A Close Look at Stucco

Problems with stucco persist, yet properly installed standard details are still the cure

by Dennis McCoy

In the neighborhoods of coastal California where I grew up, stucco was the most common exterior cladding. As a kid helping my father on projects, and then as a construction supervisor and contractor myself, I have been around stucco for most of my life. Nowadays, the kind of stucco that I grew up with is known as "conventional stucco," or "traditional stucco." When I was a kid, we just called it stucco.

Good old stucco is still around, but it's not alone. There are now at least 35 different modified, proprietary hard-coat stucco systems on the market and more than 30 varieties of exterior insulation finish systems (EIFS) that have

the look of stucco. With products continually leaving and entering the market, and new hybridized systems coming along that combine characteristics of EIFS and hard-coat systems (or go on over some other base like fibercement board), it's hard to keep track, much less understand them all.

All these new systems are penetrating markets where traditional stucco is largely unknown, and where the details that make stucco work are not part of the local tradition. In place of the standard, generic water management details that governed traditional stucco, which you could look up in the body of the building code, these new systems are regulated through evaluation reports ("ER reports") and proprietary specifications that you have to locate and study individually.

Without the base of experience and knowledge, and without simple references for proper detailing, installers have made a lot of mistakes with hard-coat stucco in new markets. Over many years in California, in the course of remodeling or adding on, I've opened up hundreds of homes clad with traditional stucco without finding significant mold or rot. But in recent years in Utah and Texas, I've been called in to remediate hundreds of homes clad with newer modified systems, where the lack of proper water management details has caused major decay problems in homes that are practically new.

The good news is that any kind of stucco — traditional three-coat, proprietary one-coat systems, and even EIFS — can work well if you apply the flashing and drainage plane principles that have always been part of traditional stucco (see "Stucco Drainage Details," page 4). But before we get into those details, let's look at the differences between traditional "three-coat" stucco, the new proprietary "one-coat" systems, and EIFS (the polystyrene-based exterior insulation finish system).

Three-Coat Stucco

Conventional or traditional stucco is called three-coat stucco because it has a 3/8-inch scratch coat, a second 3/8-inch brown coat, and a thin "color coat" on top, for a total system thickness of about an inch. All three coats are mixed from Portland cement, sand, water, and some lime for workability; the top coat has color powder and may include some polymer additives.

But the system starts with a drainage plane based on some type of building paper over the wood framing of the home. Building codes call for two layers of Grade D kraft paper, which is made with virgin wood fibers. The paper is there to drain water, so it has to be carefully tied into flashings around all windows and doors. Metal flashing systems are also installed to divert roof water away from the stucco system, and to protect any penetrations. The paper and flashings have to overlap each other in a way that creates a shingle effect.

Over the papers and flashings, a stucco netting or metal lath is fastened to the wall with staples. Stucco netting looks like chicken wire, but it is actually a heavier-gauge galvanized-steel wire. Expanded metal lath has the look of a heavier grating, but it serves essentially the same purpose.

Next comes the base coat, troweled into the lath mesh and tooled with grooves while wet, to provide keys for the second coat to lock into. The 3/8-inch-thick second coat is applied and tooled flat, and then both must cure for 7 days before the color coat gets troweled on. Like all cement, stucco will shrink and crack; many traditional contractors will wait 14 days to make sure the first coats have completely "cracked out," so new cracks won't telegraph through the top coat.

Three-coat stucco is designed to be porous. Rain soaks into it, then drains out when the storm ends. The papers and flashings are vital to protect the house — without them, water will soak the wood and create conditions for rot.

Flashing details frequently involve the interaction of two trades. Here, for example, the stucco crew members responsible for installing the building paper had to remove and reinsert a gable vent installed by the framers so that they could run building paper under the vent flange.

One-Coat Stucco

Since the mid-1980s, a handful of manufacturers have introduced thin-coat stucco products that collectively are called "one-coat" (or sometimes "two-coat") stucco. One-coat is nearly

identical to conventional stucco in concept and design, except that the base coat is applied in one layer instead of the original two-step scratch- and brown-coat process. The base coat is mostly sand and Portland cement, as in conventional stucco, but it also includes synthetic polymers and fiberglass reinforcing strands that increase both the tensile and the compressive strength. The required total thickness is just 3/8 inch, instead of the standard 3/4-inch total for the three-coat base.

The idea behind one-coat systems was to save labor and time in the schedule. With the added components, base coat could be put on in just one layer, with no second plastering and no wait in between.

In practice, I'm not sure one-coat is all that economical. The proprietary mix ingredients add cost, and finding and following the special instructions for the proprietary systems add complexity. One experienced stucco contractor, a friend whose work I respect, told me that he gave up working with one-coat because it was too complicated. His crews rebelled against the required special detailing, and he also found that with only 3/8 inch of thickness, it was harder to achieve a nice, uniform finish over the usual irregularities in a house frame. (A common defect I see in one-coat installations is a base coat much thinner than the required 3/8 inch, at least in spots.)

The other big selling point for thin-coat systems is that the fiberglass and polymer additives help the stucco withstand the winter freeze-thaw cycle.

The thinner base coat is still applied over wire lath or expanded metal, and over a system of papers and flashing the same as we need for conventional stucco. The same screeds and expansion joints are also part of this system, although at different thicknesses. But unlike three-coat stucco, one-coat systems require a 48-hour moist cure. The applicator is responsible for keeping the base coat moist for the first 48 hours after application. The color finish is also required to go on within 72 hours of the base coat application. Proper curing is more critical with one-coat than with traditional stucco, because the acrylics tend to isolate cement particles from water in the mix. If the coat isn't kept moist, it may dry out before the cement has a chance to react with water (hydrate), which it must do to form the strong cement compounds that give the cladding its strength. Without the correct moist cure, the base coat is likely to be weak and crumbly.

One-coat stucco usually receives one of the new acrylic color finishes, instead of traditional stucco's purely cementitious, textured color coat. It has a smoother and less porous look, because acrylics instead of cement bind the aggregates together — it's like sand mixed with latex paint. Many people perceive this acrylic top coat as the defining characteristic of one-coat stucco, but synthetic finishes are not really an essential component of a one-coat system — they just happened to be developed about the same time that one-coat was widely marketed. One-coat base-coat systems got code approval in ER reports without mention of any particular color finish. As long as the base coat is applied at least 3/8 inch thick, you can paint it or apply either a conventional cement color finish or a synthetic acrylic color finish over it.

An acrylic coating's higher plasticity gives more resistance to cracking and creates a more closed, water- and stain-resistant surface. But one-coat stucco finishes are still porous enough to let rain enter the system — the perception that one-coat systems reliably repel water at the surface is incorrect. And even if the coatings were waterproof, one-coat systems do crack, and they can leak at all the joints and penetrations, so water is sure to get behind them. At the same time, they are less breathable and slower to dry out than conventional stucco. So they are less forgiving of any defect in the proper placement of building papers, flashing, and lathing staples — if water reaches the wood structure of the house, it is less able to escape by evaporation.

I've seen many failed stucco systems that someone has tried to repair by applying a thick polymer coat over the existing stucco, and by surface-caulking window and other joints. This is worse than useless — it actually accelerates the damage. Water will still enter the system somewhere, and then it's trapped next to the house. My company's educational video, available from our website at www.rambuilders.com, shows an example of a home just four years old, whose framing and sheathing is completely gone because of that kind of attempted "repair." Damage that might have taken 10 or 20 years to develop under normal, breathable stucco happened in 1 or 2 years after the sealer was applied.

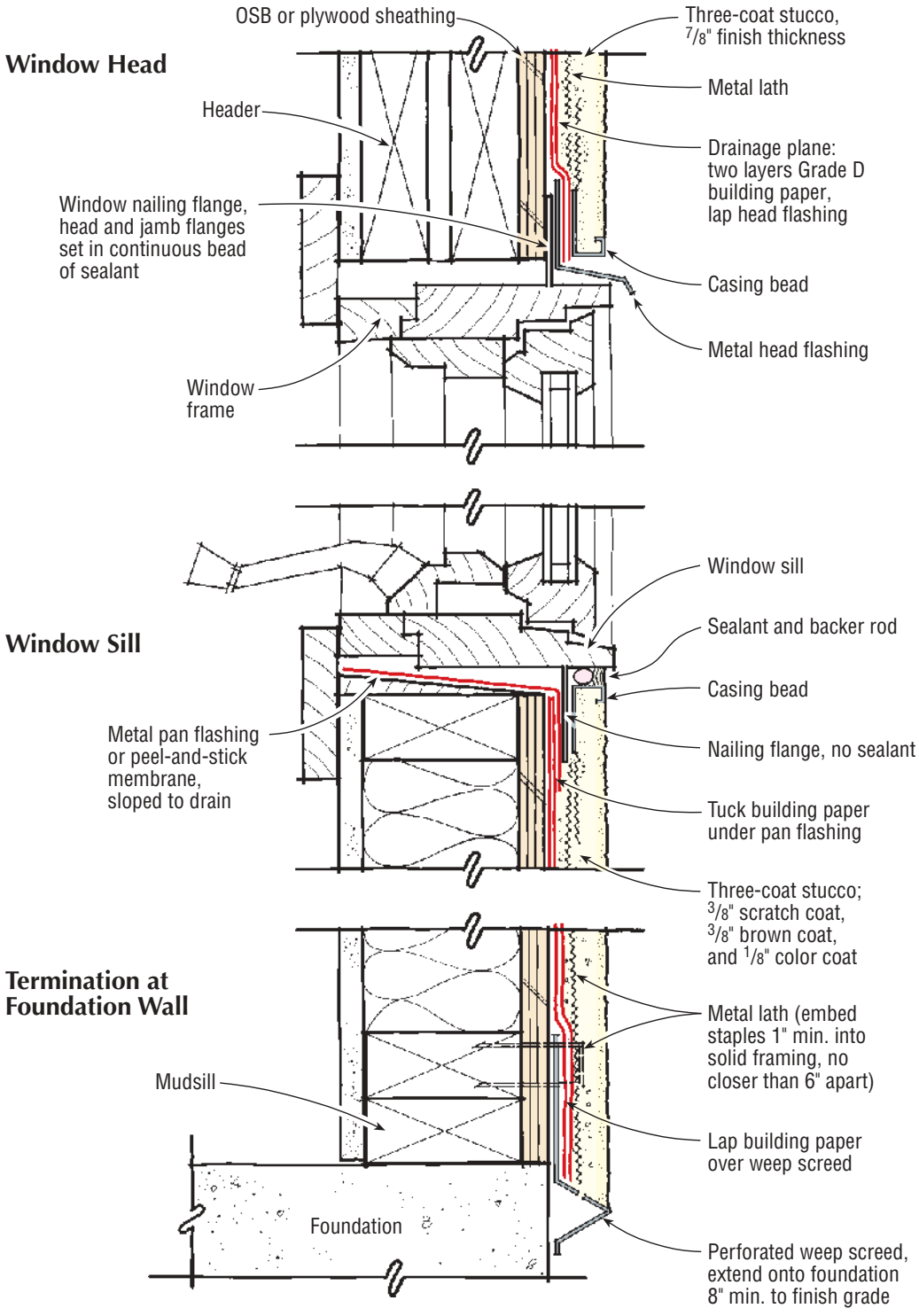
One-coat stucco finishes are still porous enough to let rain enter the system

EIFS

Exterior insulation and finish systems use just a thin (1/8-inch to 3/16-inch) synthetic top coat over a substrate of expanded polystyrene foam. Originally designed as a barrier system with no water management behind the foam, EIFS in the residential market now has to have reliable paper and flashing assemblies behind it to allow water to drain. However, EIFS still requires surface caulking and sealing at joints (caulking is not part of a hard-coat stucco system).

The details for EIF systems are all specified by manufacturers in their specs and ER reports. In practice, I've found that EIFS applicators still mix and match in the field, using whatever components are cheap or easy to find,

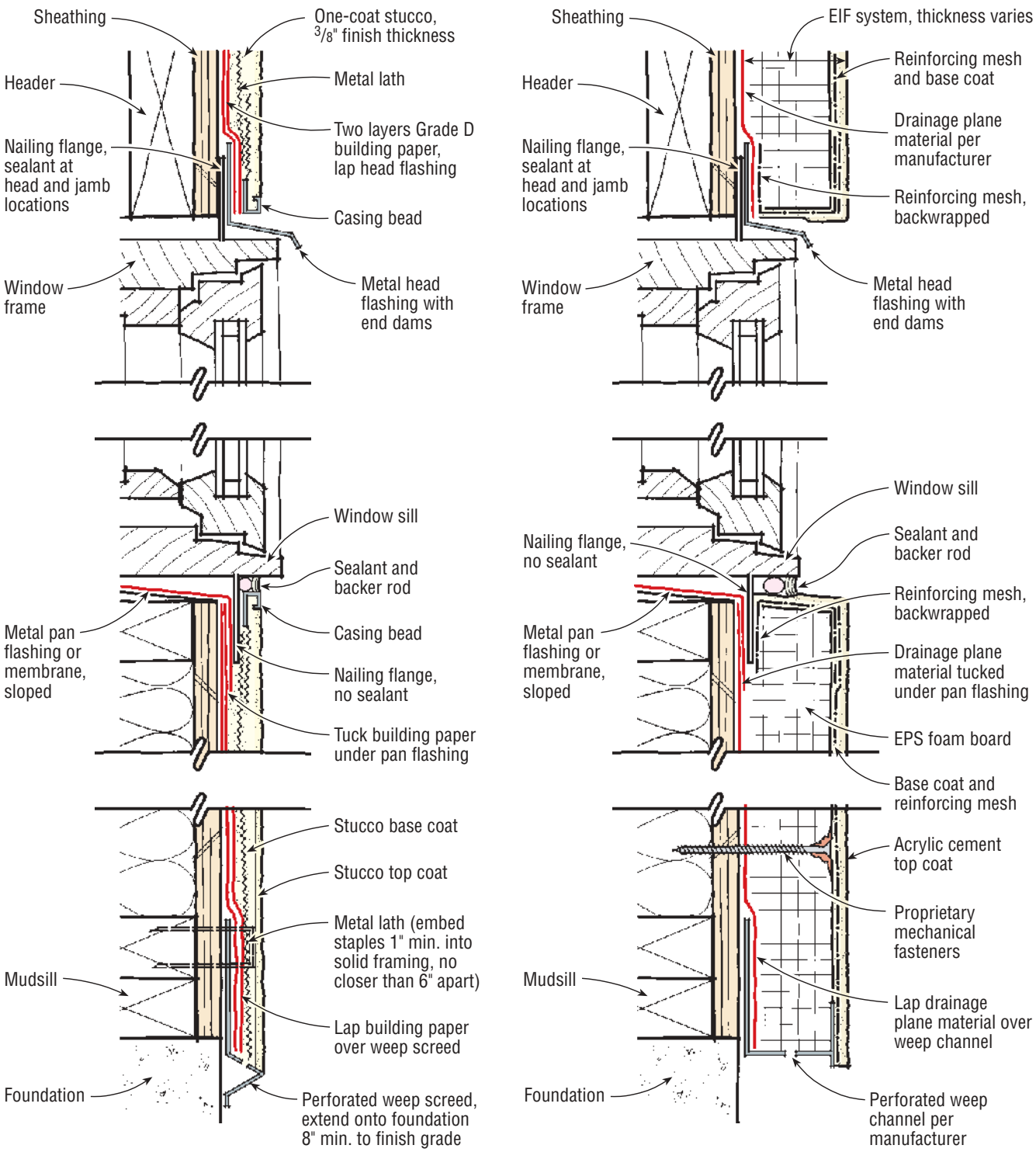
Stucco Drainage Details: Three Systems, One Principle



Traditional Three-Coat Stucco

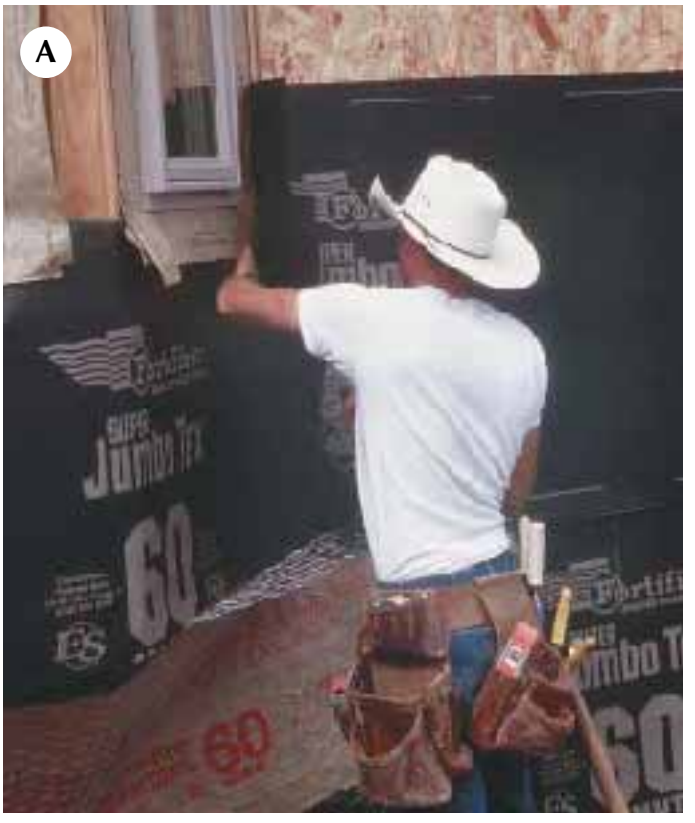
Three-coat stucco relies on traditional details to keep water flowing down the wall and away from the building. Openings, transitions, and terminations are flashed to let water escape, while building paper, lapped over the flashings, keeps water away from the wood.

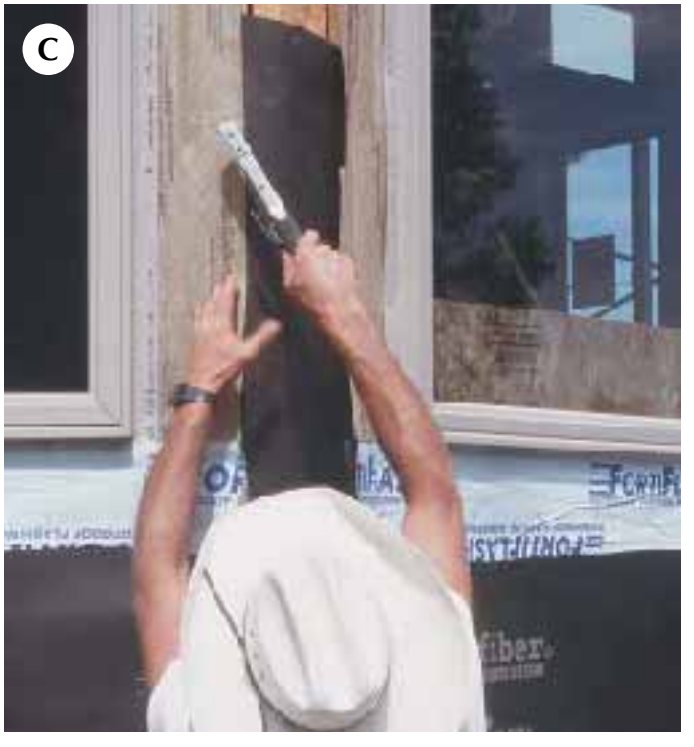
Stucco Drainage Details: Three Systems, One Principle



One-Coat System **EIF System**

EIFS and modified thin-coat systems, while they have different substrates, rely on the same water-management details as traditional three-coat stucco.





Integrating building papers with window flashings can be a challenge on site. In California, where this crew works, stucco contractors aren't typically licensed to install windows, so the paper crew must work with the existing flashing. Here, the window crew left the window perimeter protected by strips of flashing, with side strips lapped over the bottom strip and the head strip lapped over the side strips and the window flange. The paper installer lifts the bottom flap and runs paper under it (A), then seals the flashing to the paper with adhesive membrane (B). Next, he lays paper under the side window flashings and staples the flashing down before applying membrane to this joint as well (C). Paper-backed lath then butts directly to the window flange (D), but water that gets behind the stucco at the window sill and jamb will be handled by the membrane, the flashing, and the first layer of paper.

and assembling the system however they feel like doing it. With constant pressure on budgets and schedules, it's not surprising that we still find defective EIFS applications all over the market.

Even the new water-managed EIF systems use sealing top coats, so they lack the easy path for moisture escape that traditional stucco has. With EIFS, any water in the system has to make its way to weep exits — it can't readily bleed or evaporate out the face of the wall.

Drainage Detailing for Critical Spots

To make stucco work, you have to back it up with a drainage plane based on the shingle effect: water-resistant papers and flashings that direct the water down, out, and away from the wood structure of the home. The failures that I see in hard-coat stucco are usually traced to a few common mistakes in the drainage plane details.

Proprietary one-coat stucco systems and drainable ("water-managed") EIF systems come with water-handling details supplied by the manufacturers. Some are better than others, but reading and understanding all the evaluation reports and company specs out there would be a daunting task for anyone — by now, the details for all the many systems amount to thousands of pages.

The good news is that every stucco system — even EIFS — can be made to work by applying the same principles that have always applied to traditional stucco. Stucco is a porous, drainable system. Rain penetrates it and drains through it.

As you look at the following examples, keep in mind that coordination and organization on site are keys to implementing them correctly. Most flashings and transitions occur at spots where more than one trade is involved. Terminations at grade may involve landscapers or foundation crews, window flashings can involve roofers as well as window installers, roof-to-wall connections of course involve the roofers, and soffit transitions can involve trim carpenters or framers.

It's the general contractor's job to make sure those transitions are built correctly, by managing the schedule, communicating with all the subs, supervising, and inspecting. Even on custom homes, it's easy to lose control of those critical areas; on tract homes where subs put in unrealistic bids based on incomplete plans, crews are untrained, everyone is in a hurry, and confusion reigns on site, we see many, many failures at spots where two trades were not coordinated.

Weep screed. Hard-coat installations start with the application of a "weep screed" at the bottom edge of all walls. This flashing, which is perforated at the bottom, defines the bottom edge of the stucco coats. It goes on first because it is lowest: The other papers will lap over it to begin the shingle-style layering.

Weep screed is a standard item in markets where stucco is established. In new markets, people may not have heard of it. But it's vital to the performance of the system. Rain will soak into any stucco coating; the water will head downwards, and it must escape at the bottom. Weep screed lets water out through its perforations, and it stops the stucco from bonding to the cement foundation and creating a dam where water might pool. The screed should span between the wood framing or sheathing and the concrete foundation, and it should terminate at least 8 inches above grade.

Other flashing assemblies are acceptable. In some places we use a perforated J channel above a Z flashing for a bottom termination. The key principle is just that water must be allowed to escape and must be

Here, the window installers and the roofers have not coordinated their work. Roof flashing will effectively catch water coming off the main wall if stucco papers are applied to lap over it. However, the window flange dumps behind the roof flashing instead of onto it. The author's crew removed this window and reflashed the opening before reinstalling the window.

Less than ten years old, this building had been repaired twice previously with surface-sealing methods that did not work. The author's crew first stripped the stucco. At this window corner (A), badly detailed flashing and paper let water soak the sheathing and framing, leading to rot. After pulling out the window, the author's crew repapered the wall with Tyvek StuccoWrap, then applied membrane and Tyvek FlexWrap to the rough sill to protect the wood structure even if the window leaks (B). The crew then replaced the window (C), sliding the top flange under the Tyvek and sealing the flange to the Tyvek all around the window (D) before applying a second protective layer of Grade D building paper (E).

directed away from the building.

A common mistake is to pour a slab, patio, or step after the stucco is applied, and to trap the weep screed and the bottom edge of the stucco between the slab and the house. This traps water in the stucco at the bottom and ponds it against the building paper, which will eventually let moisture through. Of course, if there are reverse laps in the paper and flashings above this point, the water will already be behind the paper and in contact with the wood. This scenario can quickly destroy sills, wall plates, and studs.

Building paper. Lapping over the weep screed, as it must lap over all other flashings, is the water-repellent building paper, installed shingle-fashion from the bottom up. Code minimum is two layers of Grade D building paper.

Grade D paper is a tar-impregnated kraft paper that comes in different thicknesses with different minute ratings, based on the time it takes for water to penetrate in standard tests.

The most common varieties are 15-minute and 30-minute papers. You can pull two layers off the roll at once; because of the space between them, paired sheets of 15-minute paper installed on the wall offer more than 30 minutes of weather protection, and doubled 30-minute paper provides more than 60 minutes. There is even 60-minute Grade D paper, which, doubled, gives more than 2 hours of water resistance. Rain takes a long time to soak into the stucco itself before reaching the papers, too; so the combination of good papering under a properly applied base coat and finish offers many hours of weather protection.

Housewraps have approval for use under stucco, but I don't recommend any of them in single-sheet applications. Our experience shows that whatever sheet comes in direct contact with the stucco base coat will lose water repellency and break down over time. We use housewrap, but only with Grade D paper over it.

The latest building codes don't specify a "minute rating" requirement for paper under stucco. We adjust our paper choice to local climate conditions. In interior Southern California, we use double 15-minute paper. In the Salt Lake Valley, we use double 30-minute paper. In the Galveston Bay of Texas, we use double 60-minute paper. In some remedial work, where everyone is eager to be absolutely sure, I will even install wrinkle wrap first, then two layers of 30-minute or 60-minute paper — all lapped over or under any flashings as appropriate to achieve the shingle effect.

Builders should learn any local code requirements, and I would advise asking an experienced and reputable local stucco contractor what works in your area. If you can't consult the voice of experience, err on the side of caution: Heavier paper is cheap compared to removal and replacement.

Metal lath. Good installation of the metal lath over the papers and flashings is critical. Stapling is a big concern: I have seen bad leaks develop when the only mistake was that the lath was overstapled or stapled in the wrong places.

Lathing staples should be placed only at studs, plate lines, headers, or other solid framing members. Code requires the fasteners to penetrate 1 inch into the framing, so if the sheathing is 1/2-inch plywood, you need staples with a 1 1/2-inch leg. A wide-crown staple is the appropriate fastener, and the only way to get both legs of a 7/8-inch or 15/16-inch crown staple to consistently hit a 1 1/2-inch stud is to orient the staple vertically (this also prevents the staple from creating a water trap in the papers).

The staples should be placed no closer than 6 inches to each other. If you have to use a staple between studs — for instance, to fasten the edge of the lath near a vent penetration — use short staples that will not go all the way through the plywood. Locate all laps in the wire over studs or other solid framing members.

I've seen cases where poorly trained applicators have placed a hundred or more staples in a 1-square-foot area between studs, to pull lathing flat or close a joint. The results can be disastrous. It seems to take a certain number of staples to break apart the wood flakes in an OSB piece enough to create a channel for water flow. Once you get above that critical mass of staples, you've opened a path. In heavy storms with turbulent winds, water in the saturated stucco gets forced through the paper and the OSB along the paths created by the staples, and flows down the inside of the OSB within the stud cavity. I've opened up walls from the inside and watched the water stream in. No wall system in the industry is designed to drain water out of the stud bays — when that area gets soaked, your wall is doomed. When I tear apart a wall like that after four or five years in service, what I find is a compost pile.

Bad leaks can develop where lath is overstapled or stapled in the wrong places

Window flashings. Many one-coat manufacturers supply window flashing details, but they aren't necessarily good ones. The key, as always, is to establish good overlapping for the shingle effect. We see many houses in Utah and Texas where the paper has been applied well, but the window flashings dump under the paper. Invariably this leads to rot.

Coordination on site can make or break this installation. Where window flashings dump under the paper, it's probably because the window installers put the flashings in before the stucco installers came to paper the

building. The paper has to go on first, then the flashings, then the window, and finally the lath. Each trade has to wait for the one before, or you have to figure out a way to leave the flashings hanging so they can be integrated into the building paper later.

Another typical case is shown in the photo on page 7. Here, the window flange is likely to dump behind the roof flashings if someone is not careful. This situation was found on one of my company's retrofit jobs. My crew removed the window, papered the wall with papers lapping on top of the roof flashing, flashed the window opening so the flashing dumps on top of the paper, then reinstalled the window with flanges outboard of the papers and flashings so that water always moves away from the building as it heads downhill.

Bad window details damaged several spots on the building in the photos on page 8. Though it was less than ten years old, this building had been repaired twice previously with surface-sealing methods that did not work. After pulling out the window, we repapered the wall with Tyvek StuccoWrap, then applied membrane and Tyvek FlexWrap to the opening to protect the wood structure if the window should ever leak (as many on this building have). We then replaced the window, sliding the top flange under the Tyvek and sealing the flange to the Tyvek on all four sides. Finally, we applied a second protective layer of Grade D building paper. More than a hundred houses in this one neighborhood, built by different builders both large and small, need this treatment.

Roof-to-wall joints. The most damaging leakage we see in our work takes place where roofs intersect walls, either because a one-story roof meets a two-story wall, or because a chimney chase meets the roof. It takes work to keep the roofers and the stucco applicators coordinated so that their work

Roof-to-wall intersections create particular problems. At top left, this bad detail held up the work: The rafter placed tight to the building wall does not allow paper to slip behind it, and the flashing left by the roofers will direct water behind the stucco and into the wall if used as configured. The photo above shows a water diverter (kick flashing) installed by the author's crew in a retrofit job: This design will lead water out away from the wall and dump it off the roof's drip-edge rather than into the wall. Papers installed on the main wall can readily integrate with the membrane and flashing between roof and wall at the rafter tail. At left, a wall-and-roof intersection built without the correct flashing detail shows discoloration and staining after a few years in service; the author typically finds significant rot in buildings with this detail, even though the wall surfaces may show only minor traces of trouble.

interweaves correctly.

Every roof needs some kind of L-shaped flashing where the roof abuts the wall. Metal step flashing, or as we call it, "step shingles," is typical for asphalt or shake roofs; tile roofs usually get a continuous piece of metal J flashing.

Where stucco is new in the market, the appropriate metal step shingles for stucco application can be hard to find. Folded flashings intended for use with asphalt shingles and vinyl siding are too small for stucco. In Salt Lake City, the typical step shingles on the shelf are 8 inches long, with a 2-inch leg for the wall and a 4-inch leg for the roof. Stucco requires a 2-inch reveal between the bottom termination of the stucco and the roof surface (many EIF systems need a 3-inch reveal), and a 2-inch lap of the building paper over the metal, so step flashings must have at least a 4-inch vertical leg.

Since you can't be sure of finding the right size metal flashings in all markets, I always use rubberized asphalt sheet material like Ice and Water Shield as a backup.

However, the flashings are still important, particularly the water diverter or "kickout flashing" at the bottom of the roof, which kicks roof runoff away from the wall system. Where this is not installed, water from the roof will overwhelm the stucco system and cause at least a visual problem, and commonly a major structural problem.

Penetrations. Every penetration in the stucco — hose bibb, dryer vent, combustion air intake, or whatever — is a potential leakage point. Our solution for those spots is to use bent and soldered metal to make up a set of standard shrouds, like the hoods that cover dryer vents, in various sizes to meet the most common needs. We caulk the back side of the shroud to the paper below it, and caulk the paper above it to the shroud's top and side flanges. Then we terminate the stucco at a casing bead.

Homeowners Pay the Price

In Salt Lake City, my stucco repair business is thriving. We also have a lot of work fixing homes with EIFS and cultured stone exteriors — the underlying drainage-plane problems are the same.

Recently, I started a company, Ram Exteriors, to install hard-coat stucco on new homes. But I'm thinking of shutting it down. We haven't been able to get much business, and we have barely broken even on the jobs we have sold. The cut-rate competition is just too tough. It's ironic, but I can find plenty of work fixing bad stucco at four times the cost, and very little work applying stucco right in the first place.

The consequences are tragic for homeowners who don't understand the issues. I was called to do an estimate on one house up for sale, where the buyer had hired a home inspector from back East and the inspector had flagged the stucco system. I told the buyers they were looking at a system that was trying to drain water on the exterior and lacked the right flashings and papers under the cladding. Even if we found no structural damage, I told them, it would be at least $30,000 to retrofit the home to provide good drainage details.

That buyer backed out of the sale. But I heard that the house sold weeks later to another buyer who did not have a home inspection done. Someone has bought the trouble.

I worked for another couple who bought their home before they saw any problem. They called me because of leaks and musty odors. When my crew started to open the walls, the foreman called me from the site and said, "You better get over here, Dennis. This house is about to fall down." When I got there, sure enough — the home's framing was almost gone. There was a risk of imminent collapse.

Utah has some of the weakest liability laws in the U.S. That couple's lawyer advised them to settle for $50,000. In other states, the builder would have been on the hook for the whole value of the house. If the builder's insured, that's a hit he can handle — once, and then lose his coverage. But I know some contractors who have thought they were covered and never were: Exclusions they hadn't read in their insurance policies ruled stucco out, and they didn't even know it.

Whether your insurance covers you for stucco failure or not, that isn't a road you need to go down. The way to prevent the human cost isn't with insurance. Insurance is for unavoidable disasters, one-time deals. If stucco is done wrong, failure is predictable: You can expect it. And the way to avoid stucco failure is simple: Provide the system of flashings and papers that will keep water away from the wood. If you do, you'll have something better than insurance: a weather-resistant home exterior that does its job.

Every penetration in the stucco — hose bibb, dryer vent, combustion air intake, or whatever — is a potential leak point

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*Lifelong contractor **Dennis McCoy** owns and operates Ram Builders, Inc. (www.rambuilders.com), based in Lindon, Utah, with operations in Utah, Texas, and California.*