a basis upon which to evaluate, select and specify a proprietary EIFS, and do not provide absolute assurance of a minimum service life. As such, it is important to review the loads that EIFS may be expected to resist during its service life. In this regard, for the purpose of this article, the loads have been summarised (not including fire resistance since these are determined by the applicable building code), relevant to the various climate exposures in North America.

The process of selecting a proprietary EIFS may be somewhat confusing since the various manufacturers have different approaches to this type of cladding technology. There is a multitude of product-types for the components of these systems. The quality assurance of a proprietary EIFS can be addressed by a manufacturer having a well-established reputation, and of further benefit, the manufacturer could be ISO9000 registered.

Design

The design of an EIFS clad wall must give consideration to all of the loads on the wall assembly. It is crucial for a designer to review and consider the major performance variables that will affect the wall assembly, including; climate, relative exposure of the facades, defining the plane of air tightness (air barrier system), vapour control, rain penetration control and the placement and amount of thermal insulation. It is also crucial to consider the durability and serviceability of the exterior facades. Beyond these decisions that may affect the design of an EIFS clad wall, there must be project-specific details that address all terminations (interfaces) and penetrations in the EIFS, as well as elements within the EIFS (such as mouldings and reveals). To properly implement these details, a mock-up of the wall assembly should be constructed and reviewed prior to construction.

The substrate onto which the EIFS is installed is not part of the EIFS itself, however, EIFS is not self supporting or load-bearing and requires attachment to a suitable substrate. The substrate must be designed to accommodate the structural loads, including air pressure and wind loading, and minimise deflection (typically L/240 or L/360 is acceptable). The EIFS must also be joined to other elements of the wall, as required for other cladding systems. Further discussion of sealants is presented later in this paper.

The first consideration of the substrate selection must be the moisture management of the complete wall assembly. This precedes the decision of the attachment of the EIFS since it can invariably affect the moisture management properties, as previously defined by Bomberg, Kumaran, and Day [8]. These classifications are illustrated in Figure 2 below, supplemented by the ancillary elements for the interfaces of these systems.

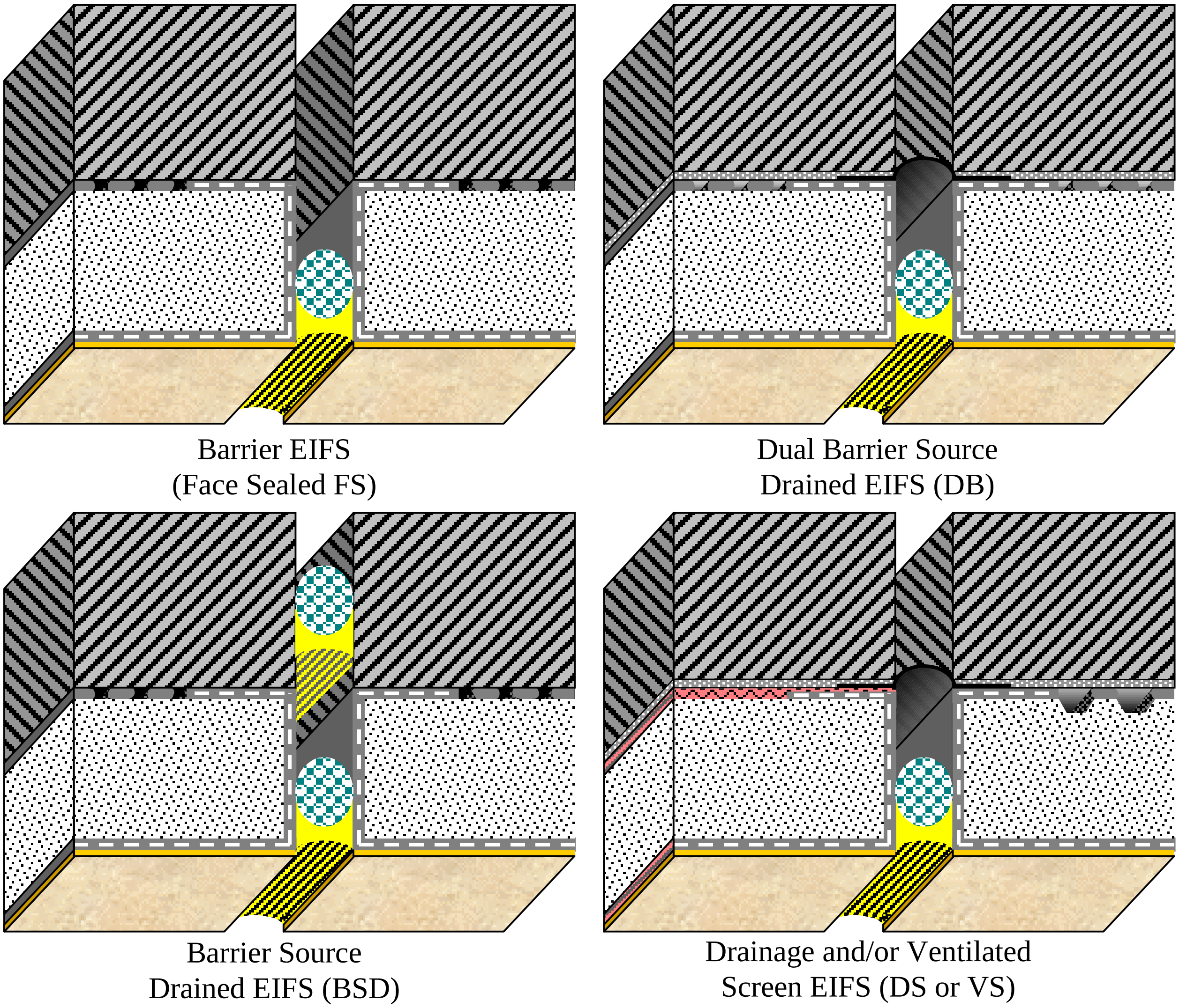

Figure 2 – EIFS Moisture Management Classifications

As a minimum for designing for a long service life, the BSD EIFS should be considered the minimum starting point for the selection and design of any EIFS clad wall. Further, if the substrate is moisture sensitive, such as wood or steel framing with sheathing, then a DB EIFS should be selected. A designer may subjectively select the appropriate EIFS type by considering four variables; 1) building height and exposure, 2) driving rain and annual rainfall, 3) complexity of the architectural facades, and 4) moisture sensitivity of the substrate. As any of these four variables increase in magnitude, the selection of a DB, DS, or VS EIFS becomes more appropriate.

The limitations of EIFS can be derived from its inherent weaknesses. Therefore, EIFS is not recommended for the following applications, unless specifically engineered to do so:

- High pollution, or chemically sensitive environments, i.e., typically not suitable for industrial applications.
- High traffic, or potentially high abuse locations, such as adjacent to shipping doors, major entrances to buildings (specifically where people or vehicles may be in direct proximity to the wall area), nor adjacent to playgrounds or recreational activities. Although some proprietary EIFS may be suitable in some of these locations, the designer must provide for adequate impact resistance, as well as recommendations for maintenance. Testing should be reviewed to determine the suitability of the system.
- If there are concerns pertaining to the integrity of the substrate, EIFS should not be used to overclad existing problems areas, such as delaminating paint on masonry, spalled brick veneer, weathered sheathing, etc.

There are other limitations that may apply to a given EIFS application, which will require provisions in the design documents. It is typically appropriate to rely upon the EIFS manufacturer’s specifications and/or the limitations stated in a CCMC EIFS listing as part of the documents, however, a designer should not be limited only to these requirements. As part of the design documents, the following information must be delineated:

- Heavy or High Impact Mesh: all high-traffic areas, as well as any areas that may be exposed to ongoing maintenance equipment (such as window washing) must be identified on the architectural drawings, with specified dimensions, and grade of reinforcing mesh. If the additional cost cannot be afforded for supplementing a proprietary EIFS with high impact resistant mesh (where required), then EIFS should not be used.
- Architectural Reveals: often referred to as ‘control joints’, or ‘grooves’ are in fact reveals cut into the insulation layer of the EIFS, prior to rendering of the lamina. These reveals can be installed for the purpose of architectural effect, and/or delineating the work areas for rendering of the EIFS finish coat. Reveals are not installed where building/substrate movement is anticipated. The profile of the reveals should be such that the horizontal edges, facing upward, be sloped a minimum rise over run of 6:12, approximately 27 degrees from the horizon. The reveals are best to

have round or trapezoid type profiles, thereby minimising the strain on the EIFS lamina and insulation, and reducing the potential for cracking to develop.

- Decorative Shapes: cornices, mouldings, and other decorative elements forming part of the EIFS are surface mounted during the EIFS installation require scaled section drawings. It is extremely important to provide a proper slope for the horizontal edges, that face upward. These must be sloped a minimum rise over run of 6:12, approximately 27 degrees from the horizon. The length of the slope must not exceed 300 mm, according to most EIFS manufacturers specifications. However, it may be prudent to consider the following measures:
  - As a rule, mouldings that are often exposed to wind-driven rain, and snow or ice accumulation, the horizontal edge should be counter-flashed with metal, including a drip edge.
  - There is another option to enhance the moisture resistance of horizontal projections, utilising waterproof base coats (not to be confused with standard EIFS base coats, which are at best, water resistant), and elastomeric or high content polymer finishes. Note: A waterproof base coat is typically low in vapour permeance an not recommended for large wall areas.
  - Smooth textures are preferred to minimise dirt and mildew accumulation, and there are elastomeric paints that can be applied to the base coat, foregoing the necessity of a textured finish coat, making the exposed surface more smooth.
  - If there is an overhang in close proximity above the moulding, the sloping requirement could be lessened.
  - Drip edges should be provided where possible. Most horizontal projections tend to accumulate dust and dirt, which then typically causes stains below as rain water moves the dust and dirt down the facade.
- Penetrations & Terminations: all penetrations though the EIFS and terminations should be detailed in the architectural drawings, that clearly delineate the interface of the EIFS and the adjacent elements. EIFS base coat and reinforcing mesh must be secured to the substrate, around the edge of the insulation, and onto the wall. This is referred to as backwrapping.

- Expansion Joints: these must occur at all junctures in the substrate, i.e., deflection tracks in steel frame walls, masonry control joints, floor lines in wood framed walls. The location and width of the expansion joints should be delineated on the architectural drawings. The thickness of the EIFS base coat should be specified at adjoining edges of the expansion joints. At the very minimum, the backwrapped base coat thickness should be 1.6 mm thick around the full edge of the insulation, preferably thicker as discussed in the Sealant section that follows.
- Base Coat Thickness: there are two key performance objectives that are affected by the base coat thickness, fire resistance and water penetration resistance. As such, the base coat must be applied to a minimum 1.6 mm thickness, and note, this is not an average, it is a minimum. Further, to ensure proper coverage, thickness, and embedment of reinforcing mesh, the base coat should be applied in two passes; the first application being cured before the second pass.
- Prime Coat for Finish: there are a few good reasons to require a prime coat, colour matched with the finish coat. The primer will ensure that the colour of the finish coat will be more consistent from one area of the wall to the next, and the base coat will not be visible in any of the shallows of the texture. It is generally well known that the base coat provides the primary water resistance, therefore, the addition of a primer will increase this attribute by forming a continuous polymer film that retards liquid moisture transport (thereby reducing the hygrothermal loads). This increased moisture resistance provided by the primer is especially important when there are concerns about the mixing quality and consistency of a given base coat application. Lastly, the primer allows the applicator to achieve a greater coverage rate of the finish coat material, which saves on material costs. Inclusion of primer coats should not contravene EIFS fire listings.
- Colours & Textures: should be delineated on the architectural drawings.

There are other factors that affect the potential service life of EIFS. Assuming that a satisfactory installation has been achieved, consideration can then be given to the actual life cycle of the cladding.

- Damage caused by impact, or accidents should be repaired immediately with compatible, or identical materials.

- A building owner should anticipate replacement of the sealants in 10 – 15 years. The quality of the EIFS installation will be the primary factor that determines the success of the sealant replacement, and the respective costs.
- The appearance of the EIFS can be improved by regular washing, every 2 – 5 years or so, depending on the building. A colour change is easily achieved with a compatible acrylic latex low lustre paint. If cracking develops, the use of a vapour permeable elastomeric paint could be considered, however, this is limited to narrow cracks only.
- The alkali attack on glass fibre reinforcing mesh, applicable mainly to Portland cement base coats, can only be quantified by the testing of the glass fibre reinforcing mesh. The glass fibres are coated with resin for protection, but a loss of tensile strength will still result from the alkali reaction with the cement. Since EIFS is no older than approximately 30 years in North America, it is not known what service life can be achieved by the reinforcing mesh component of the lamina. Therefore, as part of the maintenance of the EIFS, a consultant (experienced with EIFS) should conduct a detailed review of the cladding to ascertain the integrity of the lamina. If the EIFS is well maintained, this review may only be necessary every 15 – 25 years, depending on the exposure. It may be necessary to apply a new EIFS lamina (removal and replacement, or rendering over the existing). It is crucial that testing be presented by an EIFS manufacturer that substantiates the alkali resistance of its reinforcing mesh. In reference to EOTA or EIMA requirements, the reinforcing mesh must be subjected to a high pH in a cement or sodium hydroxide solution, for a minimum duration of 28 – 90 days (depending on the method employed), and not lose more than 50 – 60% of its tensile strength. At least 150 N/mm should be demonstrated after being subjected to the high pH solution.

In general, good flashing details that would be consistent with other cladding systems should be included in EIFS details. The flashing elements should have upturns at terminations (end dams), and the connections of flashing pieces should incorporate standing seams and S-locks. Fasteners through the face of the flashing on horizontal elements should be avoided, and additional protection with self-adhering waterproof membranes can provide added assurance.

Construction

The construction of the wall assembly is an extension of the design process. It is essential that workmanship-sensitive materials and systems receive due attention in the construction process. As such, periodic or full time inspection of a given EIFS installation should be considered mandatory by prudent designers and owners alike. This may take the form of an independent (3rd party) inspector, or possibly be undertaken by the designer if skills permit. The essential difference between designing and specifying EIFS versus reviewing its installation is having extensive knowledge of the application techniques, understanding of construction tolerances, and familiarity with equipment, environment and mixing criteria. It is not a complex process, however, it cannot be assumed that one may read a manufacturer's specification, and somehow gain all the necessary knowledge to conduct meaningful inspections.

As the basis upon which EIFS can be reviewed by a 3rd party inspector, the most significant reference, which provides extensive criteria for EIFS application, is ASTM C 1397 "Standard Practice for Application of Class PB EIFS". It is important to recognise that this standard does not address insulation materials other than expanded polystyrene, nor does it address the inclusion of a moisture barrier or substrate protection as part of the EIFS installation. Also, ASTM C 1397 is based on a somewhat dated classification of PB type EIFS, as such, there is limited use of this document for some proprietary systems. There are other references by which the proper installation of EIFS can be further studied. A list of sources is provided in the bibliography at the end of this paper.

Sealants

The wall assembly may rely, in varying degrees, upon the integrity of the sealant joints, hence, the durability of the sealant joints (which includes the adjoining EIFS) is very important and often requires a level of scrutiny somewhat greater than other cladding systems. There are two types of sealant joints for EIFS; of primary importance are movement (expansion) joints that occur within the wall assembly, of secondary importance are sealant joints that are installed where EIFS abuts dissimilar wall components, and the potential for movement is low. In general, the performance of a suitable and durable sealant relies entirely on the integrity of the cladding itself, upon which it is adhered. In comparison of EIFS to precast concrete, brick veneer or curtain wall cladding systems, the performance of the sealant is more sensitive to the rendering of EIFS itself (i.e., thickness and continuity of base coat, as well as continuity of the reinforcing mesh), and is equally sensitive to potential damage when the sealant is eventually replaced. Precast concrete, brick veneer, and curtain wall have more robust surfaces upon which to apply a sealant, further, the replacement of the sealant is typically less difficult, and less likely to cause damage to the cladding. Therefore, as a suggestion to provide a more serviceable EIFS joint, the base coat should be made thicker at the expansion joints, between 2.0 – 4.0 mm in thickness, thereby reducing the potential for damage to occur during sealant removal.

Sealants can be qualified for application on a given proprietary EIFS by testing according to ASTM C 1382. This test method requires that the EIFS coating upon which the sealant be applied shall be tested after exposure of five specimens each tested according to five different conditions, prior to tensile adhesion testing:

- Dry, Room Temperature (Control Set)
- Water Immersion (50 mm in water for 7 days)
- Freezing (24 hours, @ 18^{o}C $\pm$ 2^{o}C)
- Heat Conditioning (24 hours, @ 70^{o}C $\pm$ 2^{o}C)
- UV (Ultraviolet)/Condensation (as per ASTM G 53, 2500 hours, 8 hr UV @ 60^{o}C alternating with 4 hr condensation @ 50^{o}C

After each set of specimens is subjected to its respective conditioning, it is subjected to tensile loading, in increments of 10%, 25%, 50% & 100% elongation. The tensile load is measured at each increment, and the data is tabulated for reporting.

Further to testing sealant adhesion, in accordance with this standard, the following should be noted:

- The specific EIFS component (and thickness) upon which the sealant was applied.
- The tensile load at which any failure(s) occurred, the mode of failure(s).
- The use of primer(s).
- The application requirements for the primers, i.e., minimum flash and maximum exposure time.
- The EIFS manufacturer should declare a maximum load upon which the EIFS may be exposed to tensile loading through this method.
- Most important, tensile loads measured at 50% elongation, of sealant applied to an EIFS base coat should be noted by the designer. The type of preconditioning that

affects the sealant modulus should be given additional scrutiny when tensile loads exceed 150 kPa.

- It is useful to test the tensile adhesion of the sealant to the EIFS finish coat since this may occur at non-movement joints, such as a window perimeter. It is crucial that EIFS finish coats not be caulked with sealant in movement joints, nor in locations where there is any potential for snow, ice, or water accumulation in close proximity to the EIFS finish coat.

It is important to note that sealant and EIFS materials assessed according to ASTM C 1382 test method can be considered for sealant expansion joints. Further, if the EIFS and sealant demonstrate compatible performance according to this test, then the same materials can likely be used for other joints, such as window perimeters, or service penetrations, etc.

Conclusions

To design EIFS clad walls for a predictable service life is both practical and necessary. As reviewed here, the primary mechanisms that cause EIFS to degrade through exposure are directly proportional to the amount of harsh temperatures it experiences combined with wetting cycles (hygrothermal loads), loss of strength in the reinforcing mesh due to alkali attack, building movement causing cracks, and impact/abrasion damage.

A crucial aspect of predicting the service life of EIFS is maintenance and repair, and the respective costs. It is conceivable that after 25 – 30 years, a given installation may only require replacement of sealant, and surface recoating, however, the condition of a given installation can widely vary the costs of such work. Due to the complexity of the issues associated with EIFS maintenance and repair, this will work will be continued by the author in the future.

The most crucial considerations, during the design and construction of EIFS clad walls, include protection of moisture sensitive substrates, moisture management, minimising the exposure of horizontal surfaces, and ensuring satisfactory installation procedures are implemented. A pragmatic requirement for any project is to require site construction of a mock-up, that includes all the major elements of the wall assembly, interfaces of the EIFS with windows and other penetrations, sealants and expansion joints, flashing, etc. As well, the level of workmanship required for the EIFS rendering can be assessed, i.e., minimum coating thicknesses, adhesive pattern, use of mechanical fasteners, insulation and lamina installation, and selection of colours, textures and architectural mouldings and reveals. If there is a question as to the ability of the assembly performing, a field test, such as the methodology provided in ASTM E 1105, should be employed to review the performance of the mock-up. Once the mock-up has been reviewed and approved, periodic inspections should be conducted during the course of construction.

Some additional requirements that should be given consideration include the application of a colour primer coat prior to rendering the finish coat, since this improves both the moisture resistance and aesthetic appeal of the finished system. Also, increasing the thickness of the EIFS base coat at sealant expansion joints

The scope of this article has been limited to describing generic EIFS, and the designer should give additional consideration for elements and/or components that are rarely or only recently introduced; such as EIFS that have not been adequately described in this article.

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