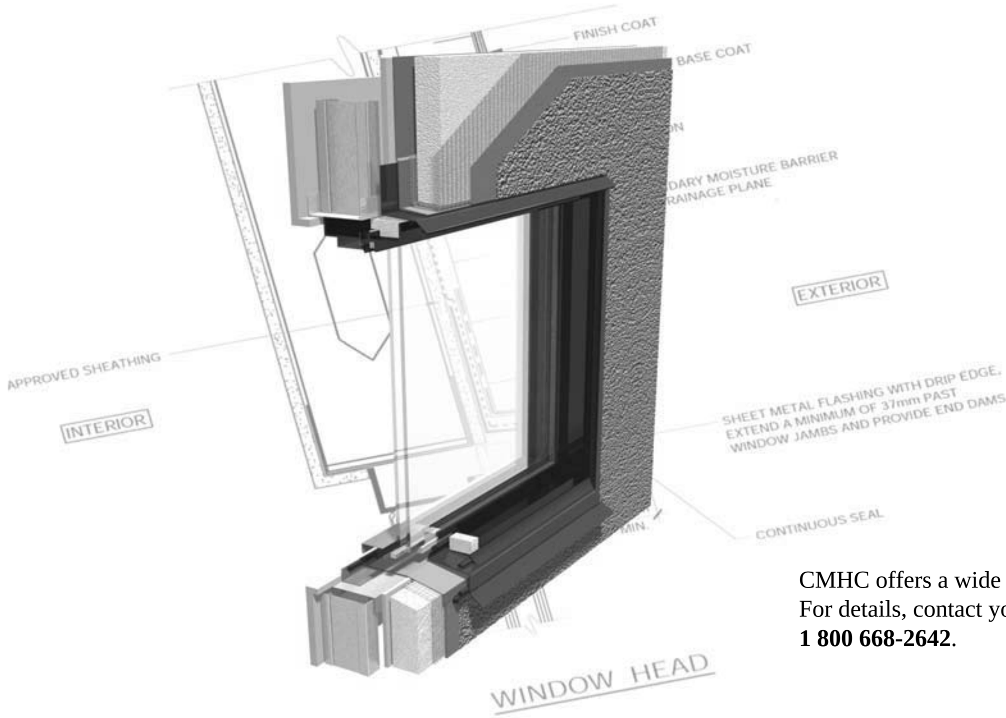
EXTERIOR INSULATION AND FINISH SYSTEMS

BEST PRACTICE GUIDE BUILDING TECHNOLOGY



CMHC offers a wide range of housing-related information. For details, contact your local CMHC office or call **1 800 668-2642**.

Cette publication est aussi disponible en français sous le titre : *Guide des règles de l'art — Systèmes d'isolation des façades avec enduit (SIFE)*, 63568

Canada

British Columbia Wall and Ceiling Association

CMHC acknowledges the financial contribution of Public Works Government Services Canada toward the publication of this Guide.

CMHC SCHL

CMHC—HOME TO CANADIANS

Canada Mortgage and Housing Corporation (CMHC) is the Government of Canada's national housing agency. We help Canadians gain access to a wide choice of quality, affordable homes.

Our mortgage loan insurance program has helped many Canadians realize their dream of owning a home. We provide financial assistance to help Canadians most in need to gain access to safe, affordable housing. Through our research, we encourage innovation in housing design and technology, community planning, housing choice and finance. We also work in partnership with industry and other Team Canada members to sell Canadian products and expertise in foreign markets, thereby creating jobs for Canadians here at home.

We offer a wide variety of information products to consumers and the housing industry to help them make informed purchasing and business decisions. With Canada's most comprehensive selection of information about housing and homes, we are Canada's largest publisher of housing information.

In everything that we do, we are helping to improve the quality of life for Canadians in communities across this country. We are helping Canadians live in safe, secure homes. CMHC is home to Canadians.

Canadians can easily access our information through retail outlets and CMHC's regional offices.

You can also reach us by phone at 1 800 668-2642
(outside Canada call (613) 748-2003)
By fax at 1 800 245-9274
(outside Canada (613) 748-2016)

To reach us online, visit our home page at **www.cmhc.ca**

National Library of Canada cataloguing in publication

Main entry under title :

Exterior insulation and finish systems (EIFS)

(Best practice guide, building technology)
Issued also in French under title: Systèmes d'isolation des façades avec enduit (SIFE).
Includes bibliographical references.
ISBN 0-660-19318-3
Cat. no. NH15-424/2004E

1. Exterior insulation and finish systems – Design and construction.
2. Insulation (Heat).
I. Canada Mortgage and Housing Corporation.
II. Series.

TH2238.7E87 2004 693.8'32 C2004-980184-8

Printed in Canada
Produced by CMHC

FOREWORD

Canada Mortgage and Housing Corporation, the federal government's housing agency, is responsible for administering the *National Housing Act*.

This legislation is designed to aid in the improvement of housing and living conditions in Canada. As a result, the corporation has interests in all aspects of housing and urban growth and development.

Under Part IX of this *Act*, the Government of Canada provides funds to CMHC to conduct research into the social, economic, and technical aspects of housing and related fields, and to undertake the publishing and distribution of the results of this research. CMHC therefore has a statutory responsibility to make widely available information that may be useful in the improvement of housing and living conditions.

This publication is one of the many items of information published by CMHC with the assistance of federal funds.

DISCLAIMER

The analysis, interpretations, and recommendations are those of the consultants and do not necessarily reflect the views of CMHC or those divisions of the Corporation that assisted in preparation and publication.

Care has been taken to review the research summarized in this *Guide*, but no attempt has been made to replicate or check experimental results or validate computer programs. Neither the authors nor CMHC warrant or assume any liability for the accuracy or completeness of the text, drawings, or accompanying diskette, or their fitness for any particular purpose. It is the responsibility of the user to apply professional knowledge in the use of the information contained in these drawings, specifications, and texts, to consult original sources, or when appropriate, to consult an architect or professional engineer.

Steering Committee for the Best Practice Guide, *Exterior insulation and finish systems (EIFS)*

Kevin Day,
EIFS Council of Canada

Luis de Miguel,
Canada Mortgage and Housing Corporation

John Edgar,
STO Corporation

Gregg Lowes,
British Columbia Wall & Ceiling Association

Acknowledgments

The following individuals are acknowledged for their significant contributions to this guide:

Bill Sullivan,
Halsall Associates Limited

James Lischkoff,
Trow Associates Inc.

John Straube,
University of Waterloo

Michael Van Dusen,
Halsall Associates Limited

1 / Introduction

2 / System selection

3 / Cladding design

4 / Retrofit with EIFS

5 / Details

Figures

Table

Details

PURPOSE

This guide is one in a series of Best Practice Guides produced by CMHC. Its purpose is:

a) To provide an understanding of Exterior Insulation and Finish Systems (EIFS) in a form that is useful to building designers, building code officials, product manufacturers, and contractors.

b) To provide recommendations for EIFS best practices to promote satisfactory performance and durability.

c) To develop a framework for functional construction details and specifications that generically illustrates best design and construction practice.

SCOPE

This guide focuses specifically on EIFS and their interface with other elements forming the building envelope, including: EIFS constituent components, joints, sealants, interfaces, and accessories.

> Since much of the technology involving EIFS is proprietary, system manufacturers must be consulted for material properties, performance, and regulatory implications of a specific system considered for use on a project. If a system is altered or constituent components are substituted that have not been tested and approved by the manufacturer, performance may be unpredictable and warranties voided. This can include the inability to know whether the modified system is capable of meeting required fire resistance ratings.

The guide covers the use of EIFS in new construction, both high-rise and low-rise. Although EIFS installed over concrete and masonry are included, EIFS attached to substrate sheathings fastened to either steel or wood framed walls dominate in this guide. Applying EIFS to insulated concrete forms (ICFs) is not explicitly addressed, but some of the principles covered could be applied. EIFS coatings applied onto traditional stucco, cement board sheathing, masonry or concrete are not covered by this guide.

The main part of the guide focuses on "best practice" recommendations for EIFS design and application. The Technical Appendix at the end of the guide discusses in more detail how EIFS perform, including crack resistance, control of air leakage, moisture management (water and water vapour) and other aspects of durability that manufacturers consider in product development. These concepts should be generally understood by those selecting or designing with EIFS. Building physics can be found in the various references in the bibliography, including Hutcheon and Handegord's *Building Science for a Cold Climate*.

The design of the wind-load bearing-backup walls, windows, decks and structure are not explicitly addressed. The components of EIFS, the interface between EIFS and other wall elements, and the hygrothermal performance of EIFS are covered.

Special interior environments such as ice arenas, swimming pools, high humidity industrial environments, or applications in hot and/or tropical climates are not considered within the scope of this guide. Specialist advice should be sought for these applications.

EIFS DESCRIPTION

Exterior Insulation and Finish Systems (EIFS, pronounced "eefs", not "eef-is") are products for cladding exterior walls. These cladding systems integrate insulation with a "stucco" like covering. While some may draw on this comparison and suggest these are similar cladding systems, EIFS differ from stucco in many respects. EIFS incorporate proprietary constituent components that have been developed and tested to be compatible, and to fulfill specific building envelope performance requirements.

The fact that EIFS include the word "System" requires emphasis. One must resist the temptation to consider the "S" as simply the plural of "EIF". Proprietary EIFS rely upon the constituent components to interact and perform as a composite system. This is unique in comparison to many other cladding materials.

In addition to the ability to provide various forms and finishes, a designer must consider the performance capabilities offered by EIFS, and select systems from manufacturers which incorporate features that meet the project requirements. Considerations include: fire safety, thermal resistance, resistance to rain penetration, interior air and moisture control, impact resistance, and other aspects of durability.

EIFS incorporate the following components:

1. insulation board, fastened mechanically and/or with an adhesive;
2. base coat with reinforcement (typically, alkali-resistant glass fibre or coated glass mesh), typically adhered to the insulation, but sometimes mechanically fastened;
3. surface finish, sometimes with a primer, adhered to the base coat;
4. joint treatments, drainage accessories, seals, and sealants may also form part of the system.

It is important to note that EIFS do not include components forming the substrate to which the cladding is applied. However, the substrate must be compatible with the EIFS, and be properly designed and installed for the EIFS to perform acceptably.

EIFS are often applied to substrates treated with a moisture, air and/or vapour barrier. Barriers that are compatible with EIFS are provided or recommended by manufacturers.

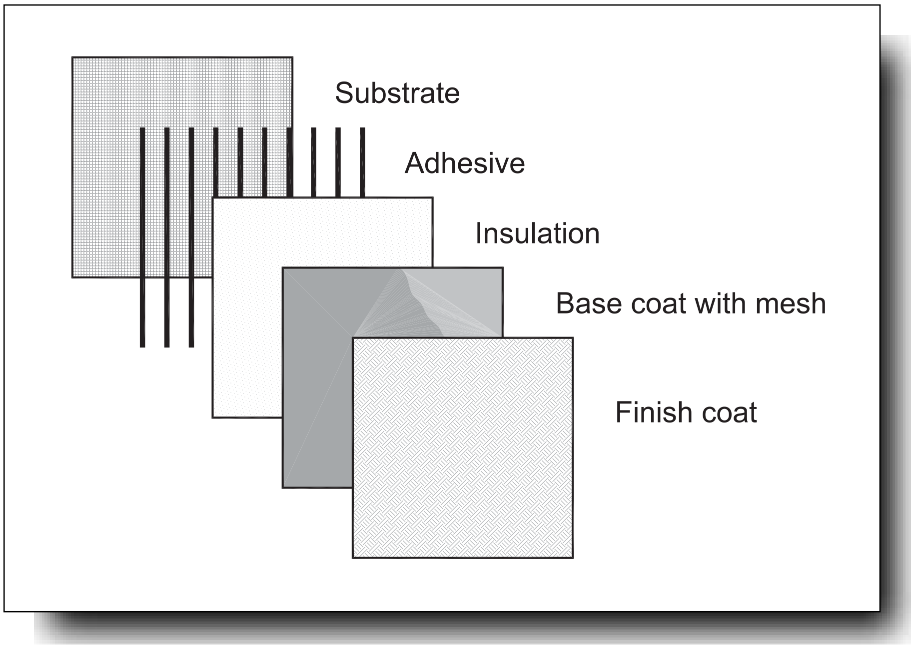


Figure 1.1: *Basic EIFS components*

EIFS do not include components forming the substrate, shown here for clarity.

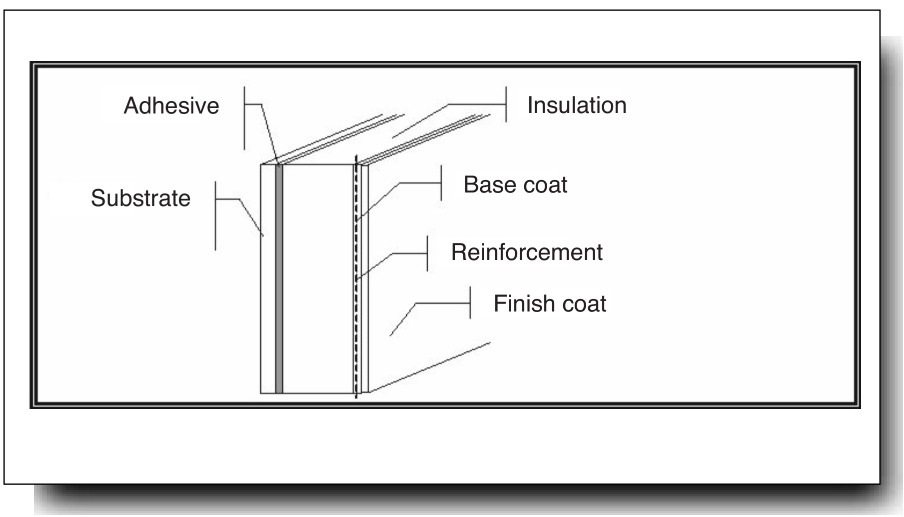


Figure 1.2: *Simplified isometric drawing of an EIFS*

A BRIEF EIFS HISTORY

EIFS evolved in Europe when conventional stucco was applied over insulation. The advent of polymer chemistry in post-war Europe led to the development of foamed plastic insulation and modern synthetic coatings that formed "laminae" in lieu of the traditional stucco. EIFS were first used in North America in the early 1970s and have now developed a significant share of the cladding market. EIFS can be field applied, or assembled as panels in a factory and attached to a building.

Formerly, EIFS were classified as being either Polymer Based (PB) (also referred to as "soft coat, thin flexible"), or Polymer Modified (PM) (also referred to as "hard coat, thick or rigid coat"). Polymer Based (PB) systems tend to be soft, thin, and flexible as a result of the higher polymer content in the base coat. While the majority of PB base coats contain cement, some do not. Polymer Modified (PM) systems tend to be thicker, harder, and rigid as a result of less polymer and a higher cement content. PM systems tend to require mechanical fastening and more control joints to accommodate movements without cracking.

There are a range of lamina thicknesses and cement/polymer ratios employed by manufacturers. Attempting to classify EIFS according to lamina thickness or by the degree of polymerization is no longer practical nor useful. As a result, these classifications have become obsolete, and are no longer used in Canada. The classifications that are of greater interest are the ability for the EIFS to comply with Building Code requirements pertaining to fire safety, control of rain penetration, and impact resistance.

EIFS ADVANTAGES

Some of the advantages associated with EIFS:

1. **Continuity of thermal barrier:** EIFS can provide a continuous exterior layer of insulation for the building envelope. This can be designed to protect the building and back-up wall structures from temperature extremes that promote undesirable thermal movements, and to protect against moisture damage from condensation. A continuous thermal barrier helps avoid thermal bridging, and takes advantage of thermal mass (heat storage). This can improve energy performance, promoting savings in both the initial and operating costs related to heating and cooling equipment.
2. **Light-weight:** EIFS have a low-weight (dead load) in comparison with masonry or concrete cladding. This can reduce structure costs, particularly for high-rise buildings and when earthquake loads significantly influence the design.
3. **Water penetration resistance:** Properly applied and maintained EIFS provide good resistance to rain water penetration. The risk for rainwater penetration tends to be limited to joints, interfaces with other materials, where the lamina is damaged or otherwise defective.
4. **Flexibility:** In comparison to rigid cladding systems, many EIFS are relatively flexible and better able to accommodate substrate flexure or other movements without cracking.

5. **Appearance:** A wide range of finish colours and textures are available. Complex surface features are easily incorporated for distinct and interesting architectural facades.
6. **Repairability:** Localized damage or defects in EIFS can be easily repaired. The appearance can typically be restored or renewed by re-applying the finish or by painting.
7. **Retrofit applications:** Light-weight EIFS can often be applied directly over existing cladding systems. This can be designed to:
   - improve appearance;
   - increase thermal performance;
   - correct problems with rain penetration;
   - improve resistance to condensation or entrapped moisture, and;
   - protect the structure and existing cladding from deterioration.

EIFS LIMITATIONS

Some limitations of EIFS are as follows:

1. **Combustibility:** Some EIFS incorporate combustible components and/or combustible foam plastic insulation. The applicable Building Code must be complied with by selecting a system that meets fire safety requirements.
2. **Impact resistance:** EIFS can be vulnerable to impact damage as a result of the relatively thin lamina. At areas where impact damage is likely, an appropriately reinforced EIFS product must be selected. In areas exposed to heavy impact or abuse, EIFS should not be used.
3. **Compatibility issues:** Each EIFS constituent component and materials that connect to the EIFS must be compatible to assure acceptable performance. This includes the lamina, sealants, joint treatments, insulation, adhesive/fastening, moisture/air/vapour barriers and substrate. The manufacturer should be consulted to verify that each component and material has been tested to be compatible.
4. **Staining:** If exposed to frequent wetting, staining by mildew growth can result. Frequent wetting can occur where the EIFS are not effectively protected from rain, or in high humidity climates where areas are not exposed to direct sunlight (north elevations, shaded areas, etc.).
5. **Sensitivity to workmanship:** As is the case with many multi-component hand applied systems, EIFS performance is sensitive to workmanship. Quality control is necessary to assure the various components are properly applied, and that they effectively work together to provide the desired performance.
6. **Long-term performance:** While a minimum 30-year service for properly designed and applied EIFS is anticipated and indicated by field performance, longer term service for many product formulations has not been determined. As with all cladding, maintenance is a prerequisite to longevity. Problems with local deterioration or moisture ingress must be dealt with promptly to achieve an acceptable service life.

EIFS DETERIORATION

When properly designed and applied, it has been demonstrated that EIFS can provide excellent performance. Some buildings with EIFS have experienced problems with deterioration and failure that has been widely publicized. However, the causes of these problems are not unique to EIFS. Similar deterioration and failures have developed at buildings employing other cladding systems. Problems experienced where EIFS have been employed have included:

1. **Leakage:** EIFS themselves are generally water resistant. When rainwater penetration occurs, the source is typically joints, interfaces or other cladding elements such as windows or roofing. Small cracks or punctures in EIFS usually do not allow significant moisture ingress, often as a result of foam plastic insulation providing moisture resistance. Large cracks or punctures that are not addressed by prompt maintenance repair can lead to water ingress.
2. **Concealed deterioration:** Where moisture has been allowed to penetrate and collect behind the EIFS, problems with deterioration have occurred. In particular, EIFS applied over paper-faced gypsum sheathing have been found with problems. The gypsum and paper facing readily deteriorates and loses strength when exposed to moisture, reducing support and adhesive attachment for the EIFS. Moisture may also lead to mold growth on the paper that requires replacement to avoid health risks. Wood based sheathings, and stud-framing are also at risk if moisture problems are allowed to develop and persist behind EIFS.
3. **Cracking:** Localized problems with cracking have developed in some EIFS applications. As many EIFS provide flexibility, which limits the risk for cracking, these problems tend to have been localized in nature. Cracks occur when joints are not provided to accommodate substrate or structure movements, when panel sizes are not adequately separated to accommodate thermal movements in the lamina, or where reinforcing mesh is not properly detailed. Maintenance repair should be completed to correct these problems if they occur.
4. **Punctures:** When employed in locations prone to abuse or impact from normal activities (and not provided with upgraded puncture resistance), EIFS become damaged. Maintenance repair can be completed to correct these problems.

CLADDING DESIGN

Cladding design requires balancing performance and durability (service life) with the available resources (money, labour, materials, time, construction sequence issues, etc.). In addition to the criteria presented in other parts of this guide, the following variables must be considered:

1. Building location (site, orientation, height, terrain, adjacent activities)
2. Climate (wind-driven rain, solar radiation, wind, ambient temperatures and relative humidity)
3. Type of building (interior temperature and relative humidity, and type of occupancy)
4. Building architectural features such as height, number of penetrations and overhangs, etc. (exposure to rain, complexity and risks related to interface details)
5. Other materials used to construct the building (structure shrinkage (wood) or settlement (concrete), the degree of protection required for organic (wood or paper faced) sheathing)
6. Workmanship and supervision (likelihood for local defects being incorporated into the work)
7. Maintenance (owner/operator tolerance and capabilities relating to effecting maintenance repair)

EIFS GLOSSARY

There are a wide variety of terms specific to the EIFS industry. A glossary of common terms may be found in the Appendix. ASTM E2110 “Standard Terminology for Exterior Insulation and Finish Systems (EIFS)” provides another reference for EIFS terms.

Chapter 2

SYSTEM SELECTION

GENERAL

The first step in designing with EIFS is to identify the basic performance characteristics required for the project. The primary considerations that lead to identifying the appropriate system(s) are: fire safety characteristics, rainwater penetration resistance, and impact resistance.

FIRE SAFETY

General

EIFS are available in a range of fire code performance classifications. Some EIFS lamina base coats are combustible, while others are non-combustible. Foam plastic insulation that is employed in most EIFS is combustible. However, in many instances, foam plastic insulation can still be used where non-combustible cladding is required. This is achieved by designing the substrate, lamina and attachment to provide fire protection to the insulation. There is also EIFS which employ mineral fibre insulation, providing further ability to comply with Building Code requirements.

When designing for non-combustible construction, the designer should identify the applicable Building Code restrictions related to the use of combustible cladding and foamed plastic insulation. Criteria, which influence these restrictions include: building height, distance from neighbouring buildings, and whether or not the building includes fire sprinklers.

Provincial Building Code fire safety requirements can differ from the National Building Code of Canada. Furthermore, building officials may apply and interpret Building Code requirements in different ways. Designers wishing to use combustible EIFS in non-combustible buildings should check EIFS manufacturer experience in the region, and confirm the requirements of the local building code official.

BEST PRACTICE NOTE: Verify Code Compliance with respect to Use of Combustible EIFS in Non-Combustible Construction

Where the building is required to be of non-combustible construction, and combustible foam plastic insulation and/or combustible base coat are to be employed, compliance with the building code interpretations of local officials should be confirmed.

BEST PRACTICE NOTE: Maintain Specification of Fire Tested Assemblies

Where a fire rated combustible EIFS is employed on non-combustible construction, the components and detailing cannot be changed from those incorporated in the test report provided by the EIFS manufacturer. Not all available assemblies are tested.

The following EIFS classifications for fire safety are based upon the 1995 edition of the National Building Code of Canada (NBC):

System Type	Insulation	Lamina Base Coat	Code Reference	Allowable Uses With Respect to Fire Safety
A	Non-Foam Plastic Insulation	Non-Combustible	3.2.3.7	These systems can be used without restriction in non-combustible construction.
B	Foam Plastic Insulation	Non-Combustible	3.2.3.7	These systems can be used in non-combustible construction on the basis of testing that demonstrates the base coat is non-combustible, and the lamina stays in place when tested according to ULC-S101 for 15 minutes. Use of this system can be restricted if limiting distances are not satisfied.
C	Foam Plastic Insulation	Combustible	3.1.5.5	These systems can be used where non-combustible construction is required on the basis of having passed the ULC-S134 fire test. Use of this system classification is limited to specific heights that vary by region and whether or not fire sprinklers are present.
D	Foam Plastic Insulation	Combustible	Parts 3 or 9	These systems are for use where combustible construction is permitted, in either Parts 3 or 9.

Non-Combustible Construction

System Type A - Compliance Through Use of Non-Combustible Base Coat and Insulation

These systems avoid fire safety risks and Building Code requirements related to foam plastic insulation. The non-combustible base coat and mineral wool insulation reduce the ability for the EIFS to contribute to the spread of fire and can generally be used without restriction.

System Type B - Compliance by Protecting with a Non-Combustible Base Coat

A means to comply with fire safety requirements is to protect the foamed plastic insulation on the exterior with a non-combustible base coat. The definition of a non-combustible material is provided in Part 1 of the Code: it must satisfy CAN/ULC-S114, “Standard Method of Test for Determination of Non-Combustibility in Building Materials”.

The NBC Sentence 3.2.3.7 (8) allows: "A foamed plastic insulation, protected by a non-combustible material, may be used on the exterior of a building greater than 3 storeys, provided that when tested according to CAN/ULC-S101-M89, "Standard Methods of Fire Endurance Tests of Building and Construction Materials" the non-combustible material will stay in place after 15 minutes. "

Systems meeting these requirements are deemed to provide adequate protection to the foamed plastic insulation. Under this Code provision, EIFS may be installed on a building of non-combustible construction of any height, provided that the limiting distances are satisfied (see Article 3.2.3.1, a series of Tables, classified by occupancy-type, and whether or not there are sprinklers).

While Code compliance is achieved, this testing may not reflect actual EIFS performance in the event of a fire. Designers wishing to further explore fire safety of a specific product should consult with the EIFS manufacturer.

System Type C - Compliance by Full Scale Fire Testing

In non-combustible construction, NBC Article 3.1.5.5 permits a combustible cladding system to be used provided it passes CAN/ULC-S134, "Standard Method of Fire Test of Exterior Wall Assemblies". This full-scale test acts to predict actual performance, and checks that fire will not continue to propagate solely because of the EIFS.

Systems passing this test are limited by the NBC to unsprinklered buildings up to 3 storeys in height, and any height if the building is sprinklered. However, some jurisdictions are more restrictive, limiting use on high-rise buildings even if sprinklers are provided.

Combustible Construction

EIFS may be applied on buildings of combustible construction without limitation, providing there is no limiting distance issue (as defined by Article 9.10.14.11). Combustible construction within the scope of Part 3 defined projects must satisfy the same conditions, specifically where Article 3.1.4.1 refers to the Part 9 requirements.

System Type D – Combustible Cladding is appropriate for use in these instances.

Protecting Interior Space from Foamed Plastic Insulation

Building Codes require foamed plastic insulation to be protected on the interior side to limit it from contributing to the fire fuel load. The 1995 edition of the National Building Code of Canada (in both Parts 3 and 9) requires that foamed plastic insulation have the equivalent of 12.7 mm (1/2 inch) gypsum as a thermal (fire) barrier when adjacent to any occupant space inside a building. Since EIFS are typically installed on wall systems that incorporate 12.7 mm (1/2 inch) gypsum, masonry, and/or concrete, this requirement is easily satisfied. (See Article 3.1.5.11 of the NBC for further information.)

Combustible Finish Coat

EIFS finishes are typically combustible. However, these are typically considered a minor combustible component so as not to be restricted by the Building Code.

RESISTANCE TO RAINWATER PENETRATION

General

Properly applied and maintained EIFS lamina generally provides acceptable resistance to rainwater penetration. In addition, systems have been developed to provide further protection against water ingress through the building envelope. These incorporate features to resist or accommodate water should it penetrate through defects that may develop during the cladding service life.

The greatest risk for water ingress occurs at joints and interfaces with the EIFS. Seals applied at these locations may be applied with localized workmanship defects. The seals are likely to fail with age and weather as they approach the end of their service life. In addition, other building envelope elements such as windows, doors and roofs may develop problems with water penetration that drains into or behind the EIFS. Providing means to collect water that may penetrate these locations and drain it to the exterior provides a significant improvement to performance. This is termed “source drainage” and is best practice whenever EIFS is applied. See Section 3.6 for discussion regarding detailing source drainage.

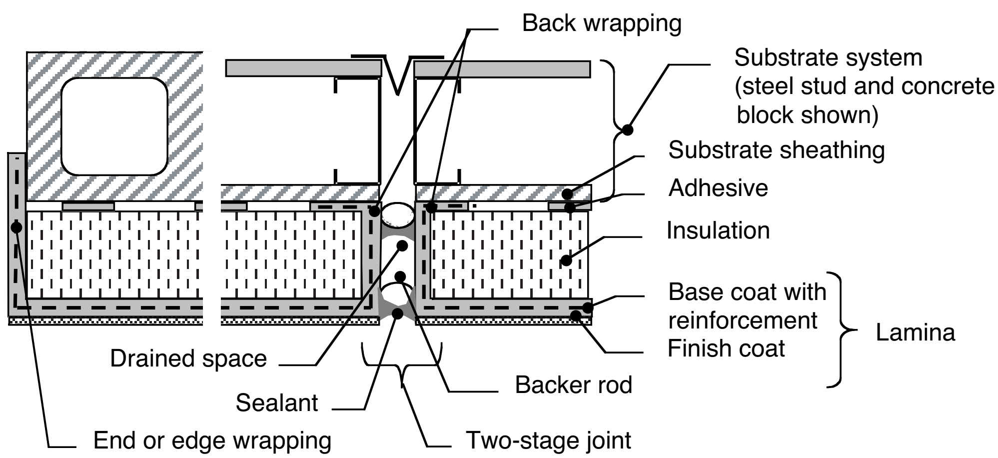


Figure 2.1: *Face sealed or perfect barrier system with drained joint*

Rainwater Management Options

a) **Face Sealed or Perfect Barrier System:**

These systems rely only upon the exterior face of the EIFS to resist rainwater penetration. They do not incorporate measures to accommodate water that might penetrate beyond the outer surface. Prompt maintenance must be implemented to mitigate the risk for water ingress. If water does penetrate the system, this system does not provide a direct path to drain it away. Moisture could become trapped within the building envelope for an extended period of time, leading to deterioration of moisture sensitive materials that may be present behind the EIFS.

BEST PRACTICE NOTE: Incorporate Source Drainage–Dual Stage Seals at Joints

Reliance on single-stage, undrained, face-sealed joints, is contrary to Best Practice. To manage water ingress through external seals when local defects occur and as they develop with age, a means to drain away penetrating water shall be provided, along with a secondary seal and flashings.

BEST PRACTICE NOTE: Provide Source Drainage Under Windows and Other Penetrations

Windows, doors and other penetrations (such as louvres, exhausts and mechanical units) can allow water to penetrate into or through the wall assembly. Flashings (or other methods of achieving “source drainage”) shall be provided beneath these penetrations to direct water that may collect beneath the penetration towards the exterior. This is fundamental where they provide protection to moisture sensitive substrates that may deteriorate in the event of leakage.

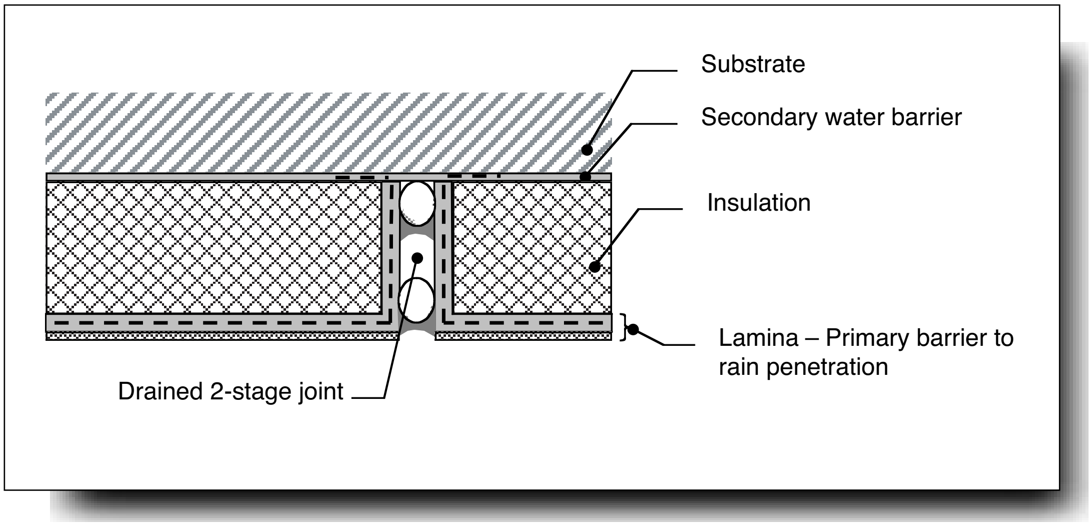


Figure 2.2: *Dual barrier system*

b) **Dual Barrier System:**

To improve the ability to tolerate periodic water ingress, a face sealed system can be provided with a second weatherproof barrier behind the EIFS insulation. This protects the substrate and resists further water penetration. Manufacturers specify various materials to provide this second barrier, including liquid-applied coatings and self-adhering membranes. Joints and interfaces between the secondary barrier and adjacent cladding elements and penetrations must be sealed and/or reinforced. To avoid potentially trapping moisture by diffusion, barrier materials should be more vapour permeable than the first vapour barrier in the total wall assembly.

No intentional drainage is provided at the second weatherproof barrier with this system. The ability for the secondary barrier to resist water ingress varies according to the product(s) employed. Moisture may still penetrate if sustained wetting were to occur as a result of major defects and/or prolonged periods prior to repair of defects.

When self-adhering elastomeric membranes are employed as the barrier, the insulation typically is mechanically fastened. The self-sealing ability of the membrane at the fastener penetrations is relied upon. Continuous liquid-applied coatings should provide a good secondary weather barrier, but typically require special reinforcing and detailing at joints.

Building paper and sheet-applied sheathing wraps have also been employed as a secondary barrier. However, these tend to permit water ingress if exposed to sustained wetting. Punctures from nails or staples used to apply these materials are also vulnerable to water ingress. For these reasons, the best practice is not to employ these materials within dual barrier systems (but these are appropriate for use in drained systems).

BEST PRACTICE NOTE: Provide a Dual Barrier System Over Moisture Sensitive Substrates

When moisture sensitive materials, such as steel stud or wood framed walls and gypsum or wood based sheathing is used behind the EIFS, a dual barrier system should be employed. The weather resistive barrier applied to provide secondary protection must be a system compatible and approved by the EIFS manufacturer.

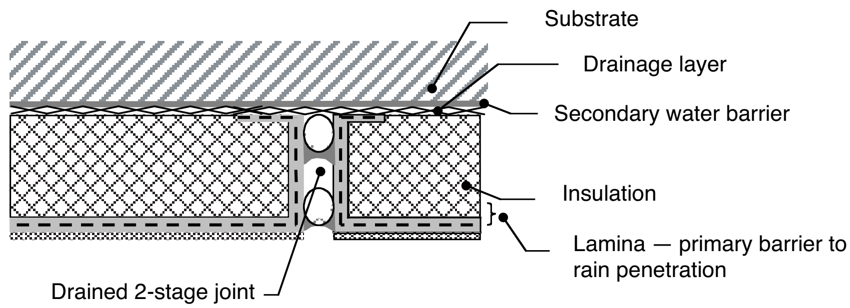


Figure 2.3: *Drained system*

c) **Drained System:**

To improve the ability for the second weather barrier to resist water ingress, a drained system incorporates a visible means to collect and drain the water to the exterior. Drainage avoids the risk of water accumulation within the system. This reduces the risk of prolonged wetting, or risks from water pressure being applied to the secondary barrier as a result of accumulating water.

The drainage improvement makes building paper or sheathing wraps suitable for use as a secondary barrier within these systems. However, waterproof elastomeric membranes would be expected to provide greater resistance to water ingress and could also be designed to provide air and/or vapour barrier functions (See section 3.4).

Drainage is generally accomplished by providing a drainage layer (such as a geotextile), slots/grooves or vertical ribbons of adhesive behind the EIFS insulation. The drainage system must be carefully detailed and installed at interfaces to assure water is properly managed to drain to the exterior.

BEST PRACTICE NOTE: Provide Drainage with Building Paper or Sheathing Wrap Barriers

Building paper and sheet applied sheathing wraps should not be employed as a secondary barrier in dual barrier systems. These tend to permit water ingress if exposed to sustained wetting that may arise as a result of the lack of drainage in these systems. Punctures from nails or staples used to apply these materials and the mechanical fastners required for the insulation are also vulnerable to water ingress if exposed to accumulating water. Where building paper or sheathing wraps are to act as the secondary barrier, drainage should be provided.

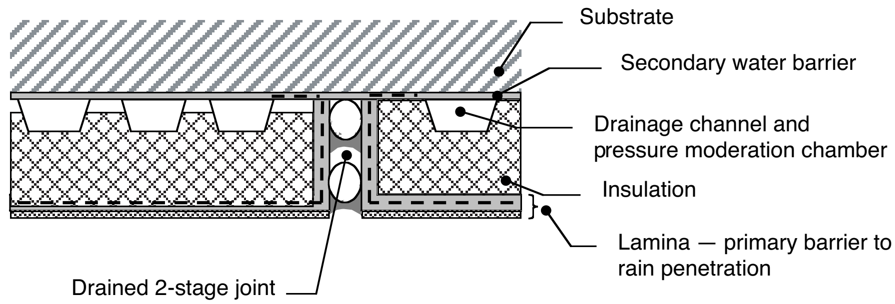


Figure 2.4: *Drained and pressure-moderated system*

d) **Drained and Pressure Moderated System:**

To further improve the performance of a drained system, EIFS are available that apply the "rain screen" principle. The drainage system is sized and vented to the exterior to assure prompt pressure equalization in response to wind pressures. This reduces the risk for wind pressures developing across the exterior lamina, limiting this as a force that might drive water through exterior defects in the first instance.

BEST PRACTICE NOTE: Incorporate Drainage in High Exposure and Difficult to Maintain Walls

For exposed walls with high rain loads and/or difficult access, best practice is to use EIFS that incorporates internal drainage. An internal weather barrier applied behind the insulation that resists bulk water penetration coupled with provisions to collect and drain away water that penetrates exterior surfaces makes the cladding less dependent upon the material qualities, workmanship, and maintenance. Moisture which may penetrate during periods when exterior defects develop, and prior to maintenance being planned and implemented, can be resisted and accommodated by the drainage system without allowing leakage and ensuing deterioration of more vulnerable building components inwards of the moisture barrier.

Performance Considerations

Selecting a system appropriate to a specific project requires a designer to evaluate the risks for water ingress and associated deterioration problems, and the ability or likelihood for inspection and repair to be completed by the owner. The following should be considered and is summarized in Table 2.1:

a) **Moisture Susceptible Substrate:**

Barrier systems present a low risk for developing moisture deterioration problems if applied over masonry or concrete substrates. This is not the case with framed wall construction. When EIFS are applied over a substrate vulnerable to moisture deterioration, best practice is to incorporate a system with a dual barrier as a minimum. Moisture susceptible substrates include steel or wood framed wall construction. Paper faced gypsum sheathing is not a recommended substrate.

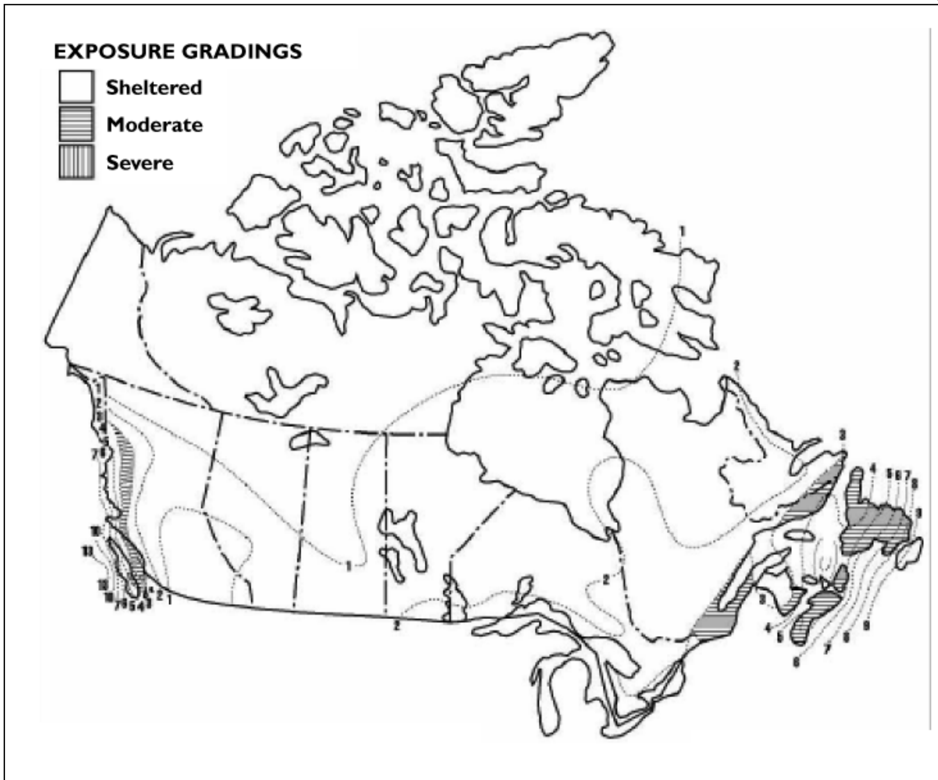


Figure 2.5: *Canada rainfall chart*

b) **Climate:**

With increased exposure to rain, the risk for water ingress and related deterioration increases. Coastal climates that experience more than 1.5 m (60 in.) of annual rain present a particular risk. In these regions, best practice would be to provide an EIFS incorporating drainage as a minimum.

c) **Cladding Exposure:**

Roof or parapet overhangs can reduce the extent of rainfall that contacts the building envelope, decreasing the frequency of wetting and risk for water ingress.

Overhangs of about 300 mm (1 ft.) to 600 mm (2 ft.) on low-rise buildings (1 to 3 storeys in height) can be expected to have a less severe exposure

Increasing building height augments the exposure. Higher buildings are exposed to higher wind speeds. The ability for overhangs to effectively provide shelter decreases with their height above the wall.

d) **Building Owner Considerations:**

For buildings over 3 storeys or about 6 m (19.69 ft.) in height, the ability to inspect and maintain the exterior seals and EIFS surface becomes difficult. Defects, which may develop at these locations, are not as likely to be observed and promptly corrected. Unless there is a willingness and ability to accept and overcome these difficulties, best practice would be to apply a drained or pressure moderated system in these instances.

e) **Regulatory and Professional Liability Insurance Requirements:**

Some jurisdictions and professional liability insurers have requirements related to the level of protection that must be provided by EIFS. The protection offered by a pressure moderated system may be necessary to comply with these requirements.

Table 2.1: *Recommended rain control strategies*

System	Best Practice Recommendation
Source drainage at joints	• Incorporate for all applications
Face sealed or perfect barrier EIFS	• Not to be applied over moisture sensitive substrates such as steel or wood framed walls, or wood or gypsum sheathing. • Appropriate only over mass substrates such as masonry or concrete block.
Dual barrier EIFS	• Minimum protection over moisture sensitive substrates such as steel stud or wood framed walls, or wood based or gypsum sheathing. • Appropriate for 1 to 3 storey heights protected by minimum 300 mm (1 ft.) to 600 mm (2 ft.) overhang. • Not appropriate for coastal climates with more than 1.5 m (60 in.) of rainfall. • Not recommended for cladding over 3 stories or 6 m (18 ft.) in height unless difficulties inspecting and maintaining can be tolerated by the owner.
Drained EIFS	• Best practice protection in all instances where accommodating water ingress through the EIFS is desired. • A minimum requirement in coastal climates with more than 1.5 m (60 in.) of rainfall.
Pressure	• Maximum protection against water ingress through the EIFS.
Moderated EIFS	• Required for high building exposures in coastal climates by some jurisdictions and professional liability insurers.

IMPACT RESISTANCE

The expected impact and abuse that the EIFS will be exposed to needs to be evaluated and addressed by the design. The loads to be considered include:

1. ***At-grade:*** Activities near grade can lead to the EIFS being hit by people, bicycles, lawnmowers, gardening tools, snow removal equipment, shopping carts, garbage bins, automobiles or ladders. The design can reduce these loads by incorporating features such as bollards, curbs, or planters. These can provide barriers that separate the EIFS from the impact risk.
2. ***Balconies and terraces:*** Activities in these areas can also increase impact loads on the EIFS. People, chairs, barbeques or wheeled carts may impact the EIFS.
3. ***Projectiles:*** Hard objects may be thrown at EIFS. This is a particular concern in areas where children play, such as schoolyards, sports areas and playgrounds. Wind-borne projectiles can also cause damage during severe weather.
4. ***Suspended maintenance activities:*** Cables and ropes used by suspended access equipment can bear on locations where EIFS includes projections such as sills, cornice or ledge details. These details should be avoided or provided with special protection or support. Persons accessing the exterior cladding for inspection or maintenance by bosun’s chair or suspended stages can also damage EIFS. While they can be minimal and adequately managed by maintenance, upgrading should be considered to improve durability.

Improved impact resistance is achieved by providing heavier and/or additional layers of reinforcing mesh, as well as thickening the base coat. The manufacturer should be consulted for system-specific methods.

In instances where abuse or persistent and high impact loads are likely, EIFS may not be an appropriate cladding choice. In these instances, an alternate thick cladding such as concrete or masonry may be more appropriate. In general, EIFS should not be used immediately adjacent to walkways at schools and shopping malls, or at loading docks.

BEST PRACTICE NOTE: Design to Limit Impact Damage

Areas that are expected to see increased impact loads should be identified and specifically addressed by the design. These areas include those: adjacent to pedestrian walkways; near locations where projectiles may be thrown against the EIFS such as sporting areas, or school playgrounds; adjacent to where vehicles travel including loading docks, and; where suspended access equipment might bear on the cladding. At these areas, the design should incorporate measures to prevent the impact, incorporate an EIFS with a higher impact resistance, and/or substitute an alternate, more impact resistant cladding at damage prone locations.

GENERAL

Once EIFS with the desired performance characteristics has been selected, cladding design must address other components and details required for the EIFS to perform as intended and to obtain acceptable building envelope performance. Design categories that must be addressed include: the substrate, thermal insulation, air and vapour control, movement joints, interfaces, and joint seals.

Design drawings and/or specifications should provide guidance regarding EIFS joints and interfaces with other building envelope elements, including:

- roofs;
- at-grade;
- windows;
- other cladding;
- balconies;
- penetrations such as signs or guard anchors;
- mechanical exhausts or louvers. The details should clearly indicate the junctions and seals associated with the primary and secondary water barriers and air and vapour barriers. For large or complicated projects involving a drained or pressure moderated system, shop drawings should be added as a contract requirement to allow large scale design details and incorporate the specific features and requirements of the EIFS to be applied. However, shop drawings should not be required just to avoid completing the design; they are only intended to delineate the propriety of different manufacturers' systems as they relate to the project.

A mock-up should be completed prior to proceeding with EIFS application to confirm that the design details can be implemented, and to provide an opportunity to resolve any difficulties that may be encountered upon application.

BEST PRACTICE NOTE: Complete an EIFS Mock-Up

Prior to proceeding with the general EIFS application, a mock-up should be completed and tested to review the EIFS as-built details. This should involve typical interface details (junctions with other cladding elements, penetrations such as windows, etc.) and the colour(s) and texture(s).

SUBSTRATE

a) **Back-Up Structure**

The back-up structure to which the EIFS is applied must possess adequate strength and rigidity to support the cladding and resist lateral loads (typically wind) as specified by the applicable Building Code, as well as any other structural loads that may arise from the design. It must be adequately reinforced around openings such as windows and doors. Unique details such as parapets and balustrades must be accounted for.

Movements that arise from structure deflection, thermal movements, shrinkage or creep should be identified. The back-up wall should be provided with joints wide enough to accommodate these movements. The ability for the building envelope to accommodate the movements that occur at these locations must also be considered.

Where applicable, prescriptive Building Code requirements (such as NBC Part 9 requirements for wood framed walls) can be relied upon to help design a suitable back-up substrate to receive the EIFS.

Structural engineering design can be used to establish substrate details appropriate for a specific project. However, this is typically not included within the mandate of the building structural designer. Attention is required to assure the design responsibility is assigned to a competent professional. A specialist could be retained to establish the structural design for incorporating within the design documents. Alternatively, the responsibility for design and submitting shop drawings can be assigned to the builder.

For pre-fabricated or engineered stud wall assemblies, shop drawings should be prepared to design and detail the back-up structure. These drawings should be sealed by a Professional Engineer, and must indicate the design wind loads and deflection limits. A qualified Professional Engineer should also check the shop drawings as part of the design review.

The Canadian Sheet Steel Building Institute “Lightweight Steel Framing Design Manual” (CSSBI 51M), and steel stud manufacturer design tables provide valuable information to assist in designing steel stud back-up walls. The framing system should not rely upon bracing provided by sheathing boards.

For substrate systems constructed with a cold-formed galvanized steel stud frame, minimum 18-gauge studs should be employed. This is consistent with best practice recommendations provided by the steel stud manufacturing and brick cladding industries. This minimum thickness improves confidence that strength and stiffness requirements will be achieved, results in a framing system which can be more effectively and reliably connected by either screw fastening or welding, and provides more robust members which can better tolerate problems with localized corrosion damage without significant structural weakening. If welded connections are employed, welds must be protected by zinc rich coating.

To provide adequate resistance to corrosion in the presence of accidental or periodic exposure to moisture, all steel framing forming part of the exterior cladding back-up should be hot dipped galvanized in conformance with CAN/CSA G164 – "Hot Dip Galvanizing of Irregularly Shaped Articles".

The substrate rigidity/stiffness required to limit the risk of EIFS cracking varies depending on the specific products. Manufacturers typically specify maximum permissible deflections as a ratio of the length of the span between supports ("L") based on the lamina flexibility. In general terms, the range of design criteria which is required by manufacturers can be categorized as follows:

Substrate Deflection Limit/ Stiffness	Applicability
L/240	Minimum recommended stiffness for flexible EIFS
L/360 to L/720	Required for more rigid EIFS

BEST PRACTICE NOTE: Minimum 18-Gauge Hot Dipped Steel Stud Framing

For back-up systems constructed with a cold-formed steel stud frame, minimum 18-gauge thickness and hot dip galvanizing corrosion protection should be employed. This minimum thickness improves confidence in meeting strength and stiffness requirements, results in a framing system which can be more effectively connected by screw fastening or welding, and provides more robust members which can better tolerate problems with localized corrosion damage without significant structural weakening. If welded connections are employed, welds must be protected by zinc rich coating.

b) Sheathing Boards as an EIFS Substrate

The substrate to which the EIFS is applied must meet the criteria set by the manufacturer. The surface must be suitable for receiving air or vapour barriers, adhesives and/or the fasteners used by the particular system. Acceptable substrates include: concrete, masonry, non-paper faced gypsum based sheathing boards, cement based sheathing boards, and wood based sheathing boards. Where the EIFS is adhered or secured to a sheathing board substrate, the sheathing board must be designed to resist wind loads. This requires proper fastener selection and spacing.

Reduced risk of deterioration and improved durability can be achieved if the EIFS substrate does not contain elements that are vulnerable to softening, corrosion and/or rot when exposed to wetting.

The substrate can often be exposed to rain wetting during construction (depending on building envelope sequencing). Wetting of the substrate may also occur at localized areas during service as a result of rainwater penetration through defects that are not promptly addressed by maintenance repair. (This will depend upon the selected EIFS, the quality of a secondary barrier if provided, and the effectiveness of details to provide source drainage). Interior sources of wetting can also lead to wetting of exterior wall components. These can include air or vapour barrier defects (see Section 3.4), plumbing leaks or air conditioning condensate leakage.

While many of these risks for moisture contacting the EIFS substrate are not related to the EIFS performance, substrate and EIFS replacement may become necessary if the substrate cannot tolerate these loads and deteriorates.

Paper faced gypsum board sheathing can readily lose structural integrity. In addition, mold can grow on paper facings that can present a health risk to building occupants. To avoid these risks and improve durability, best practice is to avoid paper faced gypsum sheathing as an EIFS substrate. Where gypsum sheathing is used, glass fibre faced moisture resistant gypsum board should be employed.

Wood based sheathings tend to better resist isolated, periodic wetting events. Plywood sheathing has been found to provide improved durability as compared with oriented strand board (OSB) sheathing. However, both are vulnerable to deterioration and mold growth if exposed to sustained wetting arising from un-repaired defect(s).

If the use of a moisture vulnerable substrate is still desired despite these risks, best practice would be to apply a dual barrier system that incorporates an appropriate secondary weather barrier between the EIFS and substrate. A further upgrade is to include drainage between the EIFS and secondary barrier.

Sheathing fasteners should be corrosion resistant to resist loss of strength in the event of wetting. The appropriate degree of corrosion protection will vary according to the expected moisture loads to which they may be exposed, and durability requirements. Fasteners should be galvanized as a minimum. If the design anticipates that the fasteners will be regularly exposed to humidity or moisture (see Section 3.4) that could sustain corrosion, stainless steel fasteners should be considered.

c) **Masonry or Mass Concrete as an EIFS Substrate**

Properly constructed masonry or mass concrete can provide a suitable substrate for EIFS. These materials tend to be less vulnerable to moisture related deterioration as compared with framed wall assemblies with sheathing boards. However, finished masonry or concrete surfaces can be more vulnerable to surface irregularities with deviations in workmanship. Adequate adhesion to these surfaces can be at risk of their becoming contaminated with dust or dirt. Attention must also be given to check that any form release agents, sealers or curing compounds are compatible with the EIFS secondary barrier or adhesive materials.

BEST PRACTICE NOTE: Engineered Shop Drawings for Framed Walls

For pre-fabricated or engineered stud wall assemblies where prescriptive (Part 9) Building Code requirements are not applied, shop drawings should be prepared to design and detail the back-up structure. These drawings should be sealed by a Professional Engineer, and must indicate the design wind loads and deflection limits. This is intended to assure the back-up substrate has been designed to meet the structural strength and rigidity requirements required by the Building Code and the selected EIFS manufacturer. The drawings should include:

- details for securement to the structure;
- deflection details (if required), including the maximum movement to be accommodated;
- reinforcing at windows and doors;
- unique details including parapets and balustrades;
- sheathing type, and;
- sheathing fastening requirements (fastener type, spacing and pattern). A qualified Professional Engineer should also check the shop drawings as part of the design review.

BEST PRACTICE NOTE: Provide Corrosion Resistant Sheathing Board Fasteners

Sheathing board fasteners should be corrosion resistant to assure long-term durability even if it is expected that there will only be accidental or periodic exposure to moisture. Unless a protective vapour barrier coating or membrane is applied over the sheathing and fasteners, galvanizing protection should be provided to steel fasteners as a minimum. A further upgrade to stainless steel screws may be appropriate, particularly if the design anticipates periodic exposure to moisture and/or long-term durability is desired.

BEST PRACTICE NOTE: Do Not Apply EIFS to Paper Faced Gypsum Sheathing

Paper faced gypsum board sheathing can readily deteriorate if accidentally exposed to moisture either during construction, or as a result of leakage events which may develop during service. These leakage events could arise from penetration through the various exterior cladding components, or interior sources such as plumbing leaks. With wetting, the gypsum core can soften, the EIFS adhered to the paper facing may lose structural attachment, and/or mold may develop on the paper, requiring removal and replacement of the EIFS and sheathing board. To improve durability, only non-paper faced sheathing boards should be employed.

INSULATION – THERMAL RESISTANCE

The insulation provided within the building envelope controls heat flow. This impacts building energy consumption and associated pollution related to power generation. Minimum thermal insulation requirements must be met as may be specified by applicable Building or Energy Codes, and as assumed in the heating and cooling systems design. EIFS provides the opportunity to readily incorporate a continuous layer of insulation at the exterior to meet some or all of these requirements.

The insulation incorporated within the EIFS must be compatible with and approved by the manufacturer as it forms an integral part of the system. EIFS manufacturers require that insulation produced for use in their systems provide:

- physical properties to perform within the system, including density, stability, dimensional tolerances, etc.
- adequate bond to adhesives and base coats;
- adequate strength to resist wind and impact loads; and
- sufficient flexibility (a low enough shear stiffness) to act as a buffer for movement between the substrate and the lamina, providing an ability for the system to accommodate movements without cracking.

There can be limitations in the thickness of insulation that may be provided within the EIFS. When using systems required to meet Building Code fire safety requirements (Types B or C), the insulation may not exceed the maximum tested thickness. As maximum tested limits vary between 50 mm (2 in.) to 130 mm (5.5 in.), the manufacturer must be consulted to identify the limit for a particular system.

When insulation is required to supplement that provided by the EIFS, the design must properly account for the risks of vapour condensing within the cladding assembly (see Section 3.4).

Where EIFS insulation or lamina is mechanically fastened (rather than adhered), fastener durability with respect to moisture exposure must be considered. The moisture loads to which the fasteners are exposed to vary along the fastener length. Fastener wetting may occur if moisture penetrates or accumulates within or behind the system. Increased moisture or humidity levels that could sustain long-term corrosion may arise as a result of thermal bridging which occurs at the fasteners.

BEST PRACTICE NOTE: Provide Non-Corroding Mechanical Fasteners Through Insulation

Mechanical fasteners for lamina or insulation attachment can become exposed to moisture or increased humidity that can lead to corrosion and loss of support. While hot dipped galvanizing is the minimum protection that should be provided, best practice is to use non-corroding fasteners such as stainless steel to secure the insulation.

AIR AND VAPOUR CONTROL

a) **Vapour Control**

The wall assembly must be designed so that vapour does not condense within the assembly and lead to deterioration of moisture sensitive materials. Indoor water vapour tends to drive through the envelope towards the exterior during periods of cold weather. Moisture in the exterior air tends to drive towards the interior during hot and humid weather, particularly if the building interior is cooled. If the position and selection of vapour barrier(s) and insulation is inadequate, humidity can increase and moisture may condense and collect at cool elements. If this occurs on moisture susceptible materials, deterioration or mold growth could occur. The design should consider this risk and the potential impact this may have on the long-term durability and service life provided by the components forming the wall assembly.

The interior winter relative humidity load must be determined at the design stage, and should be controlled by the mechanical ventilation system. If winter relative humidities exceed 40 per cent, extra care should be applied to the design and construction quality control to address the increased risks pertaining to the high moisture loads.

A traditional polyethylene or other type of vapour barrier applied behind the interior finishes is often not an essential component of a wall assembly clad with EIFS, except where stud cavity insulation is required.

Where the cladding insulation is provided solely by the EIFS, the risk for deterioration related to entrapped condensation is reduced. In this instance, the substrate is well protected by maintaining it close to interior humidity and temperature conditions, and the dew point where moisture condenses and accumulates within the cladding falls within the EIFS. As long as a vapour barrier is provided on the EIFS substrate, the quantity of moisture that can penetrate and accumulate within the insulation should be small and be able to evaporate out of the system.

Where additional insulation is provided inside of the EIFS, there can be increased risks for moisture to accumulate within the cladding. During winter conditions, the additional insulation prevents warming of the exterior EIFS substrate and may lead to condensation-related wetting of the substrate. Limiting the quantity of supplemental insulation limits substrate cooling to avoid this risk. Hygrothermal analysis is required to determine the extent to which supplementary insulation can be provided, and requirements for vapour barriers.

For small quantities of supplemental insulation, a static hygrothermal analysis may be employed to confirm that the dew point is not moved away from the EIFS, causing it to fall near or within moisture sensitive substrate components.

If greater amounts of supplemental insulation are desired, a dynamic hygrothermal analysis should be completed. A computer based analysis accounts for local weather patterns and can estimate the extent to which moisture and vapour penetrate from both interior and exterior sources. The extent to which moisture has accumulated within the cladding during each season is estimated. The humidity or moisture accumulation at sensitive components and the time it is present before evaporating can be examined to predict whether deterioration is likely, or whether protective measures (such as coatings, or zinc based corrosion protection) can be relied upon to achieve acceptable durability. This analysis should be conducted and interpreted by an experienced professional who understands the limitations and practical application of the results.

BEST PRACTICE NOTE: Design Insulation Supplementing EIFS to Avoid Concealed Moisture

If insulation is required to supplement that provided by the EIFS, the design must properly account for the risks of vapour condensing within the wall assembly. A hygrothermal analysis should be completed to confirm the amounts of insulation as well as the quality and position of vapour barriers(s) are adequate.

b) **Air Barrier**

A continuous and effective air barrier system is a required part of the building envelope assembly. This means identifying planes (or multiple planes) of air-tight materials, and providing effective seals at penetrations and interfaces. If an adequate air barrier is not achieved, bulk air movement through the cladding can lead to significant moisture accumulation and associated deterioration.

The plane(s) of air tightness may be located anywhere within the wall assembly. The ideal location considers construction sequencing, the ability to achieve effective air seals at joints and interfaces, and the risk for the air barrier deteriorating or becoming damaged during construction or in service. For EIFS, the two most common locations are at the interior drywall and/or at the substrate. The air pressures/wind loads applied to the air barrier must be considered by the design.

To make interior gypsum board (drywall) an effective air barrier, careful detailing and sealing is necessary to maintain continuity. Details that require special attention include:

- terminations at floors/ceilings, intersecting walls, structural elements, and windows, and;
- penetrations such as electrical outlets or mechanical exhausts or air intakes.

The substrate sheathing can be used to provide an air barrier plane which is easier to detail and seal to adjacent components prior to EIFS application. The number of penetrations to seal are reduced, and continuity across floors and interior partition walls is more easily achieved. However, where source drainage beneath penetrations such as window and door sills is desired, achieving air seals without obstructing drainage requires attention. The air barrier planes in this instance must extend around, and seal to the inside surface of the penetrating component.

Tests show that sheathing boards can provide acceptable resistance to air leakage if joints and interfaces are sealed. This is typically achieved using adhesive tapes or in combination with a continuously adhered weather barrier applied as part of the EIFS. Stapled or nailed sheet weather barriers applied over the sheathing may provide air leakage resistance if continuously applied and sealed. However, these sheet materials are not an air barrier unto themselves. They rely upon tight contact with the sheathing and foam plastic insulation to provide support and help seal fastener penetrations.

If the air barrier surface is exposed to wetting, the pressure drop which occurs when resisting wind can act to draw water in through defects which might otherwise not cause significant problems. Providing an air barrier that is separate from the secondary weather barrier may therefore further reduce the risk for water ingress. This would be a particularly benefit where fastener perforated sheathing wraps are employed.

In a face-sealed or perfect barrier EIFS, the lamina/insulation and associated seals are inherently airtight. However, to limit the potential for water being drawn through defects, best practice is to provide a separate air barrier plane inside of the EIFS.

BEST PRACTICE NOTE: ***Provide an Independent Air Barrier***

An air barrier independent of the EIFS lamina and exterior seals should be provided to limit air leakage through the cladding, and reduce air pressures acting on exterior surfaces which may act to draw water inwards. The air barrier plane can be provided by a continuously sealed surface at the substrate, or towards the interior of the cladding. Continuous and durable seals must be provided at penetrations and interfaces, including at windows, doors, exhaust vents, floors, intersecting or penetrating interior walls, roofs and foundations.

MOVEMENT JOINTS AND CRACK CONTROL

In addition to assuring appropriate substrate selection, adequate jointing must be provided to accommodate movements, which occur without lamina cracking. These movements include those normally expected to arise with thermal expansion of the EIFS and substrate deflection.

a) **System Movements**

The EIFS lamina will expand and contract with changes in temperature. The linear thermal coefficient of expansion for complete EIFS panels varies depending on the product. Laboratory testing has determined that the coefficient typically ranges between 0.008 to 0.015 mm/°C/m.

To control and accommodate movements without cracking, manufacturers specify maximum EIFS panel sizes and joint details specific to each system. Manufacturers also specify the reinforcement and application details necessary to allow the system to provide adequate crack resistance. These can include:

- staggering and offsetting insulation joints;
- eliminating joints in the insulation and substrate at openings and aesthetic joints, and;
- providing additional diagonal reinforcing at window corners.

If a joint is required within EIFS to accommodate movement, a reveal or vee groove in the EIFS surface is not recommended for this purpose. All movement joints in EIFS should be designed and constructed with clear joints that accommodate movement without binding, stressing or deforming of the EIFS, in conformance with manufacturer requirements.

BEST PRACTICE NOTE: Do Not Rely on Reveals or Vee Grooves as Movement Joints

If a joint is required within EIFS to accommodate movement, a reveal or vee groove in the EIFS surface is not recommended for this purpose. All movement joints in EIFS should be designed and constructed with clear joints that accommodate movement without binding, stressing or deforming of the EIFS, in conformance with manufacturer requirements.

b) **Substrate Movements**

Additional movements caused by the structure or substrate can also occur and may not be accounted for by the manufacturer specifications. Locations where these movements occur must be identified and joints added to limit the risk for cracking. Locations that require attention include:

- where expansion joints are provided in the structure or substrate;
- where the substrate changes from one construction type to another;
- where structure deflection and shrinkage (concrete creep or wood shrinkage) occurs, such as at joists, beams or suspended floors; and
- where support conditions change, such as where panels return onto terraces, penthouses or balconies.

Panel joints should be aligned with the anticipated movement locations. The joint widths must be wide enough to accommodate the expected movement, and to allow durable joint seals to be installed (see Section 3.7 – Joint Seals).

In considering the maximum panel sizes specified by the manufacturer and the locations where substrate movements are likely, the designer should identify locations where the joints are to be provided. These should be identified on elevations provided in the design drawings and/or the shop drawings.

BEST PRACTICE NOTE: Design Joints Where Movements are Anticipated

Joints should be aligned at locations where movements are expected to occur and so as to divide the panels into sizes that do not exceed the manufacturer's specifications. The joint locations should be drawn on elevations provided in the design and/or shop drawings.

INTERFACES

a) **Interface Details Requiring Attention**

The greatest risk for water ingress problems relates to the interface between EIFS and other elements. Careful detailing is necessary at the design stage to assure that weather and air seals, and drainage are achieved at these locations.

The design drawings and/or the shop drawings should provide details of EIFS interfaces with the following elements:

- Foundation Walls
- Window and door sills
- Window and door heads
- Window and door jambs
- Other dissimilar cladding elements
- Exhaust box penetrations
- Other penetrations
- At intersecting balustrades and parapets
- Below roofing (parapets, overhangs)
- Above roofing (penthouses or returning walls)

b) **Drainage at Interface Details**

A single seal provided at the exterior surface between the EIFS and adjacent components is expected to eventually develop defects, which can allow water ingress. To accommodate this water ingress without leading to leakage or deterioration, best practice is to incorporate drained joints. This involves providing a means to drain away water, which may accidentally penetrate external seals at some point in the cladding service life.

To limit the risk for water, infiltration at joints, provide water resistant barriers, flashings or secondary seals behind the exterior seal. Drainage gaps and positively sloped surfaces are required to assure water is directed towards the exterior. Pressure equalization of the internal drainage system with an effective air barrier and venting can also help reduce the amount of water which penetrates the joints.

Specific comments regarding achieving source drainage are as follows:

i) Where sealant is employed as the back-up secondary seal, the same attention to detail as is required for the exterior seals should be applied (see Section 3.7). The sealant will be tooled to extend and flash water within the joint to drain holes provided in the exterior seal.

ii) Where there are corresponding joints in the substrate, the secondary seal can be provided using sealant or self-adhering flexible waterproofing.

iii) Where provided, a dual barrier can be relied upon to resist further water ingress provided it is continuously applied, without penetration, and provided with a continuous and clear drainage cavity, which is open to drain at the lower level.

iv) To accommodate the potential for water leakage through windows and doors, sills should be provided with waterproofing or pan flashing that extends behind the window/door, with upturns at the perimeters and slope to direct water to the exterior.

v) Joints should be directed and drained to the exterior at a frequency of about every 3 to 6 m (9.84 to 19.69 ft.) vertically, and 3 m (9.84 ft.) horizontally.

vi) Drainage openings should have a minimum dimension of 6 mm (1/4 inch) to allow water to escape.

vii) Horizontal joints should be compartmented at corners to prevent water being carried through the joint by wind wash.

An example of drainage where sealant is provided as the back-up secondary seal is shown in Figure 3.1.

A 20 mm wide joint requires a 25mm (min) backer rod with 10 mm of sealant. Drainage space required, 10 mm. Total joint depth will be two sealant joints (25 + 10) + space = 80 mm. This is not suitable for thin eps on the exterior. Peel and stick membrane seals will be preferable. Also, two-stage joints are difficult to inspect but membrane seals can be checked prior to the installation of the EIFS.

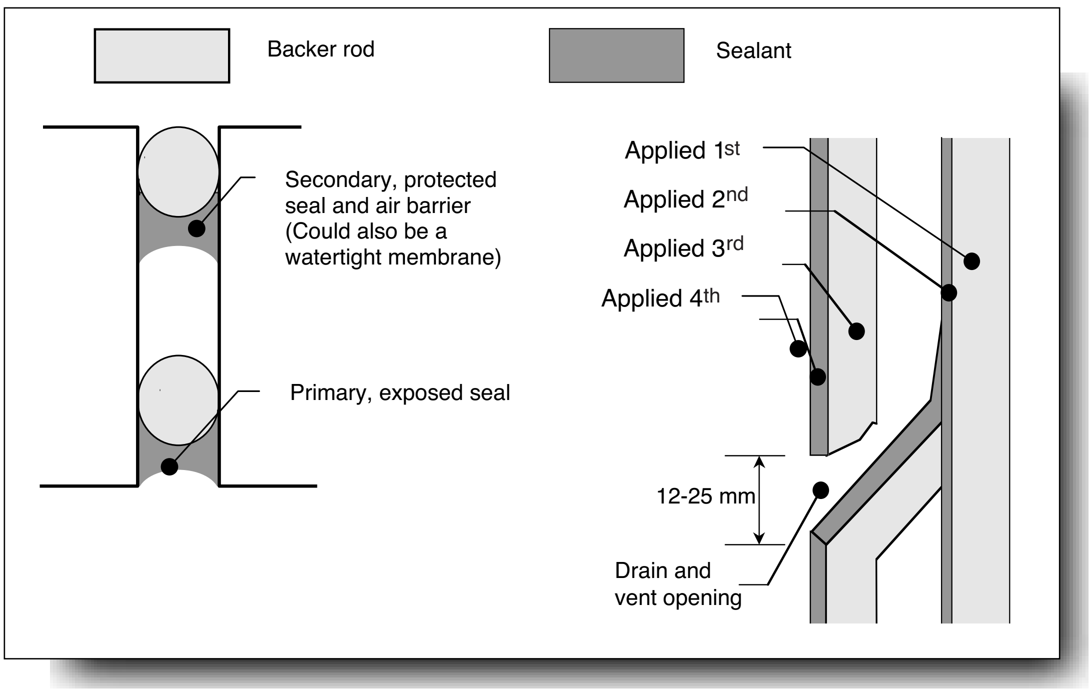


Figure 3.1: *Joint drainage*

BEST PRACTICE NOTE: Complete Mock-Up Water Testing at Window and Door Interface Details

Water testing at window/door interfaces with the EIFS should be completed to check that the as-built construction has provided an adequately water resistant assembly. The testing should involve applying, as a minimum, the window design pressure across the cladding assembly. This should be completed prior to the installation of interior finishes or stud space insulation to allow checking for ingress into the wall cavity.

JOINT SEALS

Achieving acceptable joint seals in EIFS assemblies requires strict adherence to standard industry practices with respect to sizing to limit strain, providing a proper sealant profile, and employing proper backing.

However, there are also additional requirements that need to be considered when sealing to EIFS lamina:

a) **EIFS strength:** The strength of the insulation, the lamina, and the base coat adhesion to the insulation can be exceeded if the joint seal is not sufficiently flexible and generates too high a stress when stretched open. This can tear the EIFS lamina, creating a breach where water ingress can occur.

b) **Chemical adhesion:** Chemical bond between the lamina and sealant is necessary to achieve adequate adhesion. The sealant and lamina chemistries must be compatible to assure adequate bond. As sealant and lamina chemistries vary, acceptable adhesion cannot be assumed for a specific sealant or class of sealant material.

c) **Lamina surface strength:** The lamina surface strength can also be low, allowing sealant to pull away adhesively.

d) **Finish coat:** If sealant is adhered to the finish coat, adhesive failure may arise. This might be caused by the sealant developing poor bond to the finish (in some instances as a result of additives in the finish intended to avoid water absorption or dirt pick-up). The finish adhesion to the base coat may be weaker than the sealant adhesion. The finish can also soften or re-emulsify when exposed to wetting. To avoid the finish interfering with the sealant adhesion in these ways, manufacturers typically require that the finish materials be omitted from the sealant adhesive surface.

e) **Rough surfaces:** When sealing to rough surfaces, pores and voids may arise through the sealant adhesive surface. These can lead to water ingress problems, particularly if a face sealed system is employed. Exposed aggregate finishes can pose a particular problem.

Primers are generally required to promote acceptable sealant adhesion. In high humidity applications, primers are typically required to prevent surface moisture from interfering with the sealant adhesion.

To check the adequacy of a specific sealant and associated primer to a specific EIFS, a test procedure has been developed: ASTM C1382 - “Test Method for Determining Tensile Adhesion Properties of Sealants When Used in Exterior Insulation and Finish Systems (EIFS) Joints”. This standard involves measuring the sealant load applied to the lamina at varying degrees of elongation after having undergone varying environmental conditions:

- dry and at room temperature;
- immersed in water for 7 days;
- freezing for 24 hours;
- heat conditioned for 24 hours, and;
- condensation and UV exposure.

It is important to note that this standard does not provide a pass or fail criteria for the sealant/EIFS application. It is incumbent upon the designer, manufacturer and/or contractor to interpret the test results and design the sealant joints appropriately.

Construction methods and sequencing can make it difficult to omit the finish coat at the sealant bond line, or to apply the sealant prior to the finish being applied. Some manufacturers may permit sealing directly to the finish. This is usually limited to specific lower risk joint seals that are not expected to be exposed to significant wetting or large movements. An example is joints around punched windows or sealants around exhaust penetrations. To check the suitability of these seals, further ASTM C1382 test results that involve sealant adhesion to the finish should be available and evaluated.

Industry practice for sealant design is to provide joint widths no less than 4 times the anticipated movement. This limits strain to 25 per cent. To limit risk of excessive loading of the lamina or underlying insulation, the maximum ASTM C1382 test results should not exceed 100 kPa (15 psi) at 25 per cent elongation. In addition, to provide reliance that bond is adequate, no sealant failure (adhesive or cohesive) should occur up to 50 per cent elongation.

Where sealants are improperly applied, or movements are greater than anticipated, thin laminae can be torn and require repair. In addition, removing sealant when renewal becomes necessary can result in damage to thin laminae. To reduce these risks and promote the ability to maintain seals, the lamina should be specified to have adequate strength at joints. For thin laminae, lamina thickening and/or special reinforcing should be considered at joints.

In determining the joint seal profile, sealant manufacturer requirements must be complied with, including minimum and maximum sealant thickness. In general, the sealant depth-to-width ratio should be 2:1 to 4:1, the width should be no less than 12 mm (1/2 in.) but preferably greater than 20 mm (3/4 in.), and the depth should be no less than 5 mm (3/16 in.).

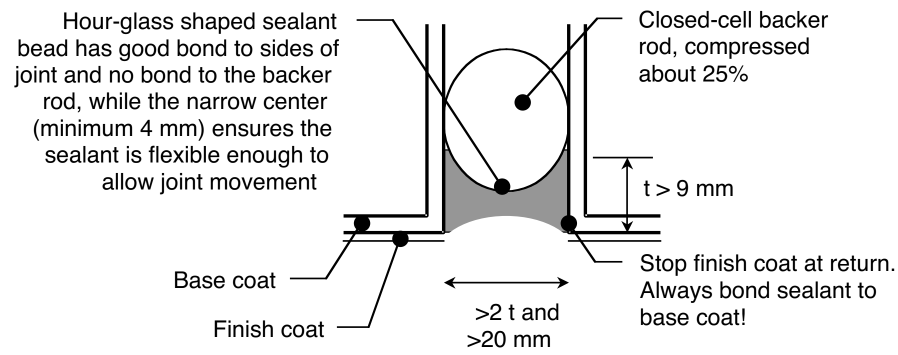


Figure 3.2: *Proper sealant design for joints*

Figure 3.2 shows the proper design of an EIFS sealant joint. Important points include:

1. A closed-cell foam backer rod should be used. The backer rod should be sufficiently compressed in the joint to ensure that it can remain in place during sealant application.
2. The finish coat should not be returned into the sides of the joints to allow the sealant to be bonded directly to the base coat.
3. The sealant should be tooled in a concave form to ensure compaction, to create a surface skin, and to produce an hourglass shape. The hourglass shape helps ensure that the sealant is sufficiently flexible while maintaining an acceptable bond surface (bite).

BEST PRACTICE NOTE: Assure Sealant Compatibility

Sealants and primers employed with EIFS must be specifically tested to confirm they obtain adequate adhesion and do not promote excessive load transfer to the lamina. ASTM 1382 test results should be reviewed to determine whether performance is likely to be adequate. As a minimum measure of acceptable performance, the load applied to the test samples at 25 per cent elongation should be less than 100 kPa (15 psi), and failure should not occur at 50 per cent elongation. Further confirmation as to adequate sealant adhesion should be confirmed by test cutting at the time of initial mock-up.

BEST PRACTICE NOTE: Strengthen Lamina at Joints

Where sealants are improperly applied, or movements are greater than anticipated, thin laminae can be torn and require repair. In addition, the need to complete future sealant removal can damage laminae. To reduce these risks and promote the ability to maintain seals, the lamina should be specified to have adequate strength at joints. For thin laminae, base coat thickening and/or special reinforcing should be considered at joints.

PROTECTION FROM PRECIPITATION

When the cladding design does not include details to limit rainwater falling or being directed onto the EIFS surfaces, the risks for deterioration increases. While properly designed EIFS can resist deterioration from this loading, long-term performance may suffer and increased maintenance is likely to become necessary. Water, which is allowed to directly fall or drain onto cladding, leads to wetting patterns and uneven dirt accumulation. Mold growth can occur at areas with persistent wetting. Increased wetting can also lead to surface erosion, sealant failure, and increased water ingress if exterior defects develop. Increased maintenance and repair, including more frequent cleaning and re-coating of the finish is likely to become necessary to maintain acceptable performance and appearance.

Horizontal EIFS surfaces such as at sills, cornices and reveals are also exposed to increased wear and tear from ice. While EIFS can be sloped and provided with additional protective coating to achieve adequate durability, best practice is to protect these surfaces with a sheet metal or other durable flashing that incorporates a water shedding drip to protect the EIFS below these surfaces from increased wetting and staining. If a flashing is omitted, the EIFS should be sloped a minimum of 6:12 (50 per cent), or 3:12 (25 per cent) in areas with low exposure.

Where EIFS meet horizontal elements such as grade, terraces or balconies, rainwater splashing and snow accumulation can also lead to increase wetting and exposure to ice. Terminating the EIFS a minimum height above these locations, or providing a flashing to improve protection can improve durability in these areas.

The following design features should be considered to promote durability:

1. **Overhangs:** An overhang that provides shelter from rain can dramatically reduce the frequency and amount of cladding wetting.
2. **Flashings on horizontal surfaces:** Horizontal surfaces can be provided with a flashing material to provide increased durability, as well as to incorporate a drip edge to help shed water away from the EIFS.
3. **Drips:** Flashings, which protect upper EIFS terminations, should be provided with a drip edge that projects a minimum 20 mm (3/4 in.) beyond the EIFS face to avoid water run-off onto the finish. The underside of projecting details and at lower EIFS terminations over cladding elements should also be provided with a drip edge or flashing to direct water away from the cladding.
4. **Termination above horizontal surfaces:** Where EIFS terminate at horizontal elements such as at-grade, roofs or balconies, it should be terminated minimum 200 mm (4 in.) above these locations. This helps reduce the wetting and associated risk for deterioration. In addition, this facilitates repair or replacement of waterproofing seals or flashings that tend to exist at these areas without disturbing the EIFS.
5. **Diverter flashings:** Where the lower edge of a sloped roof abuts an EIFS clad wall, particular attention is necessary to avoid water ingress problems. A diverter flashing should be installed at these interfaces to direct water away from the face of the wall.

BEST PRACTICE NOTE: Provide Flashings at Non-Vertical Surfaces

Surfaces that are inclined to the horizontal and not adequately sheltered are exposed to greater wetting, deterioration from ice and snow, and staining. To promote durability, these surfaces should be protected with a sheet metal flashing that incorporates a water shedding drip to protect the EIFS below these surfaces from increased wetting.

BEST PRACTICE NOTE: Terminate EIFS Above Horizontal Surfaces and Grade

EIFS that meet horizontal surfaces (roofs, balconies, etc.) and grade are exposed to greater wetting from splash, snow piling and wicking. The EIFS should be terminated at least 200 mm (4 in.) above these locations to avoid deterioration, and to allow maintenance, repair or replacement of waterproofing seals or flashings that tend to exist at these areas without disturbing the field of the EIFS.

OTHER DURABILITY CONSIDERATIONS

Other design considerations to promote durability are as follows:

a) **Lamina and Finish**

The lamina thickness specified by manufacturers tends to be the absolute minimum required for acceptable performance. However, deviations in workmanship can lead to areas not meeting this minimum. Unless strict quality control measures are applied to assure the minimum requirements are respected during application, consideration should be given to specifying application tolerances. Specifying an average lamina thickness that is slightly greater than the minimum, and that no area shall be less than the minimum, decreases the risk that areas have less than the minimum thickness. Specifying that the base coat be applied with a minimum of two passes also helps to reduce the risk for deviations in workmanship that result in locally deficient thickness.

When approved by the manufacturer, applying a primer to the base coat prior to the finish coat can help to seal the lamina, and promote a greater consistency in the appearance of the finish coat.

The pigments in deep or bright coloured EIFS finish coats tend to be more vulnerable to fading as compared with earth tones. If a deep or bright coloured finish is desired, the building owner should be prepared for more frequent re-coating to renew appearance. More durable earth tone colours should be considered for areas where access for re-coating is difficult or costly.

b) **Insects**

At grade, there is a risk of insect penetration (including termites in some regions) and/or upwards migration. Foamed plastic insulation has been found to be a desirable medium for termites to travel within. Maintaining the minimum 200 mm (4 in.) termination height above grade can help reduce risks for insect ingress. Care in the location of drainage holes, or incorporating a sheet metal flashing with sealed joints at the at-grade termination can also improve protection.

c) **Reveals**

Decorative reveals are typically formed by cutting into the insulation. However, these tend to provide a weakening, which may promote cracking at this location. In general, the cut grooves should be limited to a depth of 20 mm (3/4 in.) and a minimum of 20 mm (3/4 in.) of insulation should remain behind the reveal.

U-shaped or rounded reveals are generally preferable over square or V-cut grooves. The lower horizontal surface should be sloped to drain. In addition, the insulation should be spaced to avoid jointing at the reveals. The manufacturer should be consulted for requirements pertaining to a specific system.

BEST PRACTICE NOTE: Specify to Assure Minimum Lamina Thickness is Achieved

To promote achieving the minimum lamina thickness specified by manufacturers, application tolerances need to be considered. If only the minimum thickness is specified, strict quality control measures are necessary to assure this is respected during application. Specifying an average lamina thickness that is slightly greater than the minimum, and that no area shall be less than the minimum, decreases the risk that areas have less than the minimum thickness. Specifying that the base coat be applied with a minimum of two passes also helps to reduce the risk for deviations in workmanship that result in locally deficient thickness.

BEST PRACTICE NOTE: Apply a Primer to the Base Coat Prior to the Finish Coat

When approved by the manufacturer, applying a primer to the base coat prior to the finish coat can help to seal the lamina, and promote a greater consistency in the appearance of the finish coat.

BEST PRACTICE NOTE: Select Non-Fading Finish Colours or Plan for Frequent Re-Coating

The pigments in bright EIFS finish colours tend to be more vulnerable to fading as compared with earth tones. If a bright coloured finish is desired, the building owner should be prepared for more frequent re-coating to renew appearance. More durable earth tone colours should be considered for areas where access for re-coating is difficult or costly.

Chapter 4

RETROFIT WITH EIFS

GENERAL

EIFS are particularly suitable for retrofitting existing buildings. The low weight can usually be accommodated by the existing structure and substrate with little or no reinforcing. The thermal protection can be designed to improve energy efficiency, protect existing wall assemblies experiencing problems with leakage or deterioration, reduce problems with moisture accumulation within the wall assembly, and provide a new architectural appearance.

Most principles presented apply to both new construction and retrofit applications. However, retrofit applications can introduce additional issues that need to be addressed by the design. At a minimum, the following should be assessed when retrofitting with EIFS:

1. **Structural Adequacy of the Substrate**

   Determining the structural adequacy of the substrate in a retrofit application can be more difficult. Drawings or details regarding the original design are often not available, particularly with respect to anchors, connectors and fasteners may not be readily available. The original design may not comply with modern Building Code standards. The extent to which the as-built condition is defective as a result of original deviations in workmanship or substitutions should be determined. In addition, the extent to which deterioration has weakened the substrate must be evaluated.

   The appropriate reinforcement and/or remedial measures necessary to provide acceptable structural integrity must be designed and implemented prior to applying EIFS.

2. **Surface Contaminants**

   Additional care is required in evaluating the suitability of existing substrates to receive EIFS. Weathered, dirty surfaces may require special cleaning in order to achieve adequate adhesion. Particular care is required where previous paints, coatings or sealers have been employed that may inhibit adhesion. Sealants at joints, (particularly silicones) can leave residues that would inhibit adhesion. Field testing should be completed to verify acceptable bond is achieved by products applied to the aged substrate.

3. **Substrate Deterioration**

   EIFS provide the opportunity to protect substrates that are experiencing problems with deterioration.

   This can include masonry or concrete walls with poor material properties that makes them vulnerable to freeze/thaw deterioration. The EIFS can be designed to control moisture content and avoid freezing so as to correct the problem. This can avoid the need for costly and disruptive replacement of the substrate.

   Corrosion of steel anchors or reinforcing that may exist with masonry or concrete assemblies may also be controlled with EIFS. Corrosion can develop in the presence of salts (admixed, de-icing salts, or from the ocean). Concrete “carbonation”, a natural weathering of concrete, eliminates the corrosion protection concrete normally provides to embedded reinforcing steel. Corrosion can lead to concrete cracking, spalling and delamination.

An experienced professional should be involved in determining whether EIFS are suitable in these situations, and developing a design that can achieve acceptable performance.

4. **Moisture Management**

   Careful consideration of the existing wall assembly and how it will perform after EIFS are applied is required. Older wall assemblies may not have adequate air or vapour barriers. The EIFS should be designed to work with the existing assembly to avoid concealed moisture problems. Consideration may need to be given to selecting an EIFS with a secondary barrier that is vapour permeable to improve the ability for drying to the exterior.

5. **Interfaces**

   In detailing EIFS at existing buildings, attention should be given to the need for renewing or replacing other elements of the building envelope, such as windows and roofs. Details should allow for these subsequent programs without damage to the EIFS, or consideration should be given to renewing these other elements in conjunction with the EIFS application.

Chapter 5

DETAILS

GENERAL

This section provides sample details that exemplify best practice. These are intended to generally convey design requirements. Modifications will likely be necessary to accommodate specific design and project requirements.

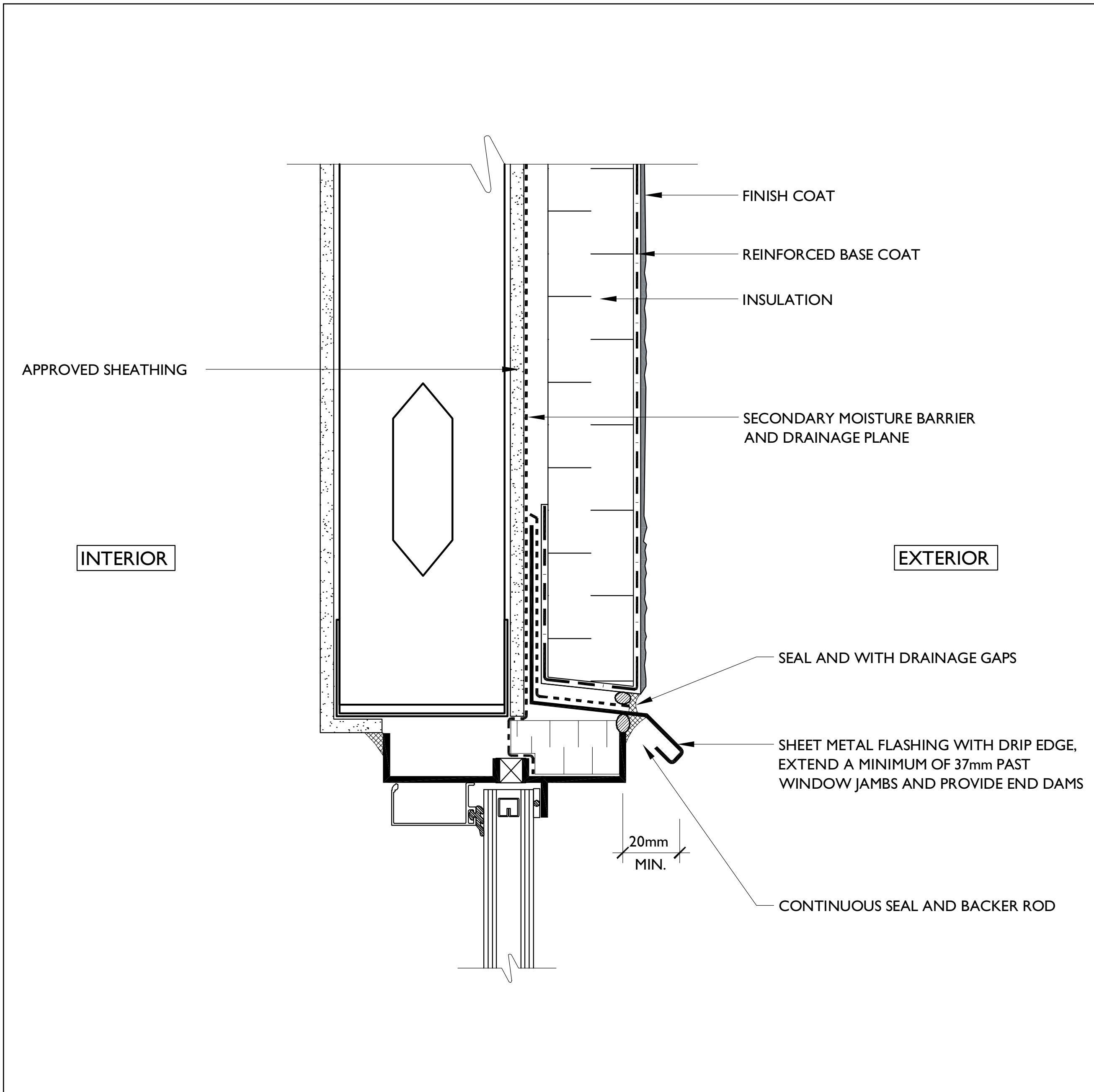
WINDOW HEAD – DETAIL 1

Construction Sequence

- steel stud back-up erection
- sheathing installation
- rough window opening preparation
- sheet metal flashing installation
- secondary moisture barrier application
- EIFS installation
- window installation
- exterior sealant application

Notes

- Align the window in the rough opening to minimize thermal bridging at the EIFS/window interface.
- Ensure the air and vapour barriers are tied into the window framing.
- Provide a sufficient gap between the EIFS and metal flashing to allow drainage.
- Provide source drainage below windows to collect and drain to the exterior, incidental moisture that penetrates through EIFS/window interface or window assembly (refer to Details 2 and 3).



Detail 1: *Window head*

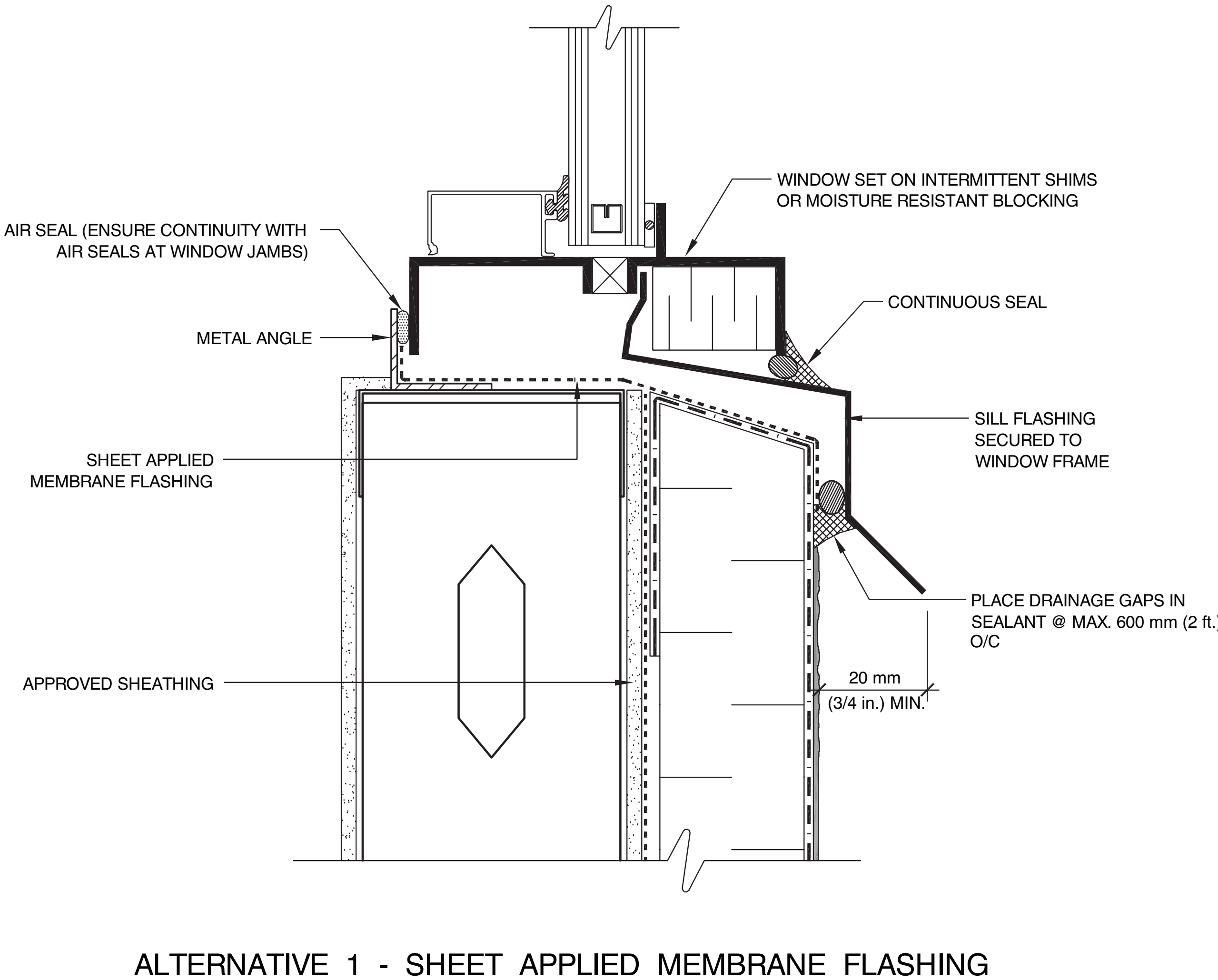
SOURCE DRAINED WINDOW SILL – ALTERNATIVE 1 – DETAIL 2

Construction Sequence

- steel stud back-up erection
- sheathing installation
- secondary moisture barrier application
- EIFS installation
- sub-sill membrane flashing and metal angle installation
- window/sill flashing installation
- exterior sealant application

Notes

- Align the window in the rough opening to minimize thermal bridging at the EIFS/window interface.
- Ensure the air and vapour barriers are tied into the window framing. (To maintain drainage, avoid using spray-applied foam to provide air barrier continuity at the sills.)
- Slope top of EIFS for positive drainage.
- Where possible, avoid fastening the windows through the sub-sill flashing.
- Use moisture resistant shims/blocking below windows. Make shims/blocking discontinuous to allow drainage.



Detail 2: *Source drained window sill – alternative 1*

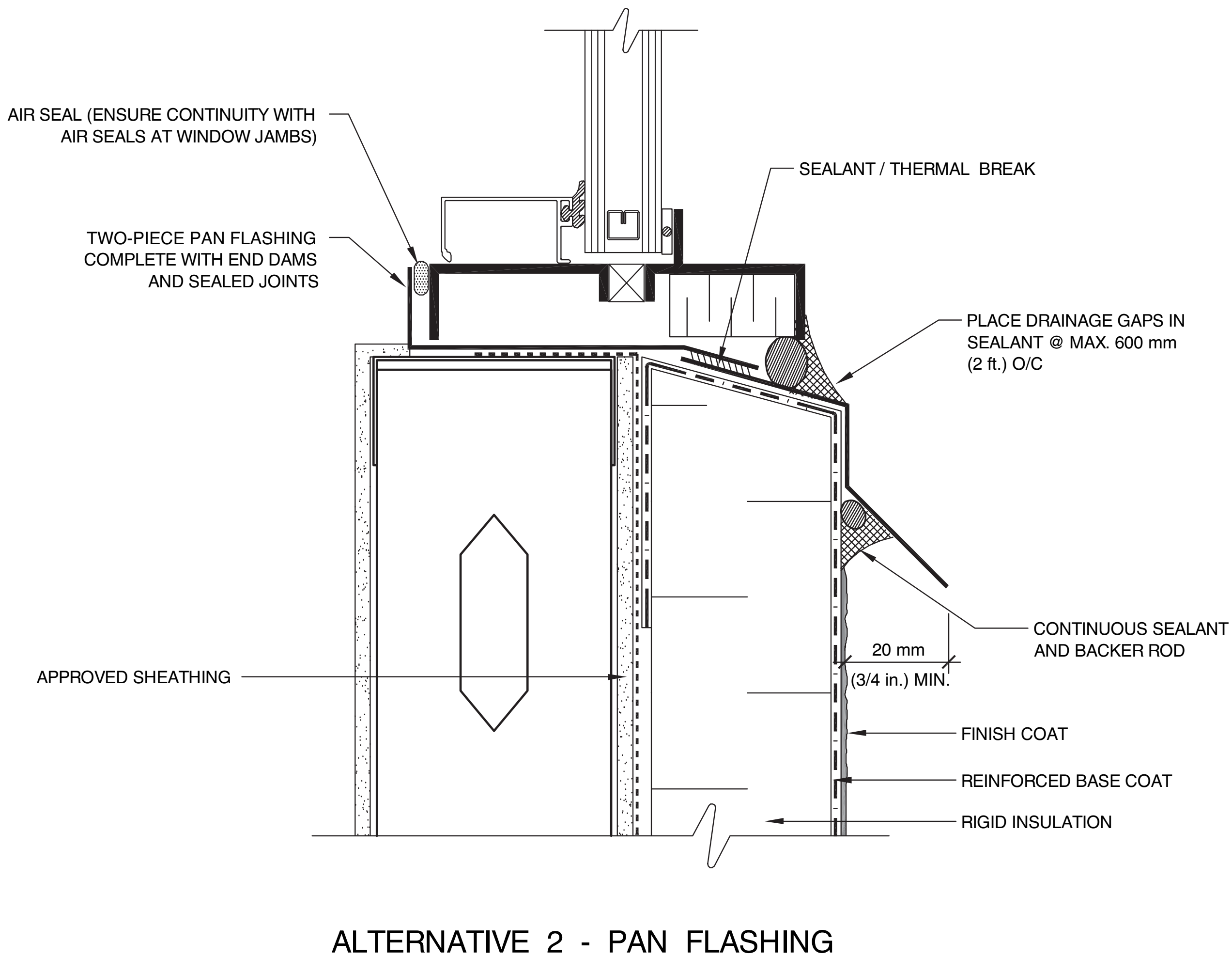
SOURCE DRAINED WINDOW SILL – ALTERNATIVE 2 – DETAIL 3

Construction Sequence

- steel stud back-up erection
- sheathing installation
- secondary moisture barrier application
- EIFS installation
- pan flashing installation
- window installation
- exterior sealant application

Notes

- Align the window in the rough opening to minimize thermal bridging at the EIFS/window interface.
- Ensure the air and vapour barriers are tied into the window framing. (To maintain drainage, avoid using spray-applied foam to provide air barrier continuity at the sills.)
- Slope top of EIFS for positive drainage.
- Avoid fastening the windows through the pan flashing.
- Use moisture resistant shims/blocking below windows. Make shims/blocking discontinuous to allow drainage.



Detail 3: *Source drained window sill – alternative 2*

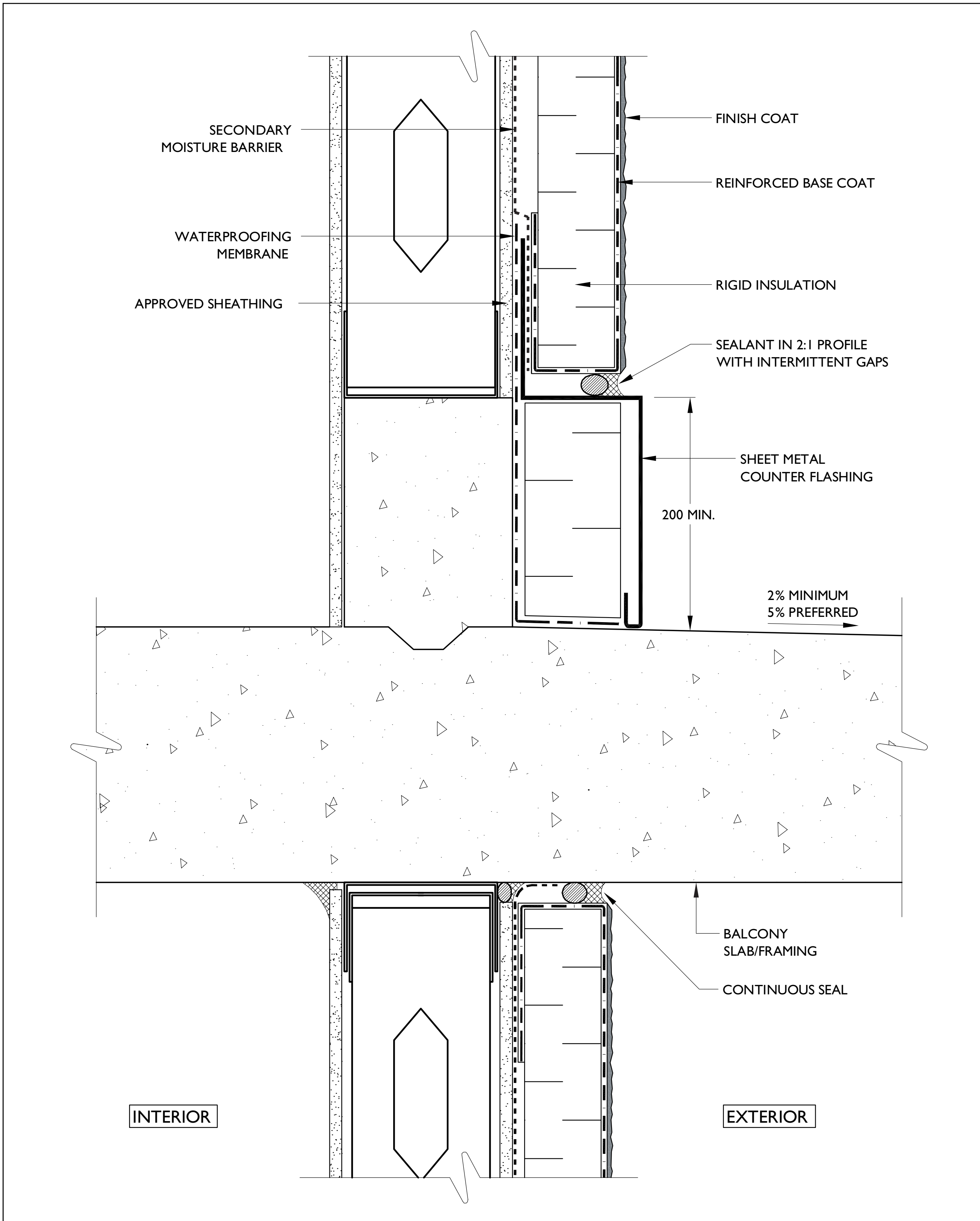
INTERFACE WITH BALCONY/TERRACE – DETAIL 4

Construction Sequence

- steel stud back-up erection
- sheathing installation
- waterproofing membrane application
- insulation and sheet metal counter-flashing installation
- secondary moisture barrier application
- EIFS installation
- exterior sealant application

Notes

- Provide deflection detailing in steel stud back-up below balcony/terrace slab.
- Size gap between top of EIFS and underside of balcony/terrace slab based on expected movement.



Detail 4: *Interface with balcony/terrace*

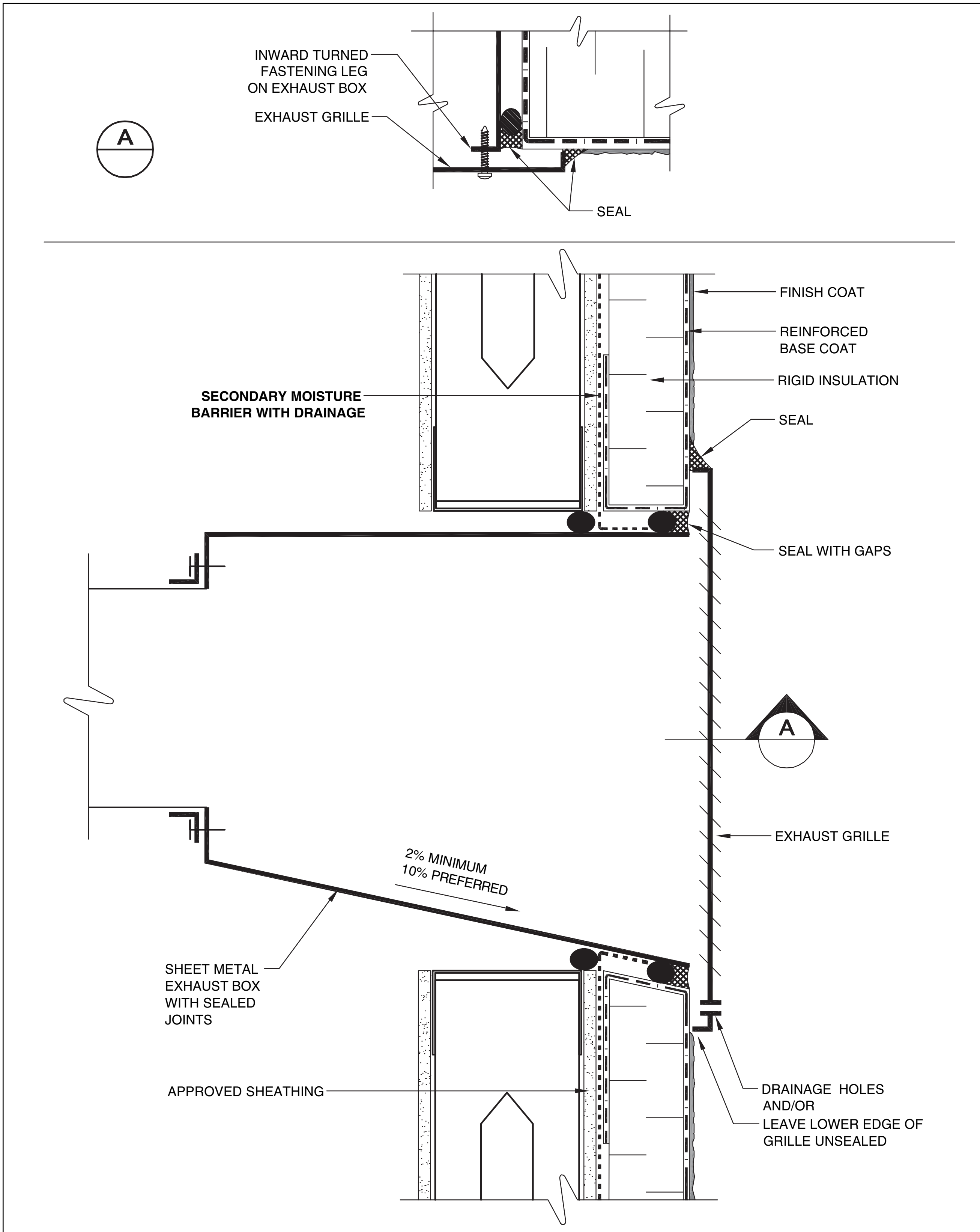
THROUGH-THE-WALL EXHAUST PENETRATION – DETAIL 5

Construction Sequence

- steel stud back-up erection
- exhaust box installation
- sheathing installation
- secondary moisture barrier application
- EIFS installation
- exhaust grille installation
- exterior sealant application

Notes

- Slope bottom of exhaust box for positive drainage to the exterior.
- In areas with high exposure to wind-driven rains, consider a scooped/hooded exhaust cover in lieu of traditional grille.
- Insulate around exhaust box/ducting to minimize thermal bridging.
- Detail exhaust box to be air- and water-tight.
- Ensure the air and vapour barriers are tied into the duct box.



***Detail 5:** Through-the-wall exhaust penetration*

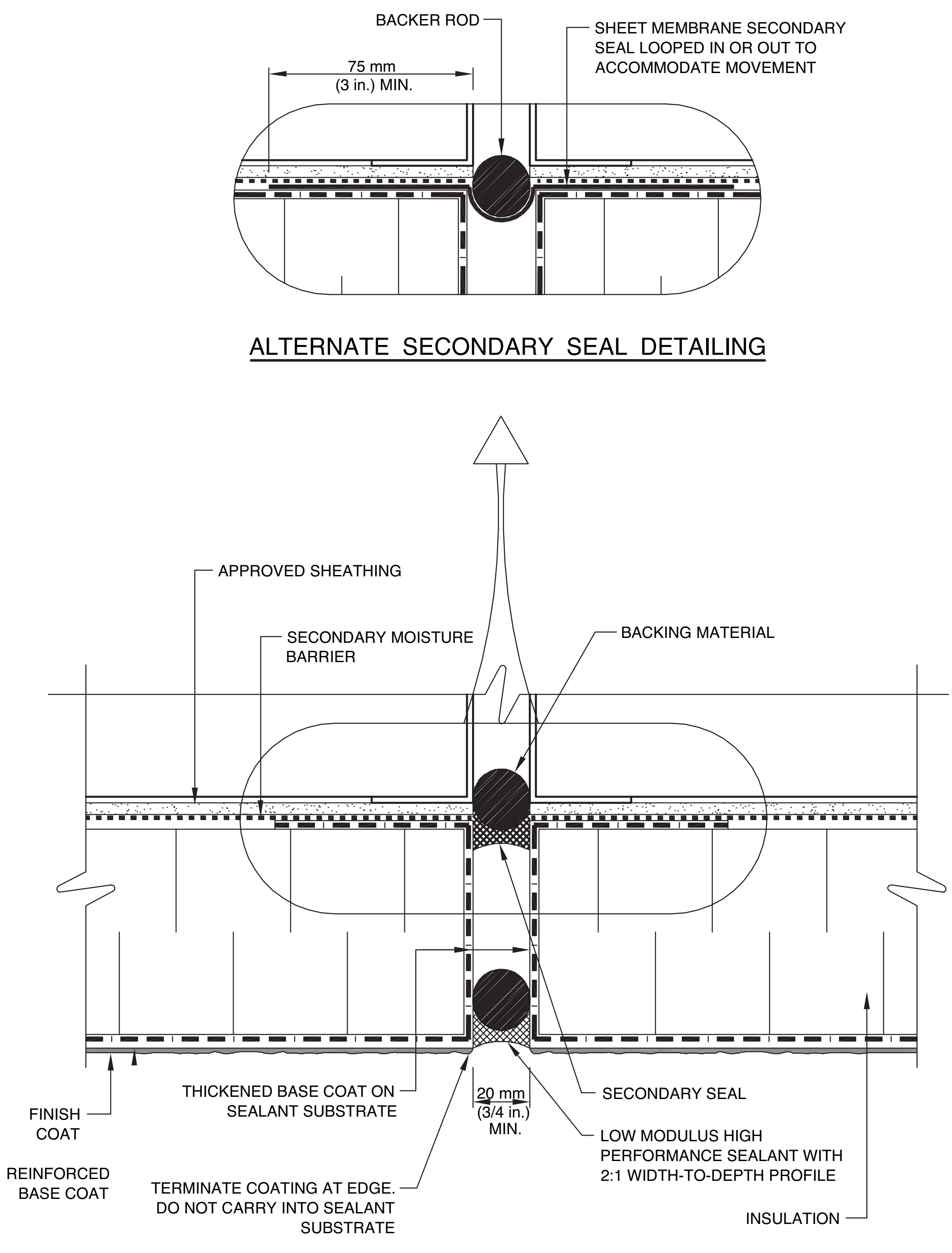
DUAL STAGE MOVEMENT JOINT – DETAIL 6

Construction Sequence

- steel stud back-up erection
- sheathing installation
- secondary moisture barrier application
- EIFS installation
- sealant application

Notes

- Size the movement joint such that the width is minimum 4 times the expected movement.
- Provide drainage to the exterior at regular intervals.



Detail 6: *Dual stage EIFS movement joint*

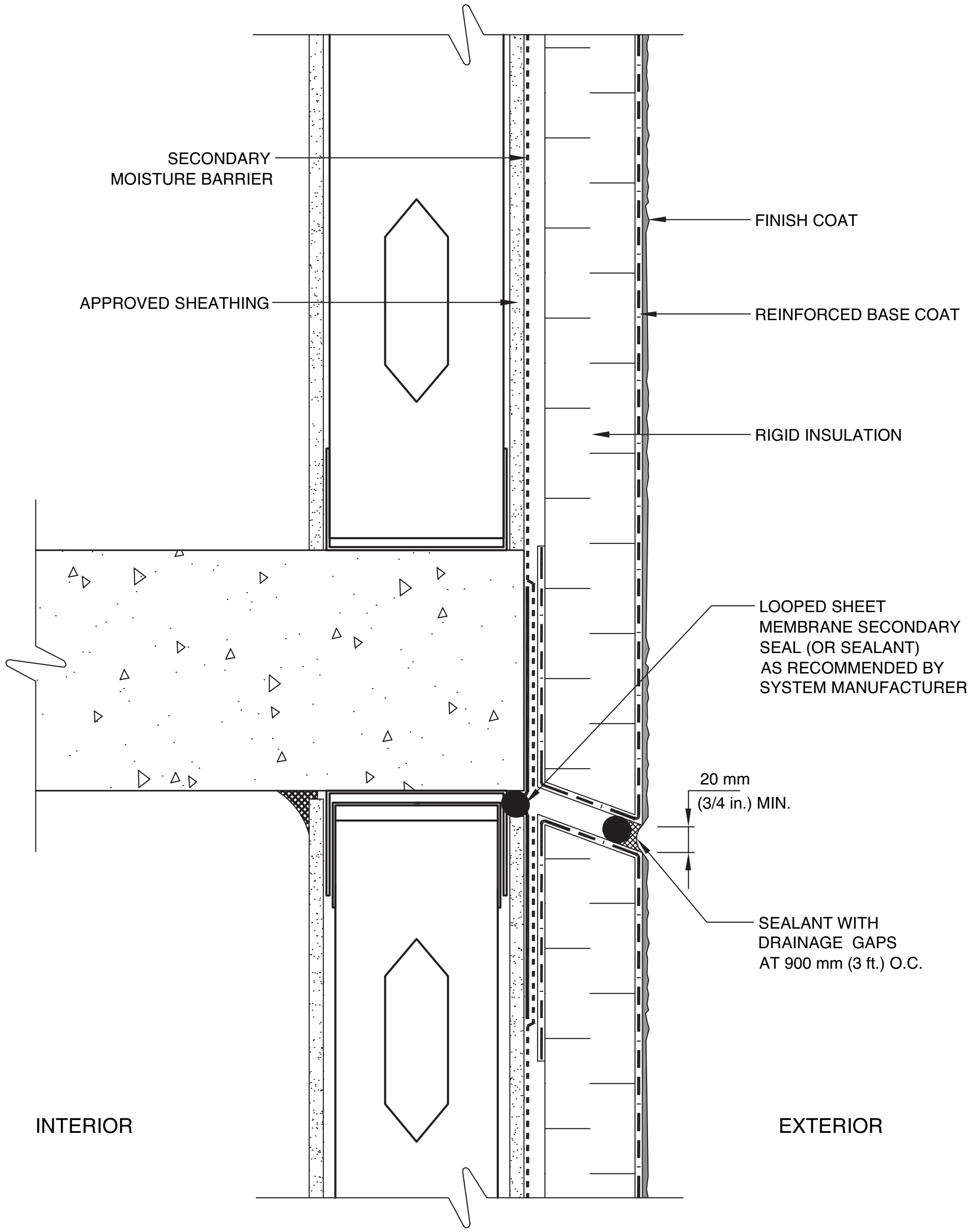
EXPANSION JOINT AT FLOOR SLAB – DETAIL 7

Construction Sequence

- steel stud back-up erection
- sheathing installation
- secondary moisture barrier application
- EIFS installation
- sealant application

Notes

- Provide deflection detailing in steel stud back-up below underside of slab.
- Size EIFS joint based on expected movement.
- Slope top of EIFS panels for positive drainage.



Detail 7: *Expansion joint at floor slab*

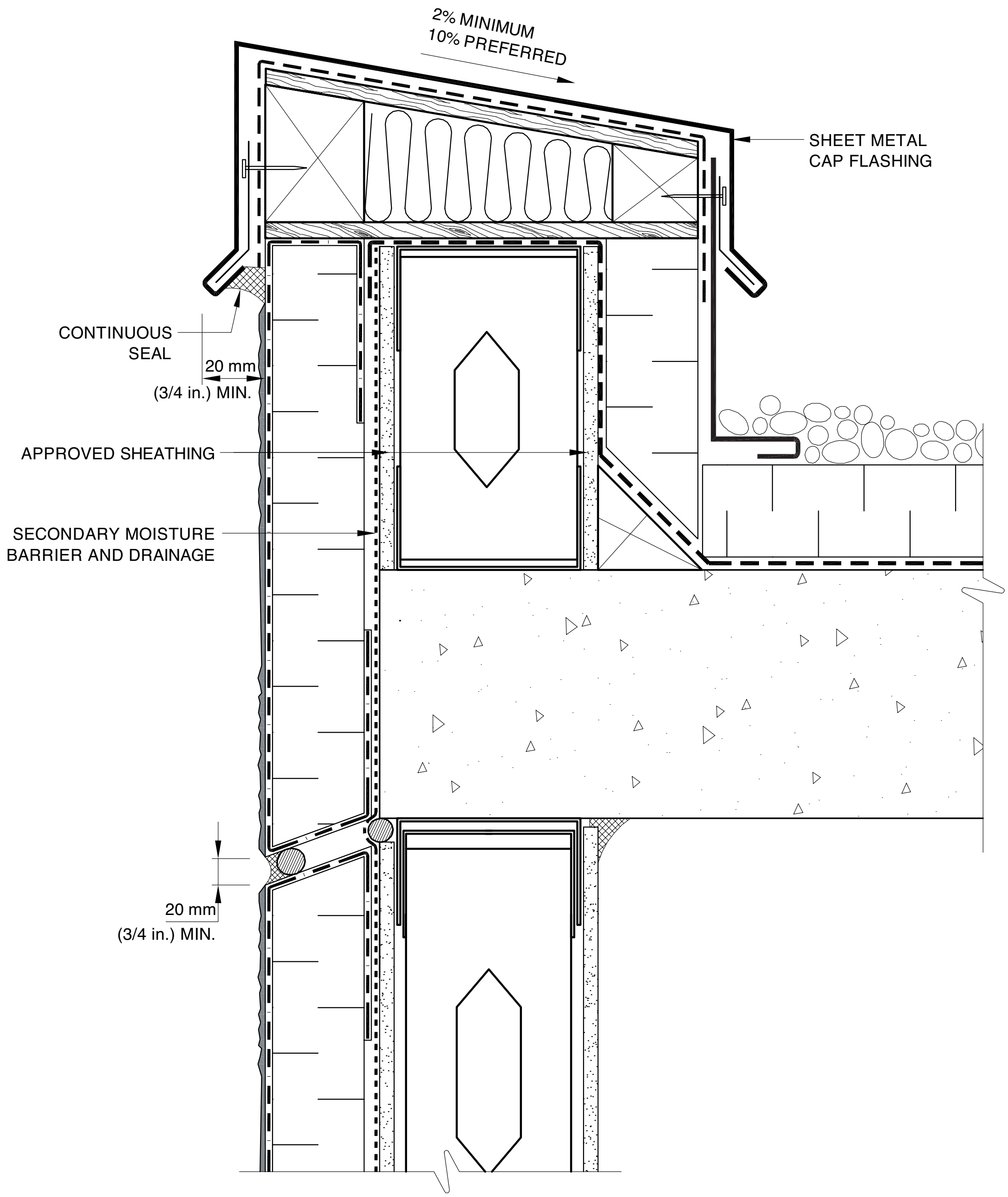
ROOF PARAPET – DETAIL 8

Construction Sequence

- steel stud back-up erection
- sheathing installation
- secondary moisture barrier application
- roof membrane application
- sloped blocking installation
- EIFS installation
- cap membrane application
- sheet metal installation
- sealant application

Notes

- Detail assumes that an overhang is either impractical or desired due to aesthetic considerations.
- Ensure air and vapour barrier continuity is maintained between wall and roof assemblies.
- Provide deflection detailing in steel stud back-up below underside of roof slab.
- Provide movement joint in EIFS at underside of roof slab (refer to Detail 7).



Detail 8: *Roof parapet*

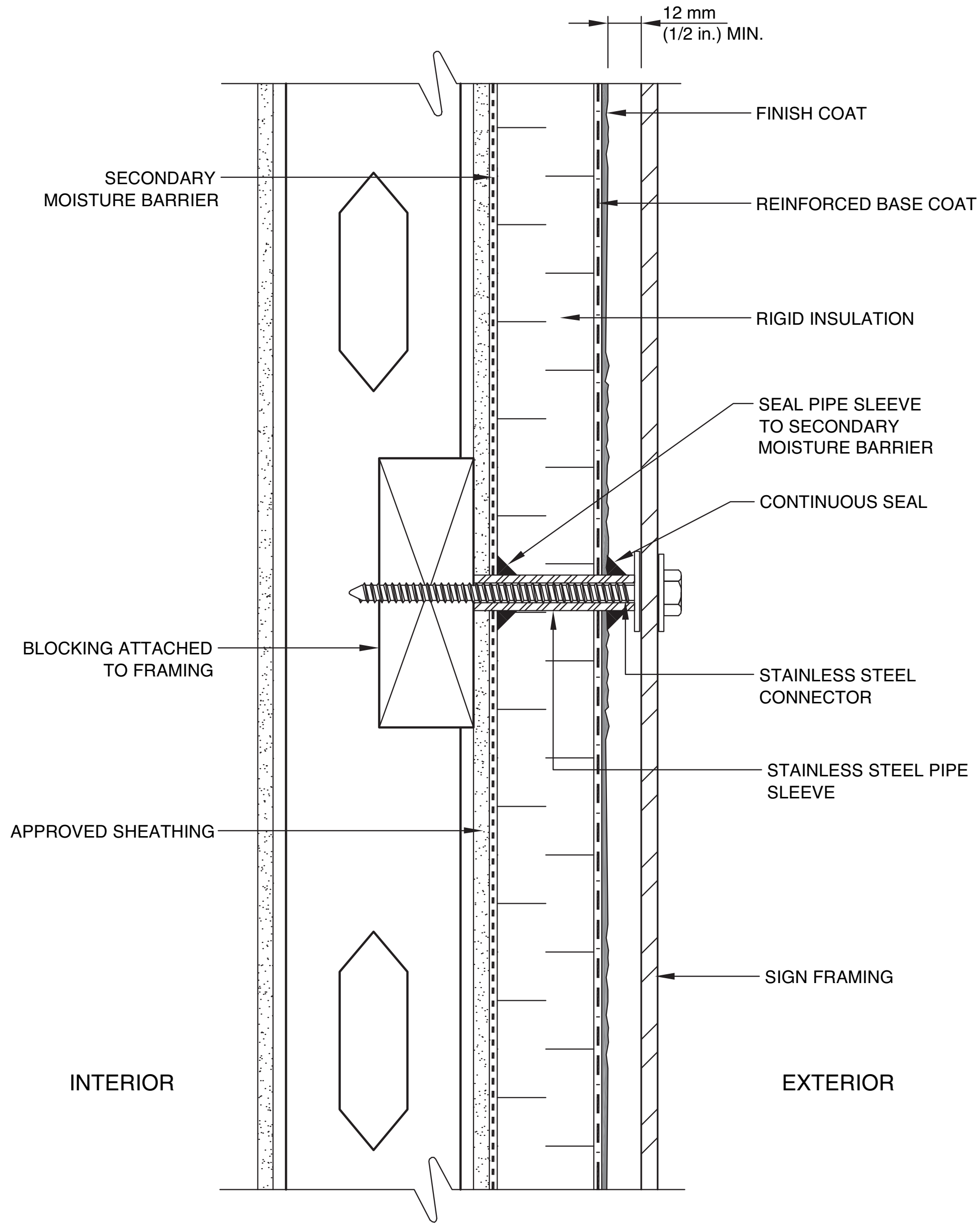
SIGN ATTACHMENT – DETAIL 9

Construction Sequence

- steel stud back-up erection
- blocking and pipe sleeve installation
- sheathing installation
- secondary moisture barrier application
- EIFS installation
- sealant application
- sign installation

Notes

- The blocking and connections should be designed by a structural engineer.
- Prior to installation of the sign, add neutral cure (non solvent based) sealant to the opening in the EIFS prior to installing the pipe sleeve. Insert the sleeve and tool off the additional sealant around the projecting sleeve.



Detail 9: *Sign attachment*

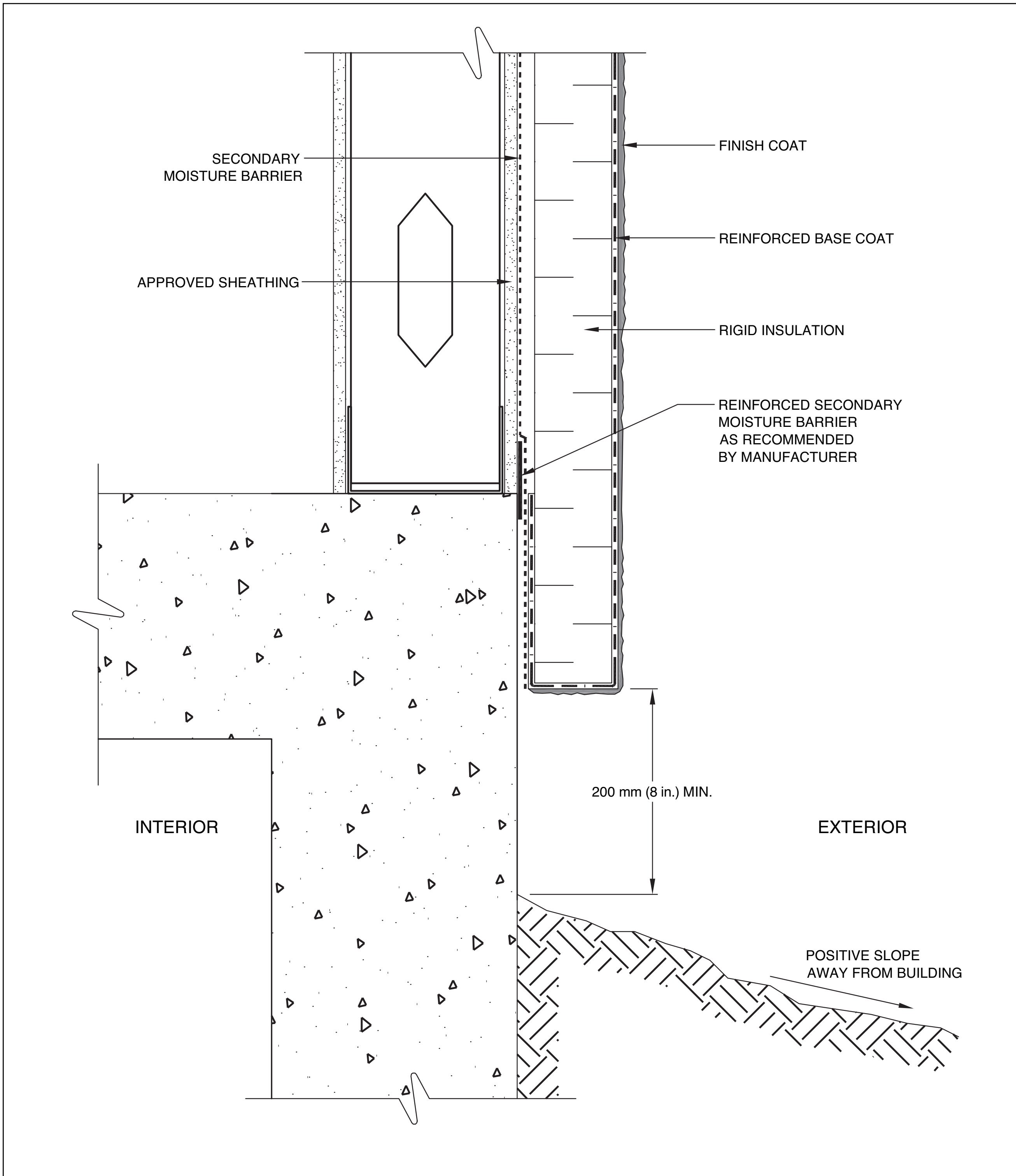
TERMINATION AT GRADE – DETAIL 10

Construction Sequence

- steel stud back-up erection
- sheathing installation
- secondary moisture barrier application
- EIFS installation

Notes

- If the overlap onto the foundation wall exceeds 600 mm (1 ft.), provide a joint in the EIFS at the base of the stud wall.
- Increase base coat thickness and/or upgrade reinforcing mesh in high traffic areas.
- Provide interior and/or exterior insulation below the EIFS to limit thermal bridging.



Detail 10: *Termination at grade*

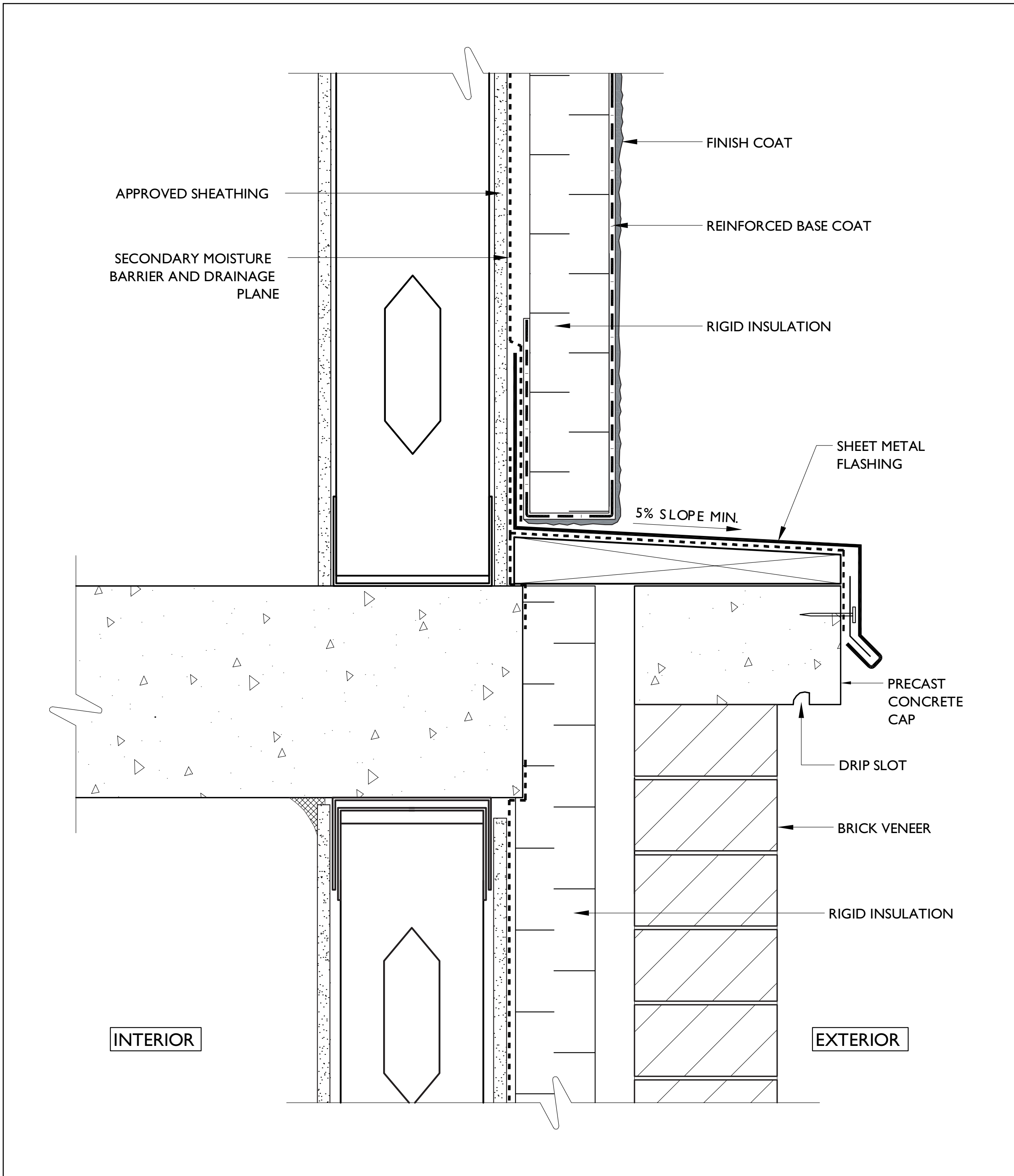
HORIZONTAL JUNCTION WITH BRICK VENEER – DETAIL 11

Construction Sequence

- steel stud back-up erection
- sheathing installation
- brick installation
- sheet metal flashing installation
- secondary moisture barrier application
- EIFS installation
- sealant application

Notes

- Provide a sufficient gap between the EIFS and metal flashing to allow drainage.
- Provide positive slope (5% min) on sheet metal flashing.
- Detail sheet metal flashing joints to limit water entry into the brick cavity (provide wet seal between sections or "S"-locked joints).
- Ensure air and vapour barrier continuity is maintained between cladding assemblies.



Detail 11: *Horizontal junction with brick veneer*

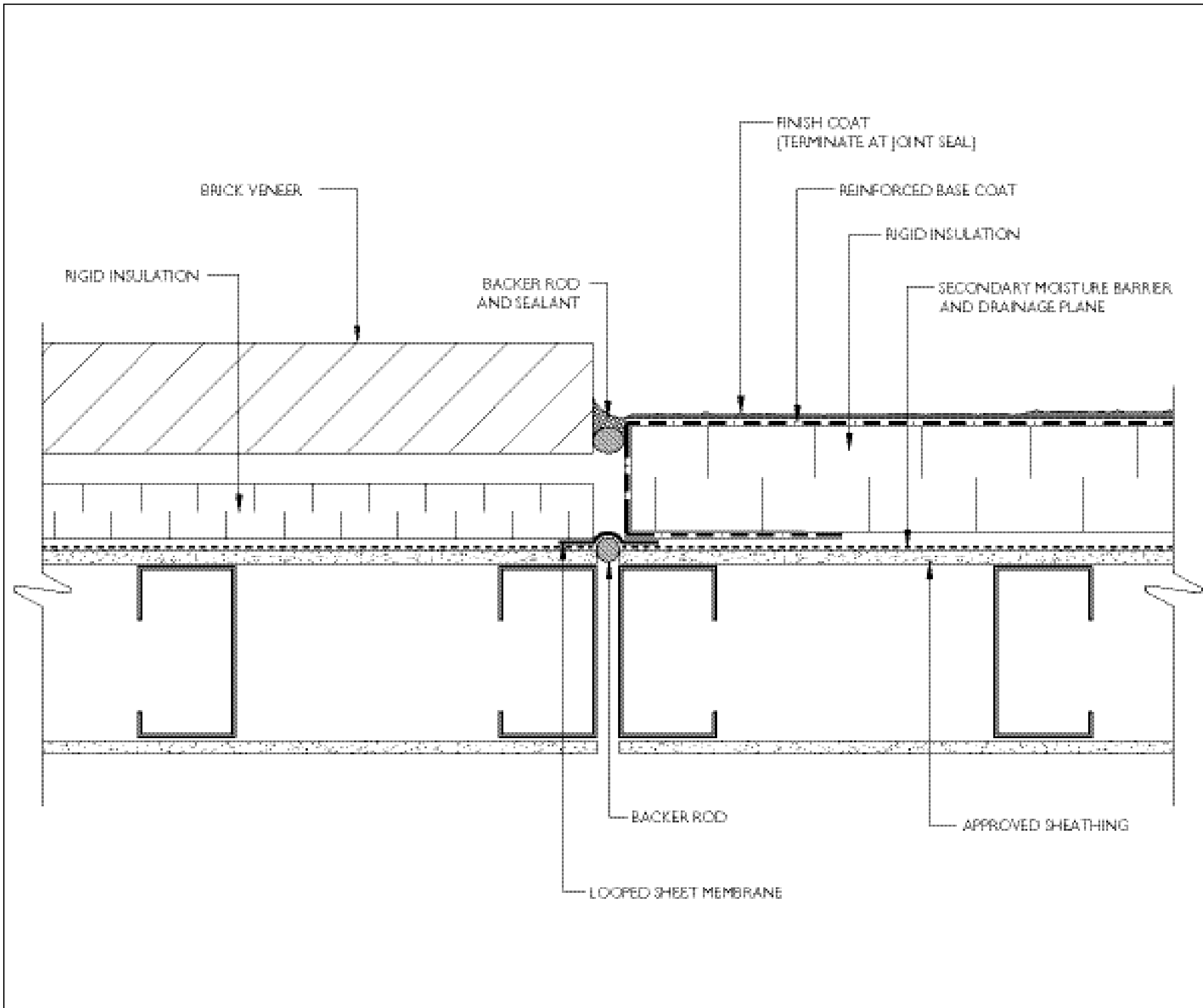
VERTICAL JUNCTION WITH BRICK VENEER – DETAIL 12

Construction Sequence

- steel stud back-up erection
- sheathing installation
- secondary moisture barrier application
- brick/EIFS installation
- sealant application

Notes

- Size joint between EIFS and masonry based on expected movement.
- Align internal flashings in EIFS and masonry at same level. At EIFS/masonry interface, either make the masonry flashing continuous with the EIFS flashing or end dam the flashing onto the EIFS.
- Ensure air, vapour and moisture barrier continuity is maintained between cladding assemblies.



Detail 12: *Vertical junction with brick veneer*

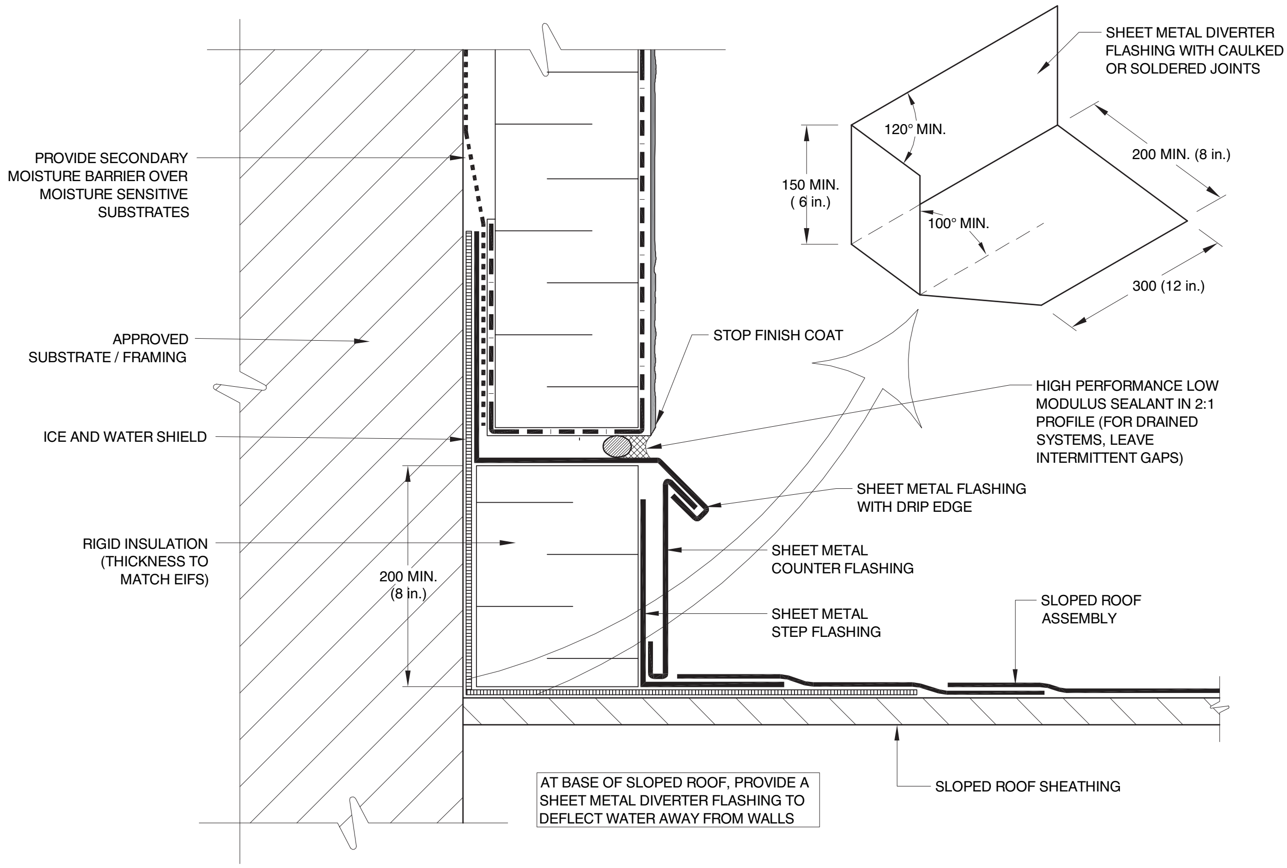
SLOPED ROOF-TO-WALL INTERSECTION – DETAIL 13

Construction Sequence

- steel stud back-up and roof structure erection
- roof and wall sheathing installation
- ice and water shield application
- insulation and sheet metal flashing installation
- secondary moisture barrier application
- slope roof assembly and EIFS installation
- exterior sealant application

Notes

- Leave drainage gaps in sealant at base of slope.
- Provide diverter flashing at base of slope to deflect water away from the walls below.
- Ensure air and moisture barrier continuity is maintained between wall and roof assemblies.



Detail 13: *Sloped roof-to-wall intersection*

Appendix A
EIFS GLOSSARY

The following is a glossary of the terms used in this guide. (Italicised terms are defined in this glossary).

Accessories Preformed metal, fibreglass or plastic members for use to form corners, edges, control joints, or decorative effects.

Adhesive A substance or compound used for bonding surfaces together, e.g., insulation board to the *substrate*, usually applied in the form of a liquid or paste. An EIFS adhesive and base coat may be the same material.

Aesthetic joint Term that is being phased out and replaced with the term "*Aesthetic Reveal*".

Aesthetic reveal A groove cut into the insulation board which serves the function of decoration and/or to provide a starting or stopping point for finish coat application. Refer to ASTM C1397.

Air barrier system A three-dimensional assemblage of materials that is designed to provide the primary resistance to airflow through an enclosure. May be an air-vapour barrier when its function also includes the control of vapour diffusion.

Back wrapping Carrying the system *reinforcement* and base coat around the ends of the *insulation boards* and terminating between the insulation and *substrate*. Typically, at system interfaces and terminations to firmly attach the *base coat* to the *substrate* and protect the edges of the *insulation board* at these locations. Also refer to *End wrapping*.

Backer rod A resilient material (typically closed-cell polyethylene) formed into a circular cross-section and provided in rope form, placed in a seam or joint to provide backing, act as a *bond breaker*, and allow providing an appropriate profile when applying *sealant*.

Base coat A compound used to embed and to cover the reinforcing fabric of an *EIFS*, depending on the system type. The *base coat* acts as the primary weatherproofing layer.

Bond breaker A tape, sheet, wax pencil or liquid applied material that prevents adhesion on a designated surface. See also *backer rod*.

Capillary action The movement of water within the spaces of a porous material due to the forces of adhesion, cohesion, and surface tension. *Capillary action* explains how liquid water is transported through cracks in concrete, wood, brick, etc. *Capillary action* causes water to "travel" in narrow spaces between materials.

Capillary break A material, or an air space, in an assembly that permits little or no *capillary action*, and hence breaks the transport of liquid water through an assembly made up of porous materials. Metals, glass, plastics, bitumen, etc. are often used as *capillary breaks* between, for example, concrete and wood.

Cement board A *sheathing* product made of cement-bonded fibre-reinforced composites (typically glass or wood fibres are used as reinforcing). *Cement board* is moisture and fire resistant and is used as a *substrate* sheathing. Refer to ASTM C1186.

Cold joint The visible junction in a finish coat, due to the lack of maintaining a wet edge during the finish coat application. Refer to ASTM C1397.

Construction joint See *Joint*

Control joint A formed, sawed, or assembled joint acting to regulate the location of cracking, separation, and distress resulting from dimensional or positional change. Refer to ASTM C1397.

Crack The result of forces which exceed the strength of a material at a particular location. A *crack* may only extend to the reinforcement, or narrowly penetrate the full depth of the lamina without damage to the reinforcement. A perforation is meant to be a broken or damaged reinforcement.

Cure To develop the ultimate properties of a *wet state material* by a chemical process.

Dry To develop the ultimate properties of a wet state material solely by evaporation of volatile ingredients.

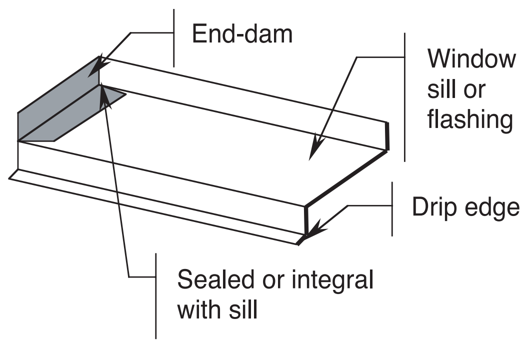
Durability The capability of a building, assembly, component, product, or construction to maintain serviceability over a specified time.

Drip edge A geometric feature provided in an exterior building surface to ensure that flowing water will drip free rather than be pulled back toward a vertical enclosure element. A drip groove is commonly employed in solid materials like concrete whereas a *drip edge* is used for thinner sheet materials.

End wrapping The act of wrapping the *reinforcement* and *base coat* around the edges of the *insulation board* and terminating and bonding to the *substrate* at an opening in the *substrate*. Like *back wrapping*, *end wrapping* is a means of securely fixing the *lamina* where it ends at *joints* and penetrations.

EIFS Acronym for: Exterior Insulation and Finish System

Embed To encapsulate the reinforcing mesh in the base coat.



Isometric of a typical End-dam

End-dam A vertical or near vertical upstand from the end of a *flashing*, or window sill, used to prevent water from flowing horizontally off the end of the *flashing* or sill.

Expanded polystyrene *Expanded polystyrene* (EPS) is a rigid cellular foamed-plastic insulation material manufactured by expansion of expanded polystyrene beads within a mould. This mould creates an open cell structure filled with air. EPS Type I is the most widely used insulation for EIFS applications. Type I has a density of 16 kg/m^3 (1 lb /ft.^{3}), Type II is 24 kg/m^3 (1.5 lb/ft.^{3}).

Expansion joint A structural separation between building elements that allows independent movement without damage to the assembly.

Extruded polystyrene *Extruded polystyrene insulation* (XPS) is a rigid cellular foamed-plastic insulation material manufactured by extrusion of polystyrene in the presence of a blowing agent. The blowing agent dissipates out of the closed cell structure over time creating a structure that resists liquid water penetration and vapour diffusion. The manufacturing process for XPS insulation results in a smooth surface skin, which may require additional treatment in order to ensure the proper adhesion of EIFS coatings.

Factory mix A material prepared at the point of manufacture and is ready to use without the addition of other materials, except possibly water to adjust consistency.

Field mix A material mixed in the field with other components and/or water.

Fibreglass-faced gypsum sheathing An increased moisture resistant type of exterior gypsum *sheathing*. The gypsum core is silicone treated for water repellency and the glass matt applied to each face as reinforcement meeting the requirements of ASTM C1177.

Finish coat The coating applied to the *base coat* to finish the *lamina*. The *finish coat* provides colour, texture, water protection, dirt resistance and ultra violet ray resistance.

Flash set The early hardening of stiffness in the working characteristics of a Portland cement paste, usually with the evolution of considerable heat. Stiffness cannot be dispelled nor the plasticity regained by further mixing without addition of water; also known as **"quick set"**.

Flashing A durable waterproof material used to redirect or shed drained water to the exterior, or, occasionally, to act as a *capillary break*.

Framing member Studs, joists, plates (tracks), bridging, bracing, and related accessories manufactured or supplied in wood or steel.

Gypsum sheathing Exterior grade gypsum board used as *sheathing*, typically treated with water repellents. In this guide it is referred to as gypsum sheathing, as per ASTM C79.

Initial grab The ability of a wet state material to remain in place just after it has been applied.

Initial set A time-related set caused by the hydration process.

Insulation board Rigid sheet material which provides thermal resistance. Commonly, foam plastic such as *EPS* or *XPS* are used; although, polyurethane and polyisocyanurate may be found with some *EIFS*. Still, others use mineral fibre. Some systems have panels grooved at the back to encourage drainage.

Joint An interface between elements. *Joints* may be needed to allow for movement of different parts of a building or assembly, or may be required to make construction sequences practical. In all cases, the functional requirements of the enclosure must be maintained the same as for the body of an enclosure element, although aesthetic requirements may be relaxed.

A *join*t may pass through the entire enclosure assembly, in which case it is a building movement joint, or more commonly referred to as an expansion joint.

Control *joints* are surface cuts or intentional geometric features that control the location of shrinkage cracks and may be proprietary requirements.

Construction *joints* are formed between successive building elements during construction work.

Lamina Composite layer installed over the insulation, comprised of the *reinforcement*, *base coat* and *finish coat*.

Mechanical fasteners Fastener assemblies (usually a screw and a special washer) of various proprietary types used to attach *EIFS* components to the *substrate*.

Pot life The duration of time that the wet state material remains workable after it has been mixed.

Primer (adhesion promoter) A coating intended to prepare the surface of the substrate for the subsequent application of an adhesive.

Primer (for finish coat) A coating intended to prepare the surface of the base coat, prior to the finish coat application. Typically this improves the consistency of the finish coat and texture and enhances the water-repellent property of the lamina.

Reinforcement Material or materials used to improve the mechanical properties of the *base coat*. It may consist of one or a mix of polymer fibres, alkali-resistant glass fibres, and, most commonly, plastic coated fibreglass mesh.

Sealant A flexible, elastomeric material used in the assembly of the building enclosure to cover gaps, seams or joints to provide a clean finish, waterproof, or airtighten.

Substrate sheathing Material to which the exterior insulation is fastened or fastened through to the framing members. The substrate sheathing comprises typically board materials such as plywood or fibreglass faced gypsum board. When the structural wall is comprised of masonry or concrete, the EIFS may be applied directly to the masonry or concrete without the use of a substrate sheathing.

Substrate The structural plane of the building to which the *EIFS* is attached, e.g., exterior *sheathing*, concrete masonry, concrete, etc.

Surface sealer Material used to enhance weather resistance.

Temper To bring to a workable state by adding water.

Texture Any surface appearance as contrasted to a smooth surface.

Vapour permeance A material layer or enclosure assembly property that describes how easily water vapour diffuses (i.e., moves from high to low concentration) through it. The units typically used are metric perms [ng/(Pa.s.m^2)] or US perms [grain/(hr· ft^2in Hg·)]. One US perm equals 57 metric perms. A 6 mil sheet of polyethylene has a vapour permeance of 3.4 ng/m^2/s/Pa. The lower the permeance number, the more *vapour retardent* the material.

Vapour retarder A layer within an enclosure assembly that is intended to control diffusive vapour flow. A Type I *vapour retarder* has a permeance of 15 ng/(Pa.s.m^2) or less, and a Type II *vapour retarder* has an initial permeance of 45 ng/(Pa.s.m^2) and 60 ng/(Pa.s.m^2) or less, after aging, Also called a *vapour barrier* or vapour diffusion retarder or an air-vapour barrier when its function is combined with that of the *air barrier*.

Weather barrier	A membrane or material layer that allows little or no water penetration. Usually has a low air *permeance*, but may have a wide range of vapour *permeances* (from very low to very high). The liquid transport properties of a material change with moisture content and applied pressure.
Wet edge	The leading edge of a continuously applied *wet state material*.
Wet state materials	The adhesive, base coat and finish coat components applied in liquid or semi-liquid state.

Appendix B
TECHNICAL APPENDIX

INTRODUCTION

The main portion of the EIFS Best Practice Guide provides useful advice on the selection, design, and construction of EIFS. This part of the guide provides background technical information to help users understand some of the key building science aspects that form the basis for the Best Practice Guide. The bibliography provides the names of some of the better texts dealing with building and climatic factors for those readers wishing more detailed information.

As moisture is the primary source of premature failure in walls, building designers and owners must ensure that EIFS installations are adequately protected from the damaging impacts of excessive wetting. Moisture can come in contact with EIFS walls form:

- direct exposure to driving rain and melting snow; and/or
- from water vapour in the air – from both the exterior and interior.

This Appendix explains how to deal with moisture from the above two sources, then addresses some key aspects of lamina design, and finally offers means of analysis to address the issue of interstitial condensation.

EIFS AND DRIVING RAIN

As building construction evolved, designers and builders of both low-rise and high-rise buildings took measures to protect the walls from excessive wetting. Designers have incorporated cornices and overhangs to shelter the uppermost and most exposed portions of walls from rain. They designed window heads and sills with dams and drips to direct water away from window and wall surfaces. Originally, walls were much thicker, preventing or slowing down the ingress of rain by absorption. When water did succeed in entering any of the wall components and/or simply soaking the exterior surface of the wall the lack of air tightness, thermal insulation and vapour permeance of the wall system allowed for effective drying.

In recent times, competitive market pressures and more stringent regulatory requirements have combined to reduce the drying potential and to eliminate many of the architectural features which formerly served to shield exposed parts of the windows and walls from water. The result in many cases is that driving rain creates two conditions that can be harmful to EIFS walls:

1. increased wetting of all surfaces
2. increased water ingress through joints and penetrations resulting in prolonged saturation

In the case of EIFS walls, the EIFS portion of the wall (Stucco insulation combination) is, for all practical purposes, impermeable to rain penetration. It is the joints between EIFS panels and between EIFS and other wall elements and the joints sealing penetrations and openings that provide the vulnerable points for water entry. More about joints and sealing strategies is presented in the following sections.

PERFECT BARRIER OR FACE SEALED WALL

The combination of wind and rain (i.e. driving rain) can lead to water leakage into the wall system through any unintentional openings. On the windward side of the building, a positive pressure difference develops across the wall while on the leeward side a negative pressure difference develops across the wall. The pressure drop occurs across the components of the wall that present a resistance to air flow. In the case of EIFS, the lamina and insulation combination is usually airtight. The result is that a portion of the total air pressure drop occurs across the outer most skin.

Rainwater, which has wetted the wall, flows over the exterior visible joints in the EIFS and where there are discontinuities in the joint sealant; wind-drive rainwater is pushed into the wall by any positive pressure differences that may exist. Once in the wall, water must escape by vapour diffusion (drying).

During the heating season, the temperature gradient, (the difference in temperature between the indoors and the outdoors), will lead to an increase in the water vapour pressure in the rain-wetted areas. The rate at which moisture can diffuse through the materials on the exterior side of the wet areas depends on the water vapour permeability of the EIFS lamina, the insulation, and where the water penetrated inboard of the EIFS insulation and lamina.

During the summer, and particularly when the walls are exposed to solar radiation on the outside, moisture in the wall can diffuse toward the interior. The rate of diffusion depends on the permeability of the various wall components.

Sustained high relative humidity within the wall cavity on the interior side of the EIFS insulation and the exterior sheathing is not desirable. A combination of relatively high temperature and high humidity can support mold and mildew growth and may lead to corrosion of ferrous metal components in the wall.

TWO-STAGE JOINTS AND SOURCE DRAINAGE

Two-stage joints incorporate a drainage space between two seals within the joint. An outer bead directly exposed to water and sun and an inner bead that is protected form direct exposure to water and sun. The inner bead is installed in a much more airtight fashion than the outer bead. As a result the majority of the pressure drop is across the inner bead. But since it is not wetted with water, wind-driven rain entry is eliminated through any defects in the inner bead. The outer bead contains intentional drainage openings. Two-stage joints are the classic “belt-and-suspenders” approach to mitigating rainwater entry through exterior cladding. It is for this reason that two-stage joints are considered best practice for all applications. This concept can be incorporated at any vulnerable leakage point in a wall system and if done so can be referred to as source drainage.

DRAINED OR RAIN SCREEN DESIGNS

The inherent "belt-and-suspenders" drainage approach can be taken one step further and incorporated throughout the entire wall system: not just at joints. Typically a drainage cavity is fully incorporated between the insulation-lamina combination and the substrate sheathing that allows for any water that bypasses the outer skin to be drained harmlessly to the exterior. Pressure-moderated systems equalize the pressure across the entire surface between the EIFS insulating boards and the substrate.

Visible drainage may be provided by applying the insulation adhesive with a notched trowel so that continuous vertical drainage channels are formed. Some proprietary systems provide drainage channels and pressure moderation chambers in the profile of the EIFS insulation. EIFS manufacturers provide proprietary prefabrication details to periodically intercept the vertical drainage system and provide drainage to the exterior.

The substrate sheathing requires a secondary water barrier to arrest any further inwards movement by water that enters the drainage cavity. This could involve building paper or a sheet applied sheathing wrap. A trowelled on barrier or elastomeric membrane can provide improved water resistance. These latter materials are usually also installed as an air barrier

SEALANT DESIGN

It is imperative that the sealant joints have the proper design and installation. Each joint must satisfy two conditions:

1. the surface to which the sealant adheres to has to be compatible with the sealant
2. the shape of the cross-section of the sealant must provide the correct joint-width-to-sealant thickness ratio.

To satisfy the first requirement, the installer must be careful not to apply the finish coat over the surface to which the sealant is adhered. Installers provide a backer rod to form the correct sealant cross-section shape and push the backer rod sufficiently far into the joint to enable creation of an hour-glass shaped sealant section where the joint width becomes 2 to 4 times the throat depth of the sealant depending on the sealant and manufacturer's recommendations. The hourglass shape of the sealant is important as:

1. this shape maximizes the sealant area which is bonded to the base coat of the lamina, allowing bond stresses between the sealant and lamina to be minimized
2. this shape optimizes the stress strain relationship of the sealant allowing elastomeric type of deformations without failing the sealant itself during deformation; either in tension or compression.

LAMINA BEHAVIOUR

All building materials expand upon heating and contract upon cooling. In addition to thermal deformation, materials containing Portland cement also experience contraction due to shrinkage upon drying. In an EIFS application, the lamina is considered to be restrained so that contraction due to temperature decrease and drying shrinkage has to be fully compensated by tensile strain.

The lamina is a complex material made of glass fibre reinforcement and a polymer-modified cement matrix. When this composite is subject to tensile strain, both the matrix and the glass fibres resist the applied tensile force. The proportion carried by each depends upon their respective moduli of elasticity and their cross sectional areas.

The tensile strain capacity of the matrix increases with an increase in polymer content and a corresponding decrease in Portland cement content. Regardless of the ratio in the matrix of polymer content and Portland cement content, before the ultimate tensile strain capacity of the composite is reached (that is when both the glass fibres and the matrix crack), the matrix itself cracks. As long as the composite is properly designed with respect to the reinforcement (amount of glass versus thickness of base and finish coats), when the matrix cracks and the entire load that it was carrying is transferred to the glass fibre reinforcement, that amount of reinforcement is sufficient to withstand the applied load.

As the thermal strain increases, it is relieved by the formation of additional cracks throughout the matrix. Eventually, the matrix cracks to the extent that further stress relief is not possible. At this point, the stress in the glass fibre reinforcement starts to increase, until its strength is finally reached. At this point, the glass fibre reinforcement fails across one of the matrix cracks. When this happens, all the force previously carried by the reinforcement in the lamina is now transferred to the foam insulation layer. Because this insulation layer is relatively malleable, the insulation allows the crack to open up whereby the stress in it is relieved. The most likely location of such cracks is over joints between the insulation boards. In properly designed lamina, the ultimate strain capacity is considerably higher than the sum of the shrinkage and thermal contractions. In other words, if any cracking does occur, the cracks in the matrix are barely visible; they are too narrow to admit liquid water and likely to close up over a period of time.

In some cases, the composite may be inadvertently under-reinforced. In such cases, the formation of the first matrix crack exceeds the capacity of the reinforcement thereby resulting in the formation of a large crack through the composite. This happens when the matrix design thickness is exceeded. This is likely to occur in areas where the surface of the insulation is not flat and the base coat is used to fill depressions in the surface of the insulation.

COMPONENTS

Substrate

The substrate sheathing to which an EIFS is applied must be structurally sound and sufficiently flat. Specifications vary among manufacturers, but as a guide, substrates should be straight and plumb with no variations in excess of 6 mm (1/4 in.) over a 2.4 m (8 ft.) length.

Substrate sheathing must be tolerant to incidental moisture. Oriented strand board, plywood, and glass-fibre-faced core-treated gypsum, meeting the ASTM C1177 standard, are acceptable sheathings if not exposed to prolonged wetting. Sheathing compliant with ASTM C1278 may also be used. Exterior grade gypsum board sheathing, compliant with ASTM C79, has been found to be too moisture sensitive and is not recommended as a substrate. It is vulnerable to deterioration from wetting prior to being covered with EIFS and from accidental periodic wetting that may occur over the service life.

The condition of the substrate must be checked when attaching EIFS with an adhesive. Form-release agents on concrete walls, masonry treated with penetrating water repellents, and old paint on concrete block, may not allow for acceptable bond. If there is any doubt about the quality of the substrate, field testing should be conducted with the adhesive and insulation specified for the project.

When sheathing is applied over framed walls, joints in the sheathing should not line up at window corners because cracks are likely to telegraph through the insulation and cause the lamina to crack (see following figure).

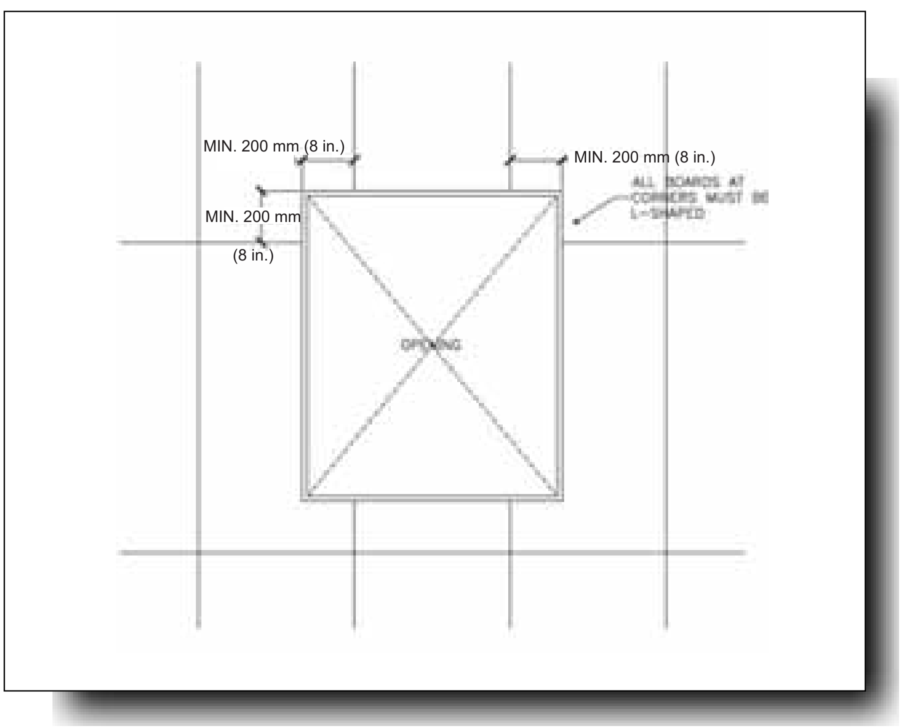


Figure B.1: *Joint layout of sheathing boards to minimize cracking*

Insulation

The shear stiffness of the insulation is important to the performance of the lamina. It allows differential movement to occur between the substrate and lamina, such as may occur with thermal expansion and contraction. The insulation acts as a buffer for movement between the substrate and the lamina. Manufacturers specify an insulation that is soft enough to allow the lamina to perform as intended. Substituting a more rigid insulation would result in cracking.

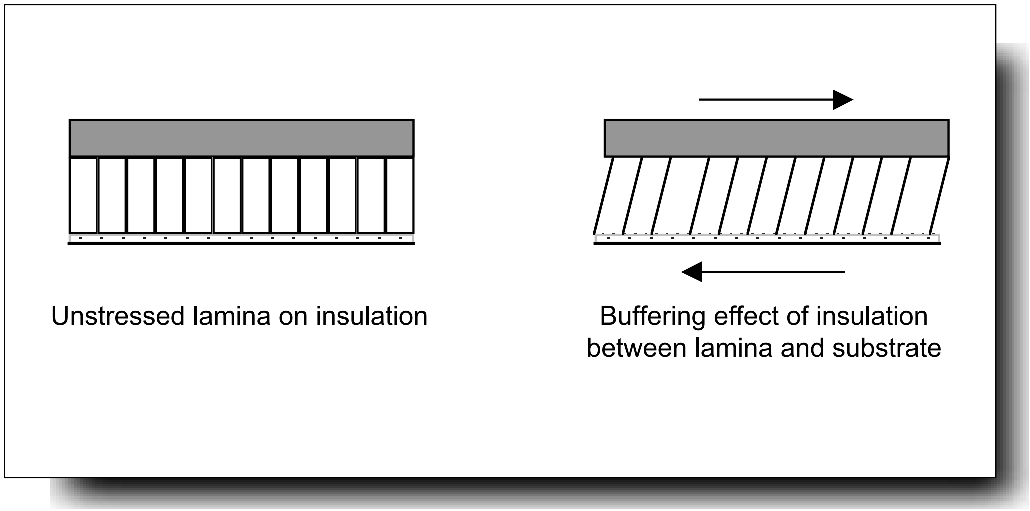


Figure B.2: *Insulation buffering effect*

Joints between insulation boards must be made as tight as possible to prevent the creation of stress concentrations. Open cracks must be filled with slivers of EPS or with one-part polyurethane foam (usually supplied in pressurized cans) before the base coat is applied.

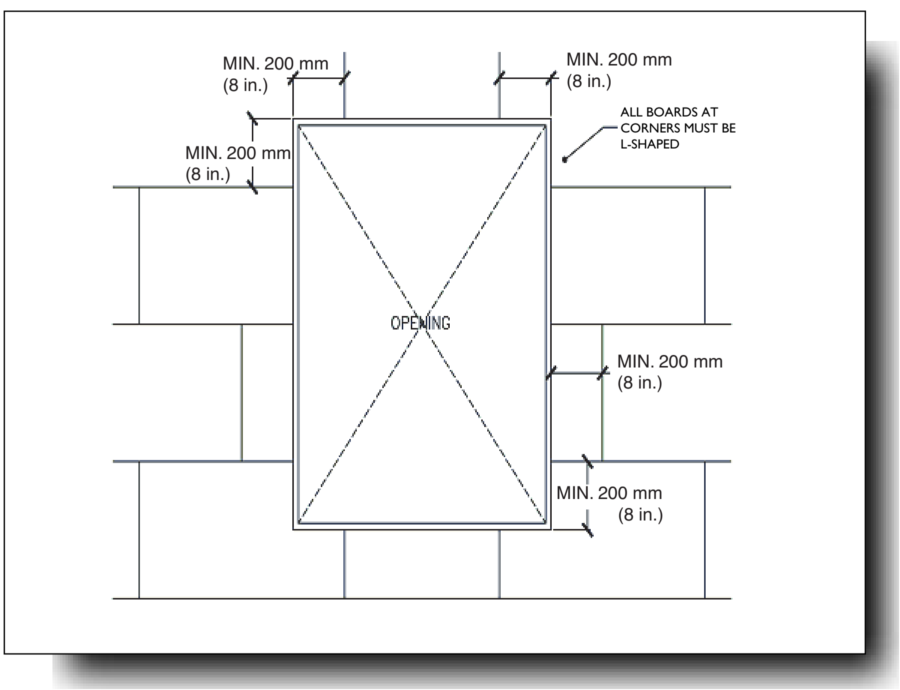


Figure B.3: *Insulation joint layout around openings*

For the same reason, all sharp corners of openings penetrating the EIFS must be framed with a solid piece of insulation. This typically requires the used of L-shaped insulation pieces.

Continuous vertical joints in the insulation boards at building corners should also be avoided to reduce the potential for cracking. Interlocking or staggering the insulation as per the following figure helps to resist corner cracks.

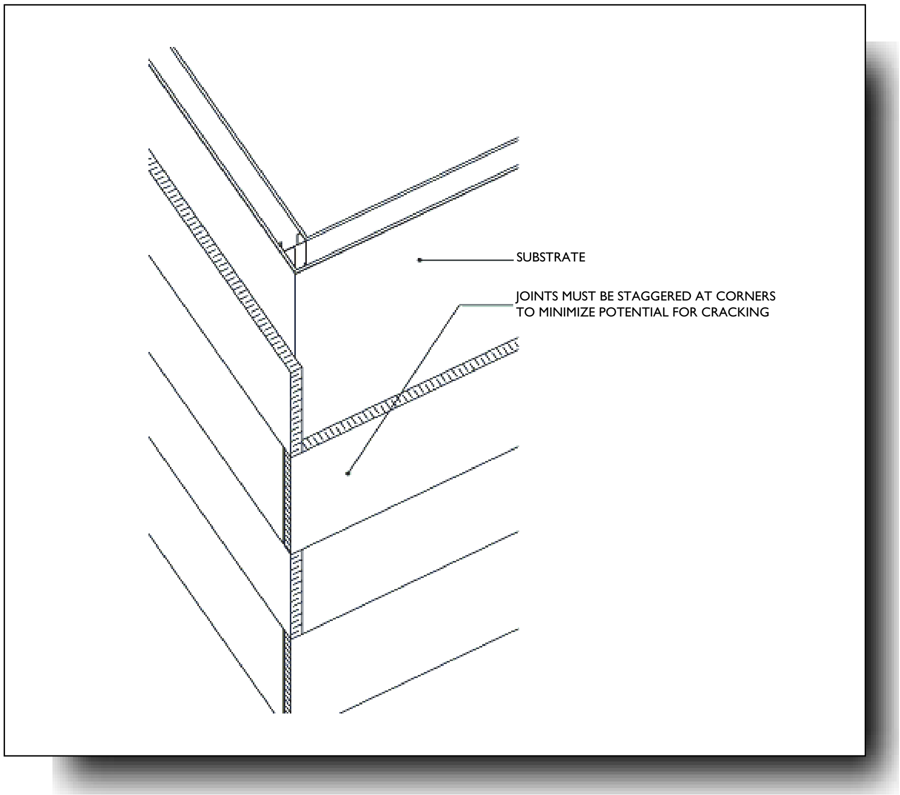


Figure B.4: *Insulation joint layout at corners*

Insulation Adhesive

Insulation adhesives are prescribed by the EIFS manufacturer to be compatible within the system and provide adequate strength. Testing is completed to demonstrate capacity to resist negative wind loads. Adhesives are primarily applied in two different ways:

1. a series of ribbons, applied with a notched trowel as specified by the manufacturer
2. perimeter ribbons and dabs, usually 50 – 100 mm (2-4 in.) diameter at 200 to 300 mm (8 to 12 in.) centres

Some trowel-applied adhesives used to attach the cladding to the substrate may also perform as the secondary and air barrier when fully coating the substrate. Air barrier continuity is usually assured by membranes across joints.

The properties required of an adhesive will vary for different substrates. Wood-based substrates, e.g., oriented strand board and plywood, will shrink and swell due to humidity changes resulting in movement at the joints. These substrates may require a more flexible adhesive.

Insulation Fasteners

Many EIFS make use of mechanical fastening as the primary or secondary means of attaching the insulation or lamina to the substrate. Mechanical fasteners are also used if adhesive attachment is difficult or impossible because of the condition of the substrate, such as when using plastic film coated or sheathing wrap secondary water barriers as most applied adhesives do not adhere to these materials.

Manufacturers typically use proprietary fasteners for their systems. These could be a metal screw or a power-driven pin that passes through a plastic washer. The washer is important because it spreads the forces over a wide area, reducing the stress on the soft insulation. Plastic washers should be used because they do not corrode and conduct little heat. The fastener is metal because of the strength required. Corrosion-resistant metals or protective coatings must be used.

In EIFS with thin laminas, the outside face of the washer and screw head must be flush with the outside face of the insulation. The base coat and reinforcing are applied over the washer. If the fastener is recessed, it will cause a thickening of the base coat which can result in cracks. If the fastener protrudes, it will create a visible bump in the finish and/or push the mesh too close to the exterior of the base coat. Note that installing the washer flush with the insulation means that wind loads are transferred from the lamina through the EPS before being taken up by the washer and screw fastener.

EIFS with thicker coats and reinforcing may locate the washer outside of the reinforcing mesh. This provides a strong mechanical bond between the reinforcing and the substrate. Manufacturers' recommendations should be followed.

Fasteners must be installed sufficiently close together to resist the design wind loads. This spacing is a function of not only the pullout resistance of the fastener, but also the failure load of the insulation-to-washer connection. In many instances, the horizontal spacing is prescribed by the distance between framing members. For high wind loads and wide fastener spacing, the ability of the insulation to carry the loads laterally to the fasteners should be checked. Thicker insulation may be needed for these structural reasons.

Lamina

EIFS reinforcement is typically a glass fibre balanced fabric reinforcing mesh. It may be either woven or non-woven. The alkaline environment of base coats caused by cementitious compounds would cause the glass to deteriorate. To prevent alkali deterioration, manufacturers employ reinforcing that has been suitably coated with alkali-resistant polymers such as acrylic, PVC, or styrene.

Manufacturer base coat formulations vary. Dry-mixed base coats only require the addition of water, whereas wet mixes may require the addition of only Portland cement. Base coats contain three primary constituents: polymer emulsions, aggregates, and water. Most also contain some amount of Portland cement. Small amounts of pigment, biocides, de-foaming agents etc. may also be present.

The base coat must be installed with sufficient thickness to completely coat and encapsulate the mesh reinforcing within the base coat. This seals the mesh from contact with both the finish coat and the insulation. If a complete coating is not provided, the mesh will not be protected from deterioration and a true composite will not be formed. Manufacturers' recommendations should be followed because excessive or uneven base coat thickness can cause cracking and differential absorption. Greater crack resistance is not achieved by a thicker base coat alone. Significant increase in base coat thickness must be coupled with relative increase in mesh weight and strength.

Supplemental diagonal mesh is often required at locations where stress concentrations risk causing cracking, such as at corners of openings (see following figure).

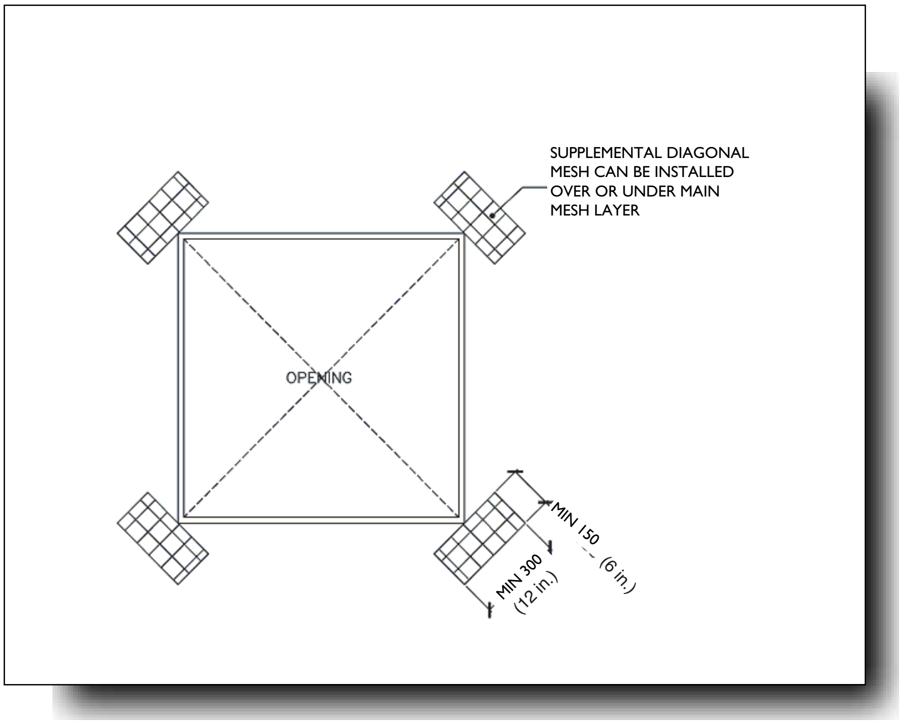


Figure B.5: *Use of supplemental diagonal mesh at opening corners*

Finish

There are a variety of finishes that can be applied to the base coat, including:

- polymer based;
- all polymer: acrylic or silicone modified (over thin base coats);
- polymer-modified cement over thicker polymer-modified cement base coats;
- silicone emulsions (not silicone modified) have tested to be very durable but are also much more expensive.

Quality finish coats often include pigments and aggregates and additives to resist dirt pickup and mold growth, plasticizers, air-entraining agents, etc. The size and grading of the aggregates and the method used to apply the finish coat allow for a wide range of surface texture, while pigments provide an almost unlimited range of colours.

Bright, non-earth tone colours such as blues and reds tend to fade over time.

Dark colours such as dark green and brown are likely to become warm with solar heating; this might present a concern with softening of foam plastic insulation.

Appendix C
SITE INSPECTOR AND APPLICATOR CHECKLIST

GENERAL

This checklist is intended for quality control review during application. Additional requirements or restrictions specific to an EIFS product or a specific project design may also need to be added to this checklist. In all cases, the written directions provided by the EIFS manufacturer should be followed.

BEST PRACTICE NOTE: Build and Test a Mock-Up

A mock-up should be completed and tested prior to the EIFS application to establish and verify the project detailing with respect to the substrate construction, sheathing application, secondary moisture barrier, air/vapour barrier, drainage details, and lamina. This should include typical joints, drainage details, and penetrations.

BEST PRACTICE NOTE: Test Sealant Adhesion

Sealant adhesion should be qualitatively verified by a trial application of the actual lamina, sealant primer and sealant materials delivered to the site. Sealant bond to EIFS is dependent upon chemical adhesion, and this may vary according to normal variations in the manufactured product, or as a result of variations introduced at the site. Testing adhesion provides an important check of the actual chemical and mechanical adhesion achieved. Periodic adhesion tests should also be conducted over the course of the work to check that subsequent batch lots of materials do not result in a change in performance.

1. GENERAL

- Access, *clean* water and power supply
- Weather conditions – now, freezing in the near future, and/or wall protection on hand
- Coordination with other trades, e.g., windows, sealant, waterproofing
- Insulation and Portland cement stored out of rain
- Pails of emulsion protected from freezing

2. SUBSTRATE

- Flat and level (to specifications)
- Surface condition for bonding (e.g., blast clean, test bond, remove coatings)
- Ability to resist lateral and vertical loads

3. INSULATION

- Type and approved supplier as per specifications
- Boards flat and square, beads well fused
- Storage away from rain wetting

4. AIR AND WATER BARRIER

- Type as per specifications
- Type and quality of Portland cement (if used) and mix ratios
- Proper tools
- Mixing procedures and coverage rates as per manufacturer
- Proper joint detailing and mesh reinforcing
- Curing conditions and time

5. ADHESIVE ATTACHMENT (IF USED)

- Type as per specifications
- Field bond tests required?
- Type and quality of Portland cement (if used) and mix ratios
- Proper tools
- Mixing ratio and mixing procedures as per manufacturer
- Adhesive patterns and coverage rates
- Curing conditions and time

6. MECHANICAL ATTACHMENT (IF USED)

- Type, especially corrosion resistance, as per specifications
- Field pullout tests required?
- Proper tools
- Fastener layout as per specifications and drawings
- Ability to accurately locate and secure fasteners to framing
- Unsealed secondary barrier punctures avoided by missed and relocated fasteners
- No fasteners over-torqued or not in structural substrate
- All fastener heads below surface
- No insulation bowing between fasteners

7. INSULATION BOARD INSTALLATION

- Board firmly in contact with substrate (especially adhesive systems!)
- Mesh properly back-wrapped or end-wrapped at all openings
- Tightly butted joints, or foam filled
- No adhesive in board joints
- Only L-shaped pieces at openings
- All boards in running bond
- All corners placed with a staggered pattern

8. BASE COAT PREPARATION

- Type as per specifications
- Type and quality of Portland cement (if used) and mix ratios
- Type and weight of reinforcement mesh as per specifications
- Proper tools for application and finishing
- All insulation sanded flat, undamaged with no gaps and not sun-yellowed
- Drip grooves and aesthetic joints routed and special foam shapes added
- Flashings and waterproof membranes in place at all penetrations

9. BASE COAT APPLICATION

- Acceptable weather conditions
- Sufficient manpower, equipment and material
- Mixing ratios and mixing procedures as per manufacturer
- Coverage rates and *minimum/maximum* thickness (as per specs)
- Reinforcing mesh embedded everywhere
- Extra reinforcing mesh installed at corners and high impact areas
- Base coat smooth and level
- Curing conditions and time
- Additional second base coat as required by specs and exposed mesh

10. FINISH COAT PREPARATION

- Type, especially colour and texture, as per specifications
- Type and quality of Portland cement (if used) and mix ratios
- Proper tools for application *and* texturing
- Base coat sufficiently smooth, undamaged, and mesh embedded

11. FINISH COAT APPLICATION

- Sufficient manpower, equipment and material
- Mixing ratios and mixing procedures as per manufacturer
- Coverage rates and texture
- Finish coat colour and texture matches samples
- Finish coat *stops at joints* to allow sealant to bond
- Curing conditions and time

Spec Note: This section specifies field-applied exterior insulation and finish system(EIFS) and prefabricated exterior insulation and finish panel system.

Part 1 – General

1.1 General

1.1.1 All conditions of the contract and Division 1, General Requirements apply to this section.

1.1.2 All work shall meet applicable codes and standards, the *Occupation Health and Safety Act* (latest edition), manufacturer's recommendations and good building practice.

1.2 Coordination

1.2.1 Ensure that the work of this section is closely coordinated with the work of related sections and with the Consultant.

1.3 Related Sections

1.3.1 Load-Bearing Metal Studs Section 05410

1.3.2 Sheet Metal Flashings and Trim Section 07620

1.3.3 Sealants Section 07900

1.4 Standards and References (incorporate into the appropriate articles)

1.4.1 ASTM C 1382

1.4.2 ASTM C 1397

1.4.3 CCMC Evaluation Reports

1.4.4 ULC-S701

1.5 Design Requirements

1.5.1 Substrate Sheathing/Substrate System.

1.5.1.1 Substrate sheathing/substrate system shall be type and condition approved by the EIFS manufacturer's field representative, and installed as per sheathing manufacturer's specifications.

1.5.1.2 Apply exterior insulation and finish system to one of the following recommended substrate sheathings or substrate system or approved equivalent:

1.5.1.2.1 Exterior grade cement board as per ASTM C1186

1.5.1.2.2 glass fibre faced, core-treated gypsum meeting ASTM C1177

1.5.1.2.3 sheathing meeting ASTM C1278

1.5.1.2.4 Cast-in-place concrete, clean of all dust, forming agents, And other *deleterious materials*

1.5.1.2.5 Unit masonry: confirm integrity for bonding and/or mechanical fastening capacity

1.5.1.3 Ensure maximum deflection of substrate under design loads does not exceed 1/240 times the span.

1.5.1.4 Ensure substrate is flat within 3.2 mm (1/8 in.) in a 1.2 metre (4 ft.) radius.

1.5.1.5 Substrate sheathing joints to be properly staggered as per manufacturer's instructions.

1.5.2 Water Resistant Barrier

1.5.2.1 On sheathing substrates, install a water resistant material such as a Code-compliant sheathing membrane, or barrier coating system forming part of the EIFS.

. 1.5.2.2 Ensure the barrier is either water shedding, or waterproof, continuous throughout the EIFS.

1.5.3 Air Barrier System

1.5.3.1 If required, incorporate an air barrier system.

1.5.3.2 Ensure waterproof air barrier system is continuous throughout the EIFS.

1.5.4 Detail Treatment

1.5.4 1 Ensure termination of EIFS at tops of walls is covered with a continuous waterproof membrane underlayment and sheet metal cap.

1.5.4.2 Conform with the EIFS manufacturer's specifications and/or the following guidelines for length and slope of inclined surfaces:

1.5.4.2.1 Minimum slope 150 mm (6 in.) rise in 300 mm (12 in.) projection.

1.5.4.2.2 Maximum length 254 mm; (10 in.).

1.5.4.2 3 EIFS system shall not be used for areas defined by codes as roofs.

1.5.5 Sealant System.

1.5.5.1 Joints in EIFS system shall use two-stage seals in joints where practical. An inner primary seal and outer weather screen drained sealant bead shall be provided.

1.5.5.2 Use only membranes, sealants, backer rod, bond breaker tape, primer and accessories approved and listed for use by the EIFS manufacturer. Sealant to be tested to ASTM C1382

1.5.5.3 Minimum joint width: 19 mm (3/4 in.) and shall be applied in a width-to-depth ratio of between 2:1 to 4:1, as recommended by the sealant manufacturer.

1.5.6 Movement Joints.

1.5.6.1 Provide two-stage sealant joints at all movement joint locations.

1.5.6.2 Provide movement joints at the following locations;

1.5.6.2.1 at movement joint locations within the substrate;

1.5.6.2.2 at building movement joint locations;

1.5.6.2.3 at floor lines of all wood frame structures and as required by the structural design of other framing types;

1.5.6.2.4 at junctions with different cladding materials and components;

1.5.6.2.5 at changes in substrate materials;

1.5.6.2.6 at changes in roof line, building shape or structural system;

1.5.6.2.7 at all other locations specified or indicated on Drawings.

1.6 Submittals

1.6.1 Product Data

1.6.1.1 Submit copy of EIFS manufacturer specifications, and installation instructions.

1.6.1.2 Submit copies of all relevant test data.

1.6.2 Shop Drawings

1.6.2.1 Submit shop drawings showing all components of the exterior insulation and finish system (EIFS) in as large a scale as practical, showing construction, methods of joining, bonding, fastening, sealing, anchorage, as well as type of material, thickness, finishes and other pertinent details.

1.6.2.2 Show details of connecting work of this Section with all adjacent building components, including window head, sill and jamb, roof parapet, base of wall termination at roof, underside of soffits, and terminations at brick masonry. Indicate on drawings input from the suppliers of the adjacent components.

1.6.2.3 Shop drawings for prefabricated exterior insulation and finish panel system shall bear the signature and stamp of qualified professional engineer registered in the jurisdiction of the project location.

1.6.3 Samples

1.6.3.1 Submit to the Consultant two 610 mm (2 ft.) x 1,200 mm (4 ft.) samples of the exterior insulation and finish system, with the specified finish and colour, specified fasteners, reinforcing mesh, control joints, and wire corner reinforcement. Samples shall represent the physical and chemical properties of the materials to be installed.

1.6.3.2 Maintain an approved sample at the project site.

1.6.3.3 Closeout Submittals

1.6.3.4 Submit to the Consultant the EIFS manufacturer's maintenance and repairs procedures.

1.6.3.5 Submit to the Consultant the EIFS manufacturer's cleaning procedures.

1.7 Quality Assurance

1.7.1 Qualifications

1.7.1.1 The EIFS applicator shall have adequate equipment and skilled tradesmen to install the system expeditiously, shall be known to have been responsible for satisfactory installation similar to that specified.

1.7.1.2 The fabricator for the exterior insulation and finish panel system shall have adequate plant, equipment and skilled tradesman to fabricate the system. The fabricator shall be experienced and authorized by the EIFS manufacturer for fabrication of the panel system. The plant shall be fully certified for local steel and welding requirements.

1.7.1.3 Erector for the prefabricated exterior insulation and finish panel system shall be the panel fabricator or shall be approved by and under the supervision of the panel fabricator with a minimum of 2 years experience.

1.7.1.4 Provide proof of qualifications when requested by the Consultant.

1.7.1.5 The EIFS applicator, panel fabricator and erector shall provide a certificate of training from the EIFS manufacturer to ensure competence and knowledge of materials and their installation.

1.7.2 Regulatory Requirements

1.7.2.1 Ensure EIFS complies with code requirements.

1.7.2.2 Submit Standards Council of Canada accredited agency listing for exterior insulation and finish system confirming its conformance with the National Building Code, applicable provincial code and municipal code requirements.

1.7.3 Mock-Up

1.7.3.1 Construct full size mock-up of exterior insulated and finished system demonstrating method of attachment, surface finish, colour and texture, including all typical components and typical connections to window and roofing assemblies.

1.7.3.2 Mock-up(s) to be to dimensions and in locations specified by the Consultant.

1.7.3.3 Mock-up(s) will serve for initial review purposes by the Consultant and when accepted shall represent the minimum standard for work.

1.7.3.4 All materials used for sample panels must be in complete accordance with this Specification.

1.7.3.5 Accepted mock-up(s) may remain as part of the work.

1.7.4 Pre-Installation Meeting

1.7.4.1 Attend pre-installation meeting to be scheduled by the Consultant on site.

1.7.4.2 Representatives of the Owner, Consultants, *Architects and Engineers*, General Contractor, third party inspector, EIFS manufacturer and contractor, substrate manufacturer and contractor, sealant manufacturer and contractor shall attend to review contract documents and site conditions.

1.8 Delivery, Storage and Handling

1.8.1 Deliver, store and handle materials following manufacturer's instructions.

1.8.2 Deliver materials to job site in dry condition.

1.8.3 Store materials under waterproof covering on elevated platforms well ventilated and protected from weather, dust dirt, ponding water, and construction activity.

1.8.4 Protect materials from freezing. Materials suspected of having been subjected to freezing are not to be used unless the Manufacturer verifies in writing the material has not been damaged.

1.8.5 Deliver and store materials in original packages with labels intact.

1.8.6 Protect unfinished insulation from direct sunlight.

1.8.7 Protect surrounding areas and surfaces from damage during installation.

1.8.8 Store materials away from open flame or ignition sources.

1.8.9 Do not transport any materials through the building unless authorized by consultant.

1.8.10 Protect finished work when stopping for the day or when completing an area in order that water will not penetrate behind the system.

1.8.11 Store prefabricated panels to prevent distortion and damage. Provide required positive protection to prevent damage to panel edges. Damage which cannot be repaired to the satisfaction of the Consultant shall be replaced.

1.9 Project / Site Conditions

1.9.1 Field applied exterior insulation and finish system: Ambient air and substrate temperatures shall be 4˚C (40˚F) or greater at the time of installation and for a period of at least 24 hours thereafter.

1.9.2 Prior to installation of the field applied exterior insulation and finish system, the substrate will be examined as follows:

1.9.2.1 The substrate shall be type approved by the Manufacturer.

1.9.2.2 The substrate surface shall be free of foreign materials such as oil, dust, direct form-release agents, paint, wax, glazing, water, moisture, efflorescence, frost, etc.

1.9.2.3 The substrate shall be examined for soundness, such as tightness of connections, crumbing, spalling of delamination or loose joints, voids and projections, etc.

1.9.2.4 The substrate shall be examined for compliance with contract documents.

1.9.3 Climatic Conditions

1.9.3.1 Temperatures during application shall not be less than the minimum recommended by the material manufacturer. Work shall not be carried out during inclement weather conditions and work in progress shall be protected until cured from inclement weather conditions.

1.10 Warranty

1.10.1 The warranty period stipulated in the general conditions of the contract shall be extended as follows:

1.10.1.1 The contractor and manufacturer shall each warranty that the work shall not leak, shall be free of defects of material, workmanship and performance, including excessive fading of finish, excessivem change in colour, or other deterioration such as cracking or grazing, 1 year for contractor workmanship, and 5 years for the manufacturer from date of total performance.

1.10.2 The contractor and manufacturer shall further agree that, at any time within these warranty periods and without cost to the owner, they shall:

1.10.2.1 make weathertight joints which are not weathertight;

1.10.2.2 replace or re-surface finish if it develops excessive fading, change in colour, or other deficiencies, such as cracking, peeling, etc. due to labour or material defects;

1.10.2.3 replace and make good any other work of this section which is or becomes defective.

Part 2 - Products

2.1 Manufacturers

2.1.1 The EIFS and components shall be as specified by the manufacturer and supplied from current stocks. No substitutes of, or additions to other material shall be done without prior written permission of the manufacturer and consultant.

2.2 Products

2.2.1 Substrate

2.2.1.1 Cement board or approved equal: Supplied or recommended by the EIFS Manufacturer.

2.2.1.2 Gypsum Sheathing: A treated gypsum core complying with ASTM C1177, surfaced with inorganic glass mats and an alkali-resistant coating. Thickness to be at least 12.7 mm (1/2 in.) to a maximum of 15.9 mm (5/8 in.).

2.2.1.3 Concrete masonry and cast-in-place reinforced concrete: Ensure concrete masonry and cast-in-place reinforced concrete is fully cured for a minimum of 28 days, clean, free of form release materials and dry.

2.2.1.4 Existing brick and concrete block. Remove or prime all painted surfaces with primer recommended by EIFS Manufacturer.

2.2.2 Air Barrier components if supplied by EIFS manufacturer:

2.2.2.1 All components of the air barrier system, including transition membrane, sealants, primers, mastics, reinforcement and adhesives shall be supplied by one manufacturer. Air barrier system shall be approved by the EIFS manufacturer and shall be compatible with the EIFS system and insulation approved .

2.2.2.2 Trowelled on air barrier. A high performance polymer-based water-resistant air barrier supplied by the EIFS manufacturer. Air permeability not to exceed 0.02 L/(s.m^2).

2.2.2.3 Reinforcement tape: Open weave self-adhering fiberglass mesh supplied or recommended by the air barrier and EIFS manufacturer. 100 mm (4 in.) wide roll.

2.2.2.4 Transition membrane: Composite membrane comprised of rubberized asphalt or SBS modified bitumen membrane backed with a high density polyethylene film. Minimum thickness 1.5 mm (1/16 in.). Supplied or recommended by the air barrier and EIFS manufacturer. Width and length to suit application. Self-adhering membrane must have tensile bond strength numbers submitted with the respective test method and reports should discern aged values from immediate values.

2.2.2.5 Transition membrane primer: Synthetic rubber-based adhesive type quick setting primer or water-based surface conditioner supplied or recommended by the air barrier and EIFS manufacturer.

2.2.2.6 Transition membrane sealant: supplied or recommended by the air barrier and EIFS manufacturer, and complying with ASTM E 2098.

2.2.3 Insulation

2.2.3.1 Rigid foam insulation: Expanded polystyrene foam insulation meeting ULC-S701, Type 1 and EIFS manufacturer's specifications and supplied by a manufacturer acceptable to the EIFS manufacturer. Nominal density of 16 kg/m^3 (1.0 lb/ft^3). Maximum size 600 mm (2 ft.) x 1,200 mm (4 ft.) with a minimum thickness of 50 mm (2 in.).

2.2.3.2 Other insulation materials in accordance with manufacturer's specifications.

2.2.4 Adhesive: polymer-based adhesive supplied or recommended by the EIFS manufacturer.

2.2.5 Mechanical fasteners: steel screw type fastener with corrosion resistant finish of type and size to suit substrate and to be supplied or recommended by the EIFS manufacturer.

2.2.6 Reinforcing Mesh: glass fibre mesh of various strengths standard, intermediate, and heavy duty, as supplied by the EIFS manufacturer.

2.2.7 Base Coat Material: Polymer-based material, supplied by EIFS Manufacturer.

2.2.8 Finishes: Polymer-based material, dirt resistant, supplied by EIFS Manufacturer.

2.2.9 Sheet metal flashing and trim: in accordance with Section 07620.

[Spec Note: Specifier should include in Section 07900, only sealants which are acceptable to the EIFS manufacturer]

2.2.10 Sealant: in accordance with Section 07900

2.2.11 Trim accessories: "J" and drip channels, expansion joints and corner beads as required and recommended by system manufacturer.

2.3 Materials

2.3.1 Portland Cement: Type 10 or 20, meeting CSA-A5 or ASTM C150, white or gray in colour, fresh and free of lumps

2.3.2 Water: Shall be clear and potable

2.4 Equipment

2.4.1 Hand or power tools associated with the plastering and EIFS trades, as supplied and/or recommended by the manufacturer.

2.5 Fabrication - Prefabricated Exterior Insulation and Finish Panel System

2.5.1 Fabricate the exterior insulation and finish panel system in accordance with the EIFS manufacturer's written fabrication instructions and as indicated on the reviewed shop drawings. Submit a copy of the EIFS manufacturer's written fabrication instructions to the Consultant, prior to fabrication.

2.5.2 Layout panel framing channels to the spacing required to provide wind load resistance in accordance with the reviewed shop drawings.

2.5.3 Cut the insulation boards to accommodate the framing channels. Prepare and install framing channels with adhesive into the precut slots in the insulation boards.

2.5.4 Apply exterior finish system in strict accordance with EIFS manufacturer's written instructions.

Part 3 - Execution

3.1 Examination

3.1.1 Examine areas to receive the field applied or panelized EIFS system for deviations from contract documents and this specification which will adversely affect installation.

3.1.2 Advise the Consultant, General Contractor and the EIFS manufacturer's representative of all deviations in writing. Do not start work until satisfactory conditions are corrected.

3.1.3 Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 General

3.2.1 Perform work in accordance with the latest EIFS manufacturer's written application instructions.

3.2.2 Where manufacturers' printed instructions are not available, or a situation is ambiguous or unique, consult the Manufacturer's Technical Representative and the Consultant to review the situation and make clarifications. Instructions will be confirmed in writing by the Consultant and/or Manufacturer.

3.3 Substrate Sheathing

3.3.1 Install substrate sheathing in accordance with the manufacturer's latest installation instructions and proper fastening pattern to resist required wind loads.

3.3.2 Prior to applying the air barrier, examine the cement board or gypsum sheathing to insure that it meets design requirements as specified in Paragraph 1.5.1.

3.3.3 Replace substrate sheathing as required to repair all gaps in excess of 9.5 mm (5/16 in.) measured in any one direction.

3.4 Preparation

3.4.1 Before installation, applicator is to take field measurements.

3.4.2 Surface shall be clean and dry, free of grease, oil, paint, and other foreign materials

3.4.3 Wall surface and ambient temperature shall be a minimum of 4˚C (40˚F) and rising.

3.5 Air Barrier

3.5.1 Apply reinforcing tape to all vertical and horizontal board joints, exposed edges at terminations, inside and outside corners, etc., of the substrate sheathing. Centre reinforcing tape on the board joint, corner edges, etc., with the pressure sensitive adhesive backing in contact with the substrate surface.

3.5.2 Mix, prepare, and apply the air barrier in accordance with the manufacture's latest application instructions. The air barrier retarder shall be applied to all surfaces, including exposed edges.

3.5.3 Install transition membrane at all movement joints, junctures to window fenestration, junctures with roofing membranes. Transition membrane shall be of sufficient width to lap both sides of joint, crack or transition a minimum of 75 mm (3 in.). Mechanically attach transition membrane to window frames where indicated on Drawings.

3.5.4 Apply specified primer as per Manufacturer's printed instructions and allow to dry. The primer must be given sufficient time to dry, as per the manufacturer's instructions and must not be left exposed beyond the time specificed by the manufacturer. The primer must be allowed to become "tacky" before installation of the transition membrane. Ensure transition membranes are installed on the same day as priming. Primed surfaces not covered by transition membranes on the same day must be reprimed.

3.5.5 Maintain the recommended 50 mm (2 in.) minimum side-lap and end-lap as per the manufacturer's printed instructions.

3.5.6 Roll the transition membrane immediately after placement to ensure continuous adhesion. The roller to be of the type and size recommended by the manufacturer.

3.5.7 Ensure the continuity of transition membrane is maintained at all penetrations and terminations. Apply transition membrane sealant as required to fill inaccessible gaps following the manufacturer's instructions.

3.5.8 Seal end of transition membrane to substrate with specified sealant at end of each work day.

3.5.9 Allow air barrier to cure for a minimum of 24 hours before the installation of the insulation.

3.5.10 Ensure completed air barrier system is reviewed by consultant prior to installation of the insulation.

3.6 Insulation

3.6.1 Install insulation over cured air barrier adhesive. Apply adhesive to the insulation board in the pattern and at the rate specified by the manufacturer. Immediately press the insulation into the adhesive and slide into position. Attachment of insulation shall be performed before the skin has formed on the adhesive. Do not allow the adhesive between the board joints.

3.6.2 Secure insulation over cured air barrier with specified fasteners at the rate specified by the manufacturer.]

3.6.3 Install insulation starting from the base of the wall with its long edge oriented horizontally, beginning in the field of the wall and working outward to outside corners. Offset insulation board joints from sheathing board joints a minimum of 150 mm (6 in).

3.6.4 Install insulation in a staggered pattern with vertical joints offset.

3.6.5 Back-wrap insulation at all terminations such as movement joints, wall openings, parapets, grade level, etc. Reinforcing mesh shall extend behind insulation board a minimum of 50 mm (2 in.).

3.6.6 Precut insulation to fit openings, corners, or projections. Board edges shall not align with corners of wall openings.

3.7 Application of Base Coat, Reinforcing and Finish

3.7.1 Inspect surface of insulation for flatness, damage, deterioration due to weathering, and repair prior to application of base coat. Ensure insulation is flat within 3.2 mm (1/8 in.) in a 1.2 metre (4 ft.) radius. The entire surface of the exposed insulation board must be rasped and cleaned off, prior to the base coat application.

3.7.2 Apply base coat in the thickness specified for the reinforcing mesh to be used.

3.7.3 Immediately embed reinforcing mesh into uncured base coat until the surface of the mesh is not visible.

3.7.4 Lap reinforcing mesh a minimum of 63 mm (2.5 in.) both vertically and horizontally as it is being embedded into the base coat. [Butt tightly all joints in heavy duty reinforcing mesh.]

3.7.5 Apply finish according to the respective application type for the desired texture.

3.7.6 Protect from rain for a minimum of 24 hours or until dry/cured

3.8 Erection of Prefabricated Exterior Insulation and Finish Panel System

3.8.1 Erect the prefabricated exterior insulation and finish system panels in accordance with the reviewed shop drawings and the EIFS manufacturer's written instructions. Submit a copy of the EIFS manufacturer's written erection instructions to the consultant, prior to fabrication.

3.9 Protection

3.9.1 Protect EIFS and adjacent materials from the weather and other damage during installation and while curing.

3.10 Application of Sealants

3.10.1 Apply sealants as per Section 07900, Sealants.

3.11 Two-stage Sealant Joint Design

3.11.1 Provide two complete beads of sealant and backing at all EIFS panel joint locations at all locations without a continuous secondary moisture barrier.

3.11.2 The inner bead of sealant will form the water and air tight seal. This bead shall be continuous and shall be located as close to the back of the panel joints as practical.

3.11.3 The outer bead of sealant will form the weather screen and shall be continuous except at drainage opening locations in the vertical panel joints. Provide a 38 mm (1 1/2 in.) long drainage opening in all vertical panel joints approximately 50 mm (2 in.) below the horizontal joint intersection.

3.11.4 Ensure a minimum 25 mm (1 in.) free drainage cavity is provided between the inner and outer bead of sealant.

3.11.5 Provide a bead of sealant and backing in the vertical panel joints between the inner and outer beads of sealant at all drainage locations as indicated on Drawings. This bead of sealant shall be installed at a minimum five per cent positive slope to the exterior.

3.11.6 Provide a bead of sealant and backing within the horizontal panel joints between the inner and outer beads of sealant at EIFS corner panels. This sealant bead will act as a baffle to compartmentalize the drainage cavity. Locate the baffle at the centre of the horizontal panel joint.

3.12 Installation of Sheet Metal Flashings

3.12.1 Execute work as per Section 07620 - Sheet Metal Flashing and Trim and in accordance with relevant drawings and details.

3.13 Final Cleaning

3.13.1 Remove materials left over by applicator at the job site.

3.13.2 Clean adjacent materials and surfaces and the work area of foreign materials resulting from their work

Appendix E

BIBLIOGRAPHY

More specialised and detailed information can be found in:

Research reports by CMHC:

Exterior Insulation and Finish Systems (EIFS) Problems, Causes and Solutions by Chris Mattock of Habitat Design + Consulting for CMHC, May 1991.

Exterior Insulated Finish System, J. Posey and J. Vlooswyk, Canada Mortgage and Housing Corporation, September 23, 1993.

Rain Penetration Control - Applying Current Knowledge by Morrison Hershfield for CMHC, October, 2001.

By others:

EIFS Standards:

"Standard Practice for Application of Class PB EIFS." ASTM C1397-02,© 2002 American Society of Testing and Materials, Philadelphia, PA.

"Test Method for Determining Tensile Adhesion Properties of Sealants When Used in EIFS Joints." ASTM C1382-02, © 1997 American Socity of Testing and Materials, Philadelphia, PA.

EIFS Publications:

"AWCI EIFS Course Manual for Mechanics & Inspectors." Canadian Version, published February 2000. Licensed to EIFS Council of Canada, by Association of Wall and Ceiling Industries, Falls Church, Virginia.

"Development, Use & Performance of EIFS," M. Williams and R. Lampo, Editors, ASTM STP 1187, © 1995 American Society of Testing and Materials, Philadelphia, PA.

"EIFS: A Curriculum for Members of 'The International Brotherhood of Painters & Allied Trades,'" The International Brotherhood of Painters & Allied Trades Joint Apprenticeship Training Fund, 1998 Washington, DC.

"EIFS: Current Practices & Future Considerations," M.F. Williams and B. Lamp-Williams, ASTM MNL 16, © 1994 American Society of Testing and Materials, Philidelphia, PA.

"EIFS Design Handbook," R. Thomas, © 1997 CMD Associates, Vashon Island, WA.

"EIFS Inspection Program Reference Manual, " R. Thomas, © 1997 CMD Associates, Version BC 1.01, Vashon Island, WA.

"EIFS: Materials, Properties & Performance," P.E. Nelson and R.E. Kroll, Editors, ASTM STP 1269, © 1996 American Society of Testing and Materials, Philadelphia, PA.

Evaluation of Exterior Insulation Cementitous Fibre-Reinforced Cladding Systems, by Trow Consulting Engineers for The Ontario Ministry of Housing, February 1989.

"A Review of EIFS," A. Larden & M. Gerskup, produced by the Ontario Architects Association, February 1998.

References

European Organization for Technical Approvals (EOTA). "ETAG 004: Guideline for European Technical Approval of External Thermal Insulation Composite Systems with Rendering", March, 2000, pg. 18.

Brown, W.C., Lawton, M., & Lang A., "Stucco-Clad Wall Drying Experiment" – BERC Report April 7, 1999, published by Canada Mortgage & Housing Corporation, section 4.

Bomberg, M., Kumaran, K., & Day, K., "Moisture Management of EIFS Walls – Part 1 The Basis for Evaluation" Journal of Thermal Envelope & Building Science, Vol. 23 © July, 1999, pg. 82.

European Organization for Technical Approvals (EOTA). "ETAG 004: Guideline for European Technical Approval of External Insulation Composite Systems with Rendering", March 2000, section 5.1.3.

Best Practice Guide – Building Technology Exterior Insulation and Finish Systems (EIFS), Halsall Associates Limited