

Special Report:

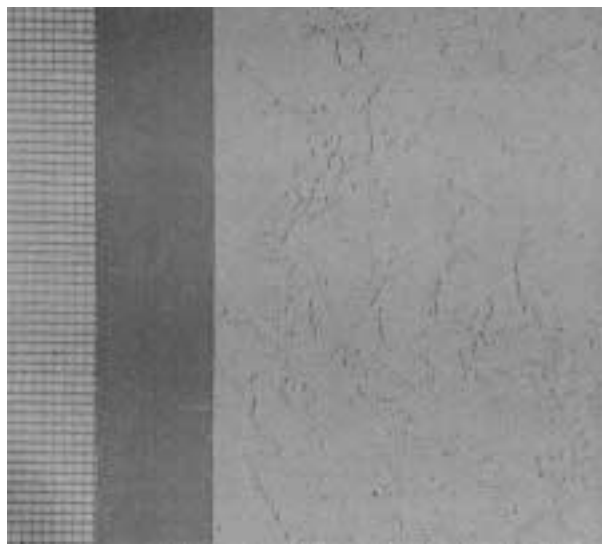
TROUBLES

WITH

SYNTHETIC STUCCO

*A state-funded study
found a pattern of
cracking, water
penetration, and
delaminated sheathing*

by Richard Piper



Soft-coat synthetic-stucco systems typically consist of (from the outside in): a thin polymer-based surface coat, fiberglass mesh embedded in a base coat of portland-cement and polymer, expanded polystyrene insulation, adhesive, and substrate. The most common substrate is gypsum sheathing, which is highly vulnerable to water damage.

Exterior insulation finish systems (EIFS), also called "synthetic stucco," have been used more extensively on commercial construction than residential (see "Synthetic Stucco and Insulation Systems," 6/87). While their use continues to increase, there are no product standards other than the manufacturers' and very little testing has been done other than by the manufacturers. The majority of the testing that has been done is for fire resistance and code compliance, not for long term durability and weather resistance. ASTM has just started the process of establishing committees that will eventually lead to ASTM standards for EIFS. The Exterior Insulation Manufacturers Association (EIMA) has printed guidelines but they offer little information besides referencing the manufacturers' recommendations.

Field Inspections

With synthetic stucco's rapid increase in use and lack of product standards, one might well ask how well these systems have performed and how long they can be expected to last. The Massachusetts Executive Office of Communities and Development (EOCD), responsible for the state-funded public housing for families, older persons, and persons with special needs in Massachusetts, asked that very question when we received reports of cracks and sealant failures on several of our buildings. One of our field inspectors did a quick survey of 15 buildings with soft-coat EIFS (see "Soft Coat vs. Hard Coat,"). The results were very disturbing.

- Two projects had total system failure and the local housing authorities were in the process of having the systems replaced.
- Eight projects had sealant failures, and many of these also had cracks in the finish.
- Four projects had some cracking of the finish but no apparent sealant problems.
- Only one of the 15 projects had no obvious problems.

A consultant was hired to perform a detailed inspection of all buildings including test cuts, moisture meter readings, and laboratory tests. We identified 19 EOCD projects with polymer-based

synthetic stucco. Two projects were not made part of the study because they had only small areas of EIFS that were well protected from the weather. The 17 projects in the study had systems from four manufacturers applied by 13 applicators; five different sealants applied by ten subcontractors; were from one to ten years old; had from 2,000 to over 40,000 square feet of finish; and were applied to gypsum sheathing on wood and steel studs and to concrete block.

Gypsum Sheathing at Fault

All 17 projects had cracking of the finish and sealant failures. While the extent of the problems varied widely from job to job, the problems themselves were similar and seemed to us to be common to all soft-coat systems. The three projects with concrete block as the major supporting surface had significantly fewer problems than the 14 projects with EPS board adhesively applied to gypsum sheathing. Block walls are a superior substrate for EIFS because they are more stable and not affected by any water that does enter the wall. Gypsum sheathing absorbs moisture, and if not allowed to dry, the paper face delaminates from the softened gypsum core. The ribbon-and-dab adhesive method, along with horizontal sealant joints with the mesh and base coat returned into the joint (back to the sheathing), cause water to collect between the insulation and sheathing. U.S. Gypsum Company has always recommended no finish system be adhesively applied to their gypsum sheathing. Their current product literature goes further and states that gypsum sheathing must always be protected by 15# felt or Tyvek, regardless of the exterior cladding used. Gypsum sheathing is not an acceptable substrate for synthetic stucco in Europe, where EIFS originated.

Two projects had especially large areas of delaminated sheathing where up to 80 percent of the insulation had come free of the substrate. The finish was intact and on the building, but could be moved by pushing on it. Because the reinforcing mesh is sufficiently strong, it prevented the finish from falling off the wall, even with large areas totally free. This obviously is an advantage in that it keeps a bad situa-



This structure looked good on the outside, but moisture readings (left) indicated wet sheathing. Further investigation revealed that some buildings had large areas of damaged and delaminated sheathing (right) from water that penetrated at trucks and horizontal sealant joints.

tion from becoming a disaster. It also illustrates one of the really disturbing facts we discovered during the investigation. The EIFS appeared to be in reasonable condition on some buildings with no complaints of leaks in the apartments. But when the test cuts were made, the gypsum sheathing was saturated, large areas delaminated, and the studs were rotting. The fact that the structure could be rotting without any obvious sign of distress is unacceptable to a building owner.

There are, however, several solutions to this problem. A weather barrier such as 15# felt or Tyvek can be placed between the sheathing and the finish system. This, however, requires a system with mechanical fasteners to secure the insulation board to the studs. The weather barrier could also be placed between the studs and the sheathing. This will allow adhesive attachment while protecting the studs and interior. A third alternative, more expensive but of higher quality, is a durable sheathing material such as Durock or Wonder-Board. These materials are perhaps ideal substrates because they will not deteriorate when wet, the adhesive will not fail when wet, and they are reasonably priced. There should still be a secondary weather barrier behind them because of possible water penetration at the joints.

Types of Cracks

Cracks through the finish and base coats were common on all of the EOCB jobs on gypsum sheathing. There were three typical crack locations:

Diagonal cracks at window corners and other large wall openings. The diagonal mesh required by the manufacturers to reinforce the corners had not been installed on most of the projects. It should always be used because there is always stress concentration at an inside corner.

Cracks caused by gaps between the insulation boards. When the insulation is not tightly butted the resulting gap is partially filled with base coat. This forms a T-shaped cross section in the base coat, and because it is rigid in comparison with the flat areas of base coat, stresses are concentrated here and cracking is common. The manufacturers' literature does not adequately

warn applicators of the problems resulting from gaps as small as 1/16 inch. When V joints fall on joints between insulation boards, as is often the case at window corners, cracks are very apt to appear. While most gaps result from careless application of the foam insulation board, they can also be caused by any of the following: inadequately aged foam board shrinking on the wall; the ribbon-and-dab method of board application which forces adhesive between boards and prevents a tight fit; out-of-square boards that meet with tapered gaps—these are time-consuming to fill even when the applicator is aware of the problem and is trying to do a good job.

Cracks at V joints. V joints are more rigid than the surface because of the V shape, which causes stress concentration and consequent cracking at the base of the V. These joints tend to "hinge" open when the surface is in tension. V joints are not allowed in Europe, but are commonly used here to limit the area in which the applicator must maintain a wet edge when applying the finish coat. Joints are frequently located at window jambs and heads, which is where insulation board joints also occur. When one or two V joints meet at a window corner the diagonal mesh is virtually impossible to install, and cracks are all but guaranteed. The manufacturers may require the diagonal mesh, but they also allow details that prevent its use.

A fourth, less common, cause of surface cracks is varying thickness of base coat. The base coat in these systems is so thin that the greater thickness required at mesh laps can cause a crack because of the increased stiffness at the lap.

U.S. System Too Thin

The thin base coat is also very weak in tension and easily punctured. In a few cases the inspecting consultant accidentally broke the surface by pushing with his thumb. A 1/16-inch (1.6mm) base coat is the typical recommendation of U.S.-made systems, but our experience shows that this is rarely achieved. The base-coat material naturally trowels out closer to 1/32 inch than 1/16 inch, much too thin for adequate strength and durability. The best way to

ensure proper thickness is to require a second application after the mesh has been trowelled into the first.

The thinnest European systems, those with much higher polymer contents, are at least 2mm thick and often thicker. One of the manufacturers used on several of the EOCB buildings is required in France to embed the mesh in a 1/16-inch base coat, and then apply a second layer of base material for a 1/10-inch-thick base. Then a liquid sealer is applied and finally a 3/32-inch finish coat. These requirements are established by the national testing laboratory based on their own physical testing and the product's performance history verified by field inspections. In the U.S. the application requirements are established by each manufacturer in a competitive market, where the final selection of the specific manufacturer is most often made by the applicator. Often this is after there is a fixed sum subcontract for the job. There is obviously little incentive to select a system that requires thicker coats and more material.

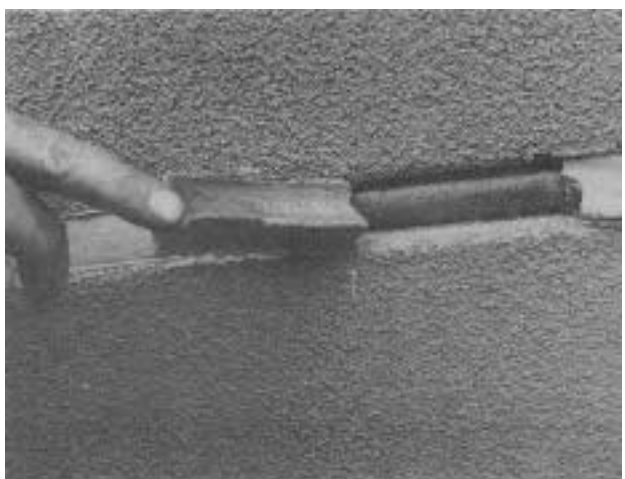
Leaky Joints

Another problem common to all 17 projects was sealant pulling away from

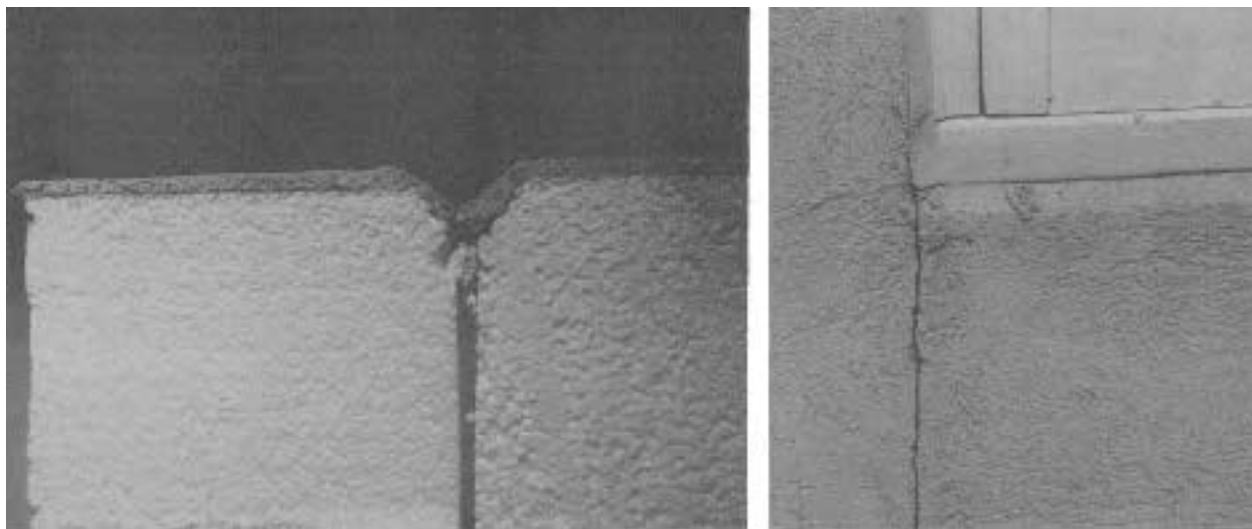
the finish coat. This is really a failure of the finish in cohesion. That is, the finish coat pulls apart with some of the finish remaining adhered to the sealant and some to the base coat. This occurred within the first year on several buildings, and is a condition that allows water to enter. The finish coats are emulsion acrylics which re-emulsify or soften when kept wet. This is not a problem on the face of a vertical wall, but can be a problem on sloped areas such as window sills. The required 6-in-12 slope is adequate to drain rain water but wet snow can stay for several days.

Repeated wetting and drying of the finish in laboratory tests and of samples at my desk reduces the time necessary to soften the finish. About an hour after placing a damp paper towel on the sample, the softened finish is easily scraped up with a finger nail. Yet the U.S. manufacturers require that the sealant be applied to this finish. The European systems require that the sealant be applied to casing beads or similar accessories.

The finish material under the sealant can get wet by capillary action, especially when the proper primers have



Many sealant failures were attributed to the fact that the sealant is applied to the finish coat, which will soften if it remains wet for a period of time. Failed horizontal sealant joints were a major source of water penetration.



V-joints are likely to crack—particularly where they fall over insulation joints (left). The gaps between insulation boards are caused by adhesive that gets squeezed between the boards. Window corners are also vulnerable to cracking (right) unless extra reinforcing mesh is used as recommended. It was missing in most of the buildings studied.

not been used to seal the rough surface. Or it can get wet from behind, through the base coat. Very often there are horizontal sealant joints with the base and mesh returned back to the sheathing, covering the edges of the insulation. This traps water that enters the insulation from anywhere above. This trapped water wets the joint; the finish softens and pulls apart when a change in temperature causes the sealant to contract. This problem can be avoided by eliminating the sealant joints wherever possible. Joints are only really needed when there is a change in the supporting wall construction, not at every floor. In fact, manufacturers' representatives have often told me, "the finish does not leak, joints leak." Yet these same manufacturers recommend a lot of joints, many of which are not allowed in European work, and many of which failed and leaked in the EOCD buildings.

Moisture meters were used to determine the wetness of the gypsum sheathing. Most of the cracks allowed water penetration, especially wind-driven rain. The water was found to move easily through the insulation until it was trapped by a horizontal joint or between the insulation and sheathing, causing deterioration of the joints and sheathing. Moisture contents of 25 percent and greater were common. Test cuts showed that gypsum sheathing with moisture readings of over 20 percent was deteriorating and no longer had adequate strength.

Details and Workmanship

The severity of these problems on the different projects appears to be related to three main factors:

Workmanship. Obviously, but nonetheless true, the more deviations from the manufacturer's installation requirements the worse the problems and the sooner they appeared. These systems are very sensitive to poor application and require careful workmanship, especially at joints and penetrations, if they are to perform well. Seemingly minor application errors can allow water to enter the system. The major manufacturers advertise their "training" and "certification" programs and many mechanics are undoubtedly given some training. There are, however, all too many applicators with little or no training and less understanding of the critical importance of precise workmanship

to the successful performance of these walls.

Exposure to wetting. Walls without soffits or gutters or that do not dry readily were more distressed. Again this is obvious. But it begs the question: why does an exterior wall material need to be protected from the weather? The systems can not tolerate any water penetration.

Surface penetrations. The number of penetrations through the finish surface affects the durability of the system. Windows, doors, pipes, fixtures, V joints, and sealant joints are all potential leaks. The best jobs had large, uninterrupted, rectangular surfaces. Many large penetrations, typically windows, had edge details that did not comply with the manufacturer's requirements for returning the mesh, base, and finish. Penetrations through the system all rely on good workmanship and sealant; neither of which are very dependable in today's market. Most manufacturers have standard details for large penetrations such as windows and doors, but many do not have details for small penetrations (pipes, conduit, railings, fasteners for downspouts, etc.) so the applicator is left to improvise. One job had 4x8s penetrating the finish without any edge treatment. Many jobs had

hose bibs, screws, or light fixtures protruding through the surface without any sealant or other protection. Moisture readings taken below these points were invariably high.

Consider Hard-Coat

What can you do if the owner wants the look of stucco or for some reason it has been decided that your next building will be synthetic stucco? First you could consider a polymer-modified, or hard-coat, system. These are a little more expensive initially, but they have several advantages. They are mechanically fastened, which allows you to install a membrane to protect the structure from water and rot. They are impact- and weather-resistant, and even if saturated will not deteriorate. Sealant is applied to metal accessories or in some systems to the thick, rigid cementitious materials. The rigid surfaces do need control joints, but cracks tend to be cosmetic. Most major soft-coat manufacturers are now or soon will be marketing hard coats.

If a soft-coat system has been selected, and your job is to get it installed, there are several things you can do. First, use Durock-type sheathing and protect the studs, or at least protect the studs with a membrane as described

earlier. Make sure that there are no gaps between insulation boards. If you can see it or put a credit card in it, it is too wide and could cause a crack. Adequate base-coat thickness and total embedment of the mesh is imperative. A second application is the only sure way of getting enough base to provide good strength.

Also remember that polymer is several times more expensive than cement, because the applicator will remember this and its bearing on his profitability. Delete as many sealant joints as possible and all V joints. Inspect all of the joints and require all mesh to be completely covered with base coat. While I could not recommend that you not follow the manufacturer's specifications, if we were to use a soft-coat system again, we would caulk to the base coat—not to the finish. ■

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Soft Coat vs. Hard Coat

Polymer-based systems, commonly called soft coats, consist of attachment, most commonly adhesive; insulation, most commonly EPS; fiberglass-mesh reinforcement embedded in a base coat; and a finish coat. The base coat is Portland cement and polymer, usually in equal parts, and is applied approximately 1/16-inch thick. The finish coat is polymer-based and ap-

plied thin, no thicker than the aggregate which is often a fine sand. These systems are flexible and lightweight, have low impact resistance, and are sold by an ever increasing number of firms. The polymer-modified or hard-coat systems are typically 1/4-inch thick, mechanically fastened, and rigid. They have high impact resistance and use primarily extruded-polystyrene insulation. They require control joints similar to true stucco.

The soft coat systems sold in the U.S. today differ significantly from the systems developed and used successfully in Europe for over 25 years. (See table for a comparison.)

The changes made to the original European systems, while presumably done to reduce costs, had several very detrimental effects. The thinner base coats with lower polymer contents have lower impact resistance and tensile strength. The thinner coats also have a much smaller margin for workmanship tolerances. The base coat is too thin to fully cover the mesh at laps. When water does enter the system it easily moves through the EPS board, allowing more and more water into the system. V joints crack very easily, allowing water to enter. If the finish coat in contact with the sealant gets wet it can not easily dry, it softens, loses its tensile strength, and is pulled apart by the sealant.

—RP

U.S. vs. European Soft Coat Process

Soft Coat Process	American	European
Base coat thickness	1/16" (1.6mm)	2mm-5mm
Polymer/cement ratio	1:1	2:1 min.
Gypsum sheathing	allowed	not allowed
Water movement through EPS board	allowed	not allowed
V joints	allowed	not allowed
Sealant directly on finish coat	required	not allowed
Casing beads and similar accessories	not allowed	required
Approved by third party testing	not required	required