

EIFS:

Practical Solutions for Addressing Damages to Existing Buildings

By Derek A. Hodgin, PE, RRO, RRC, RWC, CDT

BACKGROUND

History

The Exterior Insulation and Finish System (EIFS) was originally developed in West Germany in the 1960s. The original market for EIFS was providing an insulation layer to existing masonry structures. EIFS was introduced in the U.S. in the 1970s. U.S. manufacturers adapted EIFS for use on new construction, including wood-framed structures. An EIFS system is comprised of five components (adhesive or mechanical fasteners, insulation board, reinforcing mesh, base coat, and finish coat) that were originally intended to serve as a “barrier” cladding (see Figure 1). A successful barrier cladding serves as the only line of defense against weather and does not allow significant water penetration.

Litigation

Problems with water intrusion on EIFS-clad structures began surfacing in the 1980s. To date, thousands of EIFS-clad buildings have been the subject of litigation. While there is no single cause for damages to EIFS-clad structures, the typical arguments are summarized as follows:

- The **OWNER** does not know who caused the problems. The owner wrote checks to contractors and design professionals and relied on the expertise of these individuals to deliver an adequate product, free of defects or damage.

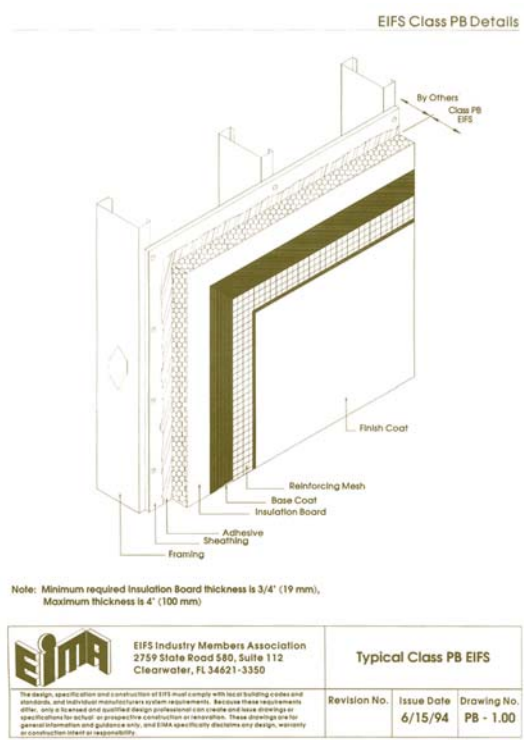


Figure 1

- The **GENERAL CONTRACTOR** blames the applicator (if available) for improper installation and the manufacturer and/or design professional for inadequate installation details.
- The **DESIGN PROFESSIONAL** blames the contractor and/or applicator for improper installation and the manufacturer for inadequate installation details.
- The **MANUFACTURER** blames the contractor and/or the applicator for

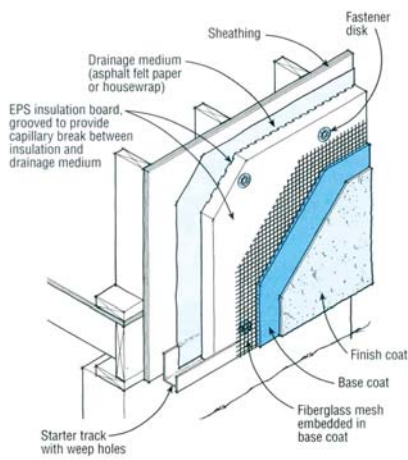
improper installation and the design professional for inadequate installation details.

Some cases involve more parties, which allows more blame to be spread around. However, the purpose of this paper is not to rehash the arguments described above but to identify areas of typical damage on EIFS-clad structures and present practical repair options.

Current Practices

While original barrier EIFS is still in use, many new construction projects (and many repair projects) include “drainable” EIFS cladding. Drainable EIFS includes the same basic component but incorporates a drainage plane and flashings to address incidental water intrusion. The drainage plane is created using a fluted insulation board and/or a drainage mat. All drainable EIFS cladding systems include some type of moisture barrier (see Figure 2). Terminations of drainable EIFS cladding systems include a weeping mechanism and flashing details.

The installation details required for drainable EIFS cladding are similar in concept with details of nearly all drainage-type claddings. While the author has not investigated or observed significant damages associated with drainable EIFS, the viability of the system is dependent on the quality of the installed details. The technical design concepts of drainable EIFS appear to make sense. However, as with all building assemblies, bad construction can always void a good design.



EIFS can be applied on wood-framed walls, provided the wall is designed to drain when the stucco cracks. The drainage plane relies on well-detailed sheathing wrap and flashing, and a grooved EPS insulation board.

Figure 2

REPAIR OR REPLACE

Determine the Extent of Damage

Before deciding to repair or replace EIFS on a damaged building, the full extent of damage must be determined. In most cases, the extent of damage is limited to localized areas at wall penetrations. This is consistent with the familiar “90/1” rule in waterproofing.¹ This rule suggests that 90 percent of all water intrusion occurs in approximately one percent of the building envelope area. Of the numerous EIFS repairs and replacement projects that have been documented by the author, this rule seems to hold true. It is very rare (never observed by the author) that water intrusion occurs in the field of an EIFS-clad wall with no penetrations.

The survey of damages should be performed by a qualified inspector using a probing-type moisture meter (see Figure 3). While non-destructive moisture meters are handy for covering large wall areas (see Figure 4), they need to be “ground truthed” on every building elevation and may miss areas that have been previously damaged but are no longer associated with elevated moisture. The moisture meter probes should be used to provide a qualitative assessment of the condition of the underlying wall sheathing (i.e., soft, hard, etc.). In areas of damage, several probes should be made to estimate the area of possible sheathing replacement. These areas should typically be enlarged (in some instances, more than 100 percent) to allow for replacement of full sheets of wall sheathing as described below. Keep in mind that the

actual area of damage on most EIFS-clad structures is relatively small.

Building Code Issues

EIFS removal can sometimes be required, even in the absence of damage. For instance, cases that include significant construction defects can dictate EIFS removal for purposes of making repairs to underlying components. An example of this scenario is when the wall framing of a structure is not adequate to meet building code (or manufacturer-imposed) deflection criteria when subjected to a load perpendicular to the wall. In the case of EIFS, the maximum allowable deflection (PM, or polymer-modified system) normal to the plane of the wall is $L/360$.² The maximum allowable deflection (PB or polymer-based system) normal to the plane of the wall is $L/240$.³ These criteria can be difficult to meet on multi-story structures in coastal (high wind) areas. This problem can also occur when building code requirements imposed on the repair are more stringent than those imposed on the original construction.

Another issue that tends to expand EIFS repair areas is replacement of damaged wall sheathing. While many repairs have been performed using partial sheets of structural wall sheathing panels, it is the author’s opinion that repairs to wall sheathing should be made using full (4’ x 8’) sheets whenever possible. At a minimum, the repair panels used should match the dimensions of panels used in the original construction (unless found to be defective). This opinion is based on maintaining the structural integrity of the framing system. If smaller structural panels are used, they should span across a minimum of three vertical studs and include blocking at the panel joints.



Figure 3

Aesthetic Issues

While localized repairs may be adequate to address damages, complete removal may be more practical to provide a more pleasing end result. In some cases where damaged areas are close together (i.e., a house with many windows), the localized repair approach would result in many patches that will be visible, even with the most skilled applicator. In these cases, complete removal and replacement of EIFS on an entire wall area may be the most practical approach to provide a uniform appearance. In some instances, this approach may cost less than multiple localized repairs.

Property Value/Stigma Issues

Owners and experts who promote total removal of EIFS often argue that the value of the property will be reduced if any EIFS remains. Additionally, an argument is made that EIFS has a stigma and will cause the owner to have a difficult time selling the property, even at a reduced price.

First, property value and stigma issues are beyond the author’s area of expertise and the scope of this paper. Second, while



Figure 4

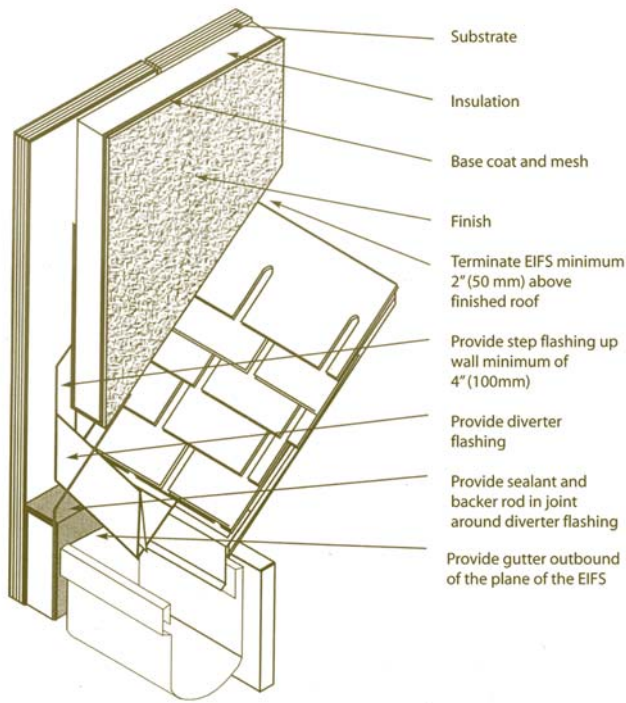


Figure 5

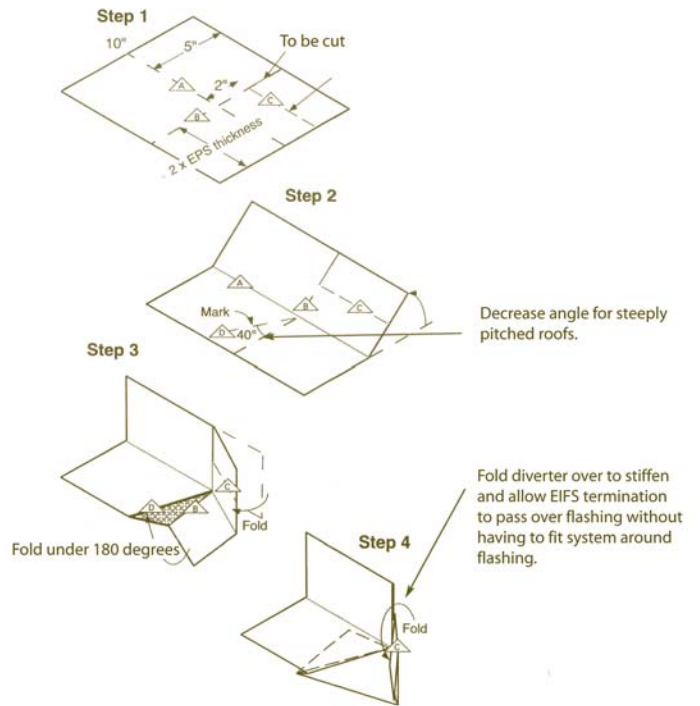


Figure 6

these arguments may be supported by other experts (that are typically not real estate appraisers), they seem to be of reduced validity in the most recent EIFS litigation, where the owners themselves purchased the structure long after the first EIFS litigation. This paper is intended to present the technical merits of repairing damages to EIFS-clad buildings. Therefore, no further discussion on these topics is provided.

tions. The absence of a proper flashing detail can result in significant damage to wall sheathing and framing located below the roof/wall intersection.

A “kick out” detail is typically included with current manufacturer installation instructions (see Figures 5 and 6). However, the importance of this detail was not recog-

nized by the industry until after significant damages were documented and litigation was well underway. As late as 1994, details from the EIFS Industry Members Association (EIMA)⁴ did not specifically include “kick out” flashing. However, a general reference was made to flashing being required in this area (see Figure 7).

TYPICAL AREAS OF DAMAGE/REPAIR DETAILS

Roof/Wall Intersections - Typical Damage

By far, improper details at this location have the potential for causing the most severe damage. This is particularly true in the case of wood-frame structures of two or more stories. The required “kick out” flashing must be installed in a water-tight manner to prevent water from being directed behind the EIFS at these loca-

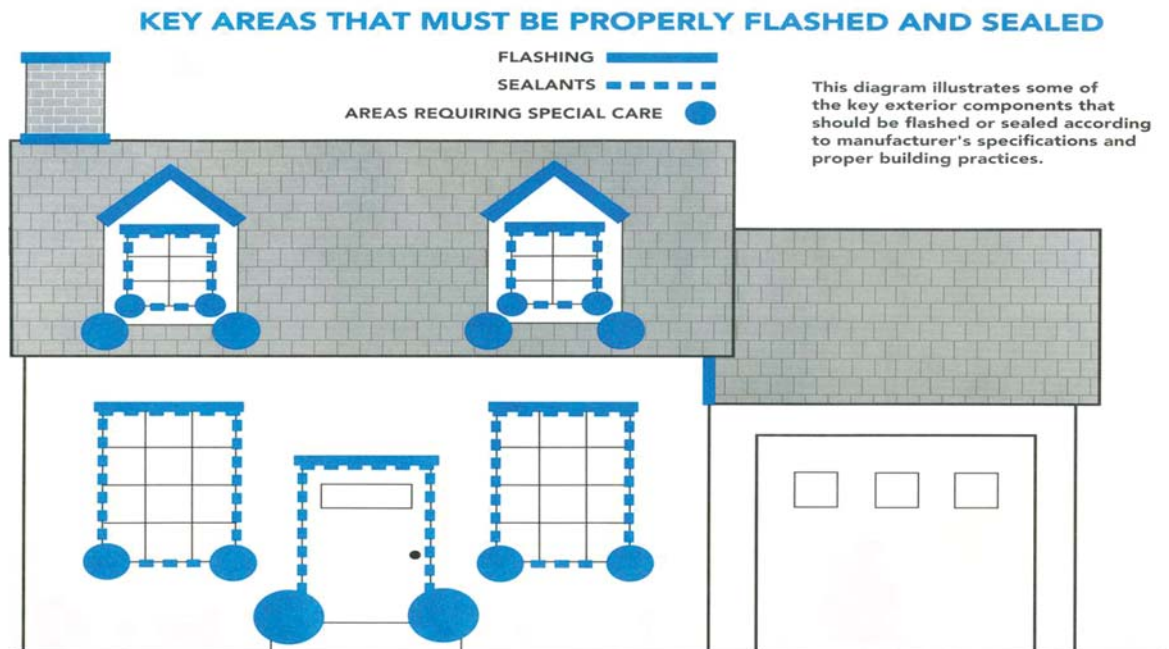


Figure 7



Figure 8

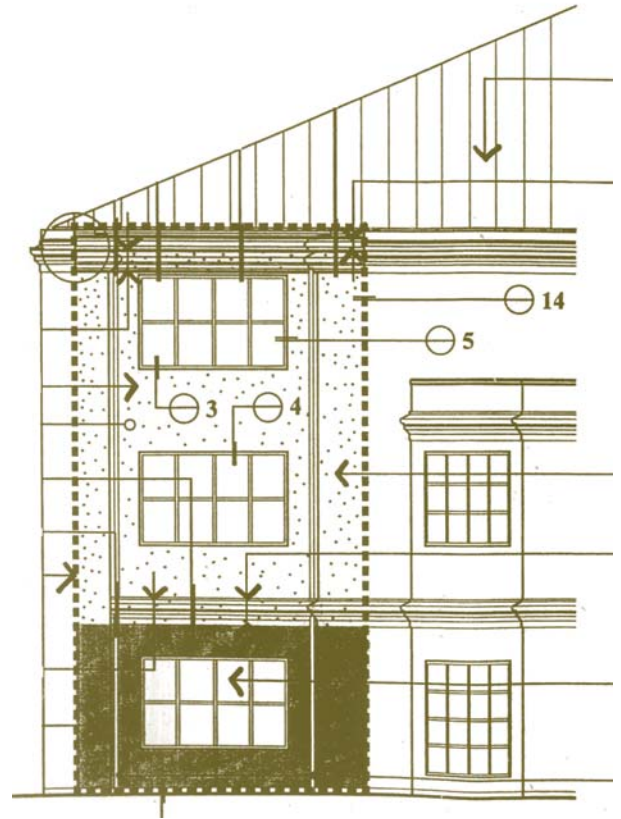


Figure 9

Roof/Wall Intersections - Repair Details

Repairing damages at roof/wall intersections typically requires the removal of large areas of EIFS below the defective intersection. Unless the wall area is large (more than 100 square feet), it is often wise to remove and replace the EIFS on the entire wall. This will result in a uniform appearance and allow all damages to be discovered and addressed.

Repair to the wall area located below the defective intersection can include barrier EIFS or drainable EIFS. However, consideration should be given to any areas of the repair that would intersect adjacent EIFS cladding. In particular, the designer of the repair should try to select a repair cladding that matches the thickness of the adjacent cladding.



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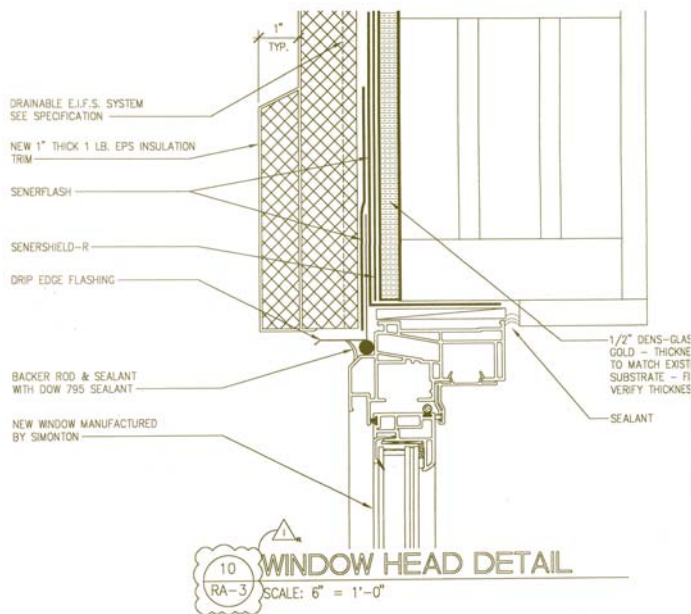


Figure 10a

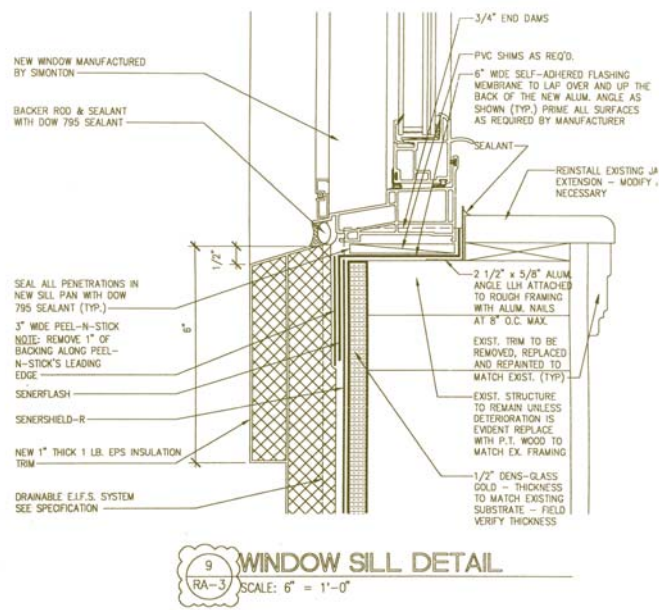


Figure 10b

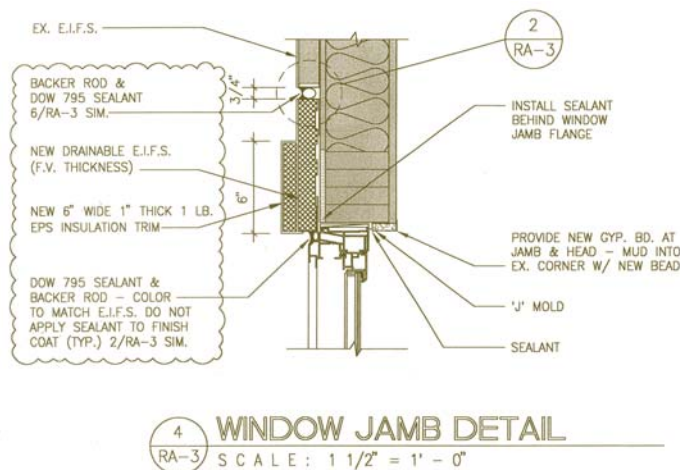


Figure 10c

should include an inspection of floor framing that adjoins the damaged wall area.

Windows - Typical Damage

Windows represent the most common "hot spot" on all EIFS-clad structures. In fact, it could be argued that windows represent the most common "hot spot" on all structures, regard-

less of cladding type. This opinion is based on the simple fact that nearly all structures have windows and nearly all windows eventually leak.⁵

These facts were not adequately addressed by the construction industry in early EIFS-clad structures, at least not in publicly-available print. Fingers have been pointed at all parties for problems associated with windows. Again, the purpose of this paper is to simply identify windows as an area of damage that may require repair. It is the job of construction attorneys and their experts to assign blame for the damage.

It is the author's opinion that structures should be designed with the assumption that all windows will leak, regardless of cladding type. For this reason, a prudent design professional should consider the window as part of the wall system and include proper water management details using wraps, barriers, flashings, etc. as necessary. Damages at windows are typically below the bottom left and right corners of most exposed windows (see Figure 8). Additional damages can be associated with larger windows that consist of multiple window units that are ganged together.

Additionally, depending on which type of cladding is selected, expansion joints and/or flashing details may be necessary to separate the repair area from the adjoining wall sections. Repair of damages caused by defective details at roof/wall intersections

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Windows – Repair Details

Window repairs are likely to include areas below the window unit. In commercial construction (where windows are often situated in a straight vertical column), it is effective to begin repairs at the top of the building and proceed toward the ground (see *Figure 9*). Depending on the extent of damages, removal of all EIFS located directly above and below the windows can be an effective approach (see *Figures 10a* and *10b*). The EIFS removal area may need to extend beyond the sides of the windows if the window units need to be pulled and reset or replaced (see *Figure 10c*). Repairs can be in accordance with current drainable EIFS details that utilize moisture barriers and flashing. Careful attention should be paid to intersections between the new EIFS repair areas and the original EIFS areas. Specifically, it may be necessary to provide a “dam” between the drainable and barrier EIFS using sealant and/or flashing (see *Figure 11*).

If no structural damages exist around the windows and the repair objective is to simply stop water intrusion, water testing of the window units may be in order. The test results will help determine if the required repair can be limited to the installation of sealant joints around the

perimeter of the window, or pulling the window unit to install sill pan flashing. Again, remember (for a long-term solution) the design professional should always assume that the window unit will even-

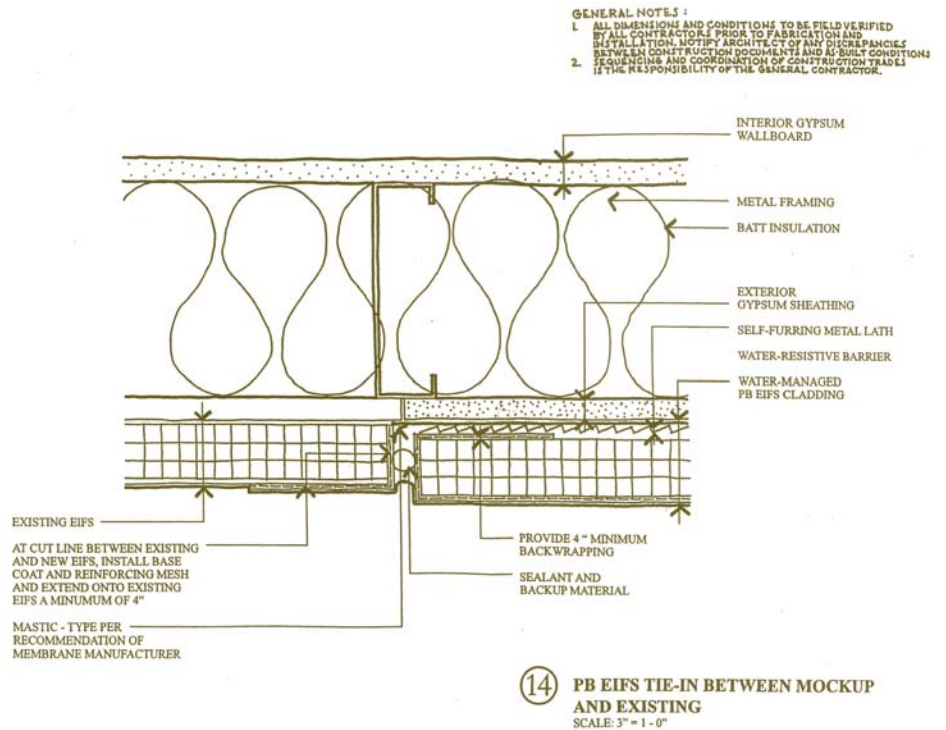


Figure 11



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Figure 12

tually leak and have provisions in the repair detail to accommodate this leak.

Penetrations – Typical Damage

Water intrusion can occur at any unsealed area where the EIFS is penetrated (i.e., decks, guardrails, utility lines, light fixtures, water spigots, etc.). These areas are associated with varying degrees of damage that are dependent upon the size of the opening and their exposure to weather.

Of the various types of penetrations, decks and porches seem to pose the most potential for damage. This is because water flow from the surface of a deck or porch is typically much greater than the flow of water running down a vertical wall due to gravity. Damages at deck and porch intersections are often exacerbated by absence of positive slope (away from the exterior wall) and wind-driven rain (see Figure 12).

Damages from other types of penetrations in EIFS are typically limited, even in the presence of poor workmanship. In some cases, the penetration can simply be sealed to stop water intrusion with no additional repairs required. Again, the actual damage is dependent upon the size of the penetration and exposure to weather.

Penetrations – Repair Details

As previously stated, the author's observations have revealed that most penetration defects do not result in significant damages. In the case of decks and porches, it can be necessary to remove large areas of EIFS below the defective penetration. The repair detail can be as shown on current industry literature (see Figure 13).

Other penetrations, (i.e., such as guardrails, lights, utility lines, water spigots, etc.) can be addressed by localized removal of the EIFS at the point of penetration. The EIFS should be removed to the

EIFS TERMINATION AT PROPERLY FLASHED DECK

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

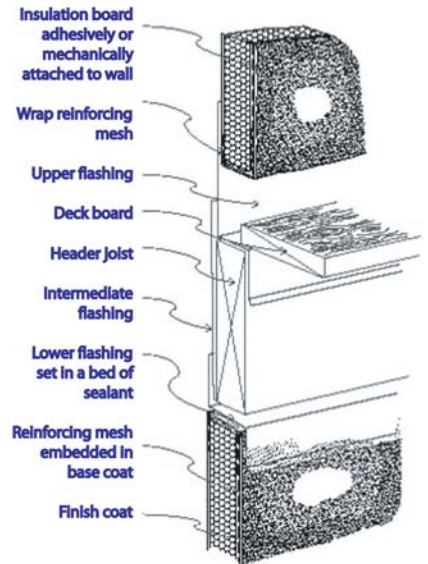
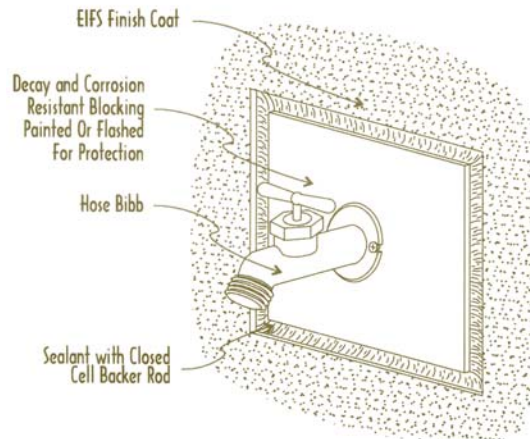


Figure 13

PLUMBING AND ELECTRICAL PENETRATIONS



HOSE BIBB ATTACHMENT

For accessories subjected to handling, such as hose bibs and railing supports, wood blocking offers protection to the EIFS while providing a base for rigid attachment. The wood blocking may be painted or encapsulated in flashing.

ELECTRICAL ATTACHMENT

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

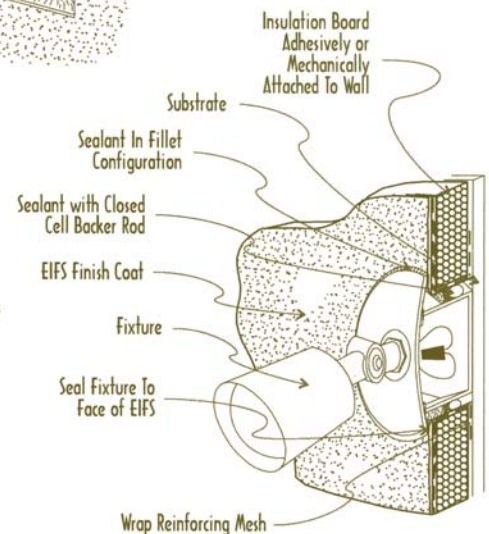


Figure 14

extent necessary to allow installation of a suitable backup material for the penetrating building component. Examples of suitable backup materials include treated wood blocking, metal or plastic sleeves, or shrouds. The EIFS surrounding the penetrations should be held back a minimum of one-half inch and properly back wrapped for purposes of installing an expansion joint using closed cell backer rod (properly sized) and sealant. The penetration repair details can be as shown on current industry literature (see Figure 14).

Floor Lines/Delamination - Typical Damage

Expansion joints are required in the system where they exist in the substrate, where the system adjoins dissimilar construction, and at floor lines in multi-level, wood-frame construction (see Figure 15). The most common symptom of an omitted expansion joint is a linear bulge along a floor line. The bulge is the result of localized delamination of EIFS along the band joist. The band joist is typically a piece of dimensional lumber that is subject to cross-grain shrinkage as moisture content in the wood decreases.

Delamination of EIFS can occur on structures when deflection limitations are exceeded. This problem is associated with under-sized framing that deflects and causes the attachment of the

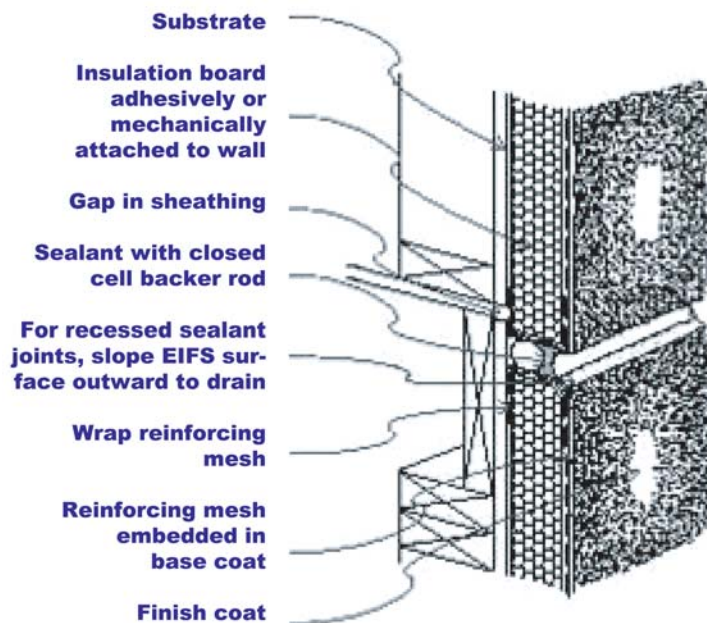


Figure 15

EIFS to be compromised. Problems can also arise at floor lines where the concrete and steel framing meet but are not in the same vertical plane. Left uncorrected, the EIFS applicator may extend the EIFS across the floor line, leaving a strip of EIFS in an unsupported condition.

FLOOR LINE EXPANSION JOINT

Expansion joints shall be installed in the EIFS system per manufacturers' recommendations but as a minimum where changes in substrate occur where a joint exists in the substrate, and at floor lines in wood-framed construction.

Floor Lines/ Delamination - Repair Details

Floor line repairs on residential structures can be as simple as removing a band of EIFS along the perimeter of the exterior walls at the floor line. After the band of EIFS is removed, proper expansion joints can be installed in accordance with manufacturer

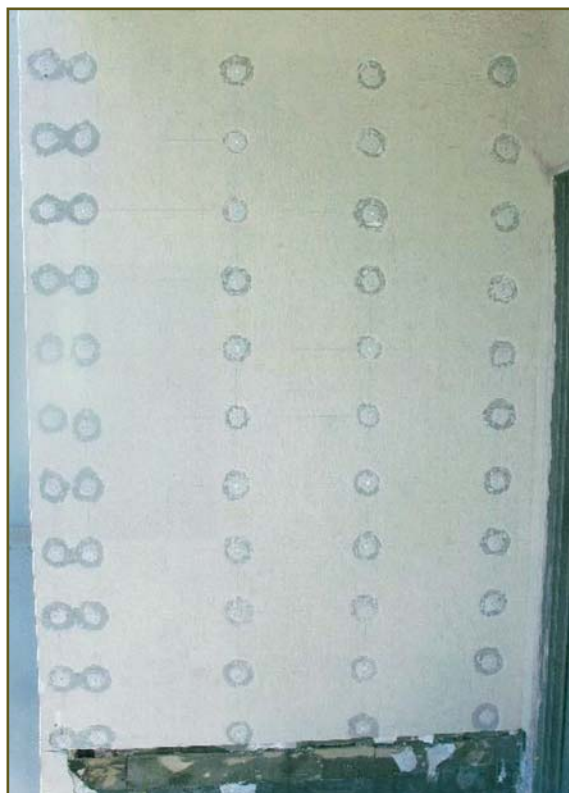


Figure 16

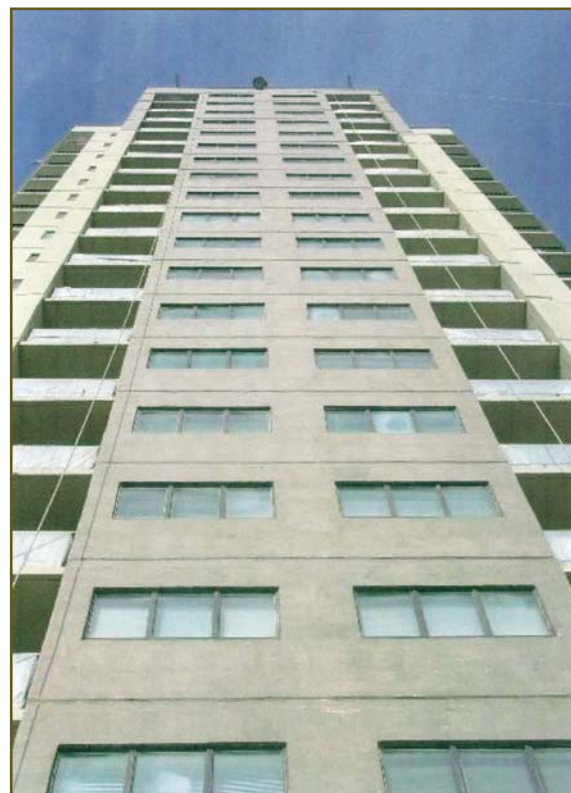


Figure 17

instructions. In an effort to eliminate the appearance of a repair, decorative bands can be added to hide or cover the expansion joint. The expansion joint installed at the floor line should match the expansion joint (if one exists) in the wall sheathing.

Floor line repairs on commercial structures can be more difficult. Depending on the existing conditions, it may be necessary to install shims or blocking at floor lines to provide necessary support for the EIFS cladding where framing systems are out of plane. Care should be taken to provide proper support and attachment of the EIFS to meet deflection and load requirements. Similar to residential construction, repair areas can be easily delineated with the installation of expansion joints. This versatility can allow for localized removal of EIFS.

In areas where EIFS has become delaminated from the underlying framing, additional fasteners (i.e., Windlock® or similar) can be installed through the EIFS cladding to re-establish the attachment (Figure 16). This type of repair can only be accomplished if the underlying framing is adequate or can be repaired from an interior side of the building. After the additional fasteners are installed, the exterior walls can be finished with the new base coat and finish coat (Figure 17). Reinforcing mesh should be installed vertically along the

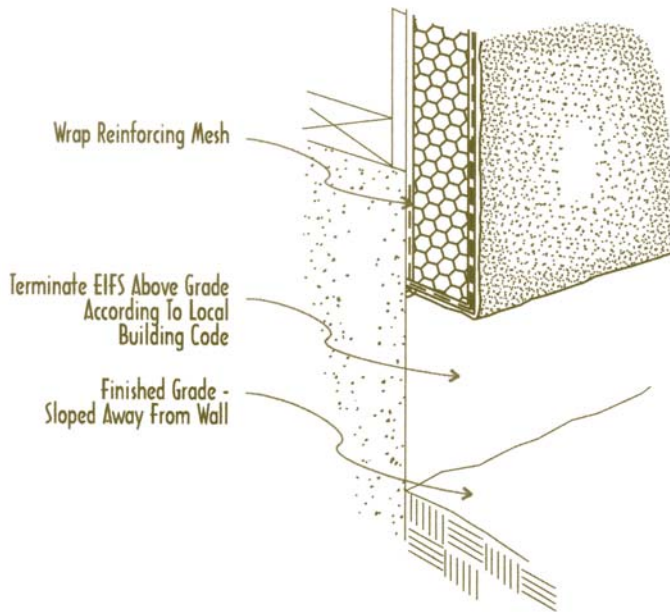


Figure 18

framing lines where the fasteners are installed.

Below Grade – Typical Damage

Depending on where one looks, EIFS should be terminated 6 to 8 inches above grade. Most building codes require a separation of 6 inches⁶, while most EIFS manufacturers and industry standards recommend a clearance of 8 inches between the EIFS and grade (see Figure 18). Unfortunately, this is not always the case. A limited number of EIFS manufacturers produced details showing their product extending below grade (see Figure 19). The author

is unaware of any manufacturer details today that show EIFS extending below grade. This condition provides a concealed and continuous path for termites to travel into the building. Extreme damage can occur in the presence of water intrusion in an area of high termite infestation probability, such as the southeastern United States (see Figure 20).

Below Grade – Repair Details

In areas where EIFS extends below grade, it may be possible to simply cut the bottom portion of the EIFS cladding away from the wall to meet current clearance

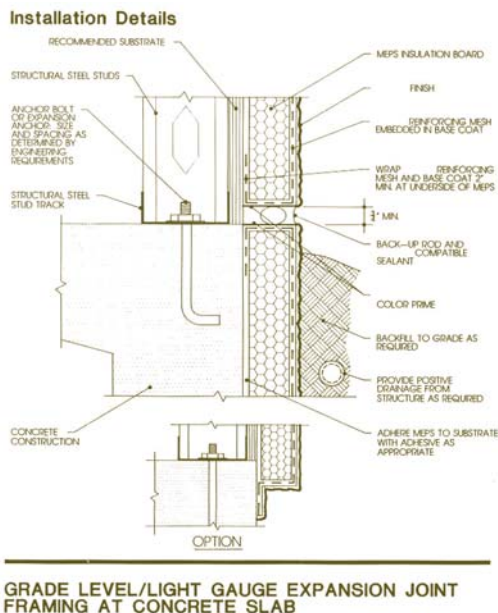


Figure 19

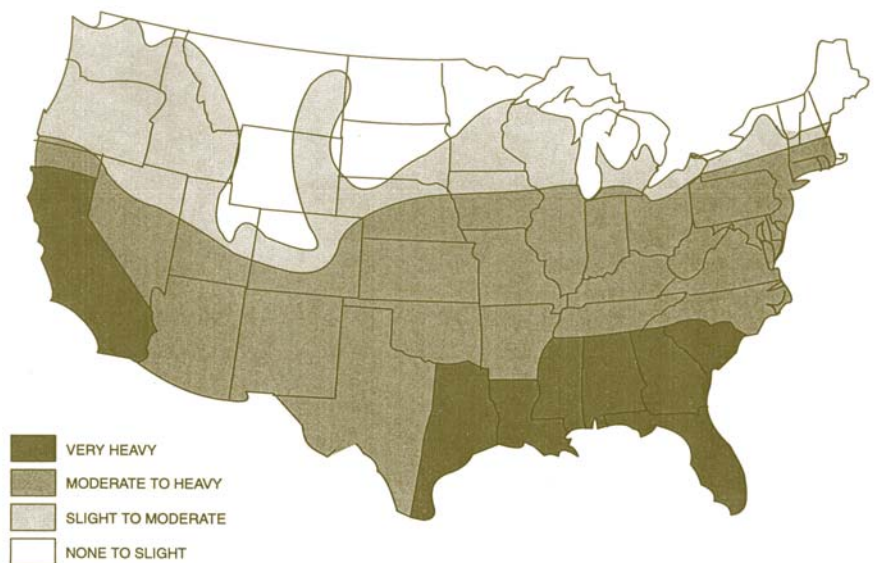


Figure 20

Note: Lines defining areas are approximate only. Local conditions may be more or less severe than indicated by the region classification.



Figure 21

requirements. However, in the presence of significant damages, a much larger area of EIFS removal will be required. Additionally, depending on the construction and framing details, logistical constraints may not allow for an adequate amount of EIFS cladding to be removed to meet existing clearance requirements. The EIFS removed from the base of the wall should be carefully inspected to determine the presence or absence of termite infestation. The author has observed termite trails in expanded polystyrene (EPS) insulation board that extended 40 feet above grade before reaching blocking where termite damage was found.

Cracks – Typical Damage

Cracks will develop at stress concentration points in the EIFS lamina. These points exist at corners of wall openings (see Figure 21), at points of transition where the lamina changes direction, and at aesthetic reveals where the insulation board changes in thickness. Unless a crack is located in an area of concentrated water flow (i.e., window opening, roof/wall intersection, etc.), damage is typically minimal. In the absence of an impact, cracks do not usually develop in the middle of a wall. Compression cracks can develop in EIFS; however,

these cracks are typically caused by structural defects and/or structural damage from water intrusion.

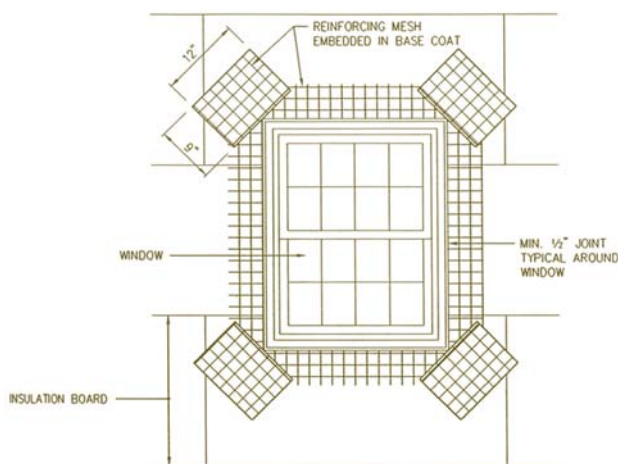
Cracks – Repair Details

In the absence of underlying damages, cracks represent the easiest of all EIFS repairs. However, the cause of the crack should be determined prior

to making repairs. Often, the cause of cracking in EIFS is the result of improper installation of reinforcing mesh. In these cases, additional reinforcing mesh can be added during the repair process in accordance with manufacturer recommendations (see Figure 22). Cracks that are the result of other causes may require more extensive repairs.

CONCLUSIONS

The total removal of EIFS cladding from damaged buildings is not always required.



NOTES:

1. TYPICAL TREATMENT AT PENETRATIONS THRU THE SYSTEM, SUCH AS WINDOWS, DOORS, ETC.
2. OFFSET INSULATION BOARD JOINTS FROM CORNERS OF OPENINGS.
3. OFFSET INSULATION BOARD JOINTS FROM SHEATHING JOINTS.

WINDOW PENETRATION DETAIL

N.T.S.
Dwg # 5608

Figure 22

ROOF KNOWLEDGE ASSESSMENT

Test your knowledge of roofing with the following polyurethane foam questions, developed by Donald E. Bush Sr., RRC, FRCI, chairman of the RRC Examination Development Subcommittee.

1. Polyurethane is produced by a chemical reaction between isocyanate and polyol. There is an "A" side and a "B" side that must be mixed together under controlled conditions in the field when installing a sprayed urethane foam roofing system. What are the components of side "A" and side "B"?
2. Most SPUF systems have a mixing ratio of one to one, or one part resin to one part isocyanate by volume. Off ratio mixing, particularly variations exceeding a 2% tolerance, may be problematic. What problematic results may be achieved by a high isocyanate or a high resin mix?
3. When mixing polyurethane systems, several time factors are important. What are the meanings of "cream time," "tack-free time," and "cure time"?
4. Tensile strength of an elastomeric coating is measured in pounds per inch but normally reported in psi. If a sample that measures .015 inches in thickness produces a strength of 20 lbs/inch, what would be the strength converted to psi?
5. Elongation measures the ultimate stretch of a thin film of unreinforced coating at rupture. This is reported in percent of original length. If one inch of material stretches to 4 inches before rupture, what would be the reported elongation?

Answers on page 18

ROOF KNOWLEDGE ASSESSMENT

Answers to questions on page 17:

1. Side "A" - Isocyanate - A highly reactive chemical grouping composed of a nitrogen atom bonded to a carbon atom bonded to an oxygen atom (NCO).

Side "B" - Resin

Polyols - "Poly means "many"

"OH" - describes chemicals with alcohol groups.

Surfactants - Surface active agents that assist in cell formations as well as in mixing of ingredients.

Catalysts - Chemicals that control initiation and propagation of polymerization.

Blowing Agents - Volatile liquids which form the cells by vaporization. Generally they are dissolved liquids.

Fire Retardants - Agents that reduce burning potential.


2. High Isocyanate - Glassy cells, brittle, friable, high density foam.
High Resin - Soft and spongy, low density foam.
3. Cream Time - time in seconds (at a given temperature) when the "A" and "B" components will begin to expand after being mixed through the spray gun.

Tack-free Time - foam is dry to the touch. When the foam is tack free, it can be sprayed over with another "lift," and with some care, can be walked on.

Cure Time - how long it takes the foam to reach its maximum physical properties. In general, within one hour the foam will reach 90% of its cure and 90% of its ultimate physical properties. Depending upon ambient temperature, the final cure will take 24 to 72 hours.

4. $x = 1333$ psi
5. 300%

Reference: The Roofing Industry Educational Institute and Polyurethane Foam Contractors Division of SPI Sprayed-In-Place Polyurethane Foam Educational Program.

Contrary to numerous reports, damages to EIFS-clad buildings are typically localized and easily repaired. Damages to EIFS-clad buildings should be carefully evaluated before deciding if repair or total replacement is required. In most cases, localized repairs are adequate to restore the integrity of the building envelope. Additionally, the versatility of EIFS allows for repairs to be made that will blend with the main portions of the building. When more significant damages exist, total removal and replacement of the EIFS are recommended on entire wall areas. Numerous localized repairs are discouraged on a single wall. The decision to repair or replace EIFS on a damaged building should be based on full understanding of the damages, building code issues, and building aesthetics. 

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PLYWOOD COULD BE FROM RAINFORESTS

Lumber from the protected rainforests of Papua New Guinea is making its way to UK, where builders are being warned not to purchase it. The Flat Roofing Alliance of the United Kingdom is warning its members not to buy imports of Chinese plywood. It carries a "CE" mark, meaning it is a Chinese export.

Some suppliers, it warns, are offering the boards at cut-rate prices. Some of it is softwood plywood, made from a pine or poplar core with a pine face. A recent report by Greenpeace has suggested that a number of UK timber importers are stocking illegally sourced plywood. The illegally felled logs are shipped from the rainforests of Papua New Guinea to China for processing, then exported worldwide. British consumers should ask for certified plywood or OSB3 board and check for BBA and FSC certification for extra reassurance.

— Roofing Cladding & Insulation