EXTERIOR INSULATION AND FINISH SYSTEMS
(AND OTHER PROBLEMS WITH BUILDING ENVELOPES)

By
N. Hall, Ph.D., P .E., A.I.A.

EIFS SYSTEM OR EIF SYSTEM?

EIFS stands for "Exterior Insulation and Finish System." Some folks contend that the correct pronunciation is "Efs" and not "E-fus." These people are specs writers. Chase them off your job sites. Other folks argue that the term "EIFS System" is redundant and the correct term is "EIF System." They also say "OSB" instead of "OSB board." These people are value engineers. Shoot them.

THE ORIGIN OF EIFS

It was first developed in Europe after World War II as a means for the rapid reconstruction of war-torn towns and cities. The energy crisis necessitated the development of retrofit wall systems that added a layer of insulation to the outside of existing walls. European construction typically consisted of a masonry wall clad with cement stucco. Materials such as cork, rock wool and fiberglass were unsuitable for use either as exterior cladding or with stucco finish. By the 1960s, expanded polystyrene became available. Despite their otherwise compatibility, the coefficient of expansion and contraction for polystyrene is about six times that of cement stucco. As a result, synthetic stucco utilizing polymer chemistry replaced traditional hard stucco as the finish coat in prototypical EIFS. Recently, the use of acrylics is being challenged by vinyl acetate ethylenes (VAEs), a European product with unproved moisture resistance and fire retardancy (most EIFS systems cannot be used in interior space because of low flame spread ratings).

In addition to lowering energy bills, the exterior placement of insulation reduced the temperature difference between habitable space and building structure. This reduced the tendency for building components to move, crack and offer pathways for moisture intrusion. The popularity of EIFS then spread across the Atlantic. The first use of EIFS in the United States was in 1969 by Dryvit System. Between 1969 and 1976, national EIFS sales remained below $2 million.

EIFS SYSTEM TYPES

"First generation" EIFS with which most of us are familiar is now called "barrier" EIFS because it was designed to keep water from penetrating the synthetic stucco cladding. Barrier EIFS is a non-load bearing cladding system consisting of (1) insulation board adhered or mechanically fastened to a substrate such as plywood or OSB board, (2) glass fiber reinforcing mesh, (3) base coat on the face of the insulation board that functions as a weather barrier and (4) a textured protective finish coat.

"Second generation" EIFS was developed in response to the high numbers of instances that water infiltrated behind the weather barrier of barrier EIFS.

There are six basic types of EIFS systems.

1) **Class PB Systems (Polymer Based EIFS**) use expanded polystyrene rigid insulation, a reinforcing mesh embedded into the base coat and usually a 1/8-inch thick coating of synthetic stucco (or lamina), depending on the thickness of the mesh. PB Systems are also called "original" or "soft" EIFS.

2) **Class PM Systems (Polymer Modified EIFS)** use extruded polystyrene rigid insulation, a reinforcing mesh installed over the surface of the insulation board and a 1/4inch to 3/8 -inch thick base coat regardless of the thickness of the mesh. PM Systems were developed for impact resistance and are also called "hard" EIFS.

3) **DEFS (Direct-applied EFS)** is an exterior finish system (without insulation) designed for direct installation onto substrates such as Dens-Glass Gold or Cement Board. DEFS is typically used at soffits, stairwells, balcony walls and areas subject to high impact

4) **OCS (One Coat Stucco)** is applied like traditional stucco (with metal lath or stucco netting) but uses a polymer modified stucco mix "right out of the bag".

5) **Quick R** is a polyisocyanurate rigid wall insulation designed for use under barrier EIFS. Typically it is fastened over masonry block to met new energy codes and provides an even substrate surface

6) **Drainage EIFS** is a polymer based system introduced in 1996. In most "drainage" EIFS systems the insulation board is grooved to permit water to run down the wall to weeps installed at the bottom of the cladding. A drainage plane such as Tyvek or felt paper is installed between the insulation board and substrate.

COMMON PROBLEMS

Most damage from water intrusion occurs at window openings, deck attachments and roof lockout flashing. An on going study (albeit incomplete) by HUD found that many common deficiencies are caused by poor workmanship, such as

1) **Thin base coat**. Applications with base coats thinner than the manufacturer's required thickness were common.

2) **Exposed mesh**. Many jobs had exposed mesh at joint edges and at terminations. Mesh that is not fully embedded is exposed to moisture and won't provide good impact resistance.

3) **Sealant failure.** Failures at EIFS field joints were common, typically cohesive failure of the finish coat.

4) **Cracking in V-grooves**. Cracking is most common when the V-groove falls on an insulation board joint beneath.

5) **Cracking at openings.** Cracking at the corners of windows and similar openings are caused by stresses at the reentrant (inside) corners.

6) **Cracking at board joints.** Cracking not associated with openings or joints occurred over the gaps between insulation boards and grow worse as the reinforcing mesh loses tensile strength from exposure to moisture and alkalinity.

PROBLEMS BREWING

Dryvit and other large manufactures concentrated on commercial markets until the 1980s. Then, large and smaller companies joined with local homebuilders associations to attack the residential market. By 1994, 35% of new homes were being clad with EIFS. In 1995 nearly 50% of new homes in the Virginia Beach area had at least some EIFS on them. As the market boomed, quality control became the first casualty.

As early as 1994, homeowners in Wilmington, North Carolina complained of water intrusion, mold, wood rot and insect infestation in the exterior walls of their EIFS-clad houses. Building inspectors discovered that the EIFS was installed without flashing and sealant. Water easily flowed behind the synthetic stucco cladding. High relative humidity of the coastal area retarded evaporation within the walls.

An American Institute of Architects (AIA) Task Force conducted a survey in Wilmington in 1995. 209 homes were inspected in 16 subdivisions, involving 19 builders, 10 applicators and 12 manufactured EIFS systems. 68% of the installations had improper or no caulk joints which at the time were required by most EIFS manufacturers. 94% of the residential homes inspected suffered from some degree of water intrusion. The Task Force concluded that Wilmington homes with EIFS had "significant problems with moisture within exterior walls… causing accelerated rotting and decay of construction materials." The cause of the problem in part "is the inability of EIFS systems, as presently engineered and applied, to adequately dram moisture once it is within the walls of a structure."

As a result of the North Carolina experience, a class action lawsuit *(Ruff v Parex)* was filed. The particulars of the lawsuit are available at www.kinsella.com/eifs. Reportedly Synergy agreed to contribute $20 million to help repair residential homes that sustained damage to homes clad with products sold under the Synergy or ThoroWall brands. The class action suit continues against Dryvit, Sto, Parex, Bonsal, Continental Stucco, Thomas Waterproof Coatings, United States Gypsum and Shield Industries.

For those interested in inspecting EIFS, the website includes the EIFS Inspection Protocol mandated by order of the Court. This protocol specifically applies to the Synergy class action settlement in North Carolina, but it has become a nationwide industry standard. The protocol requires the use of both a scanning meter like the Tramex Wet Wall Detector and a resistance probe meter like meters by Delmhorst or Lignom.

EIFS INDUSTRY MEMBERS ASSOCIATION (EIMA)

EIMA is an association of major EIFS manufacturers and installers. Absent from the ranks are United States Gypsum Company (which ceased production of its barrier EIFS in 1995) and Senergy (which resigned in 1998 to concentrate on residential markets for drainage EIFS). Senergy now markets a one-piece drainage mat/building paper (Drainage Wrap DF) for faster and easier residential installation.

EIMA is currently developing with ANSI a standard specification for the application of EIFS systems. EIMA's web site is www.eifsfacts.com

THE USG/NRCC STUDIES

After ceasing production of barrier EIFS in 1995, USG conducted a series of studies with the National Research Council Canada (NRCC). The study concluded that barrier EIFS leaked under rainy conditions and readily allowed water to enter into the sheathing and wall cavity. Although water only penetrated around windows and other openings, it penetrated even when the wall construction incorporated sealants and backer rods. Where an interior vapor retarder (required by Canadian building codes) was used, the wall cavity never dried out. The study reported favorably on drainage EIFS systems.

NORTHERN VIRGINIA STUCCO HOMEOWNERS COALITION (NOVASHOC)

With the advent of the Internet, consumers are able to research products and network with dissatisfied buyers. This is certainly true for homeowners, whether they are thinking of buying a house or are experiencing problems in the one they have purchased. Keyword "EIFS" on any search engine and you will find a wealth of information, some highly technical and some rather opinionated. One EIFS website is www.novashoc org (This website is being replaced but you can still sign on and follow directions to the new site). Whether you agree or disagree with these opinions, if you are involved with an EIFS clad residence, chances are the homeowner has visited this website.

THE NAHB STUDY

On the heels of the AIA Task Force study, the National Association of Home Builders commissioned another Wilmington study. The study called for third-party certi-fication for EIFS applications.

EXTERIOR DESIGN INSTITUTE (EDI)

EDI is an association that accredits third-party EIFS inspectors. It's website is www.exterior-design-inst.com

Currently the BOCA Building Code used in northern states requires independent third-party inspection. The UBC used in western states and the SBCCI code used in southern states does not.

CURRENT NEWS

Building codes in North Carolina and Georgia now ban barrier EIFS (but allow drainage EIFS).

In October 1998, EIMA recommended that in one and two family dwellings, EIFS be combined with a means, which allows water entering an EIFS assembly to drain.

The proposed settlement of *Ruff* v Parex will award individual payments between $15,000 to $18,000 to affected homeowners. More information is available at www.ncstucco.com. Except for Sto Corp, affected homeowners will receive $6 per exterior square foot of damage. The formula for Sto Corp stucco has yet to be determined, but the firm agreed to place $2.2 million into a payment fund.

The North Carolina Court of Appeals has instructed the trial court in *Ruff* v Parex to permit EIFS manufacturers named as defendants to add claims against home builders, sub constrictors, window manufacturers, architects and others.

Ten EIFS manufacturers and four EIFS distributors have been named defendants in a class action suit filed in Texas State court (McCray vs Parex)

Eight EIFS manufacturers have been named defendants in a class action suit filed in the U S District Court in Urbana, Illinois

At a recent public hearing in Arlington, Texas the Texas Lathing and Plastering Contractors succeeded in derailing plans to prohibit the use of EIFS on Arlington hotels and motels.

In South Carolina, a combined lobbying effort by EIMA and the Carolina Lath and Plastering Contractors Association turned aside a proposed statewide ban on EIFS with proposed legislation requiring that exterior applicators be certified.

The International Conference of Building Officials (ICBO) has agreed to adopt acceptance criteria for the use of EIFS The International Code is scheduled to replace the UBC, BOCA and SBCCI codes now in use.

SEALANTS

Most problems concerning water intrusion in EIFS systems are due to either (1) the absence of caulk sealant or (2) improperly applied caulk sealant. In general, all EIFS claddings should be held back 3/8-inch to 1/2inch from windows, doors and protrusions to allow for a

proper caulk sealant isolation joint. If the window or door detail does not permit an isolation joint, a triangular fillet joint using a small diameter backer rod and caulk sealant will be used.

There are four types of joint failure.

1) **Adhesive failure.** occurs when the sealant loses adhesion to the sides of the joint. This can be cause by poor joint preparation, lack of required sealer, incorrect sealant selection or excessive joint movement.

2) **Cohesive failure** occurs when the sealant itself fails in its strength. This can be caused by aging sealant, improper mixing or by joint movement beyond the ability of the sealant.

3) **Substrate failure** occurs when the surface of the joint sides fail. Thus can be caused by weak substrate strength or damage to joint sides by excessive load to joint area.

4) **Three-sided adhesion** occurs when sealant is allowed to adhere to three sides, preventing the sealant from elongating properly.

MOISTURE CHECKING

The four most predominant moisture transport mechanisms are:

1) **Liquid Flow:** This involves groundwater or ram moving under the influence of a driving force. Leaks will occur if three conditions prevail: (a) water is present, (b) an opening in the building envelope exists and (c) a driving force such as gravity, momentum, surface tension or air pressure differential is present.

2) **Capillary suction:** This mechanism acts primarily to move moisture through porous materials. It is a function of pore size and available moisture.

3) **Air movement:** This mechanism can move moisture into building assemblies both from with the conditioned space and from the exterior. For moisture to be moved into a building assembly, three conditions must exists (a) air containing moisture is present, (b) an opening exists in the assembly and (c) an air pressure difference acting across the opening exists. Moisture can enter a building assembly without being deposited in the assembly itself. Fast flowing air can warm the surfaces of the flow path above the dew point temperature and condensation may not occur.

4) **Vapor Diffusion:** The final transport mechanism is vapor diffusion, or the movement of moisture in the vapor state through a material.

What is an acceptable level of moisture behind synthetic stucco? The NAHB study recommends that "moisture in the vicinity of 20 percent or lower should be considered acceptable" and "moisture exceeding 20 percent but less than 30 percent should be periodically monitored." Only moisture "found to be above 30 percent at any time" should be investigated for decay.

The NAHB recommendation appears unworried. EIMA recommends "additional tests" whenever the moisture content is 20% or greater The *Ruff v* Parex protocol requires inspectors to record moisture readings of 25% or greater "as sustained moisture" but only requires mapping of areas where readings of 30% or greater are found, or where the sheathing appears "to have lost structural integrity", presumably when the meter probes meet little resistance and readily puncture rotted substrate.

SUBSTRATES

OSB (oriented strand board) is often used as substrate for EIFS systems. Recently, Louisiana Pacific, a major manufacturer of OSB distributed in the southeast was charged with 18 counts of fraud and fined $36 million dollars for shipping defective OSB to the construction industry. Resin counts were reduced and a board lower in quality than standard Grade I plywood was produced.

Other substrates include plywood, exterior gypsum board, Durorock cement board, DensGlass Gold and (for use with Quick R) polyiso board.

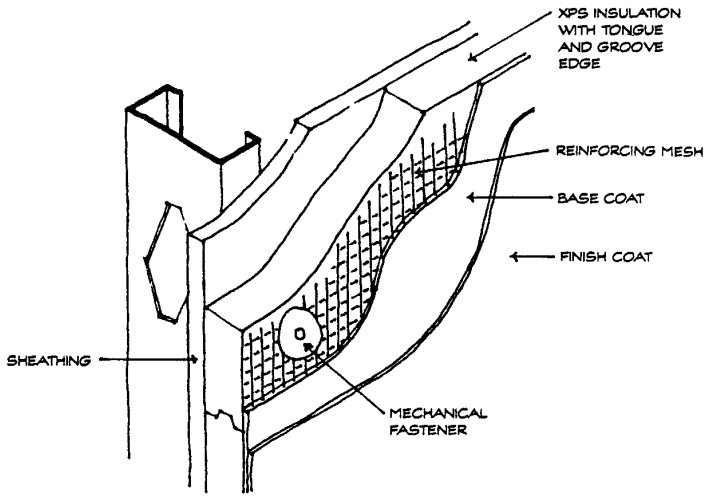
EIFS AND MOLD

With the recent popularization of indoor environmental quality issues, the connection between EIFS and mold is a growing concern. The Wisconsin Department of Health has issued on their website a health advisory connecting moisture through EIFS cladding as a source of indoor mold infestation and mold-induced illness. This set off a firestorm of controversy, leading to a June 6, 2000 ***Extra*** television program and a reclama by EIMA, pointing to a 1994 Harvard study of 10,000 randomly selected homes showing that half incurred water damage no matter what type of cladding (brick, stucco, clapboard and vinyl siding) was used.

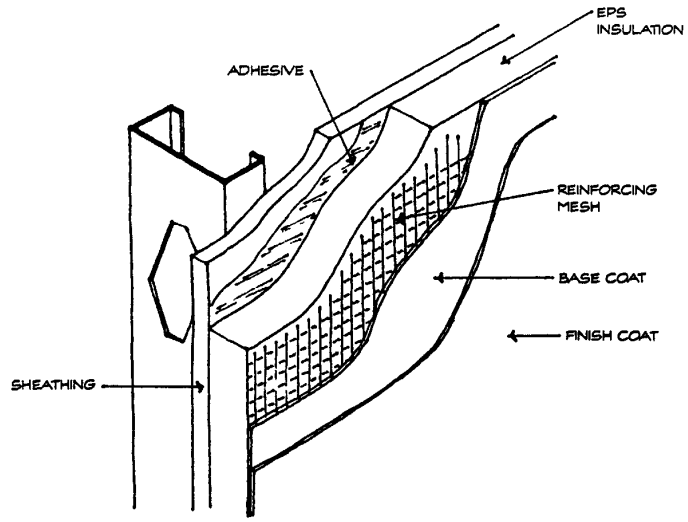
WHAT NEXT?

The move towards drainage EIFS is seen as one way to resolve the issue. However, the system avoids the problem of "keeping water out" in favor of a strategy of drainage. If the vapor barrier placed between the substrate and insulation board fails, so does the system. As reports of systems failure trickle in, a new field of legal practice called "stucco law" is already gearing for the next round of lawsuits.

Cleaners and restorative dryers are involved in EIFS disputes for various reasons. First, there is the problem of cleaning EIFS cladding. A new controversy concerns the problem of pressure washing Secondly, there is the problem of entrapped moisture. If restorative dryers must dry the inside of wall cavities, does that responsibility involve drying wet and rotting substrate attached to the outside of wood-framed walls? Finally, to what extent are cleaners and dryers to be responsive and responsible for the inspection of EIFS systems? Once the building is dry, is a dryer responsible to close openings that caused the moisture problem.



CLASS PM EIFS



CLASS PB EIFS

Figure 8 18 Two basic types of exterior insulation and finish systems (*Adapted from Williams and Williams, Exterior Insulation and Finish Systems, Current Practices and Future Considerations, ASTM Manual 16*)

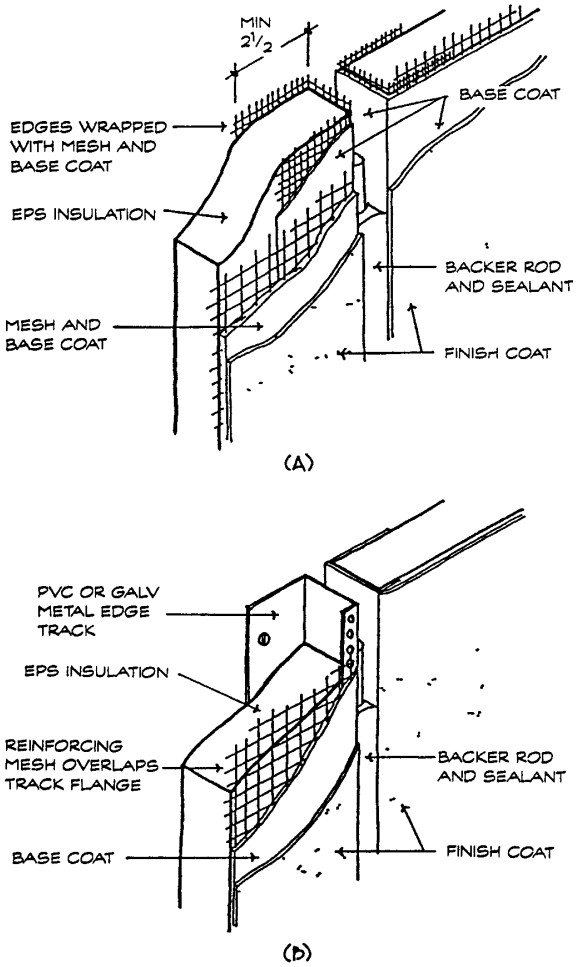


Figure 8.20 Sealant joints in EIFS

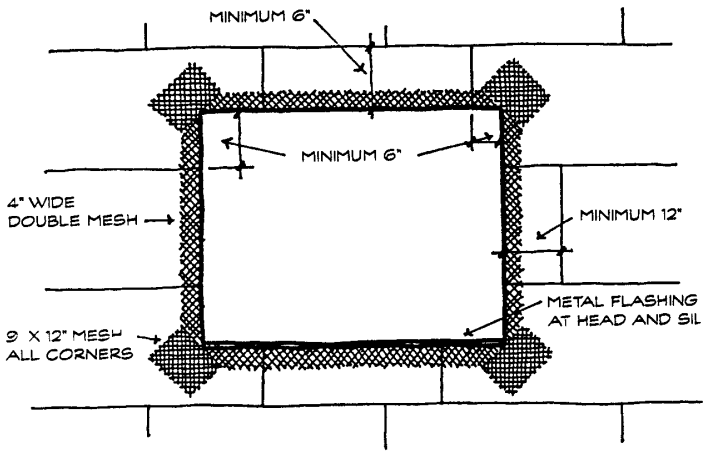


Figure 8.19 Corner reinforcing at window openings in EIFS

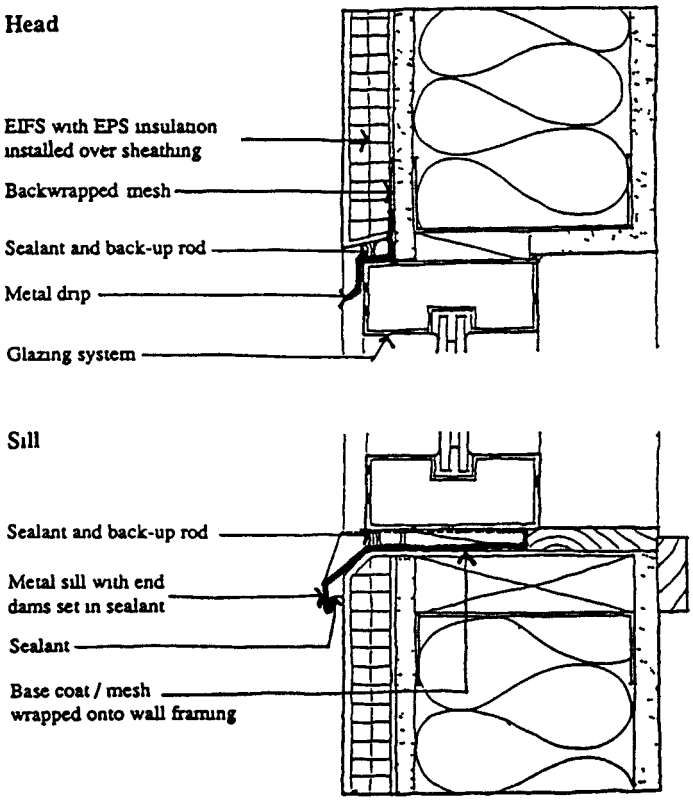
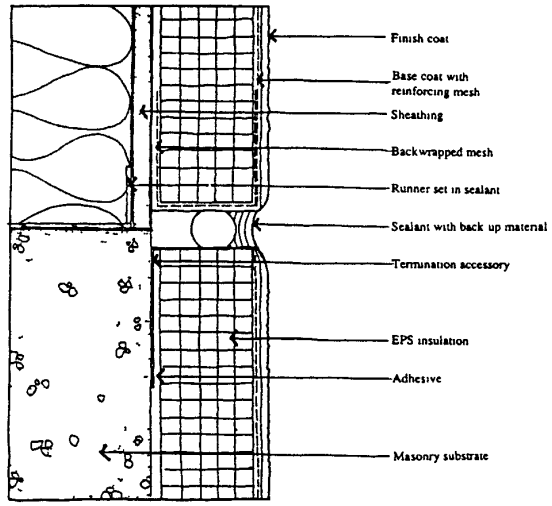
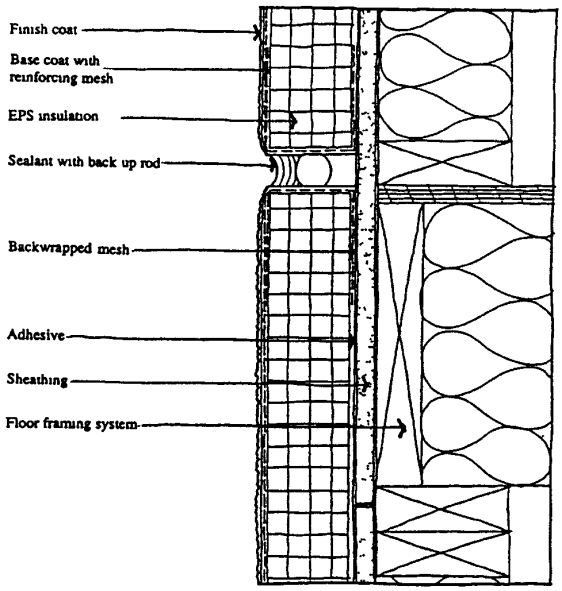


Figure 8 22 EIFS details at window head and sill (*From Williams and Williams, Exterior Insulation and Finish Systems, Current Practices and Future Considerations, ASTM Manual 16 Copyright ASTM Reprinted with permission*)

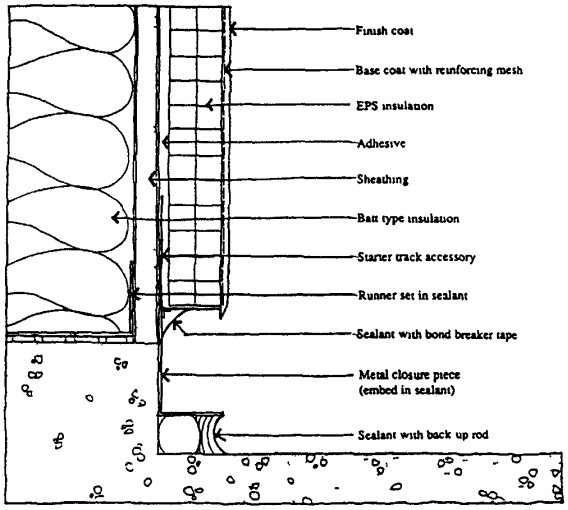


(a)



(b)

Figure 8 23 EIFS details at expansion joints (*From Williams and Williams, Exterior Insulation and Finish Systems, Current Practices and Future Considerations, ASTM Manual 16 Copyright ASTM Reprinted with permission*)



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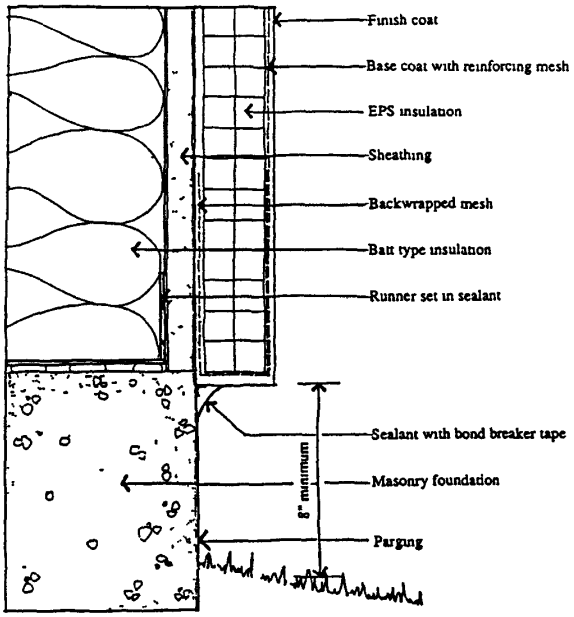

(b)

Figure 8 24 EIFS details at base of wall (*From Williams and Williams, Exterior Insulation and Finish Systems, Current Practices and Future Considerations, ASTM Manual 16 Copyright ASTM Reprinted with permission*)