EXTERIOR INSULATION AND FINISH SYSTEMS (EIFS) PROBLEMS CAUSES AND SOLUTIONS

May 30, 1991

EXTERIOR INSULATION AND FINISH SYSTEMS (EIFS) PROBLEMS CAUSES AND SOLUTIONS

May 30, 1991

PRODUCED FOR THE
CANADA MORTGAGE AND HOUSING CORPORATION
UNDER THE EXTERNAL RESEARCH GRANTS PROGRAM

PROJECT MANAGER: PETER RUSSELL

HABITAT DESIGN + CONSULTING LTD.
3683 W. 4TH AVE., VANCOUVER, B.C.
V6R 1P2

DISCLAIMER

This project was carried out with the assistance of a grant from Canada Mortgage and Housing Corporation under the terms of the External Research Program. The views expressed are those of the author and do not represent the official views of the Corporation.

TABLE OF CONTENTS

EXTERIOR INSULATION AND FINISH SYSTEMS (EIFS) PROBLEMS CAUSES AND SOLUTIONS

by
Habitat Design + Consulting Ltd.

1.0 INTRODUCTION

Exterior insulation and finish system (EIF system) is the generic description of a type of building cladding that consists mainly of plastic insulation board, glass fibre reinforcing mesh and synthetic stucco(Figs 7 &8). EIF systems are available from several manufacturers and have become a popular method of cladding low and high rise buildings in North America, since the technology was introduced from Europe in about 1969. At the present time it is estimated that millions of square meters of EIF systems are in service in Canada and the United States.

The use of EIF systems offers a range of advantages to designers and building owners that mainly derives from relatively low capital costs for installation and reduction of in-service weight compared to many traditional claddings. The possibility of obtaining architectural detailing that is easily molded or carved as well as wall surfaces that may be finished in a wide range of textures and colours has likely contributed to its popularity. In addition EIF systems can contribute to the thermal resistance of the wall assembly by providing a thermal break between the building structure and the outdoor environment. Placement of the insulation on the outer surface of the wall contributes to stabilizing the thermal cycling of the structure and thereby reducing this potential cause of cracking. EIF systems have been used to reclad existing buildings both to improve the exterior appearance and reduce heating and cooling costs.

Although EIF systems are, at least initially, an economical cladding method, concern for long-term durability of EIF systems appears to be increasing among some building officials and some building owners.(4)

2.0 PURPOSE OF THIS STUDY

This study was proposed to the external research program of CMHC in response to apparent increases in the volume of building regulations and industry recommendations that appear to be intended to improve EIF system installation quality assurance and to control onsite application. This report outlines the findings of a literature search and series of interviews that were intended to examine allegations of problems that may adversely affect EIF system performance and review solutions developed to address those problems. Aspects of EIF system wall design that may influence the long term performance of EIF systems are discussed in the context of the principles of wall design as developed by the National Research Council of Canada.

3.0 SUMMARY

Eleven principle requirements of exterior walls are outlined by Hutcheon in the Canadian Building Digest # 48 (CBD 48). The first four of these requirements; control heat flow, control air flow, control water vapour flow and control of rain penetration were used as criteria for the initial evaluation of EIF systems in this study. The means to accomplish Hutcheon's performance requirements in the design and functioning of exterior walls are the subject of many CBDs and many other documents. For instance control over rain penetration which is "...a key factor in most cases of deterioration of walls .." is, perhaps best summarized by Garden in CBD 40. Within a discussion of rain penetration and its control, a main advantage of a two stage, "rain screen wall" is presented.

> "It is not conceivable that a building designer can prevent the exterior surface of a wall from getting wet nor that he can guarantee no openings will develop to permit the passage of water. It has , however, been shown that through the wall penetration of rain can be prevented by incorporating an air chamber in the joint or wall where the air pressure is always equal to that on the outside. In essence the outer layer is then an "open rain screen" that prevents wetting of the actual wall or air barrier of the building. The success of traditional walls...is explained by this principle"

In addition to control over rain penetration, the use of the rain screen wall in building construction is considered to confer a range of other advantages:

> "A complete rain screen approach can result in easy handling of cladding movements and cracks after construction, and in reduced air conditioning loads, and permits rapid drying of cladding materials. It also permits the better positioning of insulation and minimizes the risk of condensation in the wall. With the many advantages of the open rain screen, its full development should be pursued by all designers"

Documents such as the CBDs and a series of nation wide seminars sponsored by NRC have contributed to the adoption of the rain screen (or two stage) wall as a standard approach to wall design in this and other countries. The exterior surface of a rain screen wall is not required to provide a weather tight and wind proof seal but is expected to provide a more protected environment for those elements in the wall that maintain barriers to movement of interior air, vapour and wind. EIF system walls characteristically do not employ a rain screen but are instead a single element wall that relies on an exterior "face seal" that must provide many of the barrier functions of the exterior wall.

The exterior finishes and joints of EIF system claddings must withstand wind loads, solar radiation, thermal and moisture movement as well as wind driven rain. As the exterior surface of the building generally experiences the most severe environmental conditions of the wall assembly, it is possible that any flaws in workmanship, design or damage to exterior joints or surfaces may lead to loss of control over the movement of air, vapour and water. At present, reports of problems affecting EIF system walls appear to be ultimately related to the relatively severe conditions of exposure and the correspondingly high level of performance required of the workmanship, sealants and surface finishes used in EIF systems.

4.0 EIF SYSTEM CONSTRUCTION

The most common EIF system used in North America consists of expanded polystyrene foam insulation board adhered to a exterior drywall sheathing substrate. The EPS board is usually rated at RSI 0.7 (R 4) per inch, 16kg/m3 (1lb/ft3) density, it must also meet criteria stipulated by the EIFS manufacturer including bead fusion, aging and dimensional tolerances. 100 mm (4") is the maximum thickness allowed by most fire codes on the basis of fuel content (1). The adhesive usually consists of the same acrylic polymer used in the base coat, (the coating containing a fibreglass mesh that is placed directly over the foam board insulation), and in most cases is mixed with portland cement. The adhesive is either applied in a ribbon and dab method in which the adhesive is applied continuously around the perimeter of the foam board and circular dabs are placed in the center of the board or the adhesive is applied over the entire back surface of the foam with a toothed trowel. After the foam board is mounted on the substrate a base coat is applied over the entire outside surface of the foam board. Fibreglass mesh is embedded in the base coat reinforcing the surface and ensuring a minimum thickness of base coat is applied. Exposed edges of the foam board are wrapped with the fibreglass mesh and covered with base coat. The base coat provides the primary water barrier in the system. Expansion joints either utilize a metal section as in conventional stucco work or joints are caulked. A thinner coloured finish coat of acrylic polymer and aggregate is applied over the base coat.

4.1 SYSTEM VARIATIONS

A number of variations on this system have been identified these include:

- Plywood or oriented strand board used as a substitute for drywall, this has chiefly been in low rise residential construction where wood framing is used. The foam board is typically adhered to the plywood wall sheathing.

- Concrete board (tile backer board) as a substitute for drywall. This has been recommended as substrate that will not be affected by moisture.

- Poured in place concrete or concrete block as a substrate. This is the most common system used in Europe and has proved to be one of the most stable and trouble free substrates.

- Concrete and brick walls of existing buildings have also been used as an EIFS substrate.

- Mechanical fasteners used in place of adhesives for securing the insulation board through the substrate to the framing. These usually consist of large headed screws or screw with washers. They are most commonly used in conjunction with extruded polystyrene or fibreglass board. Mechanical fasteners are generally not an economical method for use with expanded polystyrene and the use of conventional fasteners can weaken the foam board. To solve this problem one manufacturer supplies foam board with an embedded metal "hat track". (Fig 10)

- Extruded polystyrene used in place of expanded polystyrene. This material is usually rated at RSI .88 (R5) per inch, 32 kg/m3 (2lb/ft3) and must meet dimensional tolerances specified by the EIFS manufacturer. 50mm (2 inches) is usually the maximum thickness allowed by fire codes. (1). Extruded polystyrene is less water vapour permeable than expanded polystyrene. Extruded polystyrene is usually mechanically fastened to the structure potentially allowing placement of sheathing paper or spunbonded polyolefin over the sheathing. It is most often used in polymer modified systems. (Fig 8)

- Fibreglass board with a factory bonded fibreglass mesh might be used as a substitute for EPS. This material has an RSI value of 0.7 (R4) per inch and has a very high vapour permeance. This type of insulation is mechanically fastened through the sheathing to the structure. (Fig 9)

- Mineral wool board might be used as a substitute for EPS. This material has an RSI value of 0.7 (R4) per inch and has a very high vapour permeance. This type of insulation is mechanically fastened through the sheathing to the structure.

- Random fibreglass fibres as a substitute for fibreglass mesh.

4.2 EIF SYSTEMS TERMINOLOGY

Although many combinations of materials are possible the coating and base coat systems generally fall into two classes:

- Polymer Base("PB") systems , sometimes referred to as soft coats, are primarily acrylic polymer and are typically very flexible, light weight and thinner that polymer modified systems. PB systems are usually applied over expanded polystyrene foam board and always utilize an alkali resistant fibreglass mesh reinforcement.(3) (Fig 7)

- Polymer Modified Mineral ("PM"), sometimes referred to as hard coat systems, are a cementitious coating system with polymer modification. They are thicker than the PB systems because of their higher ratio of portland cement. PB systems are usually placed over the denser extruded polystyrene foam which is mechanically fastened through a nylon mesh and substrate to the framing. Due to their lower polymer content PM systems are less flexible and require careful attention to placement and detailing of expansion joints. (Fig 8)

5.0 EIFS FABRICATION METHODS

EIF systems can be either site applied directly to the exterior sheathing of the building or incorporated into a panelized system which is factory made or prefabricated under cover on the construction site. Panelized systems tend to be used in high rise construction to minimize scaffolding and allow for closer quality control. Site application tends to be more common on low rise buildings where scaffolding is not as difficult or expensive to erect.

5.1 SITE APPLIED EIF SYSTEMS

EIFS manufacturers have developed specific installation requirements, the following is a general description of site application of EIF cladding. The adhesive is first prepared by remixing. Portland cement and perhaps small quantities of water are added to the adhesive at this time. At the bottom of the wall one strip of fibreglass mesh is attached to the substrate. This strip of mesh is later wrapped around the bottom edge of the foam board to provide protection for the bottom edge of the cladding. Adhesive is applied to the back of the foam by a ribbon and dab method or the back of the board is covered with adhesive using a notched trowel. The foam board is then applied from the bottom of the wall up in a running bond. Where openings and expansion joints occur the edge of the board is covered with base coat/ adhesive and wrapped in fibreglass mesh. Expansion joints are "premeshed" with base coat and a strip of reinforcing mesh. Expansion joints are located where the substrate changes, when abutting different materials and where thermal expansion/contraction dictates. All joints are kept free of excess adhesive. Where the foam board is applied at outside corners all vertical joints are staggered. After application of the foam board, the face of the foam board is tamped to ensure it is level , all voids filled and irregularities sanded smooth. Aesthetic joints are then routed into the face of the foam. A layer of reinforcing mesh is applied with the basecoat to outside corners and diagonally at the corners of all openings such as windows. A layer of base coat and reinforcing mesh is applied to aesthetic joints (reveals). The joint is then cleaned out to ensure an even thickness of base coat is applied. The overall wall surface is then covered with base coat. The reinforcing mesh is then embedded in the base coat and completely buried. Further layers of heavier reinforcing mesh maybe applied in areas of high wear. After curing of the base coat the finish coat is mixed and applied with hand trowels. The finish coat is applied from one natural break to another such as between aesthetic joints and corners to eliminate cold joints and variations in appearance.

5.2 PREFABRICATED EIFS PANELS

Prefabricated panels are usually constructed with steel stud framing, drywall sheathing and foam board with fibreglass mesh and acrylic stucco coatings. The fibreglass reinforcing mesh which is wrapped around the edge of all foam exposed edges is also carried back to adhere to the face of the steel studs at the edge of the frame. This protects the exposed edge of the drywall sheathing and foam during and after erection. After curing of the EIFS coatings the prefabricated panels are lifted into place and secured to the structure of the building.

Some of the advantages of prefabrication are as follows:

- Exposure of the substrate to rain during construction is minimized
- Closer control of the polymer mix is possible, particularly in a factory setting
- Closer quality control of polymer application and edge detailing is possible
- During curing the base coat and finish coats can be more easily kept in the optimum temperature range and protected from rain.

Some possible disadvantages of prefabrication are as follows:

- Prefabricated panels using exterior gypsum board sheathing maybe damaged in-situ, after erection, if they are not immediately sealed into the system and water kept from getting at the back of the panels.
- Unless special attention is given to cut edges of the exterior gypsum sheathing, damage from water/freezing can occur after erection of the panels, if they are not suitably protected
- Construction tolerances of building frame may cause panels to be badly aligned, and joints of varying widths produced.
- If a window opening is positioned in the EIFS panel so that the window head is aligned with the underside of the slab above and the window unit is not built into the panel a flimsy unstable panel results due to the panel's "U" shape.

6.0 FUNCTIONS OF AN EXTERIOR WALL SYSTEM

In 1963 Neil Hucheon of the National Research Council Division of Building Research presented in Canadian Buildings Digest #48 the following principle requirements that any wall system must meet:

1. Control heat flow;
2. Control air flow;
3. Control water vapour flow;
4. Control rain penetration;
5. Control light, solar and other radiation;
6. Control noise;
7. Control fire;
8. Provide strength and rigidity;
9. Be durable;
10. Be aesthetically pleasing
11. Be economical.

Using these requirements as guidelines, and specifically items 1, 2, 3, and 4, this research project investigated wall assemblies incorporating exterior insulation finish systems. The four items are reviewed below.

6.1 CONTROL HEAT FLOW

EIF systems, by their nature, incorporate insulation materials ranging in thickness from 19mm (3/4") up to 100mm (4") and ranging in thermal resistance value from RSI 0.53 (R3) to RSI 2.8 (R16). In some cases the insulating value is a side benefit with the foam board being primarily used to provide an even surface for the base and finish coats on flat wall surfaces, or as a moldable surface for decorative treatments. The placement of an insulation material on the outside of the wall structure can have the benefits of helping to protect the structure from outside weather conditions, reducing thermal bridging through the building frame and increasing the thermal resistance of the wall. In fact EIF systems have been used in retrofit applications because of the insulating characteristics offered by this method of construction.

6.2 CONTROL AIR FLOW

Air flow occurs through walls from both inside and outside, driven by wind, stack effect, the operation of combustion appliances and mechanical equipment. Air also flows within wall cavities by natural convection. In addition air can also circulate from the interior of a building into a wall cavity by natural convection(Fig 1) (12). All of these modes of air flow contribute to heat losses in the winter and heat gains in the summer. Air flow is also a mechanism by which water enters walls both from the interior (exfiltration and circulation of moisture laden air) and from the exterior (wind driven rain). It is now recognized that the most effective method of controlling air flow through a wall is by the incorporation of a continuous air barrier system.

Based on current typical construction practices EIF systems, by providing a face seal on the outside surface of a wall, would appear to provide the most airtight element in the wall and therefore act as the wall air barrier. If this is the case it means that the EIFS cladding (consisting of the base , finish coats and the sealed joints) will present the greatest resistance to wind penetration of any part in the wall assembly and therefore will be subjected to the greatest wind induced stresses. Wind induced stresses are of course typically a larger problem in high and medium rise construction than in low rise construction.

Convection within an exterior wall cavity can be responsible for transporting heat between the interior finish and the exterior sheathing. The amount of convection that occurs in wall cavity depends on a number of factors including temperature differences between inside and outside, the conductivity of various components of the wall assembly and the type and location of convection suppressing materials such as batt insulation in the wall cavity . By insulating the outside skin of the building EIF systems raises the surface temperature of the inside face of the sheathing thereby reducing convection within the wall cavity.

Convection is effectively suppressed inside the rigid insulation board of EIF systems by the cellular structure of the insulation.

Movement of air from the building interior into the wall cavity by convection would also be reduced by exterior wall insulated sheathing such as that used in EIF systems.

6.3 CONTROL WATER VAPOUR FLOW

Control of water vapour flow through a wall assembly is determined by the vapour permeance of its components and the airtightness of both the wall components and the assemblies they form.

To promote drying it is desirable to have the exterior finish and sheathing be more vapour permeable than the interior vapour retarder. This allows water vapour in the wall cavity to move from an area of higher vapour pressure (typically inside) to an area of lower vapour pressure (typically outside). A typical permeance for the combined base and finish coat of EIF systems is 1080 ng/Pa.m2s (18 grain/ft2hr (in. Hg)) , the permeance of 25mm(1") expanded polystyrene is typically in the range of 115-333 ng/Pa.m2s (2-5.79. grain/ft2hr (in. Hg)) and drywall sheathing has a permeance of 2860 ng/Pa.m2s (49.74grain/ft2hr (in. Hg)) These permeances are higher than that of 150 micrometer (6 mil) polyethylene at 3.4 ng/Pa.m2s (0.06 grain/ft2hr (in. Hg)) commonly used as an interior vapour retarder. Extruded polystyrene at 23-92ng/Pa.m2s (0.4-1.6 grain/ft2hr (in. Hg)) has a lower vapour permeance than expanded polystyrene although still well above that of 150 micrometer (6mil) polyethylene. By comparing these permeance ratings it appears that EIF systems can readily allow for the movement of water vapour by diffusion from the interior to the exterior.

It has become widely recognized that the largest single mechanism for transportation of interior water vapour into wall and ceiling assemblies is air leakage through interior finishes into structural cavities (13). This movement of air as illustrated in Fig 1 can take the form of air passing through the wall assembly from inside to outside or the circulation of air between the building interior and the inside of the wall cavity. As long as the EIF system is impermeable to air flow, air leakage through the wall cavity from inside to the outdoors should be greatly reduced or eliminated. However, in cases where the interior finish has openings, air maybe able to circulate between the building interior and the inside of the wall cavity. This is unlikely to present a problem if the exterior sheathing is always kept above the dew point temperature of the air entering from the building interior. However, if the cavity behind the EIF system is insulated, it is possible for the inside face of the exterior sheathing to fall below the indoor air dew point during the coldest part of the year and for condensation to form, potentially leading to soaking and degradation of the sheathing (13). Some EIFS manufacturers will carry out dew point calculations at the design stage to determine the location of the indoor air dew point under design day conditions thereby helping the designer to develop a more durable wall design.

6.4 RAIN PENETRATION

"Rain penetration results from a combination of water on a wall, openings to permit its passage and forces to drive it or draw it inwards" (CBD #40) (Fig 2)

As discussed above in the section entitled Control Air Flow it appears that at least at the present time EIFS coatings and sealants will likely form the air barrier in most conventionally constructed wall assemblies. If that is the case the greatest pressure drop due to wind blowing on an EIFS wall assembly will occur at the EIFS cladding (base coat, finish coat and sealant joints). Walls that utilize EIF systems are usually face sealed single element walls and as such rely on the tightness of the exterior finish to prevent rain entry. This can have the implications stated in the following quote.

> "The tighter the exterior cladding, the greater the driving force for rain entry across the exterior cladding. The greater the driving force across the exterior cladding , the more significant any cracks, flaws or openings in the exterior cladding become with respect to rain entry. Hence the workmanship, component durability and/or some provision for moisture removal is critical in preventing rain entry into wall assemblies where the pressure drop across the wall assembly principally occurs at the exterior cladding" (14) (Figs 3,4,&5)

This statement implies that in order for an EIF system to prevent rain entry into a wall over the life of the building there must be no water on the outside surface of the wall, or no openings, flaws or imperfections in the EIFS coatings and joints, or the wall must be able to self drain if water does enter. These conditions might be met in the following ways

No water on the exterior wall cladding: It maybe possible to prevent rain from being deposited on exterior claddings where sufficient protection is provided by overhangs. This approach would most likely only be practical only in low rise buildings.

Eliminate openings in the exterior cladding: It may also be possible to face seal an exterior cladding through high standards of workmanship and quality control. It would appear that over the life of the wall, due to wind, temperature variations and solar radiation, at least some of the face sealing materials will most likely need renewing to maintain the rain shedding capability of the wall. This may require frequent inspections and maintenance of all wall cladding components.

Provide means for draining of wall cladding: It has been proposed that EIFS claddings could be made self draining through the use of pressure equalized joints (10)(Fig 15). The rational for this is that rain penetration is far more likely to occur at joints than anywhere else on the exterior surface. In this type of joint the outside seal can be relatively loose and need not be completely free of cracks flaws and openings. The wind pressure is resisted by the inside seal which must be tighter than the outside seal. The inner seal is also protected from degradation due to outside weather conditions. Pressure equalized joints have been used in other single element wall assemblies such as precast concrete panels (15)

The EIFS wall might also be modified to become a "drain screen" through the use of fibreglass board insulation, rigidly supported air barrier membrane and appropriate flashing details (5)(16)(Fig 16). The air barrier could be on the inside of the EIF system in the form of a heat bonded bituminous roofing type material that could be adhered to the exterior wall sheathing. The rigid fibreglass could be mechanically fastened through the sheathing to the framing with Z clips and screws with large washers. The acrylic stucco coatings could then be parged directly to an alkali resistant mesh that is bonded to the face of the fibreglass board. Wind pressure could be equalized behind the face of the stucco due to the incorporation of a continuous rigidly supported air barrier. In the case of water penetration of the cladding the outer face of the fibreglass board would provide a drainage layer down to the flashing at each floor level. Other self draining insulation board materials may also serve this function.

7.0 POTENTIAL EIF SYSTEM PROBLEMS

The following types of problems experienced by EIF systems have been identified in the literature and through discussions with builders, subcontractors, suppliers and consultants:

7.1 Separation of EPS board from its substrate.

This can have a number of causes including:

- Moisture deposition on the substrate with the following results:
  * Softening of the drywall gypsum core
  * Delamination of drywall sheathing(4)
  * Expansion and warping of OSB or plywood sheathing
  * Corrosion of insulation board metal fasteners

- Bond failure of adhesive due to:
  * On site modification of acrylic adhesive at time of construction, including addition of portland cement, sand or water beyond manufacturers recommendations.
  * Over-mixing of the adhesive causing separation of its constituent parts
  * Inadequate preparation of substrate
  * Incompatibility of the adhesive and substrate.
  * Freezing of the adhesive before proper set takes place

- Curling of the expanded polystyrene board:
  * This can be due to application of EPS board before it is fully cured.
  * Rapid thermal cooling of the outside skin, prior to setting up of the adhesive layer.

7.2 Separation of substrate from structure caused by:

- Moisture deposition on the substrate with the following results:
  * Softening of the gypsum core causing the screw heads to pull through and the board to pull away from the framing (5)
  * Possible corrosion of metal fasteners
  * Possible corrosion of steel studs
  * Possible rotting of wood studs

7.3 Cracks through finish and base coats

Cracking in the acrylic finish will occur where it's tensile strength is exceeded. This can be due to differential expansion rates of the insulation board and the acrylic finish, shrinkage of the finishes when curing, movement in the structure. Most of the cracks that occurs over the face of EIFS panels are hair line cracks and are due to shrinkage that is controlled by the fibreglass reinforcing mesh. Due to their small size these types of cracks do not usually provide a path for water entry. More visible cracking can occur where stresses are concentrated around windows, at corners and in areas where the base coat is thicker. These larger cracks can allow for water penetration and are due to any of the following:

* Thickening of base coat due to penetration into gap between insulation boards.(4).
* Thickening of base coat at "v" joints placed in foam for decorative reasons or to allow stopping and starting of finish application (4) (Fig.11C). Cracking of the foam board as well as the acrylic finishes can occur in this situation.
* Thickening of the base coat due to differences in the thickness of the insulation board (Fig 11B).
* Lack of reinforcing mesh at the corners of window and door openings.
* Shrinking of inadequately cured foam board.
* Base coat or finish coats applied too thinly
* Modification of the base and finish coat mixes.
* Excessive shrinkage or expansion of the insulation board due to temperature variations (6)
* Rapid drying of the base coat/finish coats prior to development of coalescing of acrylic

7.4 Failure of EIFS panel joints due to:

* Use of sealants with inadequate permanent low temperature elasticity to accommodate thermal contraction and expansion of panels.
* Failure to use bond breaker tape or backer rod behind sealant thereby restricting its ability to accommodate movement (1)
* Wrapping edge of EIFS panels with both base and finish coats. The bond between the sealant and the acrylic stucco finish coat can be stronger than between the finish and base coats. This situation can lead to the finish and base coats separating at the joint. Porosity of the finish coat will allow moisture to penetrate to the back face of the caulking , hastening failure.(1) (Fig 14)
* Cracking and fissures in sealants due to too narrow a joint space being used (Fig 12)
* Reimulsification of acrylic due to pooling of rain water on ledge at joint or wetting of joint from behind. (Fig.13)

8.0 MOISTURE DEPOSITION IN EIF SYSTEMS

Moisture is a major contributor to EIF systems failures. These failures consist primarily of moisture deposition on the substrate and subsequent softening, delamination or warping of the substrate.

Moisture can be deposited on the substrate in the following ways:

* Rain exposure during construction
* Rain penetration of joints and cracks in the exterior of the EIF system. The water can then move downward behind the insulation board or laterally and upward due to capillarity.
* Condensation of interior moisture on the inside face of the substrate. This maybe due in part to the substrate being below the dew point temperature of the indoor air because of insulation being placed behind the substrate in the stud cavity. Moisture could then transported into the stud cavity from the building interior by convection and wind induced pumping. (Fig 11A)
* Condensation of interior moisture on metal stud and metal fasteners within the wall system.

Drywall manufacturers through their Industry association recommend the following with regard to EIF systems. "Exterior Insulation and Finish Systems incorporating gypsum sheathing may be used with either mechanical fasteners or adhesives . The performance of these systems and recommendation of the proper method of attachment are the sole responsibility of the EIFS manufacturer. (9). It is interesting to note that some drywall manufacturers are now producing moisture resistant fibreglass faced gypsum sheathing board and cementitious sheathing boards .

Moisture in contact with the base and finish coats over prolonged periods of time can cause softening of those surfaces due to reimulsification of the acrylic. Sills, parapet tops, etc. should be metal flashed, steeply sloped or given a special sealer for protection. Moisture may also accumulate at horizontal joints leading to reemulsification. For this reason the caulking must be applied in a way that eliminates the ledge where water accumulation occurs.

9.0 POSSIBLE MEASURES DEVELOPED TO COUNTER POTENTIAL CAUSES OF FAILURE

9.1 Moisture deposition on the substrate material:

- Water saturation of drywall during construction
  * Protect drywall with building paper, spun bonded polyolefin and mechanically fasten EIF system to framing. If EPS foam is used this will necessitate the use of proprietary fastening systems.
  * Prefabricate complete EIFS wall panels including drywall under cover on site or in a factory.
  * Substitute concrete backer board for drywall

The methods used for moisture protection of this type will vary depending on the climatic conditions. In the Toronto/Montreal area a large proportion of the EIFS is installed using prefabrication methods. When site built construction is used in the winter months complete hoarding and heating of the building under construction is used. Rain damage to gypsum sheathing seldom occurs probably due to the relatively short duration of rain falls and suitable drying intervals. In the prairies most EIFS is site constructed utilizing hoarding in the winter months, with heat, and no special precautions are taken with regard to rain saturation of gypsum sheathing. In the greater Vancouver area there have been many recorded instances of gypsum sheathing degradation due to wetting and sometimes wetting followed by freezing. In B.C.'s coastal climate the rain can continue for days or weeks with virtually no drying time. (11)

- Joint Failure

  * Two stage sealing pressure equalizing "rain screen joint" could be used to help prevent rain entry at joints (10)(Fig.15)
  * Ensuring that edges of foam board are only covered with the fibreglass mesh and base coat and not covered with the finish coat. All contact between panels and sealants to be made to the base coat on each panel <u>not</u> the finish coat. In some cases special primers are supplied to enhance adhesion between the sealant and the base coat.
  * Ensure proper mixing of two part sealants. The sealant may fail to cure if not mixed correctly, causing failure.
  * Ensure that recommendations regarding backer rod and bond breaker and back up tapes are followed to ensure that sealant can accommodate movement of the panels.
  * Ensure joints between panels are the proper width to allow the sealant to accommodate movement. This dimension will vary depending on the dimensions of the EIFS panels and the coefficient of expansion of the insulation board used (10). Typically a minimum of joint width of 12mm (1/2") is recommended with an undersized tolerance of 3mm (1/8") (12)
  * Locate expansion joints in the following areas:
    - Where expansion/contraction joints occur in the substrate
    - Where the system abuts other materials
    - Where the substrate changes

- Where deflection channels or similar are provided in the main structure, to accommodate building frame shrinkage.
- Where significant structural movement occurs

* Double reinforcing mesh at all openings and terminations.
* Stagger all foam board joints and interlock board ends at corners.
* Ensure that all foam boards in continuous areas between expansion joints are tightly fitted together at their edges and flush to eliminate thickening of the base coat.
* Eliminate "v" joints
* A minimum of 18mm (3/4") foam board thickness should be left after cutting of esthetic grooves etc.
* Minimize movement of the substrate in wood frame structures by using kiln dried lumber.

- Prevent saturation of drywall after water penetration of EIF system.
    * Protect drywall with building paper, spun bonded polyolefin and mechanically fasten EIF system through drywall to framing. Conventional mechanical fastening of EPS board is not recommended by most EIF system manufacturers. At least one manufacturer has developed a proprietary mechanical fastening system that could be used with EPS. (Fig 10)
    * Form a drain screen system using a continuous air barrier and rigid fibreglass sheathing as conceptually illustrated in Fig. 16 (5) (16)

9.2 Deposition of moisture due to the movement of indoor air into the insulated cavity:

* Place a continuous rigid air barrier on the inside of the wall system.
* Carry out calculations to determine whether the proposed wall assembly will allow the interior face of the sheathing to stay above the interior air dew point temperature on a design day(12). Some EIFS manufacturers offer this as service to their clients.

9.3 Softening of the base and finish coats

* Avoid placing the finishes in contact with the ground or in other damp environments.
* Use detailing that eliminates puddling on parapets, ledges etc.
* Protect the base of the EIFS cladding from ground "splash back".
* Ensure ledges are eliminated at all horizontal joints.

9.4 Curling of the expanded polystyrene board:

* Allow EPS board to age according to the EIFS manufacturers recommendations

9.5 Combustion of EPS Board*

* Substitute mineral board, fibreglass board, foam glass board for EPS
* Use a polymer modified mineral system as opposed to a polymer based system
* Sprinkler the outside face of the building

---

* The fire control aspects of EIF systems are beyond the scope of this study.

9.6 Failure of bond between substrate and EPS board.

* Onsite bond test under wet and dry conditions
* Mechanically fasten EPS board with inset metal hat track (Fig10)

10.0 QUALITY CONTROL MEASURES

The durability of EIF systems appears to depend on the system design, workmanship, and quality control used during the construction process and maintenance during the life of the building. " The known failures of EIF systems seem almost without exception to be a problem of either faulty installation (the vast majority) or faulty detailing."(1)
At the current time there are no national standards are in place for the correct application of EIF systems. The American Society for Testing Of Materials (ASTM) is beginning the process of developing an American standard. The Exterior Insulation Manufacturers Association has printed guidelines that offer little more information than recommend following manufacturers directions.

The Ontario Ministry of Housing in a publication produced by TROW Inc. has produced Specification/Checklists for both prefabricated and field applied EIF systems. Also included in this definitive publication are sample construction details for prefabricated EIFS panels. (10)

10.1 WARRANTEES

At the present time warrantees for EIF systems appear to be limited to materials only when applied according to the EIFS manufacturer's directions on substrates approved by the manufacturer. The warrantee period is usually for 3 years and is limited to replacement of defective materials. The Wall and Ceiling Contractors association of British Columbia is in the preliminary stages of investigating the development of a material and performance bond similar to that supplied by the Roofing Contractors Association. The Wall and Ceiling Contractors Association is presently limited to unionized contractors who mostly carry out commercial, institional and in some cases high rise residential work.

10.2 TRAINING

Some of the EIFS manufacturers carry out training programs for the contractors who use their products and most supply consulting at the design and construction phases to ensure correct application of their products. Some EIFS manufacturers also publish detailed installation manuals to assist contractors in the proper application of their product.

10.3 REGULATORY MEASURES

10.3.1 NORTH AMERICA

Some Canadian regulators are responding to perceived problems with EIF systems by reviewing acceptable uses of these systems and requiring independent field review procedures by qualified third parties. Attached to this report are notices issued by the Vancouver Permits and Licenses Department outlining their current requirements.

The 1990 National Building Code of Canada in Part 3, paragraph 3.2.3.7 (3) makes reference to limiting the use of foam plastic insulations in exterior walls to buildings no more than 3 stories in height unless protected by noncombustible materials as specified in subparagraphs a,b, and c of that paragraph. The industry has already begun to respond to that requirement by developing a noncombustible EIFS cladding that specifically meets this code requirement. In British Columbia The Building Standards Branch is presently taking under consideration a recommendation by the EIFS industry that EIFS claddings be allowed on buildings over 3 stories with the follwing qualifications:

- Applicable fire resistance requirements are met through testing by a nationally recognized testing agency.

- A quality assurance audit program is carried out by an independent testing agency to ensure that EIFS materials conform to the same specifications as those tested and approved.

- Onsite inspections are carried out by qualified third parties.

10.3.2 EUROPE

EIF systems originated in Germany just after World War II. About 140 million square meters have been installed since then with about 12 million square meters added every year. Since the origination of EIF systems, extensive testing and certification procedures have been developed to ensure EIF systems components meet standards and the complete EIF systems are correctly applied.

Approximately 80 to 90% of all EIF systems installed in Europe utilize expanded polystyrene foam board. The vast majority of EIFS installations in Europe are over masonry or poured concrete substrates, "unsuccessful applications of EIFS to gypsum board virtually eliminated the use of EIFS in France on walls other than masonry and concrete" (6) . A need for adequate fire protection of taller buildings led to the utilization of mineral insulating boards and mechanical fasteners . Failures of EIFS as water and weather barriers led to the development of training and certification of applicators as well as the development of a wide variety of accessories designed to accommodate a range of architectural designs.(2)

The quality assurance used in France for EIF systems involves the following measures:

- A national performance standard has been developed for EIF systems, this standard includes the following major divisions:

    * General rules relating to quality of materials and performance standards
    * Characteristics of individual components and corresponding testing standards
    * Suitability for use of the complete system and test standards
    * Specifications for constituent components.

- Manufacturers submit reports on product installation procedures and test results.

- Most of the manufacturers tests are duplicated by the national scientific construction authority (CSTB).

- All applicators must be trained by the manufacture whose product they install

- Applicators who fail to install systems according to manufacturers specifications lose their certification and hence their access to that source of supply.

- Manufacturers must develop and maintain training and certification programs or loose their liability insurance

- Applicators who fail to install EIF systems to manufacturers specifications risk losing membership in the applicator's union and will not be able to obtain liability insurance and hence will not be to apply EIF systems.

This system has eliminated most of the problems of poor workmanship that were experienced by the EIFS industry during the early years of its development in France.

11.0 CONCLUSIONS AND RECOMMENDATIONS

A review of the basic performance requirements and design principles related to exterior walls suggests that EIF system claddings may require high levels of workmanship and maintenance to provide reasonable serviceability. EIF systems are typically face sealed claddings where the exterior surface and joints must remain weathertight over the service life of the building. The materials used in EIF systems in general, and those utilized at the joints in particular, are required to meet very high performance requirements due to their exposure to wind, rain, thermal cycling and solar radiation over a prolonged period of time. It is possible that in many cases the need for higher performance face sealing is compounded by the properties of the EIF system materials and the substrates upon they are mounted.

Damage to EIF system claddings may result from water penetration, moisture during construction, or in some instances moisture condensing on the back of the sheathing on which the cladding system is mounted. Moisture related deterioration maybe exacerbated when claddings are installed over substrates that are sensitive to moisture. One of the most common substrates is exterior gypsum board sheathing attached to steel studs with screws. In most cases the EIFS cladding is adhered to the face of gypsum sheathing. This type of construction can result in the entire cladding system of a high rise building relying on the integrity of the gypsum core and/or the paper facing of the gypsum sheathing. In instances where no mechanical fasteners are used in the EIF system, as is often the case, any moisture related softening of the gypsum board sheathing and/or corrosion of the screw attachments of the sheathing to studs could result in significant loss of integrity of the cladding system.

Though the present extent and severity of moisture related deterioration that maybe affecting in-service EIF system claddings has not been established concern has been expressed in some quarters, but as yet no definitive studies have been undertaken. There is no consensus on the long term serviceability of EIF systems.

It is recommended that the following steps be taken:

- Carry out field investigations of EIF systems that are presently in service ranging in age from 1 to 20 years to investigate the extent and severity of potential problems, if any. These investigations should be undertaken in as wide a range of climatic zones as possible i.e.in the Pacific maritime, Prairie, Central and Atlantic maritime regions.
- Have the results of the field investigations reviewed by the EIFS industry, building envelope specialists, designers and CMHC.
- If warranted, based on the results of the field investigations and review, carry out more detailed field and or laboratory investigations to establish the effects of condensation, wind, solar radiation, thermal cycling and rain on the performance of EIF systems.
- Investigate modifications to EIF system design and construction that would counter any problems if identified in the field and or laboratory investigations.
- With the cooperation of the EIFS industry develop a series of guidelines for manufacturers, installers and designers that would enhance the performance of EIF systems

12.0 REFERENCES

(1) K. Labs, October 1989, P/A Technics Inside EIF Systems Progressive Architecture

(2) W. Lotz, June 1987, Synthetic Stucco and Insulation Systems. New England Builder

(3) M. Williams, B. Williams, 1989 , Synthetic Stucco. Encyclopedia of Architecture Design Engineering and Construction. John Wiley and Sons

(4) R. Piper, June 1988, Troubles With Synthetic Stucco. New England Builder

(5) Thomas Morestead, 1990, Private communication

(6) S. Zage, 1989, How Exterior Insulation and Finish Systems are Regulated in Europe Where They Originated. The Building Official and Code Administrator, November /December.

(7) J.L. Crowder, R.W. Bletzaker, A Fire in New England Exposes and Exterior Insulation and Finish System Part A, Building Standards September-October 1988

(8) D. Roberts, Feb 4, 1990 Fast Burning Insulation Probed, Winnipeg Free Press

(9) Gypsum Sheathing, Gypsum Association 1603 Orrington Ave, Evanston Ill.

(10) F. Dharamshi, G. Handegord, February 1989, T. Ibronyi, Evaluation of Exterior Insulation Cementitious Fibre-Reinforced Cladding System (EICFS), Ontario Ministry of Housing

(11) Gordon Spratt, Letter to Mr. Maki City of Vancouver Department of Permits and Licences August 8th 1989.

(12) Hutcheon, Handigord, Building Science for a Cold Climate John Wiley & Sons 1983 National Research Council of Canada

(13) Canadian Home Builder's Association Builder's Manual, Canadian Home Builder's Association 1989

(14) Chapter 2 ,Moisture Movement. Moisture Control Handbook, Joseph Lstiburek , 1990

(15) Canadian Building Digest #40, Rain Penetration And Its Control, G. K. Garden April 1963, National Research Council of Canada

(16) J. C. Perreault , Private Communication

(17) Joseph Lstiburek, Private Communication

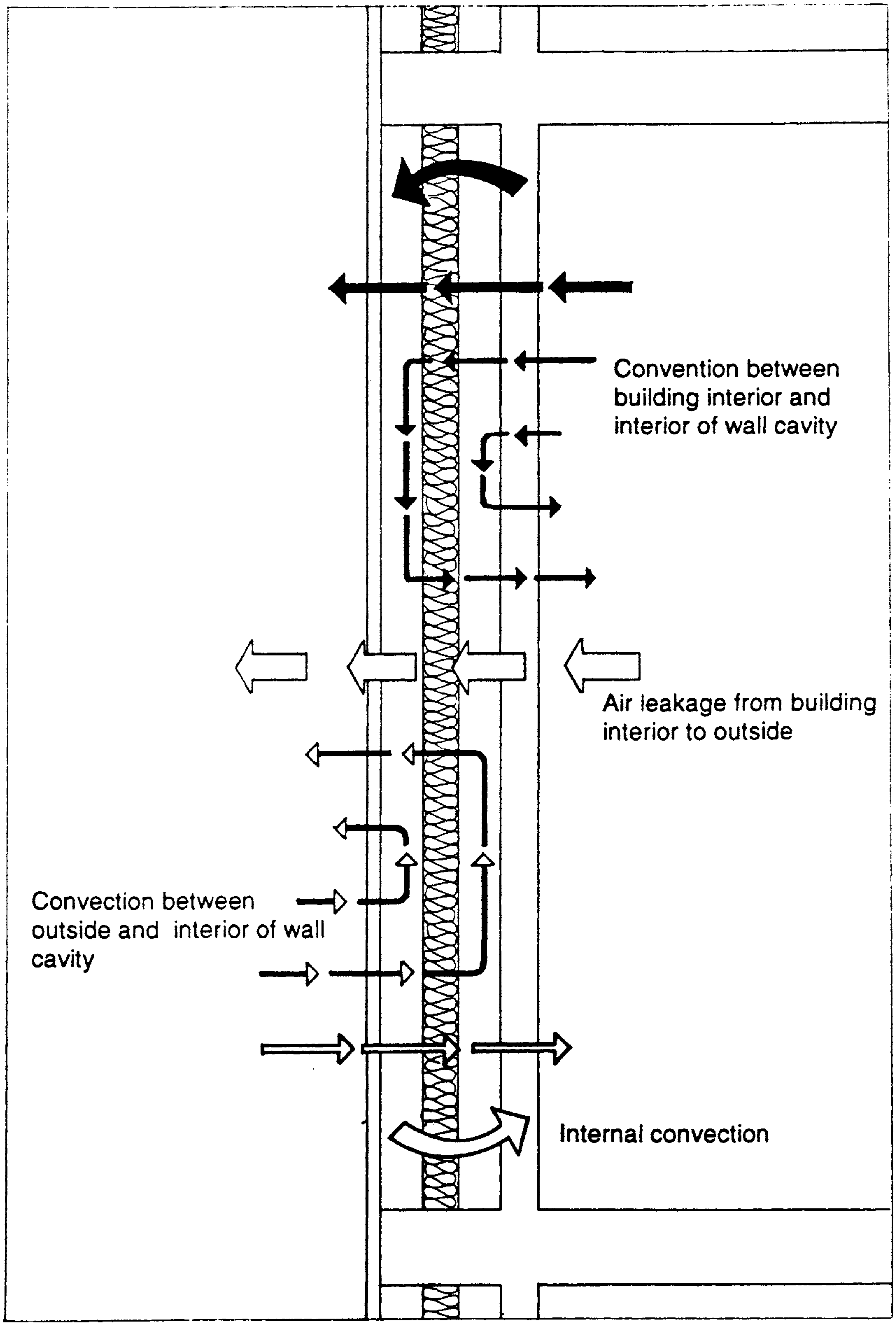


FIG 1 AIR FLOW MECHANISMS THROUGH EXTERIOR WALLS (After Hutheon and Handigord)

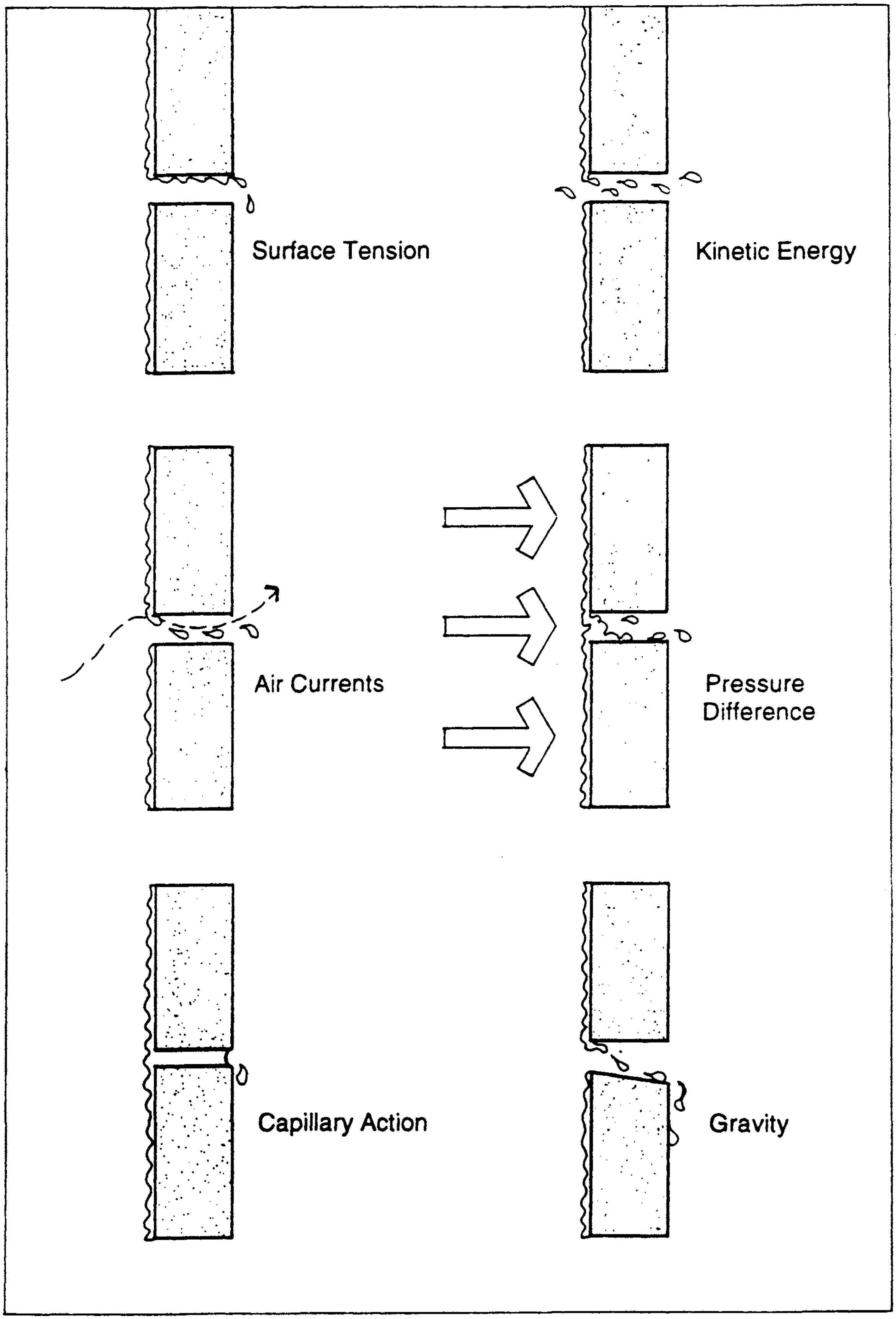


FIG 2 FORCES THAT CAUSE WATER PENETRATION OF EXTERIOR CLADDINGS

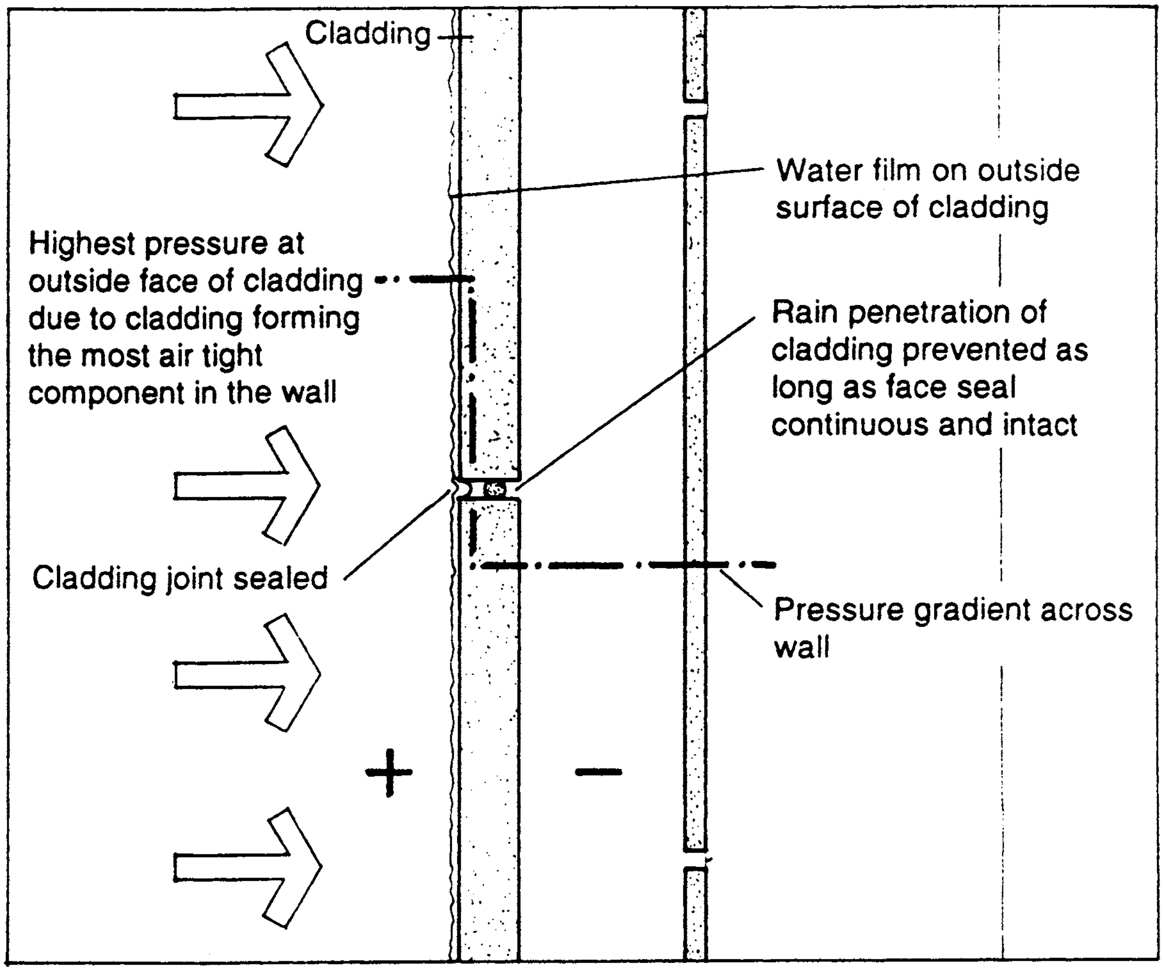


FIG 3 FACE SEALED SINGLE ELEMENT WALL

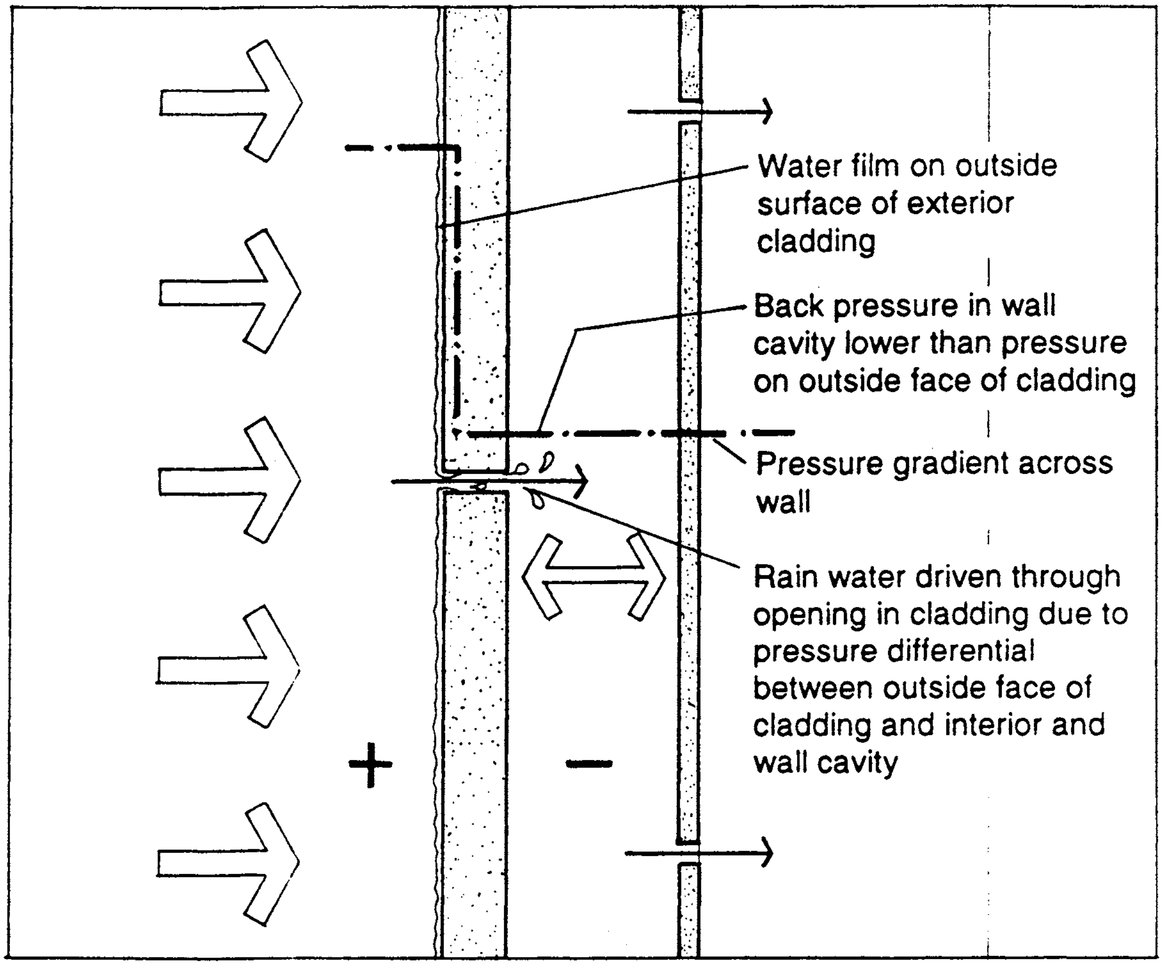


Fig 4 SINGLE ELEMENT WALL WITH OPENING IN CLADDING

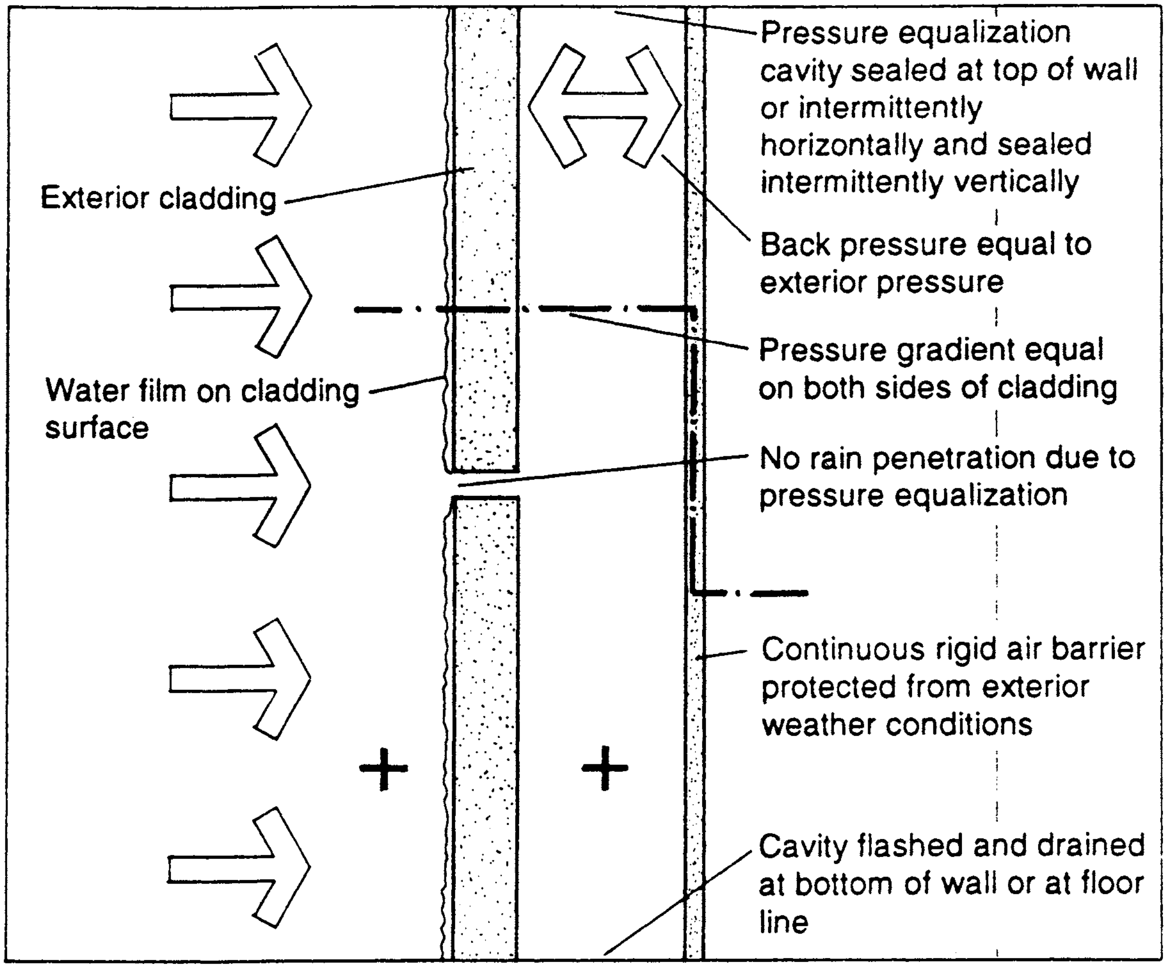


FIG 5 PRESSURE EQUALIZING WALL (RAIN SCREEN OR DRAIN SCREEN)

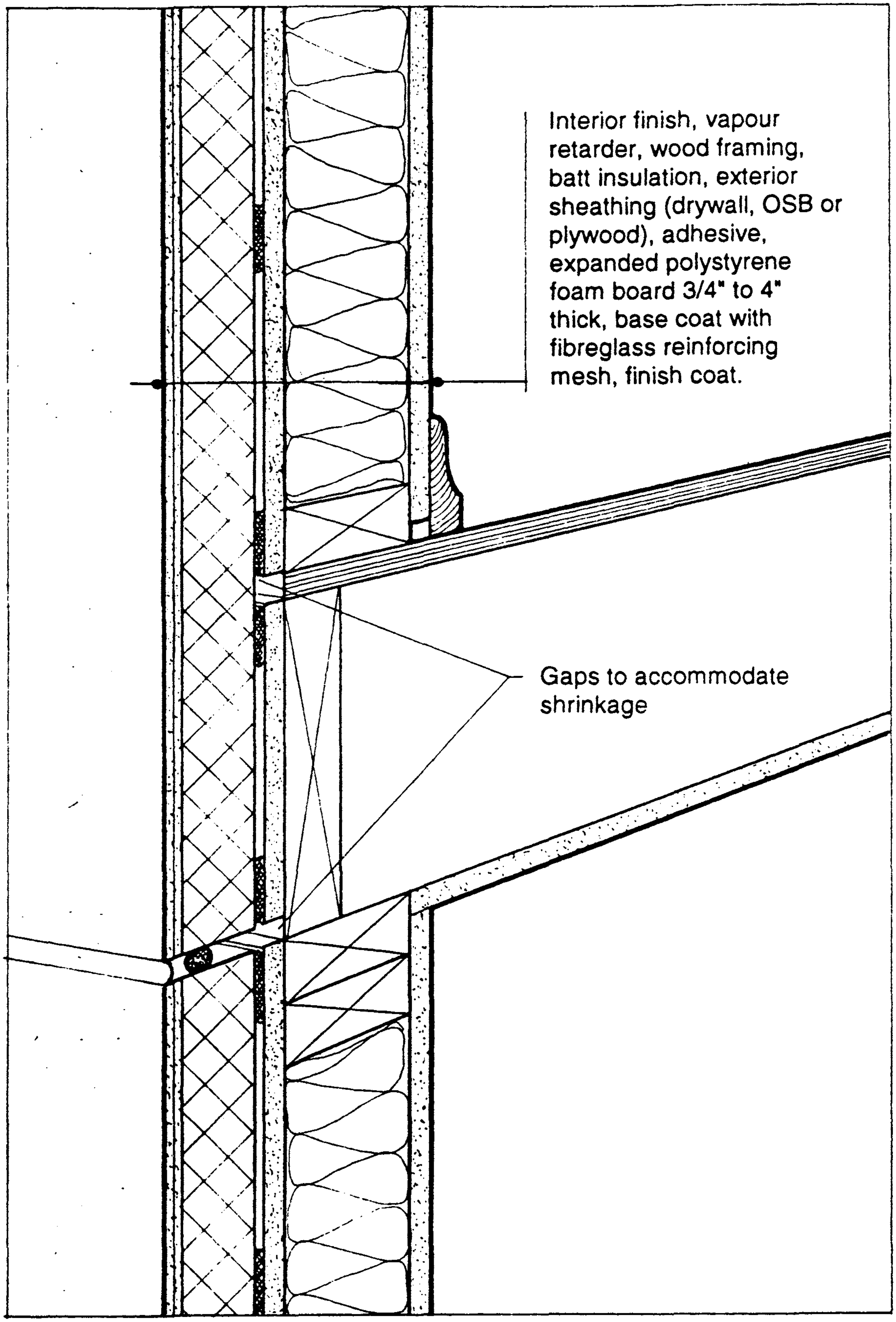


FIG 6 TYPICAL EIF SYSTEM APPLIED TO WOOD FRAMING

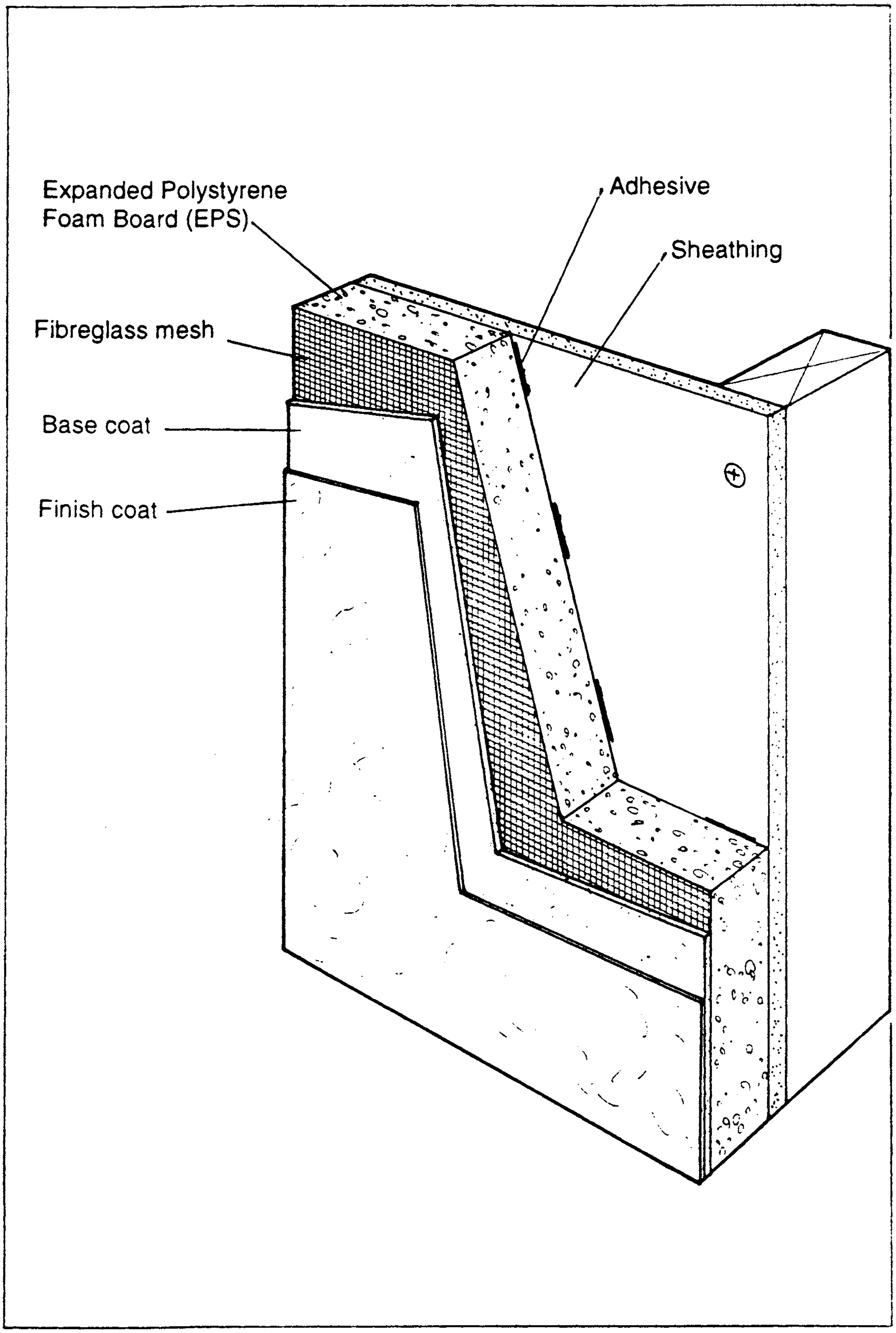


FIG 7 POLYMER BASED EIF SYSTEM

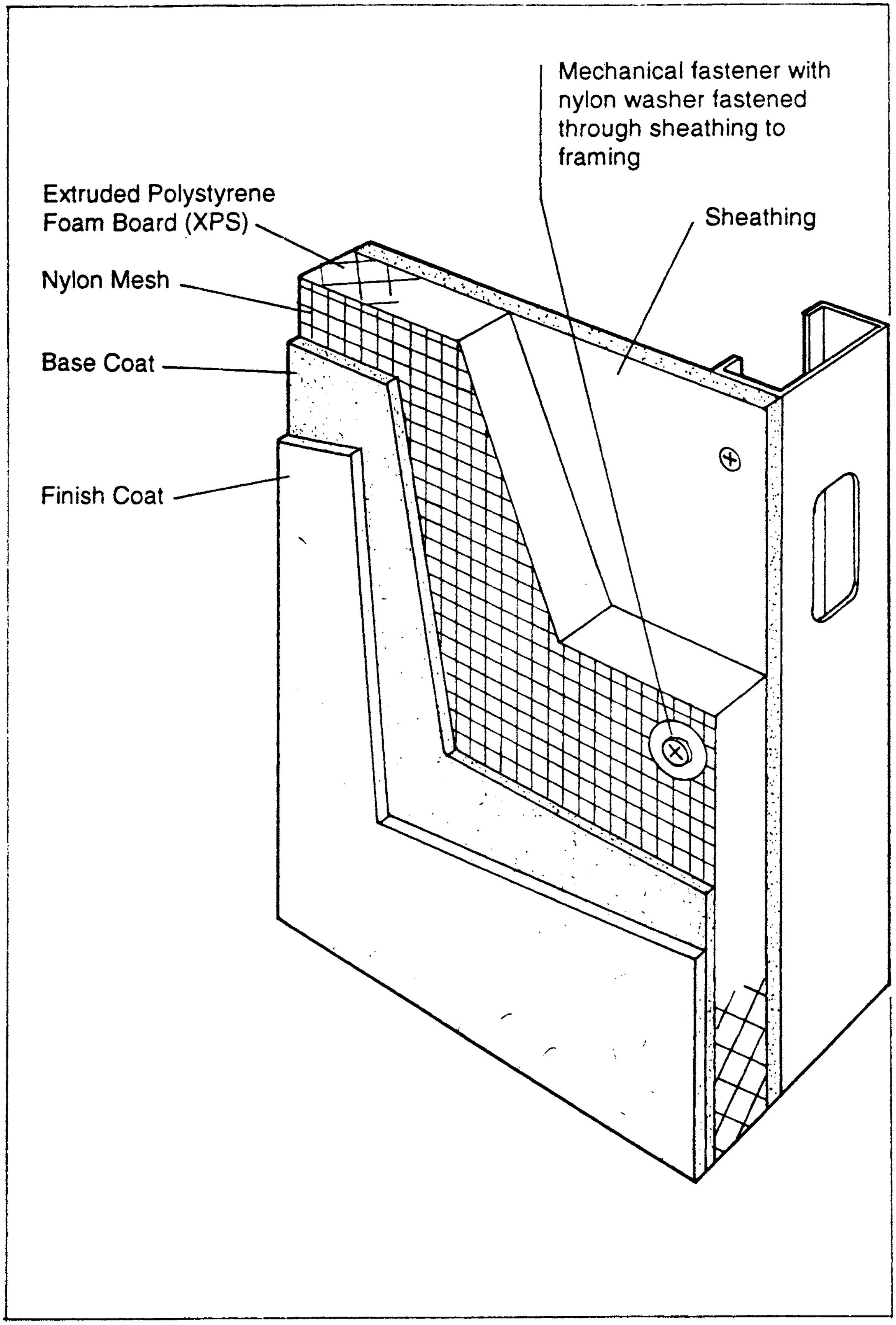


FIG 8 POLYMER MODIFIED EIF SYSTEM

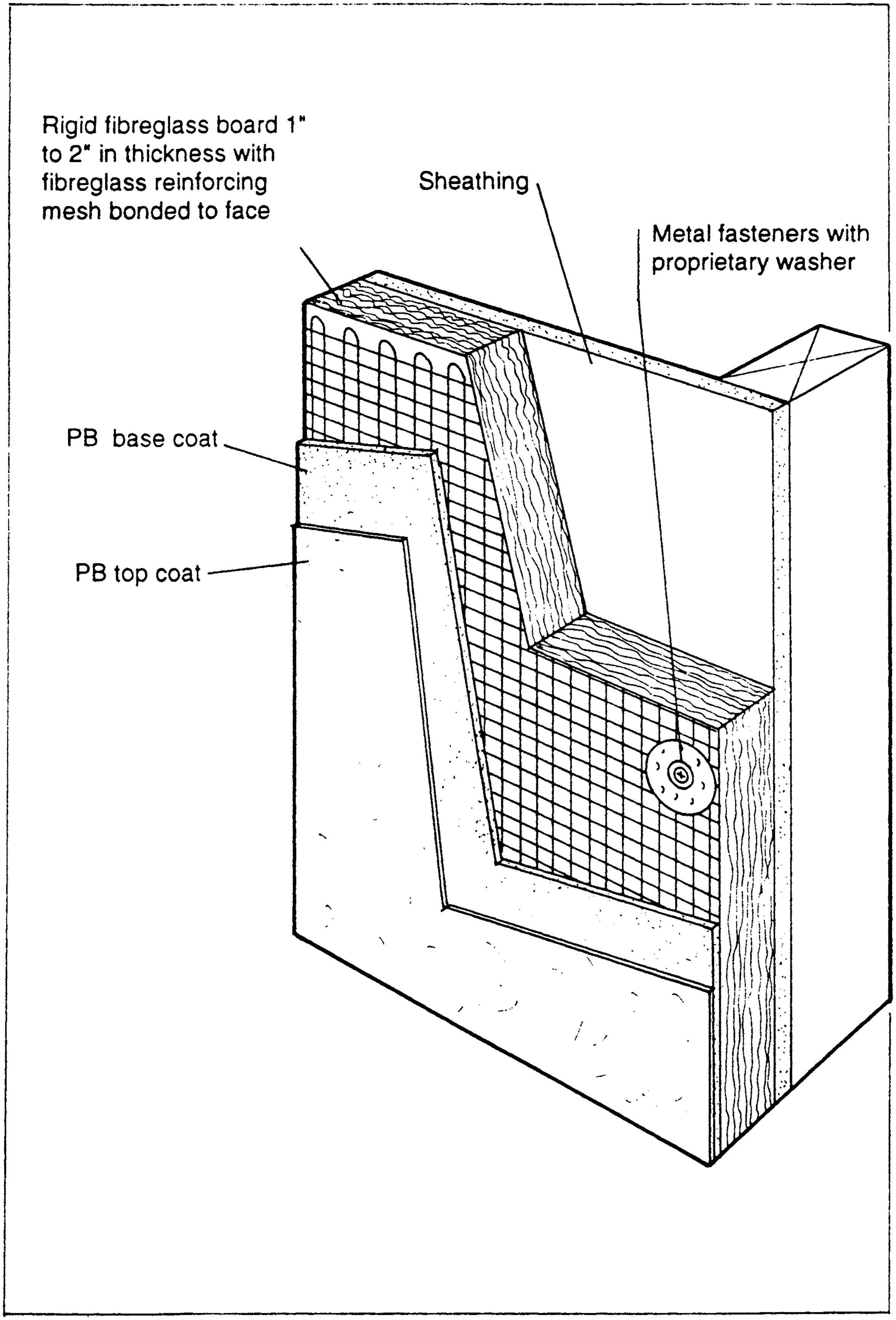


FIG 9 POLYMER BASED EIF SYSTEM USING FIBREGLASS BOARD

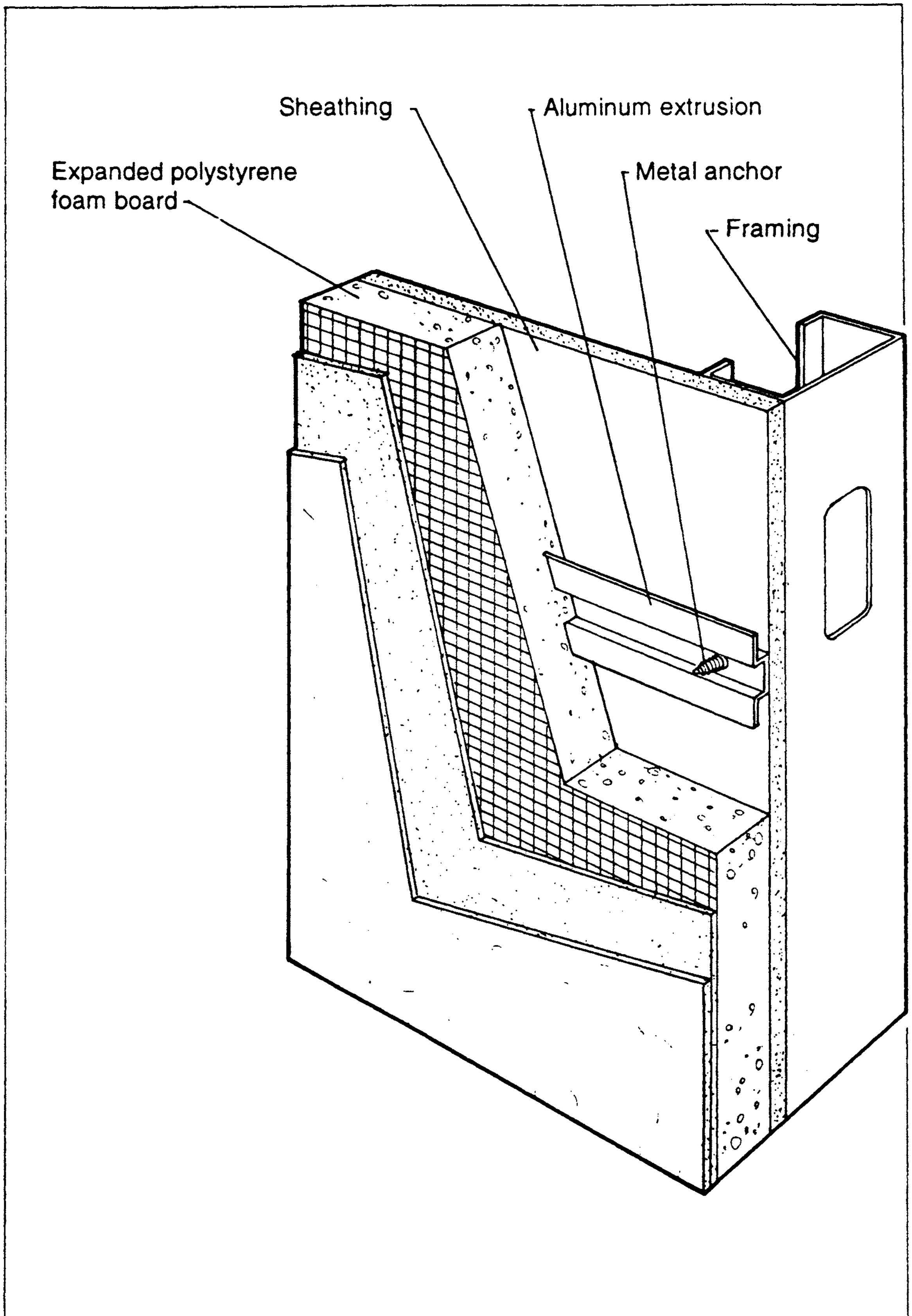


FIG 10 PROPRIETARY "HAT TRACK" METAL ANCHORING SYSTEM

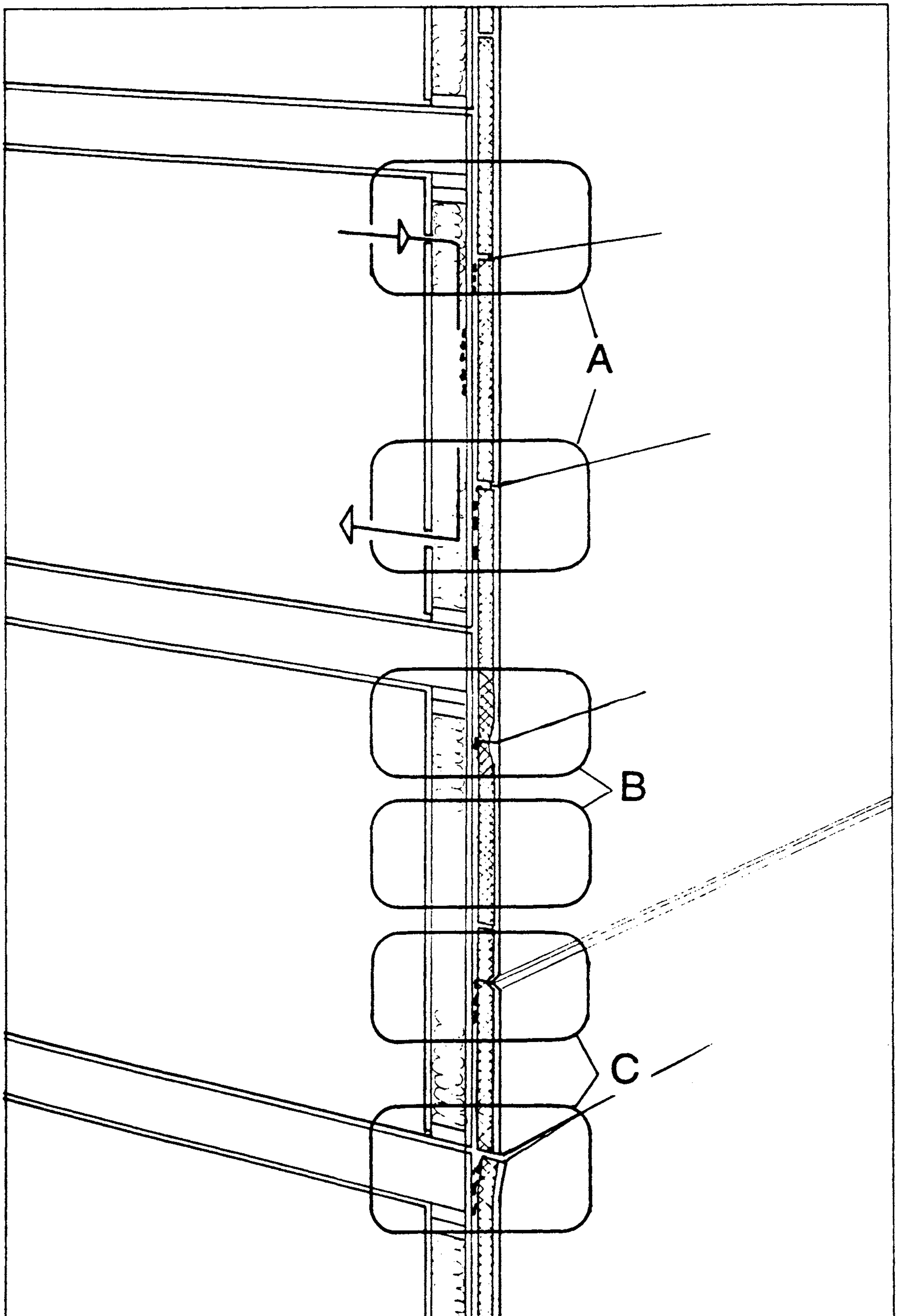


FIG 11 MULTI STOREY WALL SHOWING POTENTIAL EIF SYSTEM PROBLEMS

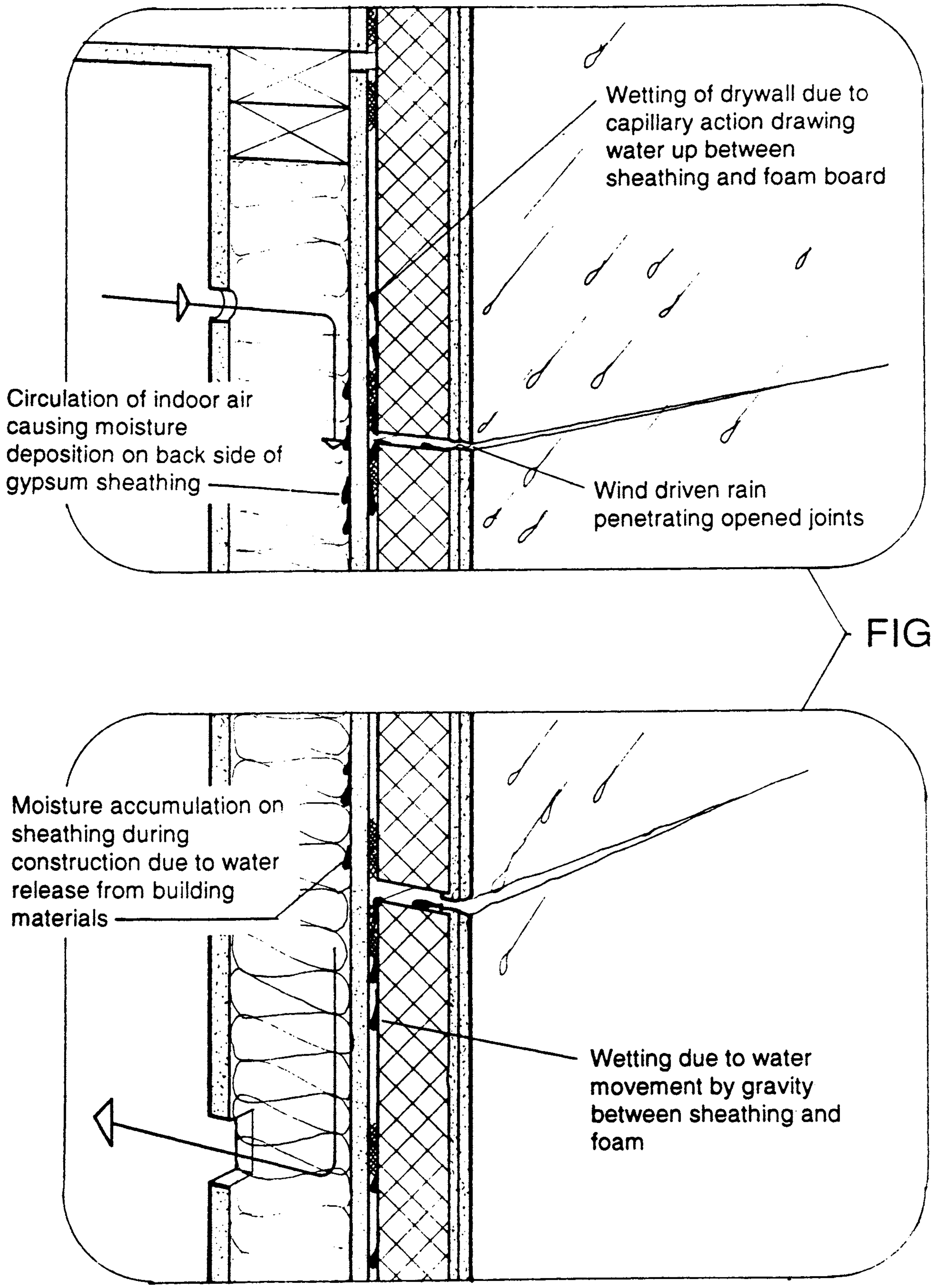

Wetting of drywall due to capillary action drawing water up between sheathing and foam board
Circulation of indoor air causing moisture deposition on back side of gypsum sheathing
Wind driven rain penetrating opened joints
Moisture accumulation on sheathing during construction due to water release from building materials
Wetting due to water movement by gravity between sheathing and foam

FIG 11A

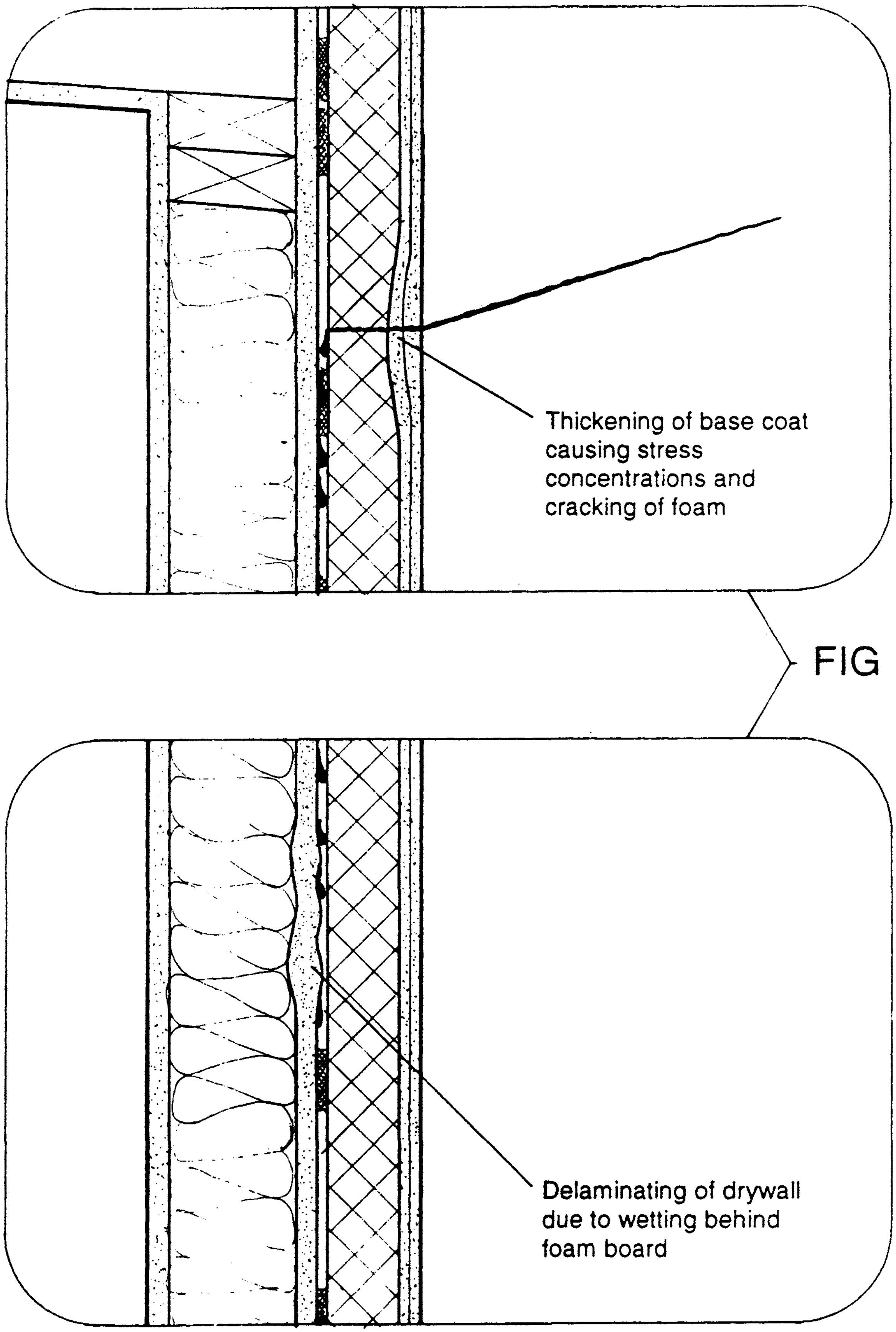

Thickening of base coat causing stress concentrations and cracking of foam
Delaminating of drywall due to wetting behind foam board

FIG 11B

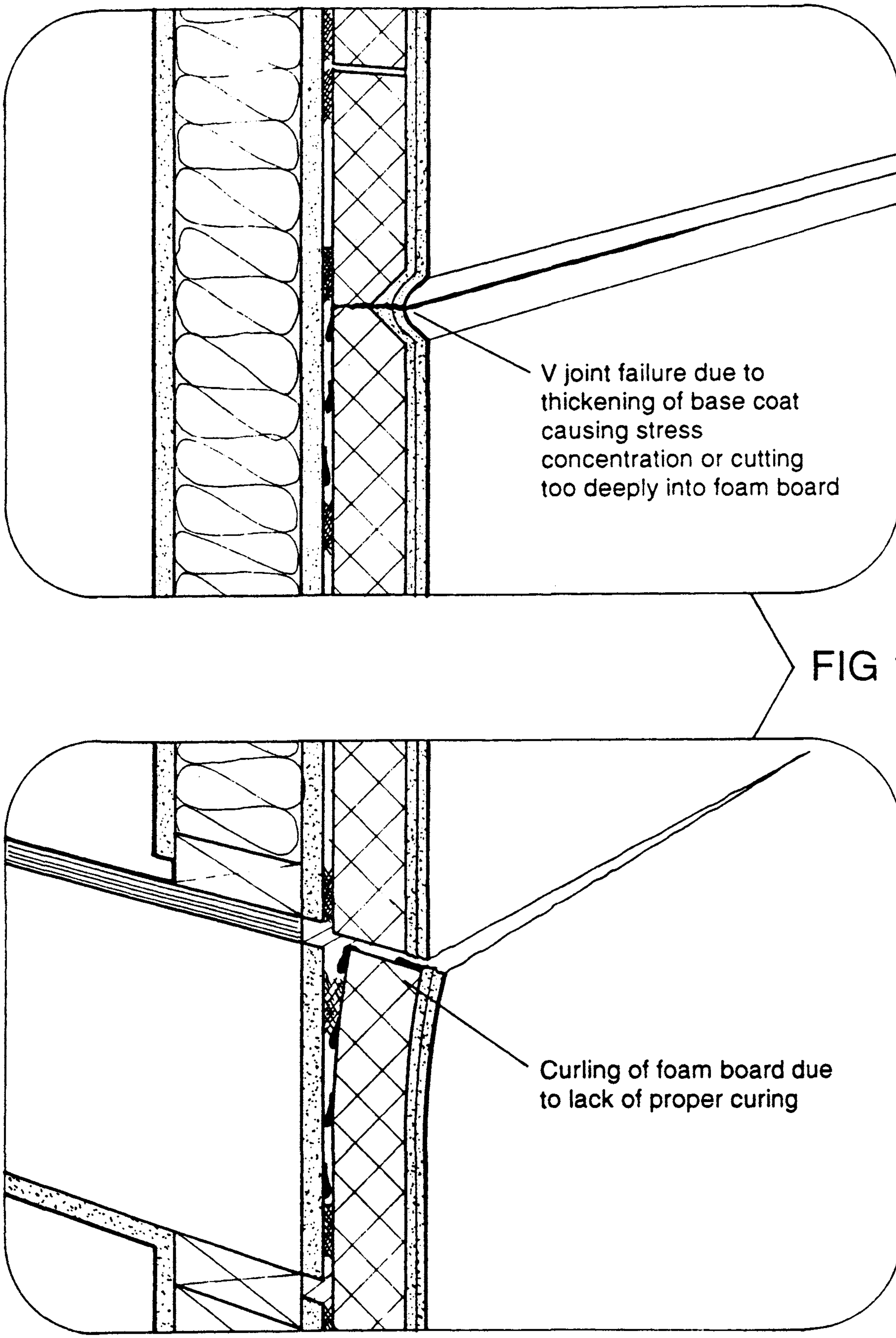

V joint failure due to thickening of base coat causing stress concentration or cutting too deeply into foam board
Curling of foam board due to lack of proper curing

FIG 11C

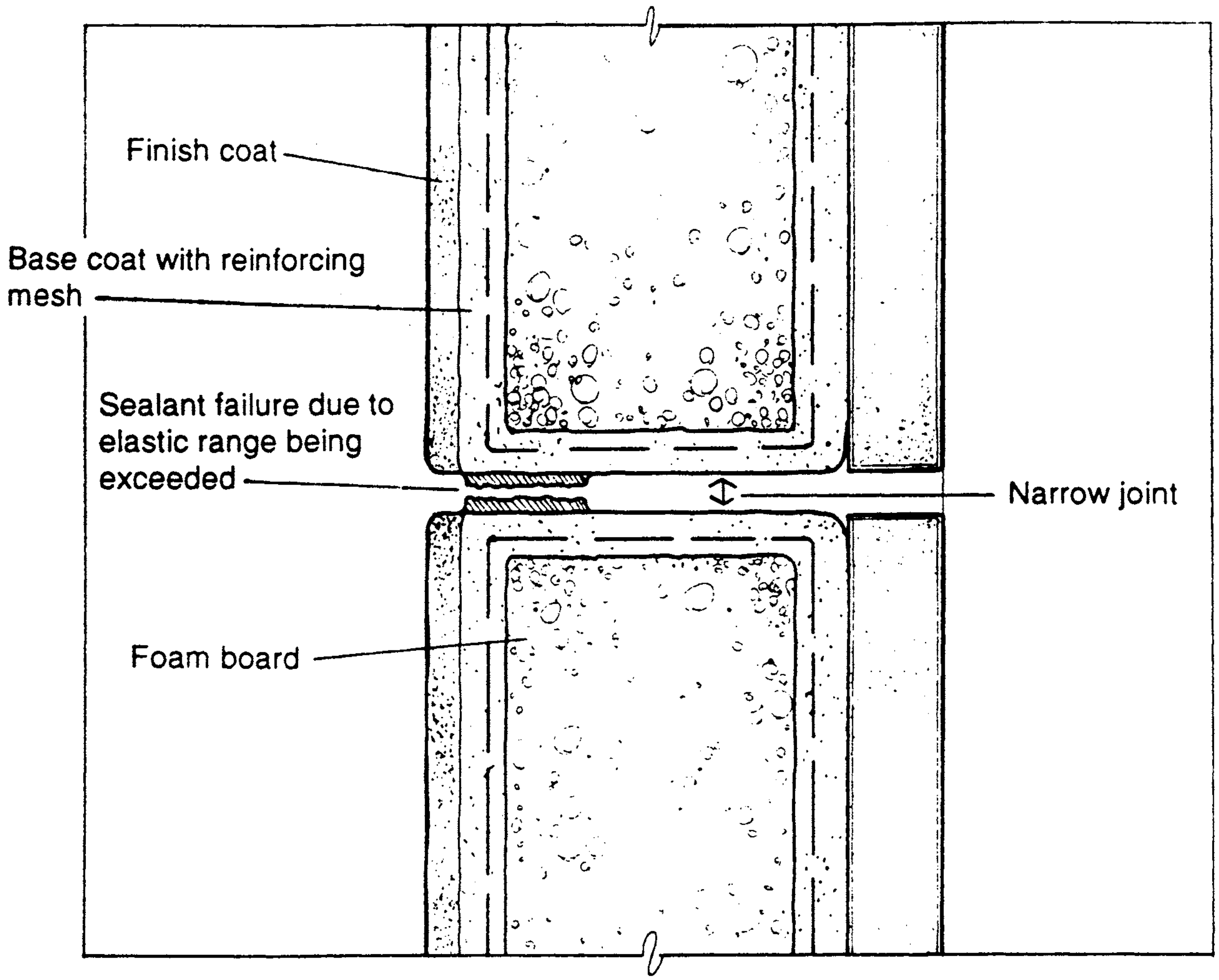


FIG 12 POTENTIAL JOINT FAILURE DUE TO NARROW JOINT

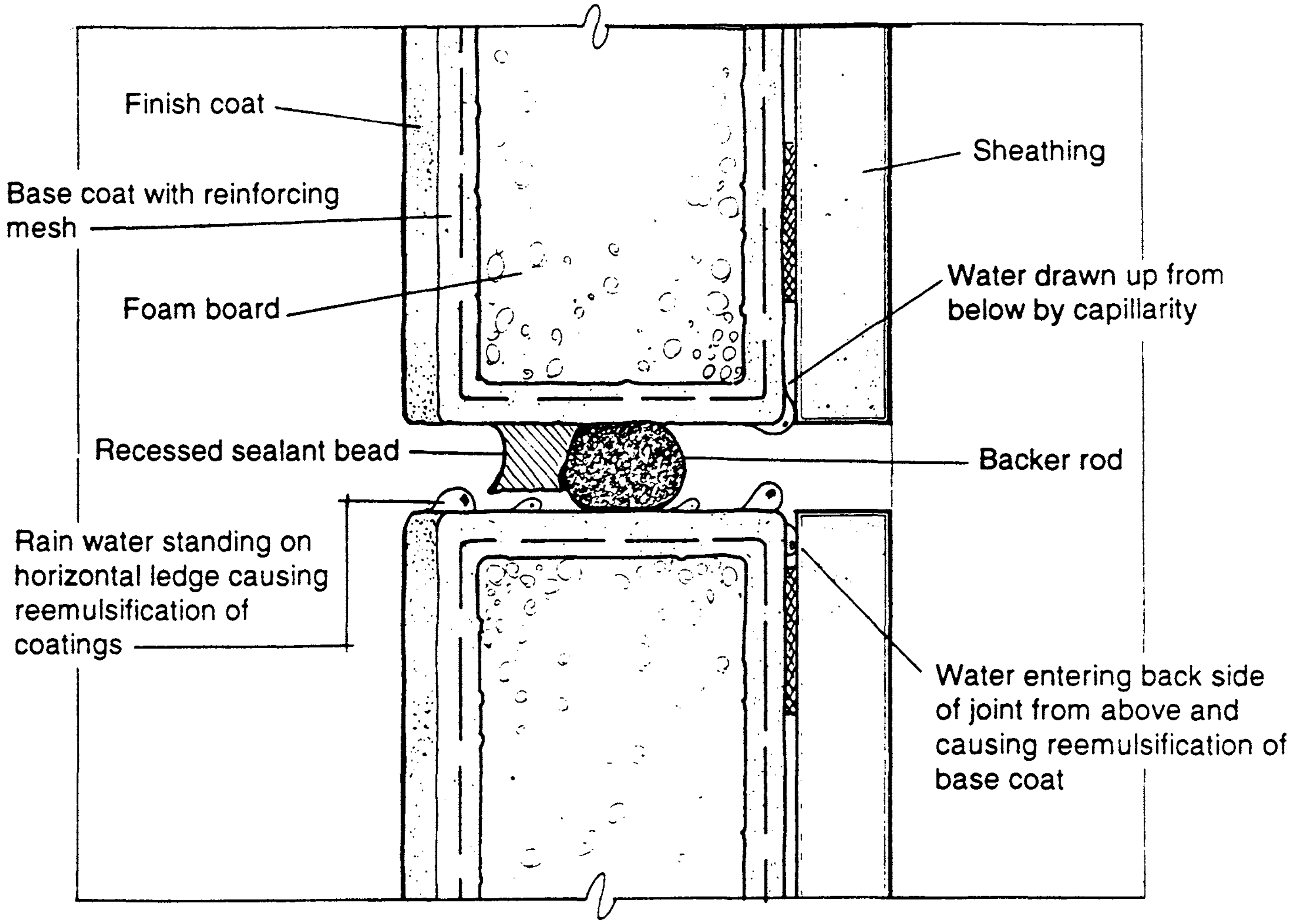


FIG 13 POTENTIAL JOINT FAILURE DUE TO REEMULSIFICATION OF COATINGS

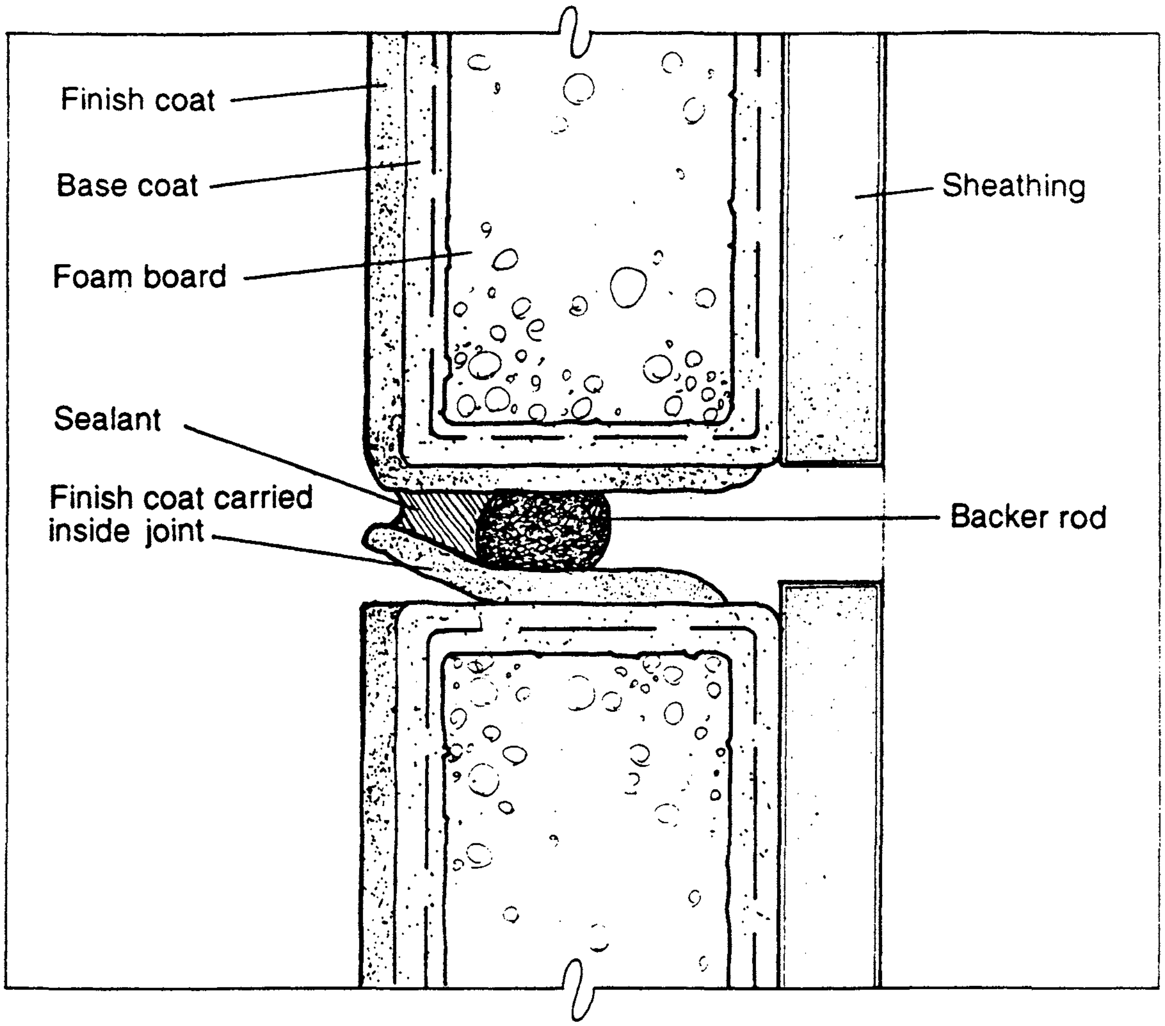


FIG 14 POTENTIAL JOINT FAILURE DUE TO SEALANT ADHESION TO FINISH COAT

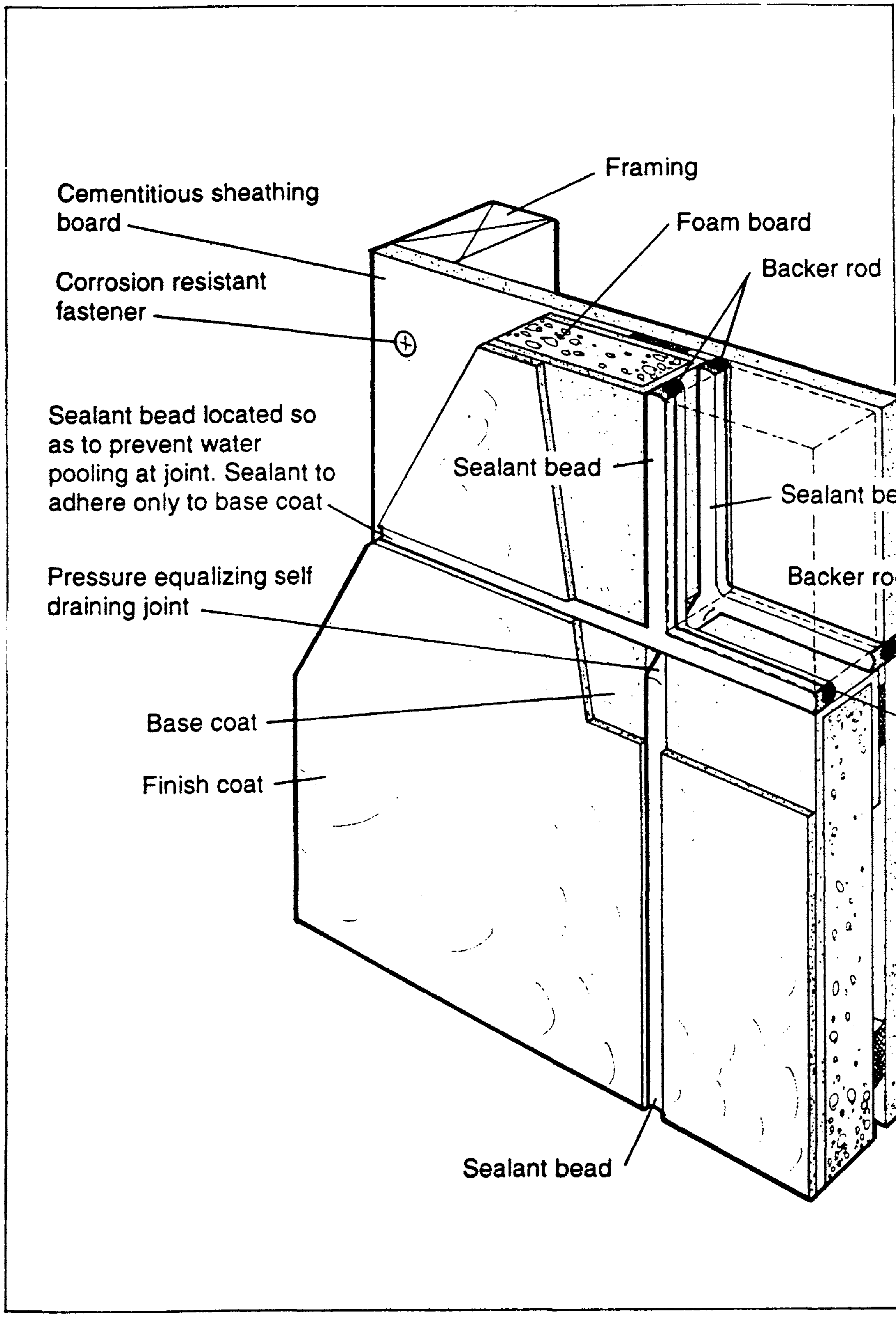


FIG 15 RECENT MEASURES DEVELOPED TO ENHANCE THE DURABILITY OF EIF SYSTEMS

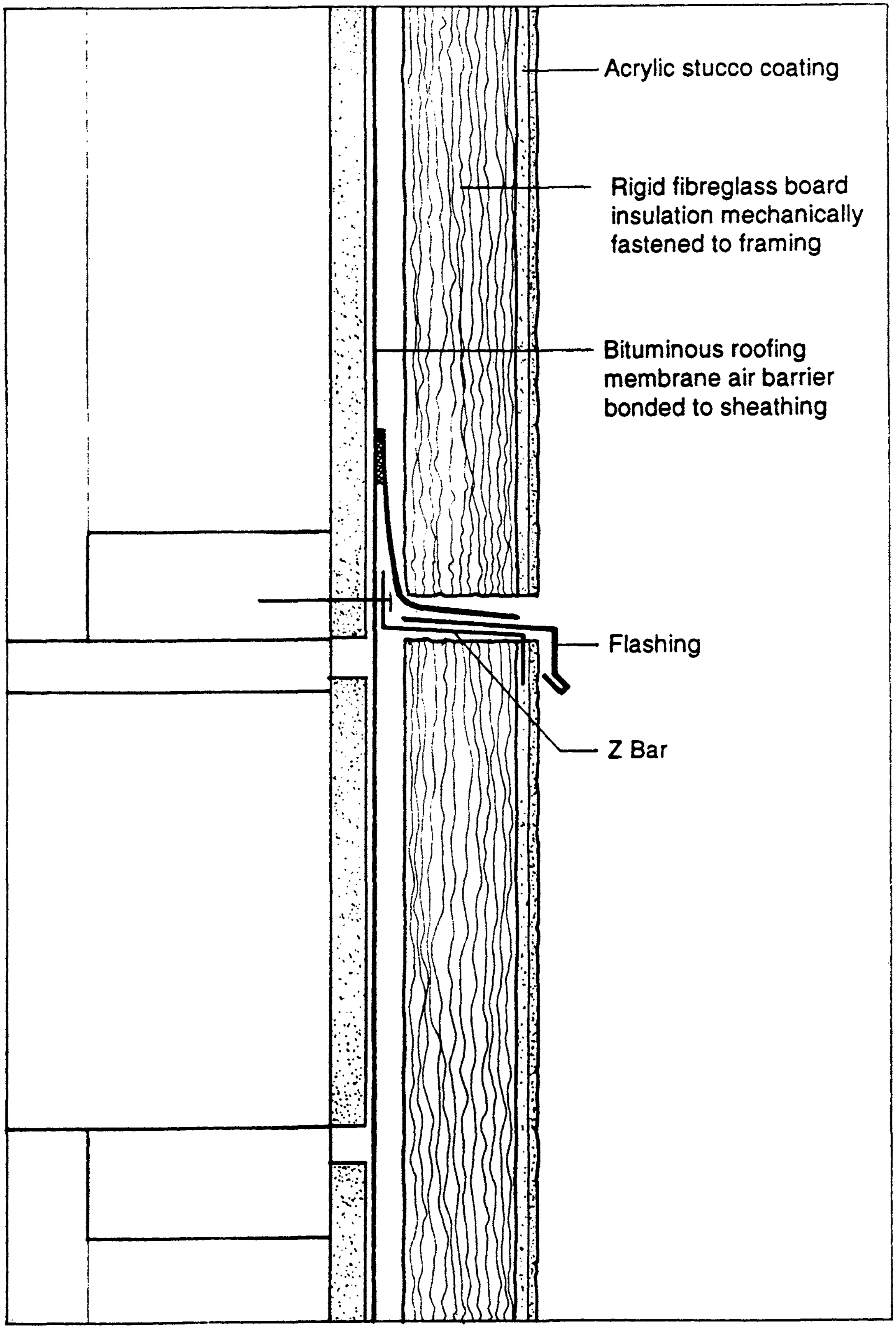


Fig 16 DRAIN SCREEN WALL CONCEPTUAL DIAGRAM

APPENDIX A: LITERATURE SEARCH

The literature search concentrated on three primary areas:

- Reference publications, conference proceedings, professional journals and magazine articles

- Manufacturers product and installation literature

- Building code and building department documents

The literature search was carried out in the following ways.

- Library searches through:

  * University of British Columbia Library
  * Housing Industry Training Centre Library at the British Columbia Institute of Technology.
  * Vancouver Public Library

- Obtaining publications from authors, publishers and funding agencies referenced in previously reviewed publications.

- Contacting building science consultants

- Contacting manufacturers of EIF systems

- Contacting manufacturers of component materials used in EIF systems and materials that could be used as substrates for EIF systems.

The literature search was carried out to identify the following:

- The methods of EIF system installation as recommended by synthetic stucco, insulation and other building component manufacturers.

- The developments of EIF systems that have evolved to meet the changing needs and solve problems encountered by the building industry.

- The documented failures encountered with EIF systems

- The quality assurance methods adopted by manufactures, jurisdictions and consultants with respect to EIF systems.

- Topics to be covered in interviews carried out with manufacturers, builders, designers and building science consultants.

APPENDIX B: SURVEY FORM

EXTERIOR INSULATION AND FINISH SYSTEMS STUDY INTERVIEW FORM

DATE____________________________

INDIVIDUAL____
ORGANIZATION____
POSITION____

EXPERIENCE WITH EIF SYSTEMS
YEARS ___________

TYPES OF APPLICATIONS
LOW RISE RESIDENTIAL ________________________________
HIGH RISE RESIDENTIAL _______________________________
OFFICE ____
COMMERCIAL ____

TYPES OF EIF SYSTEMS

TYPE OF CONTINUOUS AIR BARRIER SYSTEM USED ___________
____

TYPICAL SUBSTRATE MATERIALS USED
DRYWALL (TYPE) ______________________________________
OSB ____
PLYWOOD ____
CONCRETE BOARD ______________________________________
MASONRY ____
OTHER____

TYPE OF SHEATHING PAPER USED
METHOD OF FASTENING INSULATION BOARD TO SUBSTRATE
ADHESIVE (TYPE AND APPLICATION METHOD) _____________
____

MECHANICAL FASTENERS (TYPE AND APPLICATION) _________
____

TYPE OF INSULATION BOARD
EPS ____
XPS ____
FIBREGLASS ____
MINERAL BOARD _______________________________________
FOAM GLASS ____

TYPE OF SYNTHETIC STUCCO USED
POLYMER BASED _______________________________________
POLYMER MODIFIED MINERAL ____________________________

REINFORCING
FIBREGLASS MESH ______________________
METAL MESH ______________________
RANDOM FIBERS ______________________

SEALANTS
TYPE USED ______________________
BACKER ROD/BOND BREAKER USED ______________________

SPECIAL FEATURES OF EIF SYSTEM
____
____

EXPERIENCES WITH EIF SYSTEM PROBLEMS

TYPE OF EIF SYSTEM
____
____
____
____

FABRICATION METHOD
SITE BUILT ______________________
PREFABRICATED ______________________

SYMPTOMS OF FAILURE
____
____
____
____
____
____
____
____
____
____

CAUSES OF FAILURE
____
____
____
____
____
____
____
____
____
____
____

METHODS USED TO CORRECT FAILURE

HOW TO PREVENT THIS TYPE OF FAILURE IN THE FUTURE

APPENDIX C: CITY OF VANCOUVER REQUIREMENTS REGARDING INSTALLATION OF EIF SYSTEMS

BULLETIN 89-2

City of Vancouver

DIRECTOR

R.V. Hebert, P.Eng
873-7520

*SSISTANT DIRECTORS:
ense & Property Use Division — J. Perri
,3-7545

Permits & Inspection Division — R.L. Maki, P.Eng.
873-7522

PERMITS & LICENSES DEPARTMENT
City Hall, 453 West 12th Avenue,
Vancouver, British Columbia
Canada V5Y 1V4

Please refer to.

April 28, 1989

EXTERIOR INSULATION FINISH SYSTEMS (EIFS)

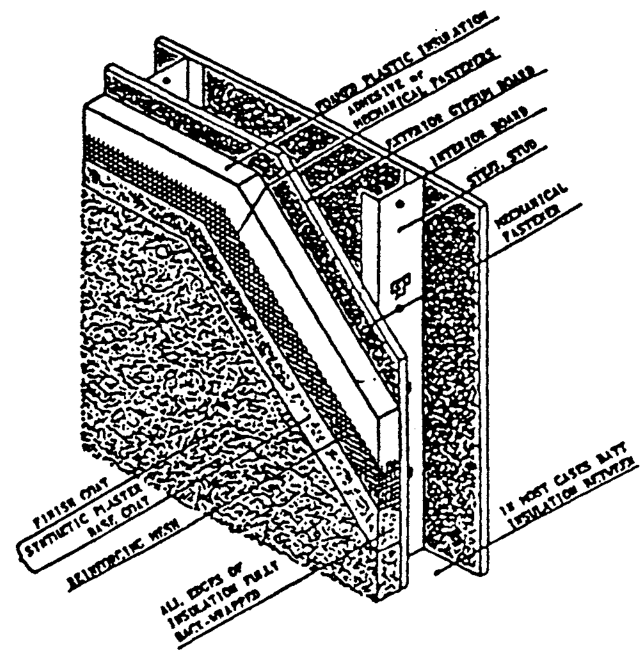
These systems are currently popular in Vancouver as exterior cladding and usually consist of a protective synthetic plaster, foamed plastic insulation wrapped almost completely around with fiberglass reinforced netting, over a substrate of exterior gypsum board attached to steel stud wall framing, as illustrated below.

For fire protection purposes the Vancouver Building By-law permits such systems for the exterior cladding in an exposing building face as regulated in Subsection 3.2.3., where the wall is far enough from the property lines, provided they comply with Article 3.2.3.5., Clause (3)(d), viz:

"...where foamed plastic is used in an exposing building face...it shall be protected on the exterior surface by...

(d) ...noncombustible material that will remain in place for at least 15 min. when tested in conformance with CAN4-S101, "Standard Methods of Fire Endurance Tests of Building Construction and Materials".

NOTE: This EIF system is only acceptable on buildings where Article 3.2.3.5. does not require noncombustible cladding due to its close proximity to neighbouring property lines.



While the synthetic plaster protection normally passes the S101 test, it usually does not meet the noncombustibility requirement, the test for which is ULC S-114. However, the City of Vancouver has accepted the passing of a full scale exterior wall test, as evaluated by the National Research Council or Warnock Hersey Professional Services Ltd., as being equivalent to meeting the noncombustibility requirement for insulation protection, but <u>not for spatial separation</u>.

Accordingly, certain manufacturers' systems, namely, DRYVIT, PRESWITT, INSUL/CRETE, (and SWISS-TEX, tentatively) to date have been approved provided the manufacturers' design and installation specification as tested is replicated on the building.

For those systems approved so far, an approved monitoring agency carries out regular Quality Audits, product verification and labelling programs at the site and in the plant. They also ensure that the qualifications and training of the site applicators are adequate to ensure consistent results.

../2

So far, we have discussed only the fire protection aspect of the exterior cladding. The architectural and structural aspects for wind and water protection and compliance with air barrier requirements are contained in Parts 5 and 4 of the By-law.

It is from these latter concerns, combined with the fire protection ones, that certain other difficulties have arisen during installation of these systems as exterior cladding. For example, it is difficult to ensure that the substrate quality is good for application of adhesive, the fiberglass is properly back-wrapped, and every batch of site-mixed synthetic plaster replicates the mix used in the referenced tests, particularly when the inspection agency is called to the site after the fact. The inspection agencies must be carrying out enough timely inspections to ensure acceptable results.

Another problem relates to the adverse weathering of exposed and completely unprotected exterior gypsum board, its consequent delamination and inadequacy as an adhesive substrate for the attachment of the remainder of the system. The use of such weathered and probably moisture-laden substrates can lead to freeze and thaw breakdown or crystallization of the substrate. Water may also be damming behind the insulation from the inadequate sealing of exterior joints, which will cause future moisture problems on both inner and outer skins.

From the number of problems experienced lately, third party inspections must increase in frequency, and where substrate without weather-protection nas already been installed for several days, it should definitely include examination of the substrate condition prior to installation of foamed plastic insulation.

The most practical solution would be the use of prefabricated panels (designed with weather-proof overlapped joints) manufactured in quality-controlled factory conditions, connected only with mechanical fasteners to the structural supports. This solution would avoid most of the above problems, and ensure quality control of the entire system.

However, if the above-mentioned problems continue, this may well become an additional condition of all approvals.

In the meantime, no permits will be issued for buildings using EIFS exterior cladding until a complete specification for the design, installation and continual weather protection is received from the project designer, and approved by this department. It must also specify enough random inspection by the quality-control agencies to ensure timely attendance to all the above concerns.

Vancouver is not alone in its concerns over EIFS cladding. The Fire Protection Committee of the National Building Code of Canada is considering limiting these systems to 6-storey buildings only, unless sprinklers are used and rigid third party inspection is provided. In the U.S.A., the International Conference of Building Officials (ICBO) Evaluation Service (associated with the Uniform Building Code) has a hearing information meeting scheduled for late April to consider acceptance criteria for EIFS related to durability and installation, among other considerations. Other national bodies currently devising standards for EIFS are the Canadian General Standards Branch (CGSB) in Canada and the American Society for Testing and Materials (ASTM) in the U.S.A.

As further information comes to light as a result of the above deliberations, Vancouver may well change its acceptance criteria for EIFS exterior cladding systems, unless better performance and construction practice are observed out on the sites.

R. V. Hebert, P. Eng.
DIRECTOR AND CITY BUILDING INSPECTOR

RVH/RLM/AG:lc

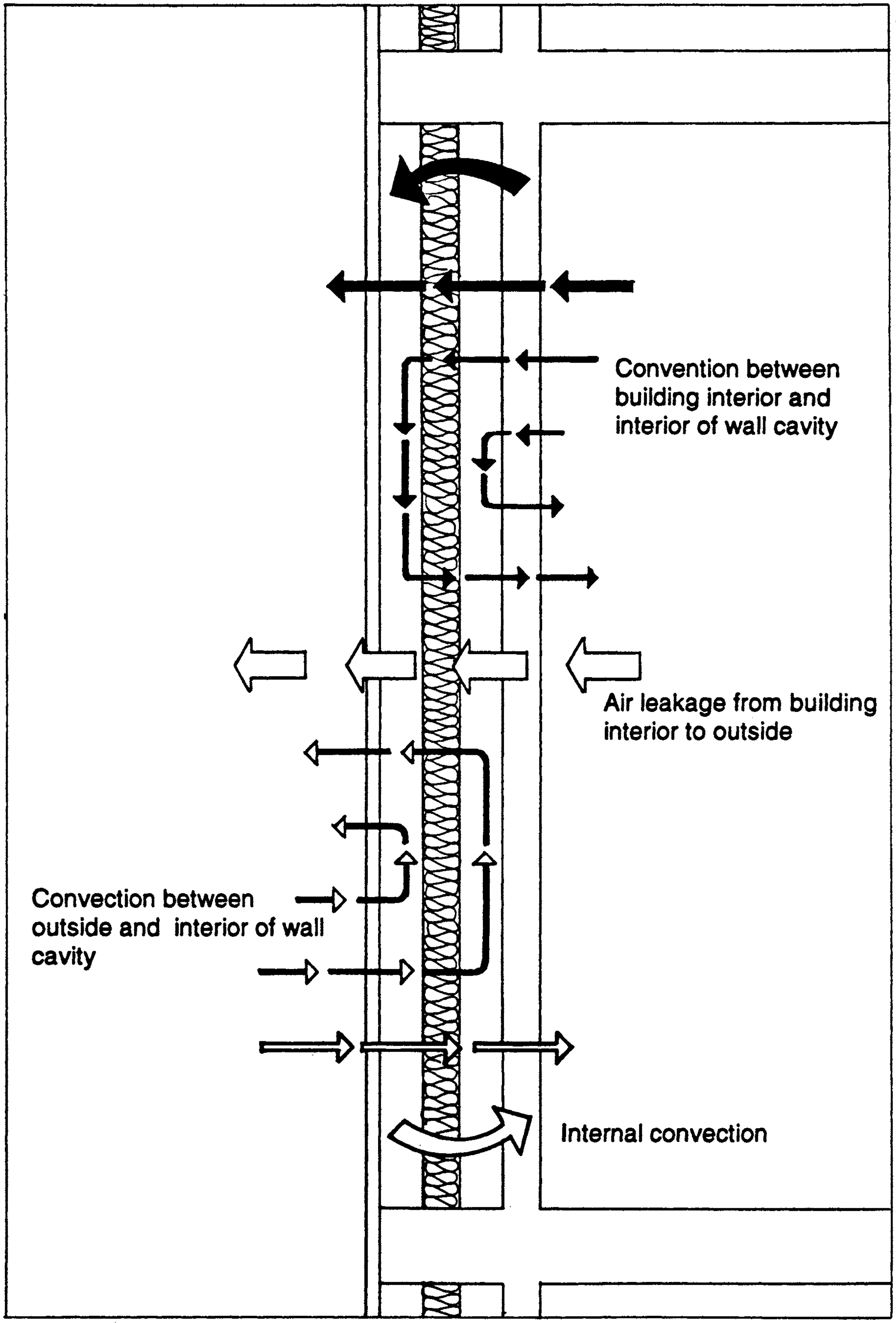


FIG 1 AIR FLOW MECHANISMS THROUGH EXTERIOR WALLS (After Hutheon and Handigord)

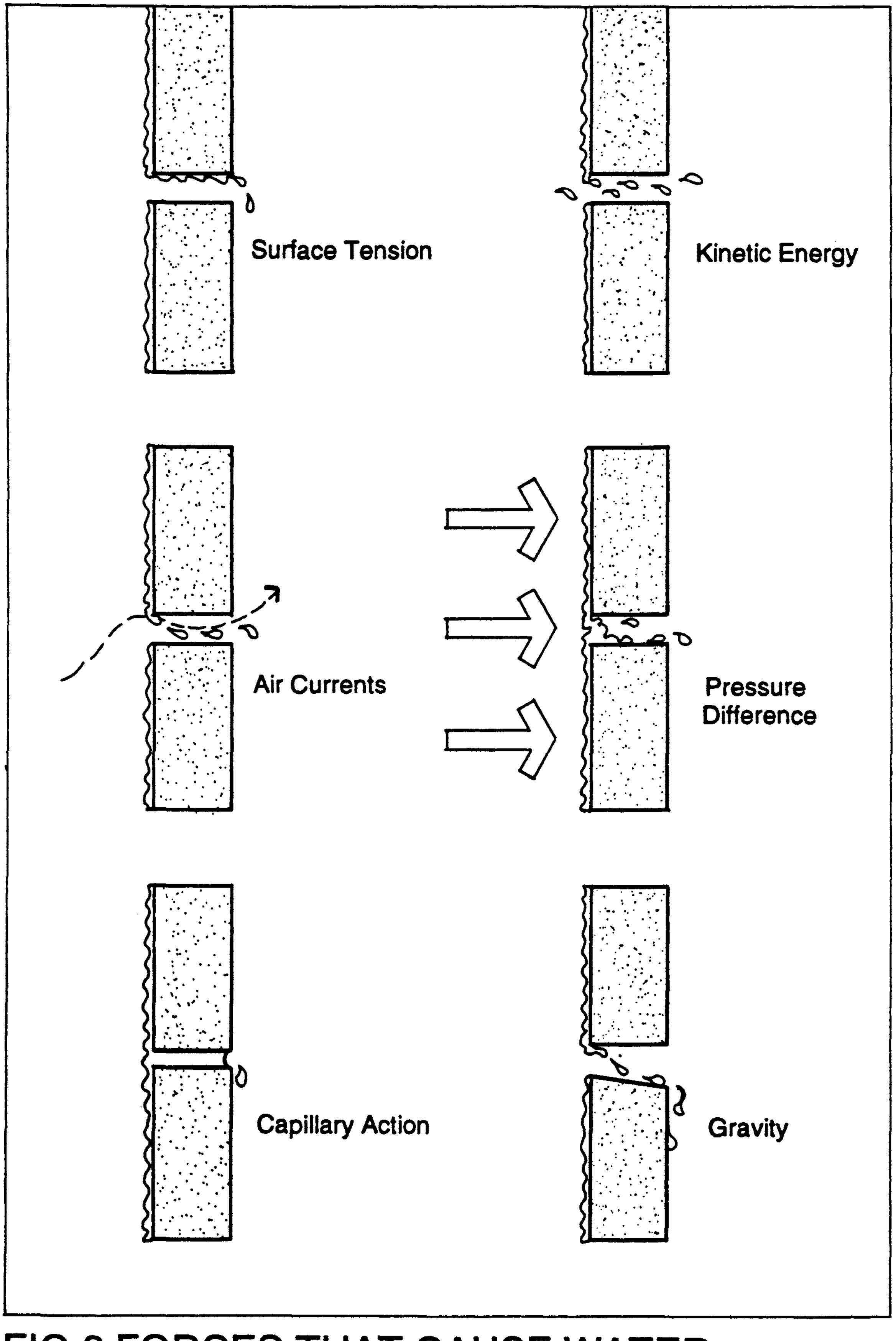


FIG 2 FORCES THAT CAUSE WATER PENETRATION OF EXTERIOR CLADDINGS

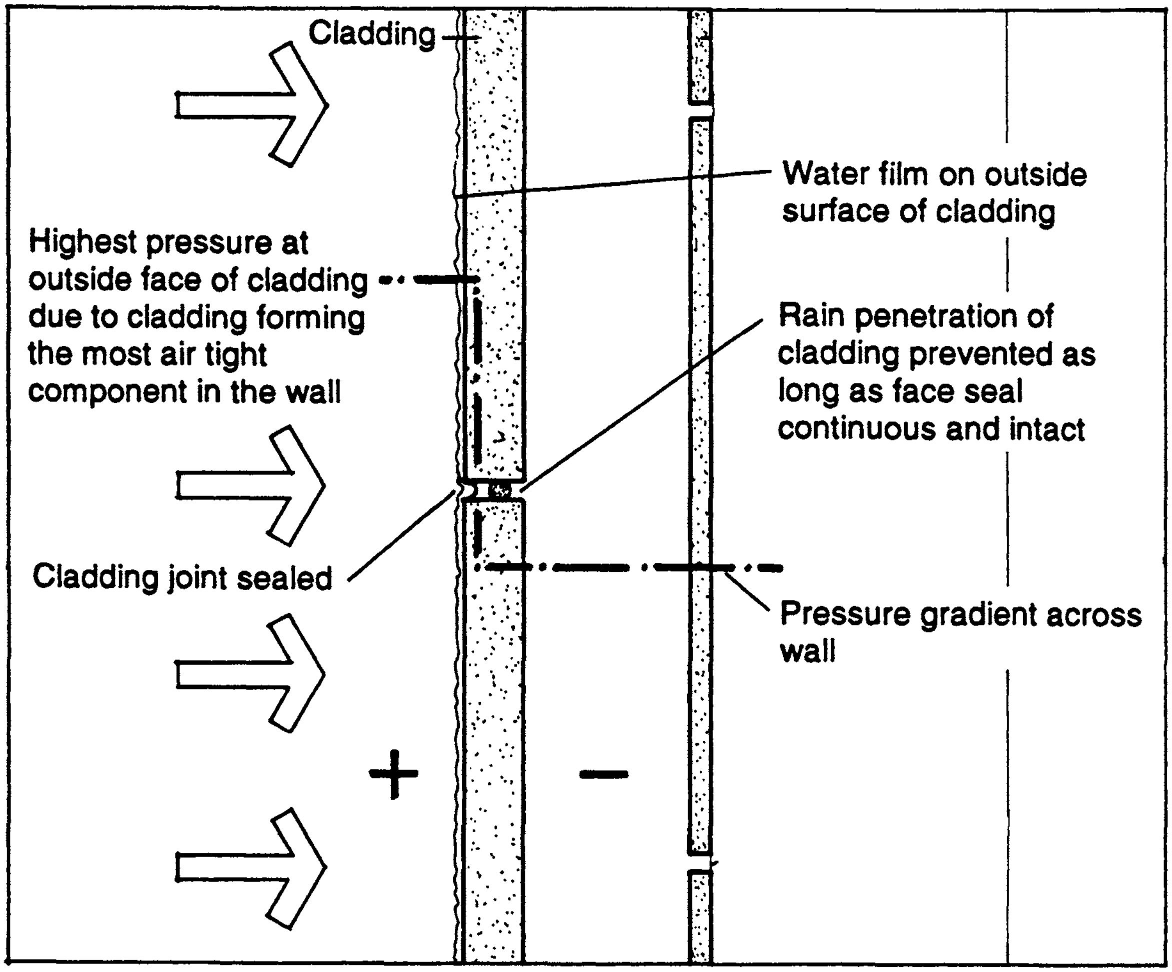


FIG 3 FACE SEALED SINGLE ELEMENT WALL

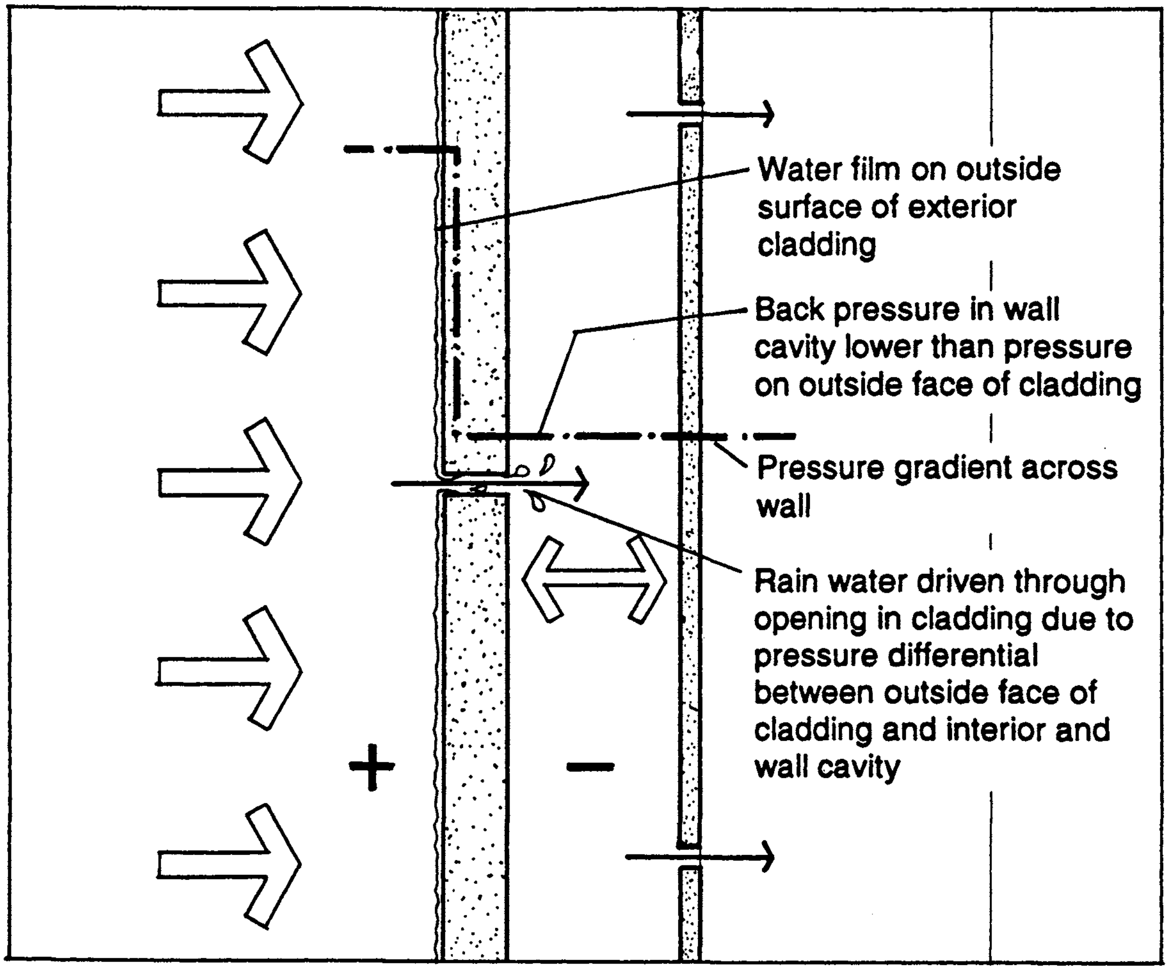


Fig 4 SINGLE ELEMENT WALL WITH OPENING IN CLADDING

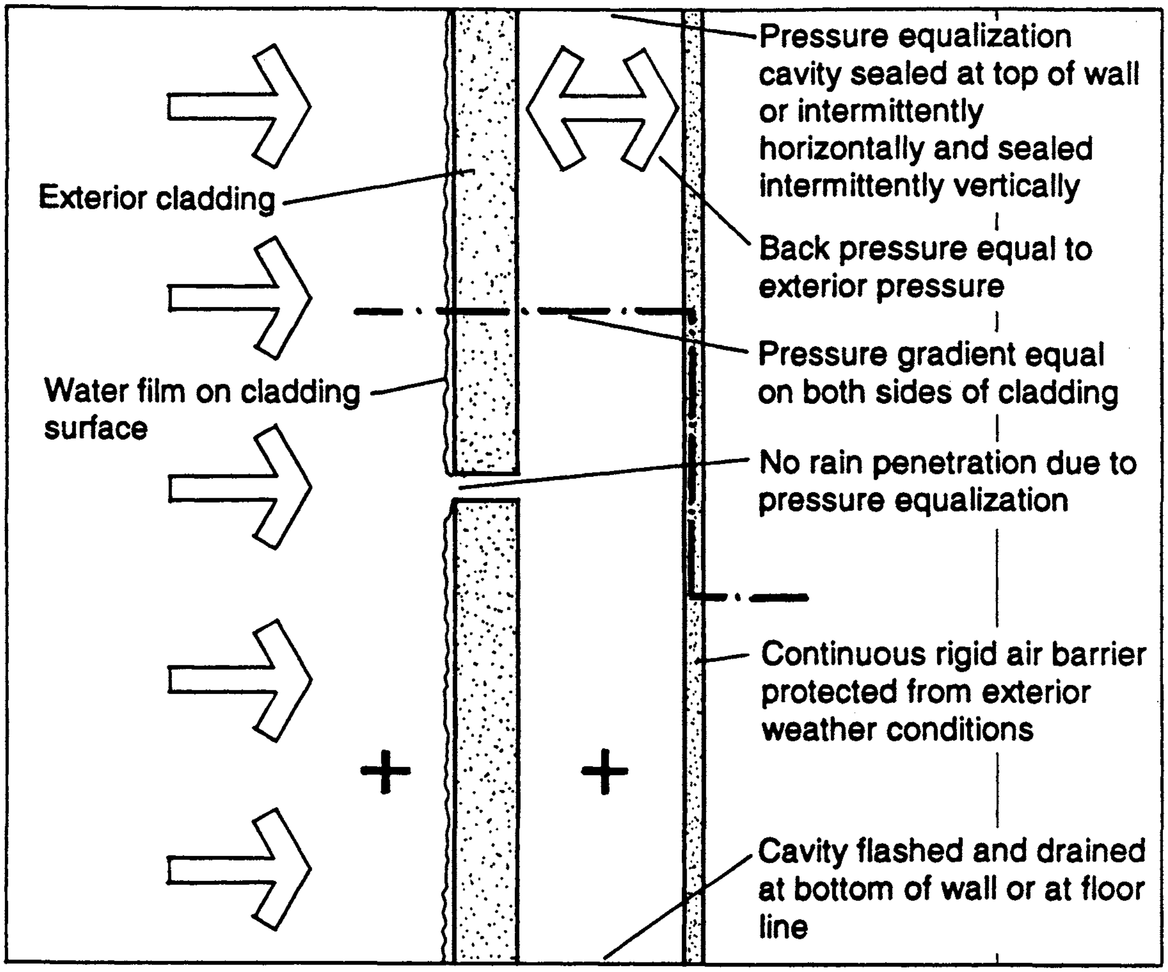


FIG 5 PRESSURE EQUALIZING WALL (RAIN SCREEN OR DRAIN SCREEN)

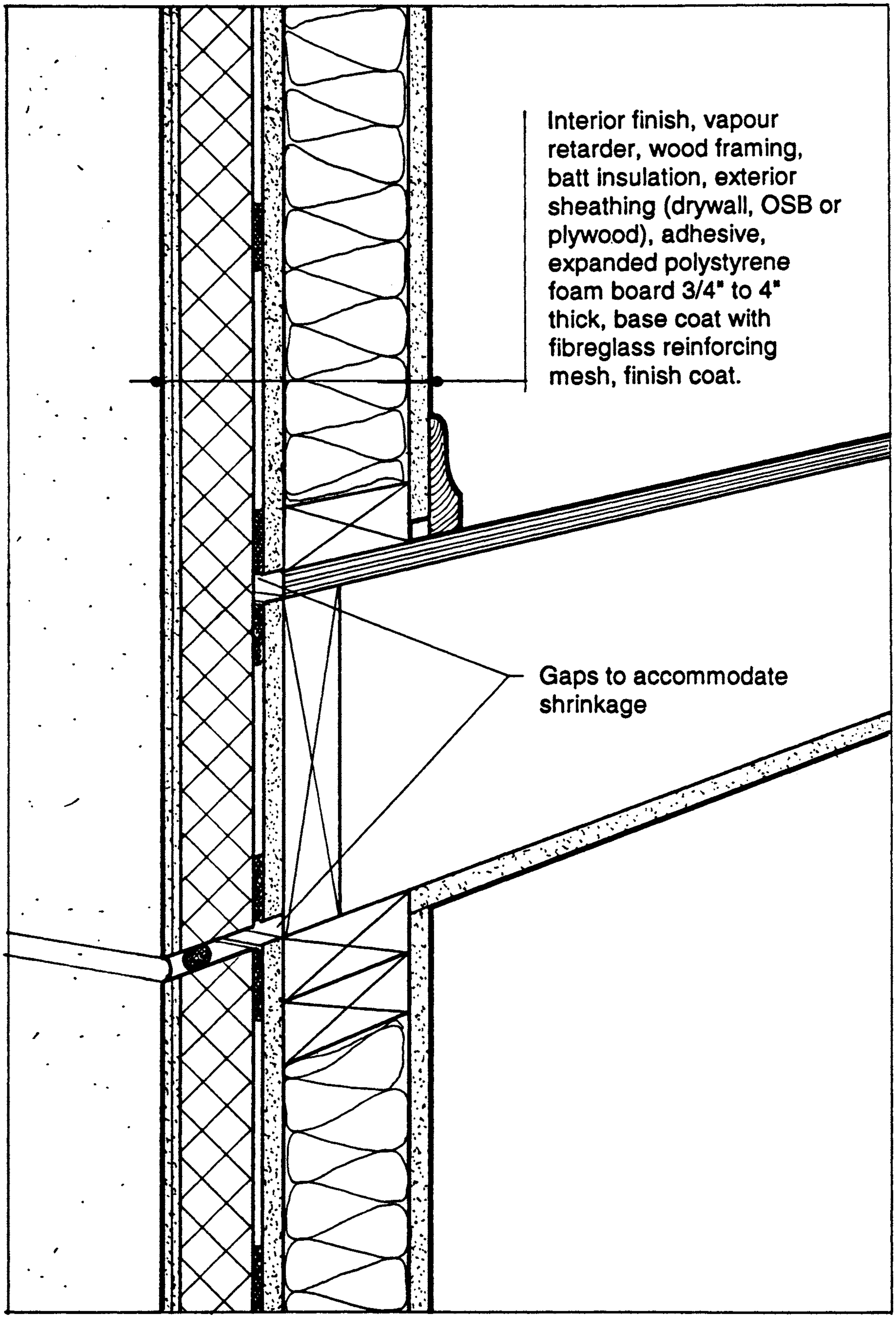


FIG 6 TYPICAL EIF SYSTEM APPLIED TO WOOD FRAMING

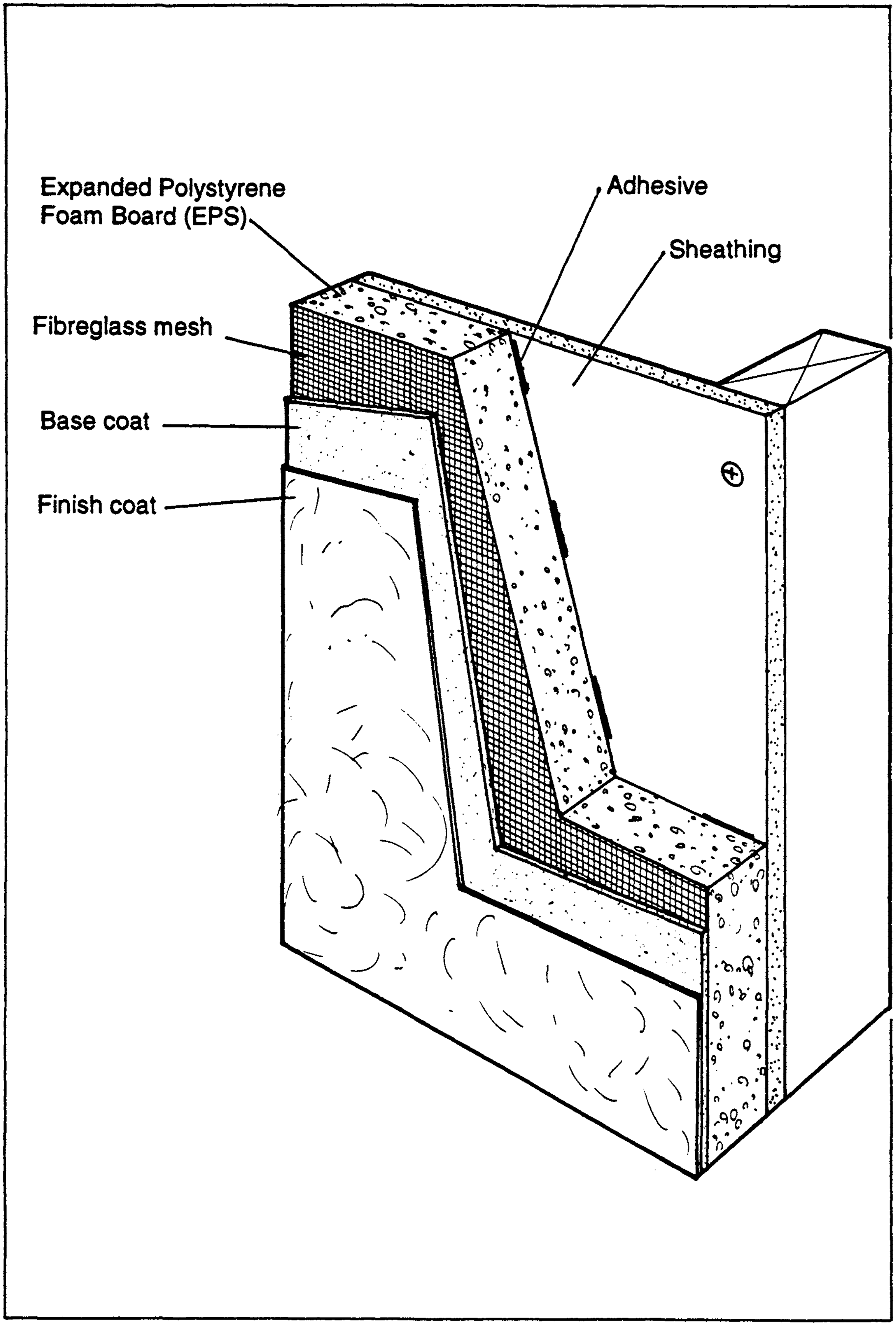


FIG 7 POLYMER BASED EIF SYSTEM

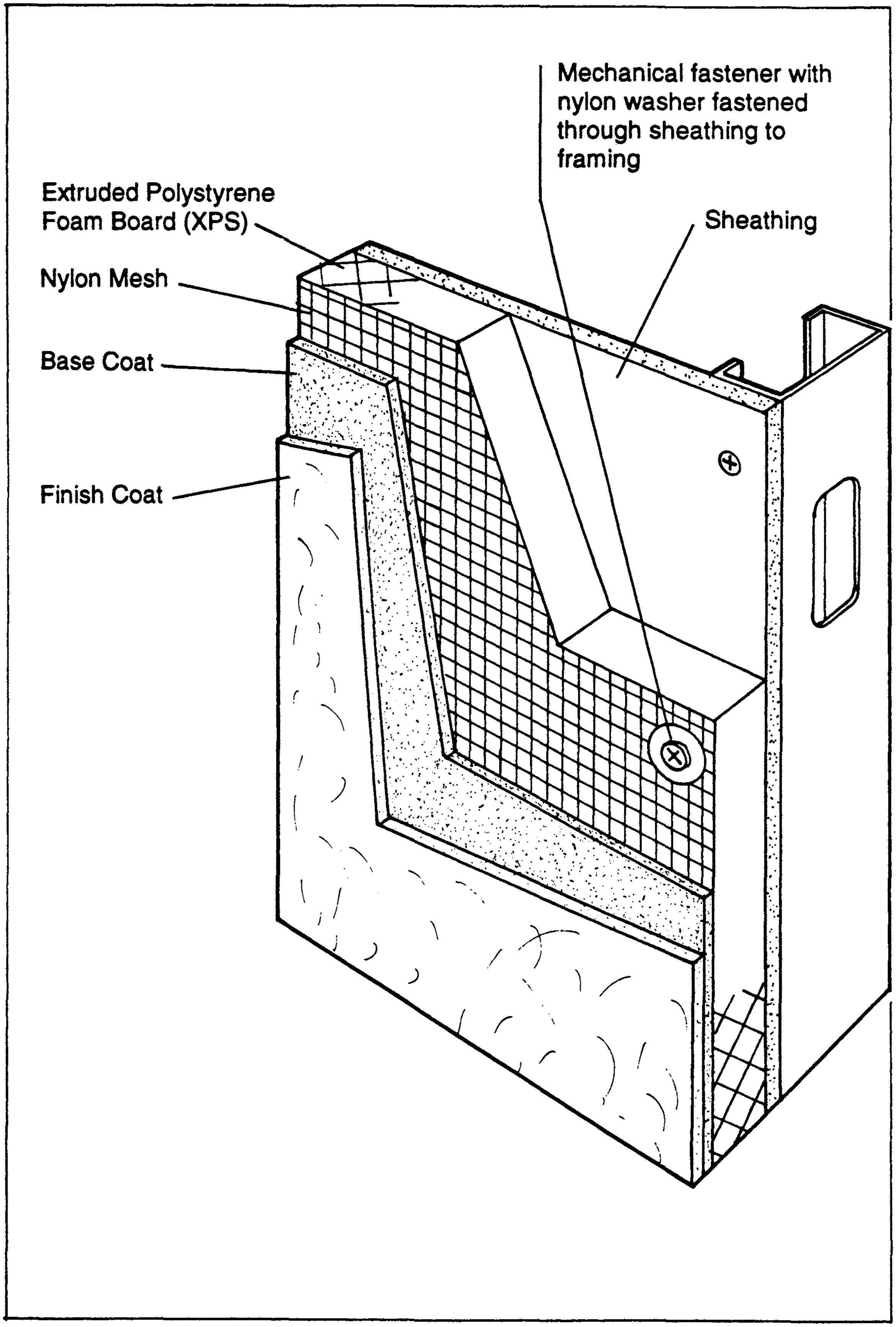


FIG 8 POLYMER MODIFIED EIF SYSTEM

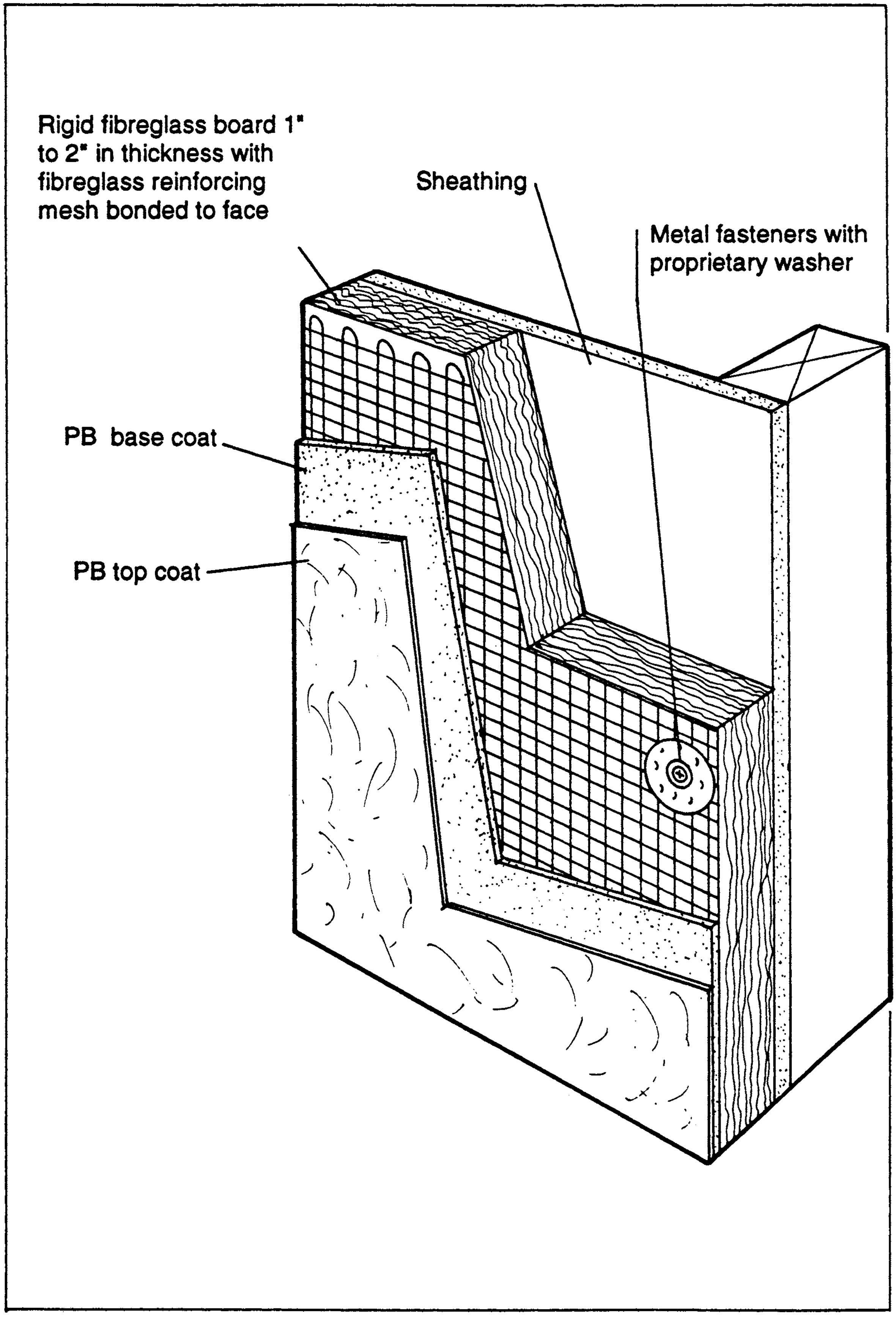


FIG 9 POLYMER BASED EIF SYSTEM USING FIBREGLASS BOARD

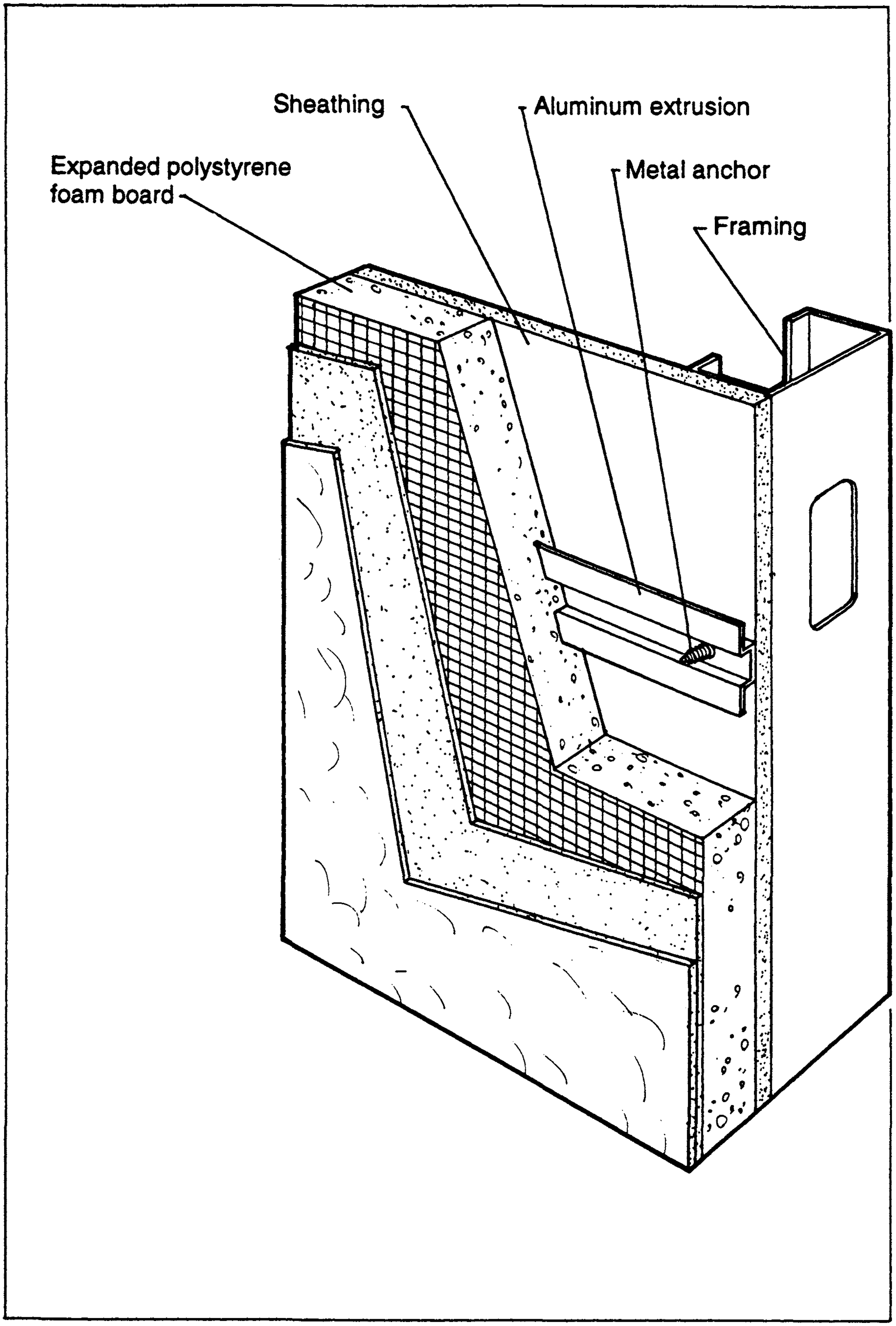


FIG 10 PROPRIETARY "HAT TRACK" METAL ANCHORING SYSTEM

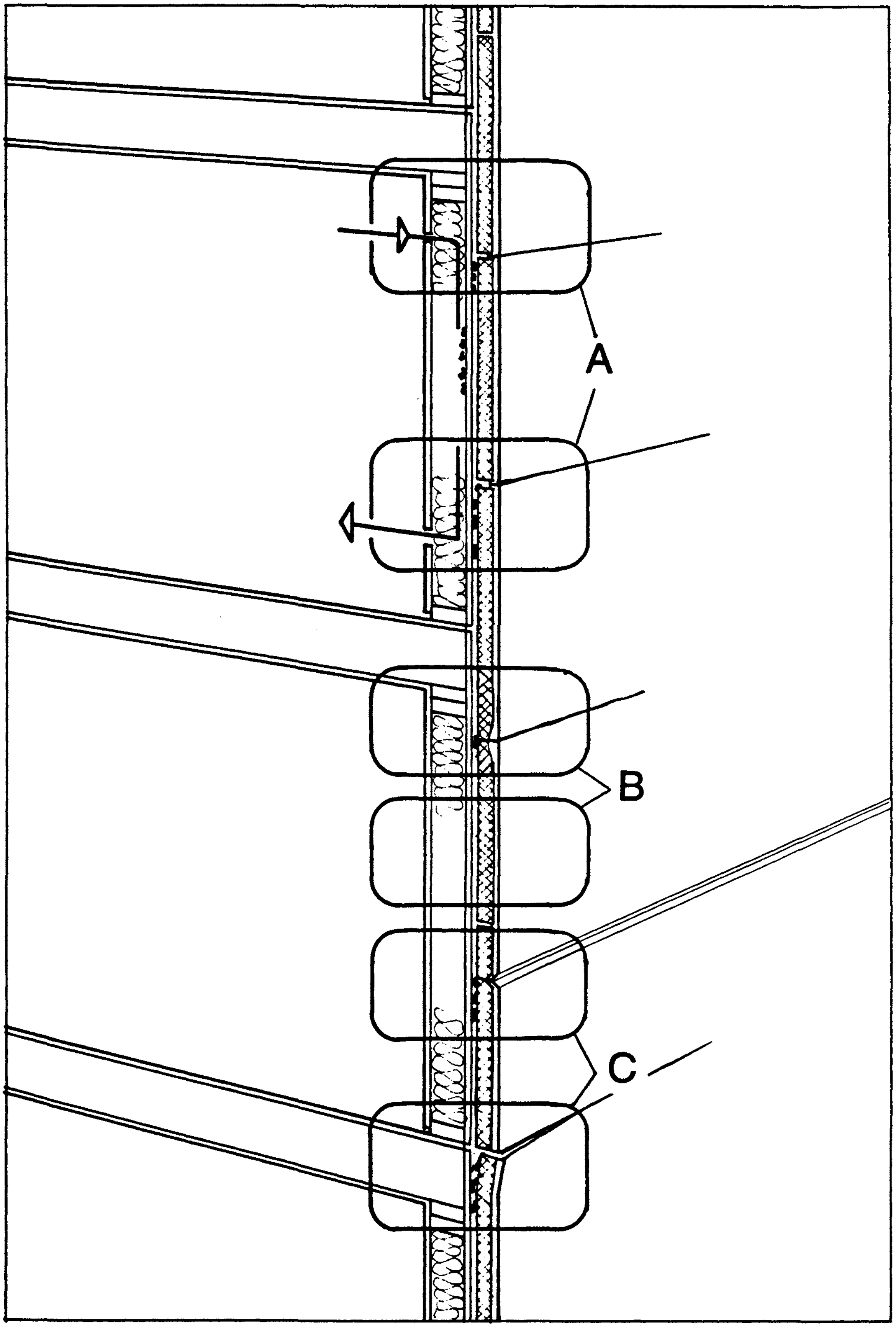


FIG 11 MULTI STOREY WALL SHOWING POTENTIAL EIF SYSTEM PROBLEMS

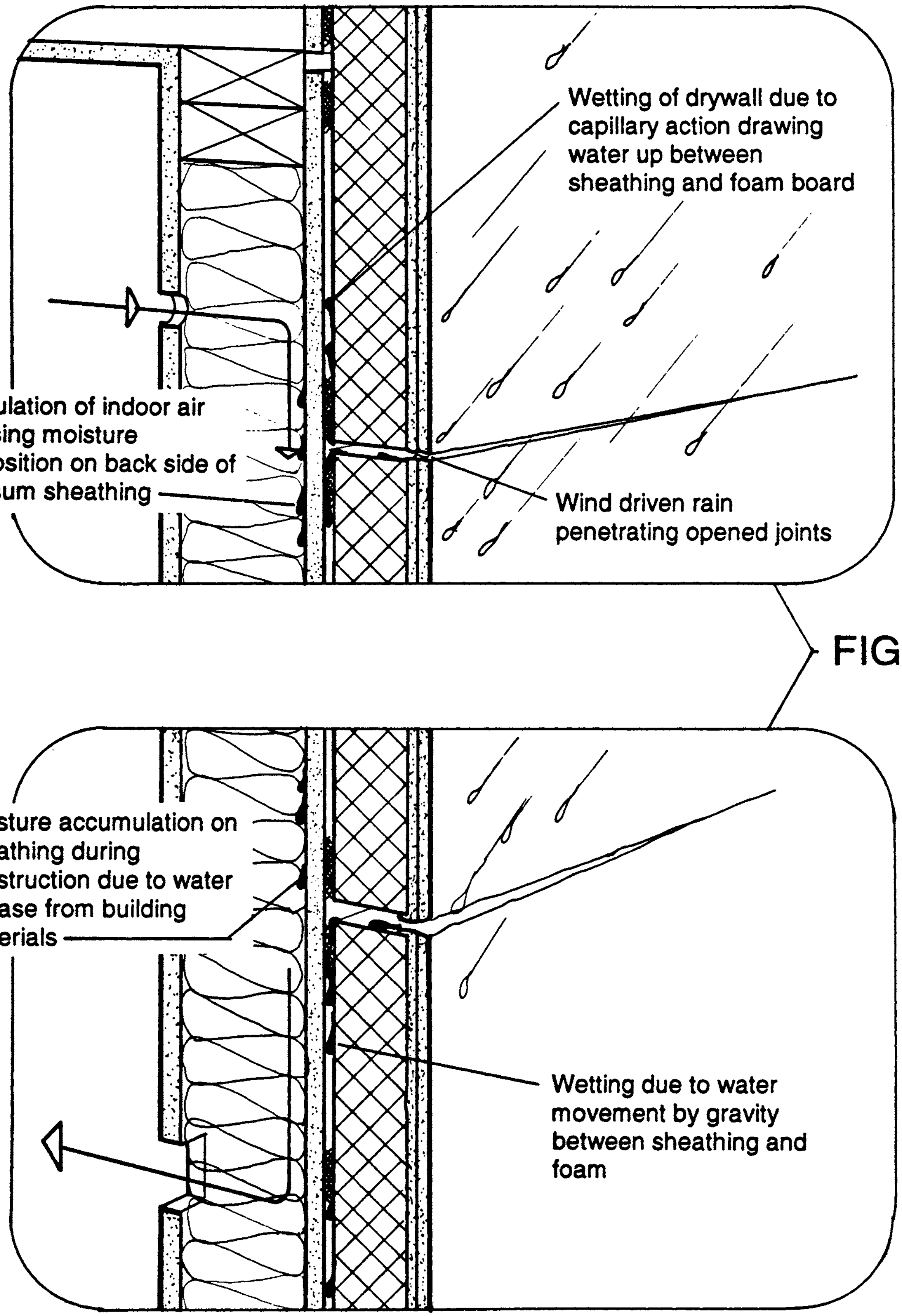
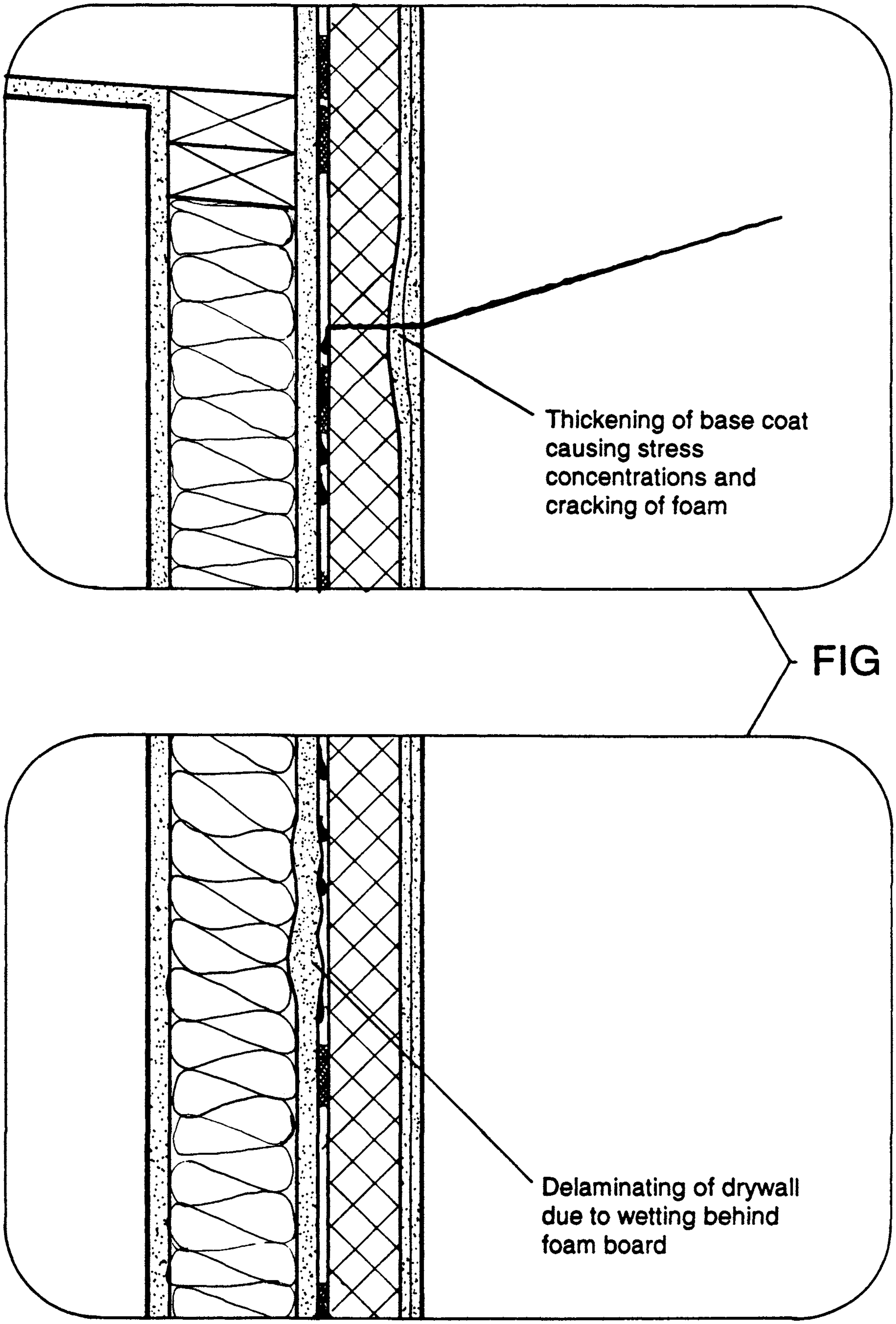
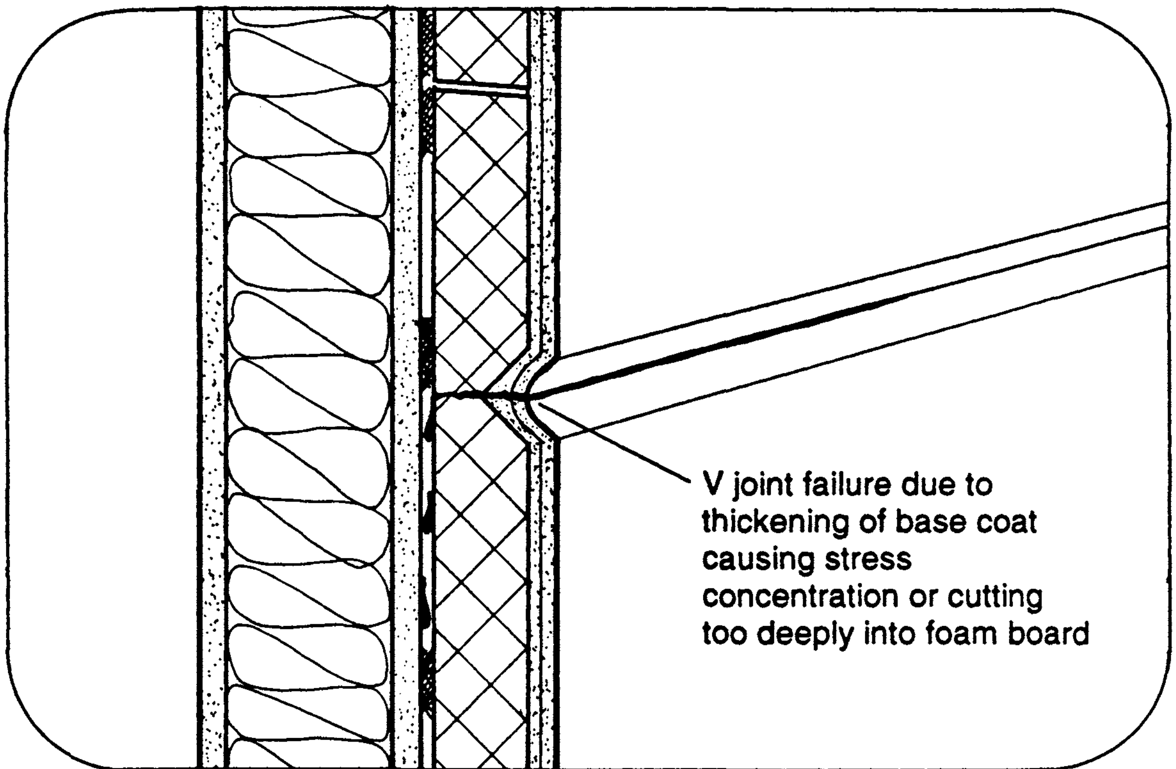

Wetting of drywall due to capillary action drawing water up between sheathing and foam board
Circulation of indoor air causing moisture deposition on back side of gypsum sheathing
Wind driven rain penetrating opened joints
Moisture accumulation on sheathing during construction due to water release from building materials
Wetting due to water movement by gravity between sheathing and foam

FIG 11A



Thickening of base coat causing stress concentrations and cracking of foam
Delaminating of drywall due to wetting behind foam board

FIG 11B


V joint failure due to thickening of base coat causing stress concentration or cutting too deeply into foam board

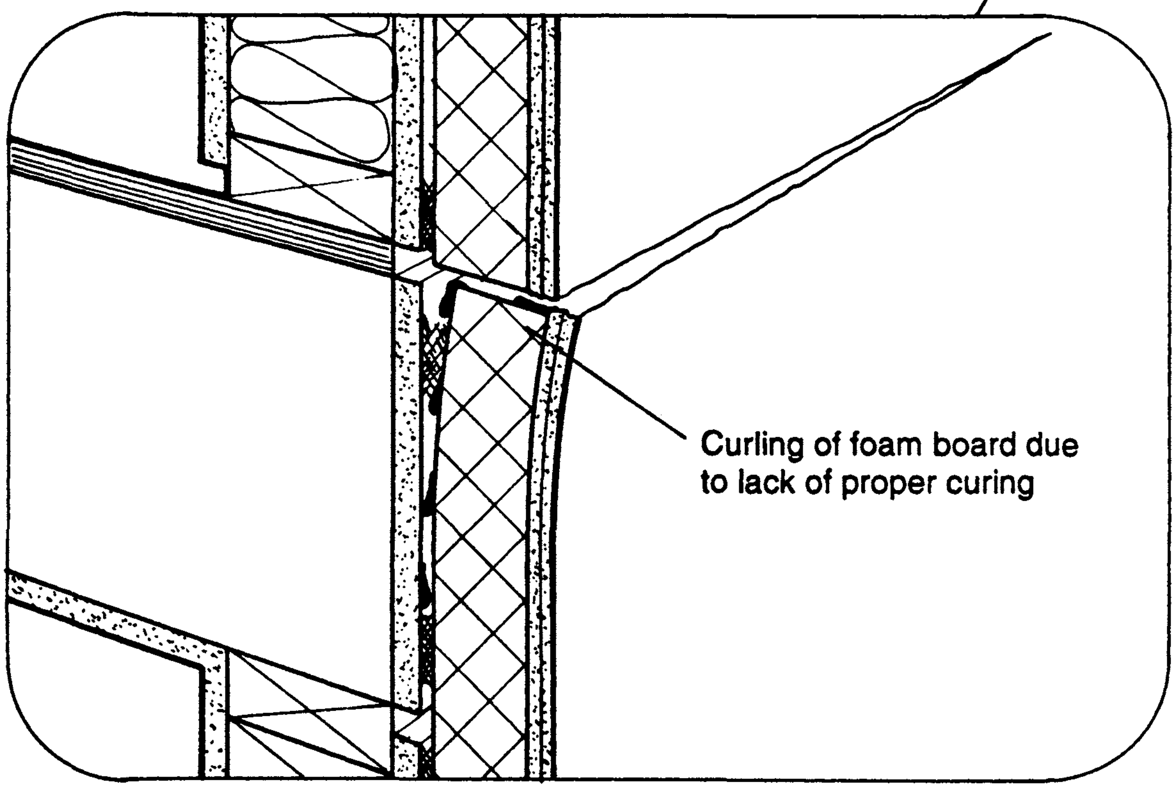

Curling of foam board due to lack of proper curing

FIG 11C

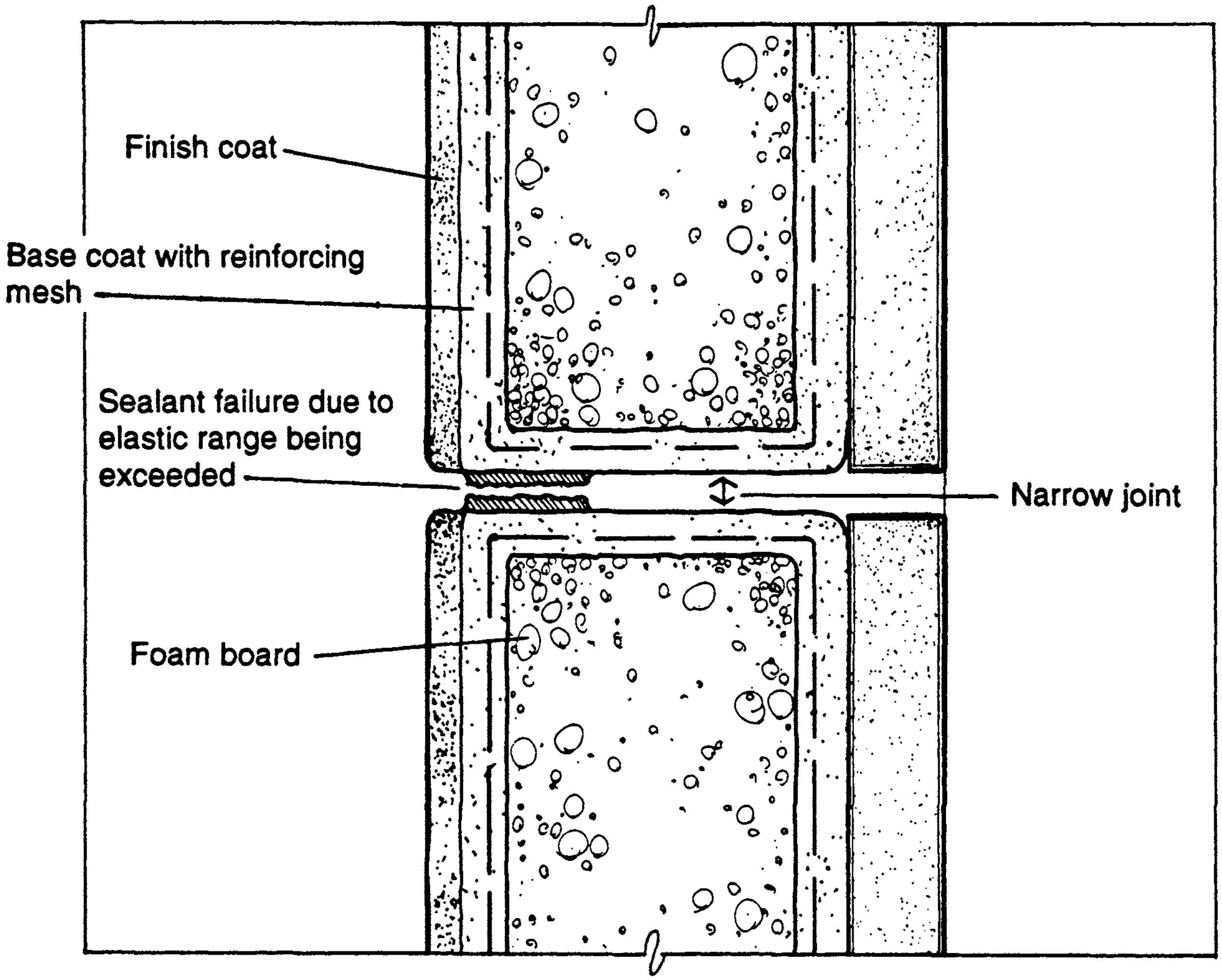


FIG 12 POTENTIAL JOINT FAILURE DUE TO NARROW JOINT

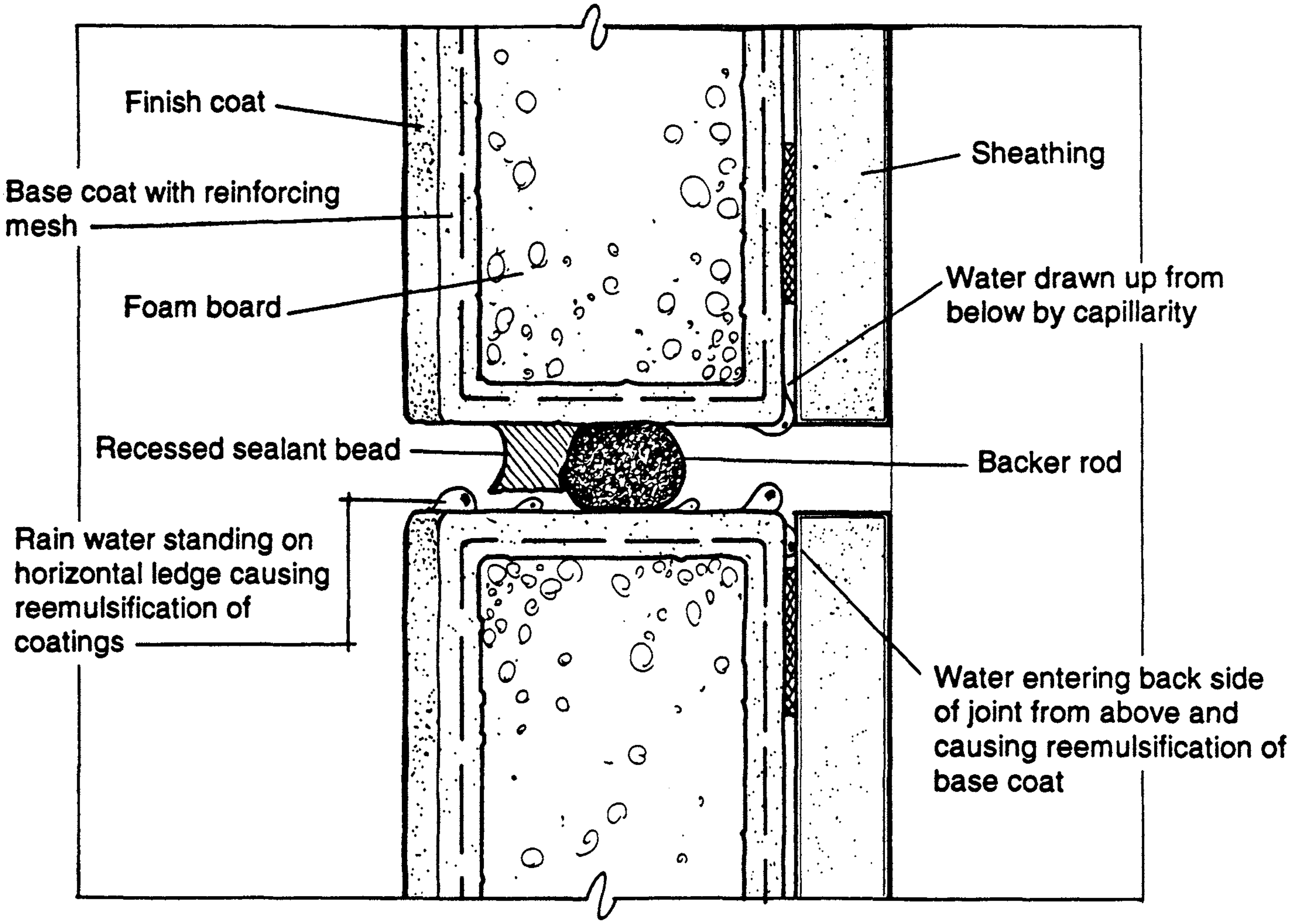


FIG 13 POTENTIAL JOINT FAILURE DUE TO REEMULSIFICATION OF COATINGS

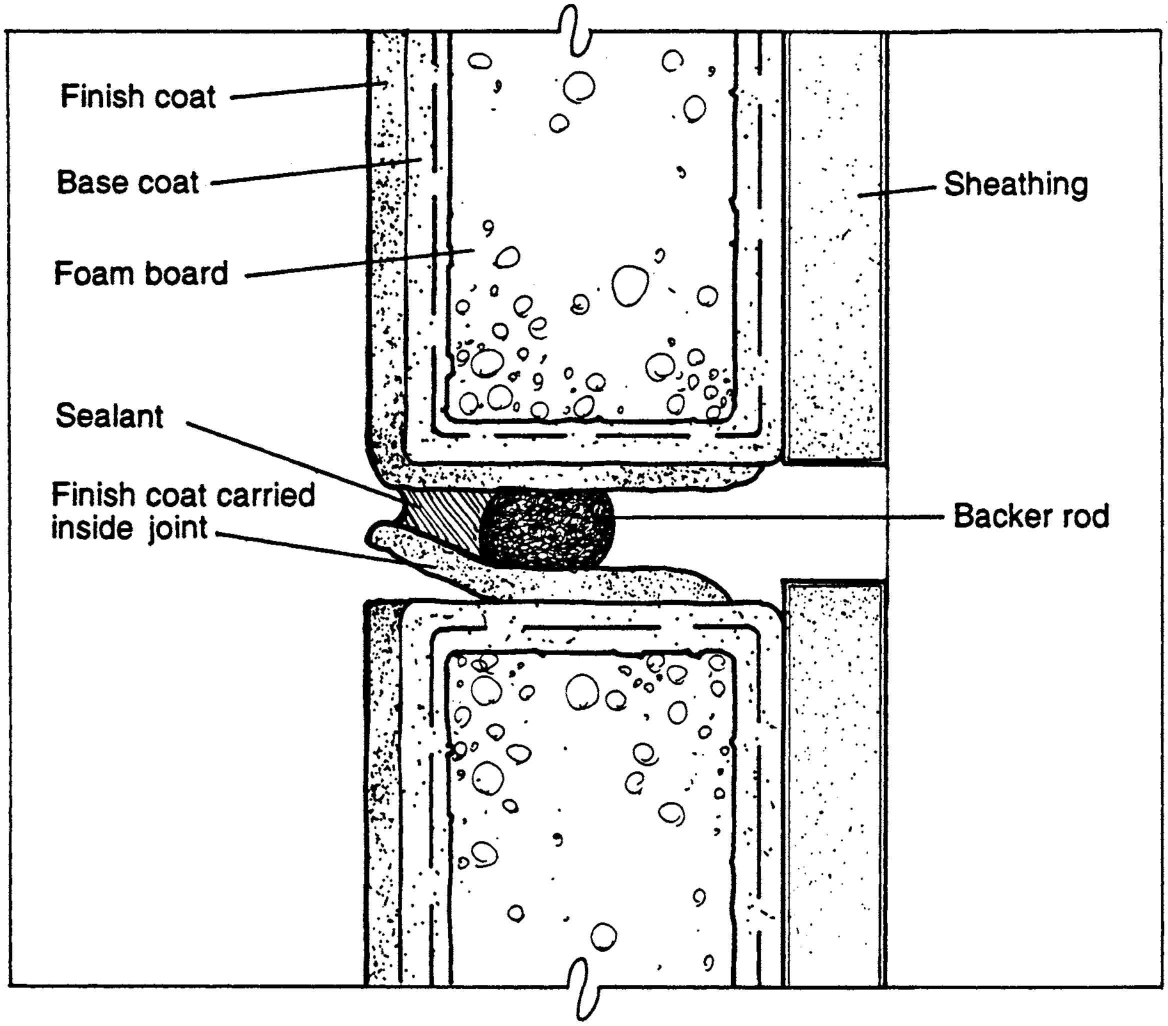


FIG 14 POTENTIAL JOINT FAILURE DUE TO SEALANT ADHESION TO FINISH COAT

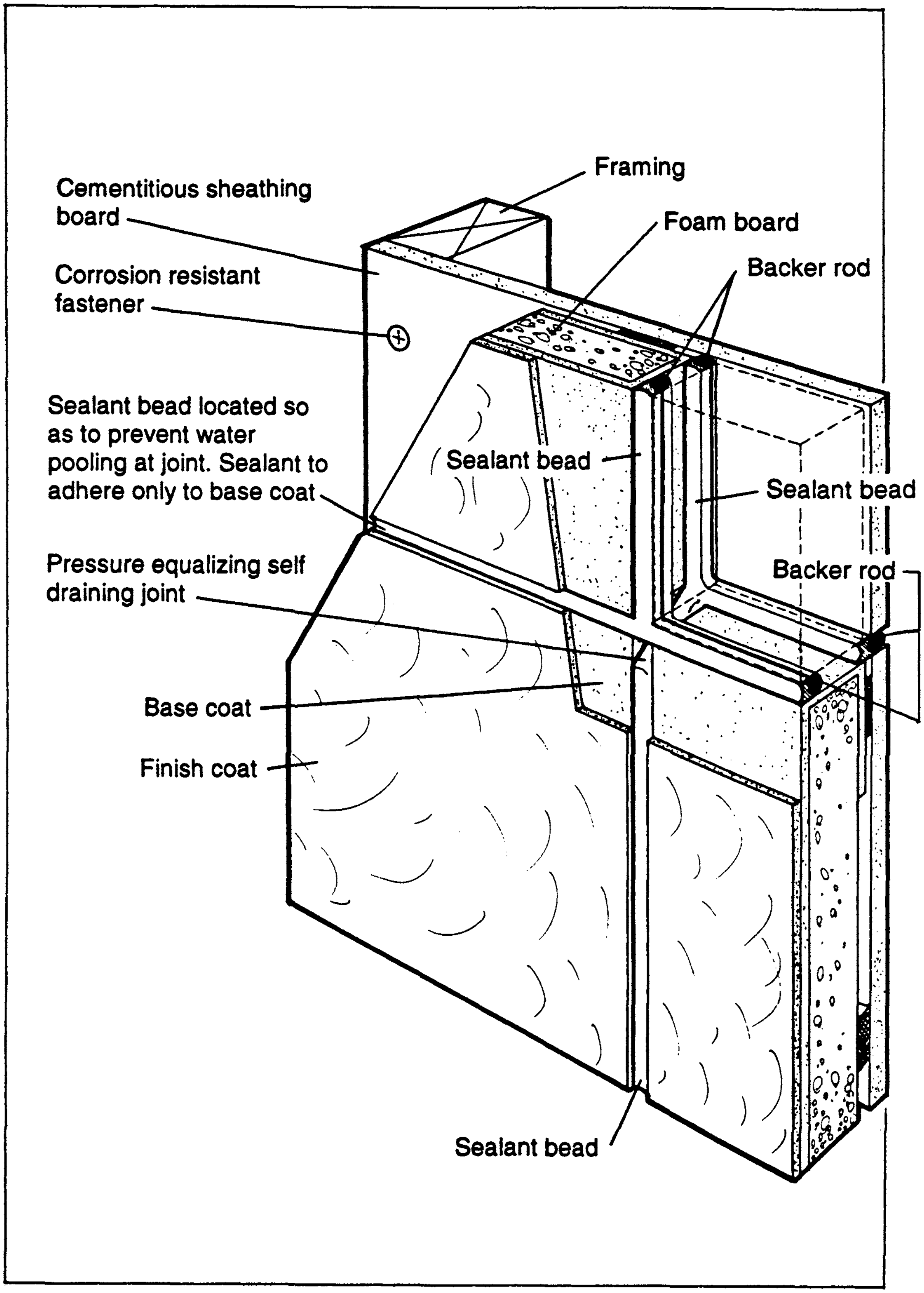


FIG 15 RECENT MEASURES DEVELOPED TO ENHANCE THE DURABILITY OF EIF SYSTEMS

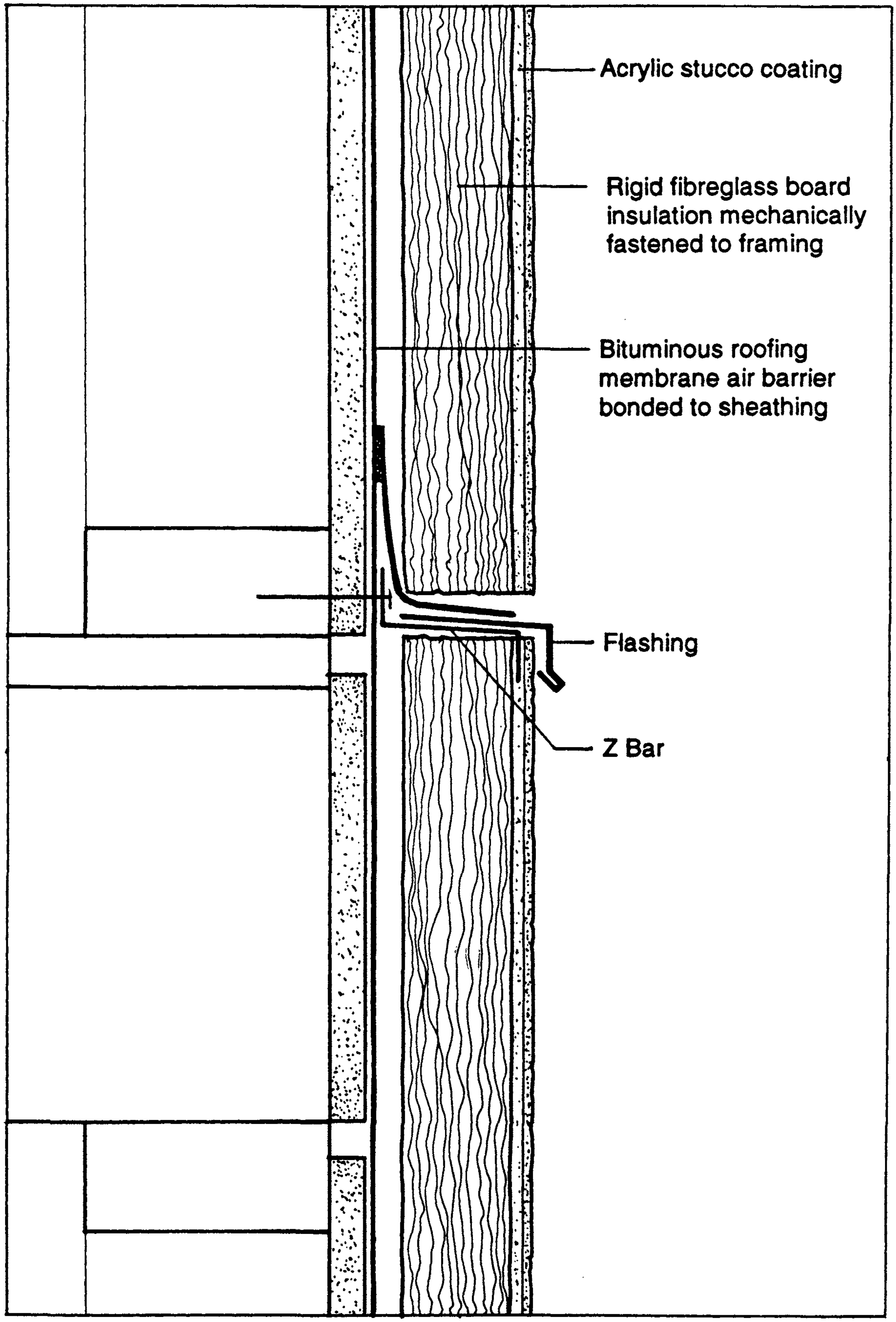


Fig 16 DRAIN SCREEN WALL CONCEPTUAL DIAGRAM