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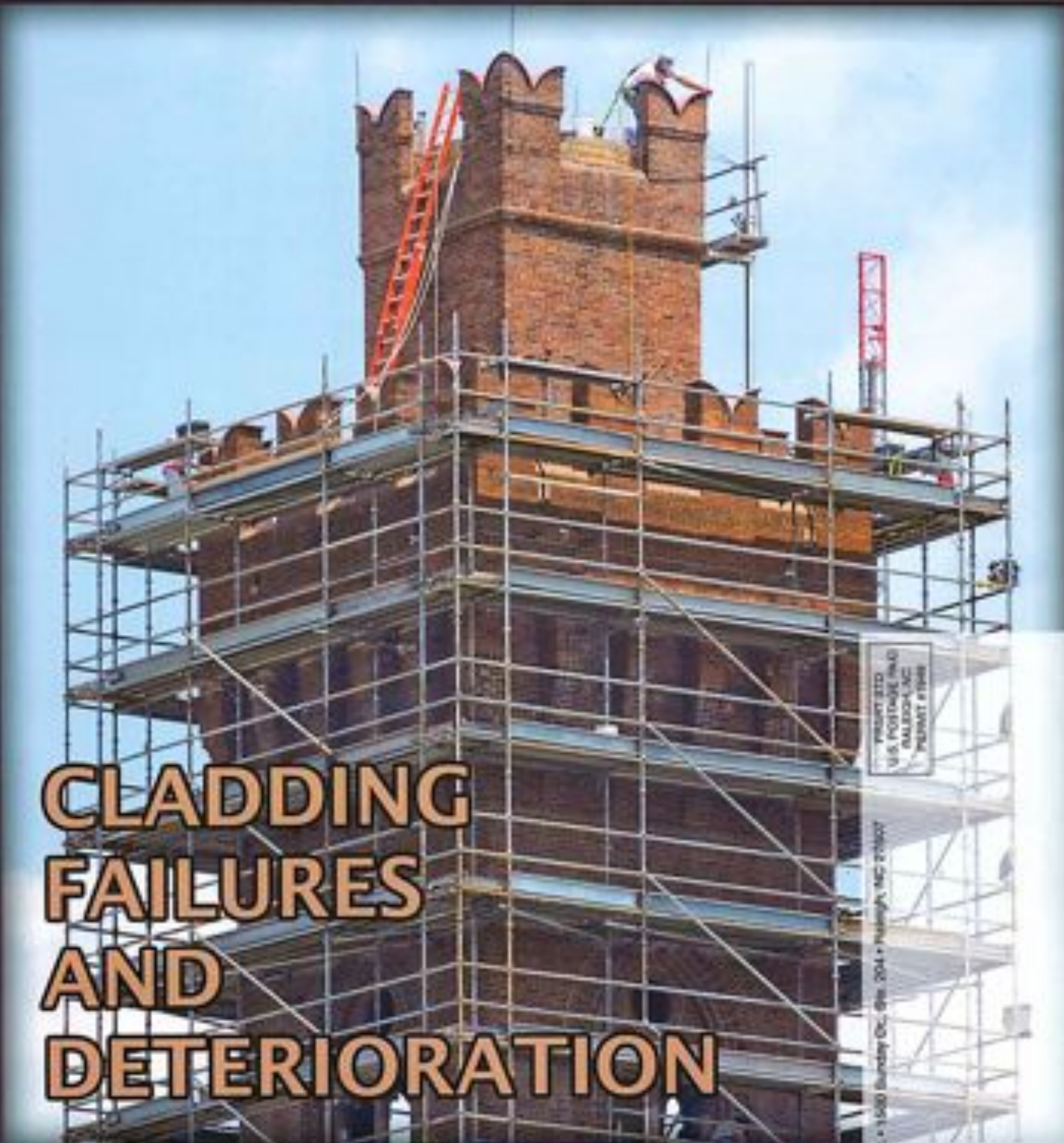

CLADDING FAILURES AND DETERIORATION

Are Your Excuses Watertight?

SITURA WATERPROOF EXPANSION JOINTS

PROJECT/CASE #2

Discovery Channel Center, Silver Springs, MD

PROBLEM/CHALLENGE

Multi-directional expansion joint, changes planes from horizontal to full vertical joints for sliding isolation slabs • Watertightness and isolation critical • The expansion joint varied from 1" to 10" in opening dimensions

SOLUTION/DESIGN

Prefabricated SITURA RedLINE® expansion joint, designed to accommodate a wide variety of on site conditions • The SITURA RedLINE® expansion joint was manufactured in a single monolithic component accommodating the various joint gap dimensions and changes in plane along its length

EXECUTION/INSTALLATION

Total joint length approximately 310 feet • Included in its length are three types of SITURA expansion joints, RedLINE® 20, RedLINE® 40 and RedLINE® 240, fabricated as one single piece with intricate detailing

SITURA EXPANSION JOINT PERFORMANCE

Project installed 3rd quarter 2002 • No leaks or callbacks

"The joint conditions in the field included slab-to-slab variations in plane, 90 degree (in plane) mitres, horizontal to vertical mitres and slab-to-slab and slab-to-wall changes. We advised the owner that if we proceeded with the standard neoprene expansion joint, the only guaranty we could offer was that the joint would leak. We suggested the SITURA Red LINE® joint as a solution. SITURA worked with us in the field to provide a continuous and seamless joint that spliced easily into the hot rubberized membrane. The result – a watertight joint and a satisfied client."

– James N. Stamer, President,
Prospect Waterproofing Company

PROSPECT

SITURA INC.
Waterproof Expansion Joints

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BETTER DESIGN AND BUILDING PRACTICES FOR REDUCING WATER AND MOISTURE PROBLEMS IN WOOD-FRAMED COMMERCIAL AND MULTIFAMILY BUILDINGS

BY STEVE EASLEY

This article was originally published in the Proceedings of the 25th Annual RCI Convention and Trade Show.

ABSTRACT

Commercial building litigation surrounding water- and moisture-related problems has risen dramatically in recent years. Moisture damage contributes to 90% of all building and building material failures (ASHRAE). Some experts estimate that as much as 80% of construction defect litigation in the construction market segment is due to water- and moisture-related failures. The purpose of this paper is to help contractors, designers, and specifiers identify designs, details, and construction practices that lead to building failures. This paper takes a step-by-step approach to examining common design and construction defects that are prone to creating moisture problems, as well as troubleshooting installation defects and selection of building materials that lead to a more durable building.

INTRODUCTION

In the U.S., the construction industry spends about $9 billion annually on construction defects due to water and moisture intrusion (ASTM). Moisture problems often lead to structural decay, failure, and even indoor air-quality problems. Most water intrusion damage is caused by poor system selection and faulty installation. This paper examines the most common causes of water leaks and how to prevent them in wood frame construction

Water-related callbacks typically result from three basic mistakes:

1. Poor design
2. Faulty construction
3. The actions of the owner

Water intrusion-related problems are universal and are the largest cause of construction defects. This is true even in relatively dry climates. It is important to understand that these problems are easily prevented and at little cost. In most cases, prevention is cheaper than the cure.

In addition to thoughtful design, education of material installers is key to a successful, profitable business. The success of any building system is only as good as the installation skills of the worst employee. So taking the time to train employees to install materials right the first time, how to identify potential problems, and to solve water leaks are critical to reducing call-back costs. It typically takes five different trades to return to repair a water intrusion event.

To reduce callbacks, it is important to develop design and construction checklists dedicated to moisture management for jobsite evaluations. A well-thought-out moisture management strategy will help identify common and uncommon mistakes that lead to failures. A good plan includes addressing a company's construction managers, purchasing agents, design staff, and trade partners. This plan should stress that preventing water-related problems is everyone's responsibility.

PREVENTING WATER- AND MOISTURE-RELATED DEFECTS

The accompanying photos and text document common and uncommon mistakes made repeatedly throughout the U.S.

Photo 1 – Condo units.

Photos 2 – Roof sloping into walls.

Photo 3 – Ridge intersecting eaves.

Photo 4 – Intersecting roof plane.

Included are simple solutions that will help fend off moisture problems.

DRAINLESS DESIGNS

Preventing water intrusion starts when the design professional puts pen to paper. Contractors should take special care to evaluate the design before they bid a project. A poor design often leads to problems during and after construction, which can lead to increased liability. The result is that more money is lost in repairs and legal costs than is made from a project. Always question, "Is this design going to drain water away from the structure or funnel water into it?"

HORIZONTAL VALLEYS

Any time a sloping roof or valley runs into a horizontal plane, the water flowing down that valley can become trapped. If there's enough water runoff at one time, it's likely to back up under the shingles and flashing. This can turn to ice in colder climates. *Photo 1* shows that a whole series of horizontal valleys has been created between these condo units. These poor-draining roofs, combined, are more likely to lead to water leaks over the life of the building. Another common mistake, shown in *Photo 2*, is a sloping roof into a wall that creates a horizontal valley condition, trapping water and leading to leaks.

Designs often result in intersecting roof planes. These intersections must be capable of handling a tremendous amount of rainwater. A 1-in rain on a 2000-sq-ft roof will deposit about 1,250 gallons of water. If water does not have a clear path to drain, but instead is obstructed by any intersecting roof, wall, dormer or eaves, it will back up and probably find its way inside the structure. In many states, the statute of limitations is ten years for construction and design defects; so ask if the design or construction practice employed can last this length of time without a problem. The solution is to avoid designs that trap water. Make sure water has an easy pathway to drain to gutters and away from the building.

RIDGE INTERSECTING EAVES

The problem with the design in *Photo 3* is that all the water that runs off the higher roof is collected in the gutter. Note that there is no downspout, so all the water that runs off the roof runs toward the poorly flashed ridge cap of the intersecting roof. The solution during the original design: drop the ridge so the eaves and the gutter can run above the ridge uninterrupted. The solution now is to pitch the gutter to a downspout at the exterior corner.

INTERSECTING ROOF PLANES

Whenever two roofs of different pitches intersect, it's important to detail the intersection to ensure the water's ability to shed away from the structure. In *Photo 4*, there's no way water draining off the roof in the foreground can drain away without getting funneled into the roof/wall intersection where the rake of the second roof blocks its path.

DESIGN SOLUTION

Photo 5 shows how to detail the intersection to avoid a horizontal valley. By keeping the gable ends on different planes, the valley is allowed to run unbroken and water can drain freely.

ROOF WALL INTERSECTIONS

Roof wall intersections are prone to moisture intrusion, in large part because


Photo 5 – Avoiding horizontal valleys.


Photo 6 – Damage at roof/wall intersection.


Photo 7 – Moisture at roof/wall intersection.

Photo 8 – Hole in water-resistive barrier (WRB).

Photos 9 and 10 – Poorly fabricated kickout flashings will lead to water damage.

kickout flashings (sometimes called diverters) are missing or poorly field-fabricated. *Photo 6* shows damage due to lack of kickout flashing at roof/wall intersections. Kickout flashings divert water away from these troublesome details. Next to window flashing mistakes, roof/wall intersections are the most problem-prone areas.

Notice the moisture concentration at the roof/wall intersection of *Photo 7*, which demonstrates the tremendous need for kickout flashing diverters.

Note the large gaps in the water-resistive barrier (WRB) at the roof-wall intersection in *Photo 8*. This will certainly lead to a failure. WRBs are often poorly installed at these areas. Sometimes, this leads to sloppy patchwork. Workers need to inspect and correct all unsealed penetrations.

POORLY FABRICATED KICKOUTS

Field-fabricated kickout diverters, such as those shown in *Photos 9 and 10*, illustrate the lack of knowledge on how to properly field-fabricate a kickout diverter. Field-made diverters are often poorly made and do not work well. There is also tremendous inconsistency from one tradesperson to the next in how these are made.

Premolded, seamless kickout flashings (*Photo 11*) are an excellent solution. They perform better than field-fabricated metal and cost only $10 or so. This product can work with almost any roof pitch. It is made of polypropylene, so it works well in both cold and hot weather.

BAD FLASHING

Properly installed flashing is the last defense against leaks. In *Photo 12*, the metal flashing is reverse shingled over the brick. The design is poor because it creates a horizontal valley. Proper inspection is required to avoid flashing-related leaks.

REVERSE SHINGLING

Walls should be treated just like roofs. Few contractors would ever install roof shingles without an underlayment or flashings and would never lap the bottom shingles over the courses above. In the same way, walls should always be covered by a WRB. Then, the WRB should be installed "shingle fashion" so that the upper layers always overlap lower layers. Too often, however, layers of roof flashing and house wrap are "reverse shingled," which results in their shedding water into the structure.

Photo 11 – Premolded kickout flashing (courtesy DryFlekt.com).

REVERSE-SHINGLED HOUSE WRAP

Look carefully at *Photos 13 and 14*, and it is apparent that the house wrap is reverse shingled. The house wrap is behind the step flashing, which means that any water that gets in behind the cladding can easily be funneled into the wall, rather than draining away from the wall. The wrap should go

Photo 12 – Metal flashing reverse shingled over brick.

Photos 13 and 14 – Reverse-shingled weather barriers.

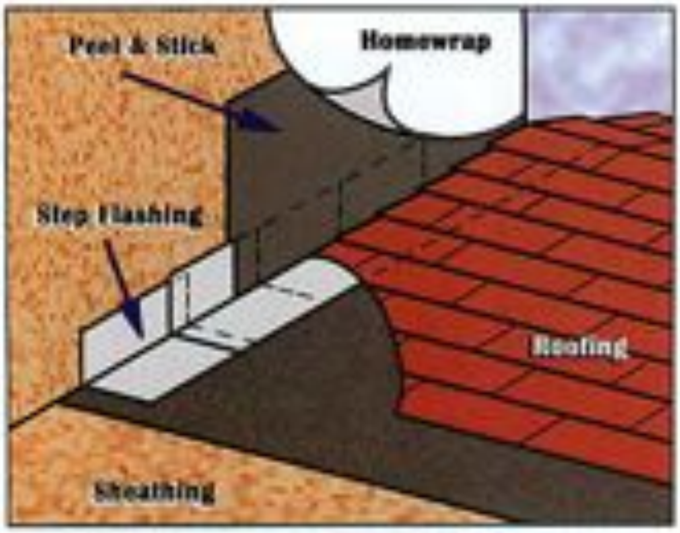

Photo 15 – Peel-and-stick flashing from sheathing onto metal flashing.

over the step flashing.

Use peel-and-stick flashing at step flashing wall intersections. This provides a tertiary drainage path for water that gets behind the wrap. Water that gets behind the house wrap now runs down the wall and is diverted over the peel-and-stick onto the step flashing.

Another caution when using peel-and-stick flashing is avoiding exposure to ultraviolet rays (i.e., just cover the 2 inches of the flashing).

Photo 18 - Vinyl Siding Drainge

Photo 16 – Missing step flashing.

Photo 17 – Missing counter flashing.

MISSING FLASHING

Where the sloping roof intersects the vertical wall in *Photo 16*, the shingles are in place without any step flashing. It will be difficult to install the step flashing without damaging the shingles. Step flashing should always be installed prior to roofing. The sloping roof in *Photo 17* has no counter-flashing under the brick relief angle. Brick cladding is not watertight and requires a drainage plane.

All cladding leaks, and vinyl siding is designed with weep holes to allow for drainage. In *Photo 18*, the secondary moisture barrier is doing its job, shedding enough water that wet spots are clearly visible underneath the vinyl siding.

WRONG WRAP OR WRB DETAILS

All claddings leak, and the more wind pressure, the more water leaks in. Rather than try to fight this fact by using a lot of caulk to try making the cladding watertight, the best strategy is to design the wall system to drain quickly and freely. This is accomplished with a well-detailed WRB that provides a second line of defense. The guiding principle for detailing this barrier is to make sure that water flowing across it always travels down and away from the building. Perforated building wraps are often marketed as air barriers and not water-resistive barriers. Many wraps look the same but perform quite differently under moisture loads. Some products have 30 to 40 holes per sq in. Do not use air barrier perforated wraps as a means to keep out water.

Photo 19 – Rips and gaps in WRB.

Photo 20A – Rainscreen product (Home Slicker cross section).

Photo 20B – Rainscreens (courtesy Benjamin Obdyke).

INCOMPLETE COVERAGE

Water-resistive barriers work well but must be installed correctly. The rips and gaps in the WRB pictured in *Photo 19* will allow any water flowing through to leak into the wall at the corners. Manufacturers require that the WRB be overlapped approximately 12 inches at the corners and, of course, sealed with an acrylic-backed tape. Often, when installers roll on the WRB, the WRB at inside corners is not tight to the inside wall, resulting in a radius or space between the WRB and the sheathing at an inside corner. The result is the cladding contractor has to slit the WRB to install the cladding, leaving a water entry point.

Photo 21 – No flashing around pipes.

Photo 22 – Poor detailing at electrical meter.

Rain screens, a space between WRB and siding, provide better drainage and drying behind claddings. The product in *Photos 20A and 20B* are manufactured by Benjamin Obdyke and are part of the Home Slicker line. Products like these reduce the potential for water intrusion in two ways:

1. They create a drainage space for water to drain, and
2. They create a capillary break to prevent water flow by capillary action.

Photo 23 – WRB at vent should be flashed.

WALL PENETRATIONS

It takes only minutes for wall components to get wet, but it takes days, weeks, or months for them to dry out. If the wetting rate exceeds the drying rate of building materials, mold and decay can occur. Notice there is no flashing around the pipes coming through the wall pictured in *Photo 21*. It would be very easy for water to run down the pipes and flow directly into the wall. *Photo 22* shows poor detailing at the electrical meter base and will surely lead to problems.

Photo 24 – Penetrations should be flashed and properly integrated with the house wrap (WRB).

Cutting large holes in the house wrap, as shown in *Photo 23*, defeats its purpose. The proper cutting technique is to X-cut the house wrap, slide the vent through the X-cut, and seal around the penetration with an acrylic tape (or a peel-and-stick flashing) before securing the faceplate. *Photo 24* shows a prefabricated flashing device made by QuickFlash that stretches around the pipe and seals it.

Photo 25 – Overstapling WRB.

Photo 26 – Synthetic stone.

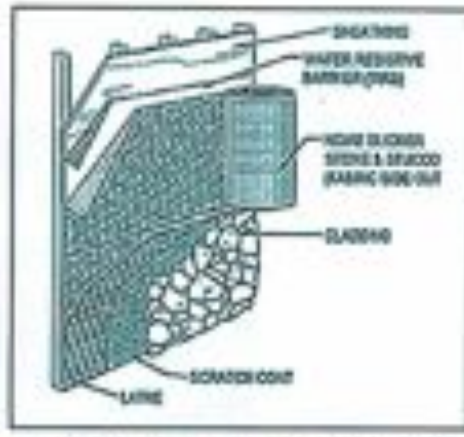

Photo 27 — Drainage membrane over WRB (courtesy Benjamin Obdyke).

PROPER FASTENING OF WRB

Every staple through the water-resistive barrier is a potential water leak. Crews should be instructed to install the WRB according to manufacturers' instructions. *Photo 25* illustrates over-fastening with staples.

SYNTHETIC STONE

Synthetic stone (*Photo 26*) creates a unique challenge. Synthetic stone systems leave no air space to promote drainage like brick veneer. A solution is to apply two layers of water-resistive barrier material before installing the lath. The outer layer functions as the first water barrier between the house wrap and mortar that holds the stone in place and allows the inner layer to function as a drainage plane and a capillary break to reduce the chance for water wicking through the water-resistive barrier. *Photo 27* shows a drainage membrane over the WRB for better drainage.

POOR WINDOW AND DOOR FLASHING

Windows and doors are holes in buildings that create hundreds of linear feet of cracks where water can easily penetrate. Most water intrusion issues occur at doors and windows due to improper flashing. While peel-and-stick flashing has become fairly popular, there is still enormous confusion in the field about the correct way to apply it around windows and doors. The biggest problems involve the flashing sequence. Most window manufacturers base their installation instructions on ASTM E2112.

Photo 28 — Proper window flashing at sill. The sill flashing was installed before the window.

Photo 29 - Head flashing attached from nail fin to sheathing.

The sill of any opening must be flashed before the window or door unit is installed. Then, install the window using a compatible sealant; apply jamb flashing, and finally, a head flashing. It is important for installers to follow ASTM E2112 and the window manufacturer's flashing instructions. The flashing overlap at corners is often four inches or more.

PROPER WINDOW FLASHING

The sequence of flashing a window is critical. Follow ASTM E2112.

- **Step 1:** WRB and sill flashing are installed before the window (*Photo 28*). Begin with a sill flashing that covers the rough sill and has a bottom flap that laps over the top of the WRB (house wrap). This will help ensure that any water that leaks through the window drains out over the WRB.
- **Step 2:** Sealant is applied at the head and the jamb areas; then install the window. Jamb flashing can go in after the window has been installed and should lap over the window flange to prevent wind-driven water from getting past the window into the rough opening.
- **Step 3:** Install the head flashing from the nail fin at the window head onto the wall sheathing (*see Photo 29*). Reinstall WRB over the head flashing.

LACK OF HEAD FLASHING

Photo 30 depicts what water running down a wall "sees" as it approaches the head of the window, underscoring how very important it is to properly flash at the win-

Photo 30 – Note the gap between the nail fin and the sheathing.

Photo 31 – Improper head flashing.

dow head. Sealant alone won't keep the water out. If the sealant ever separates and fails, there is a perfect entryway point for water into the structure. Always use compatible sealants and flashing.

IMPROPER HEAD FLASHING

The head flashing on the window in *Photo 31* is reverse-lapped over the house wrap. Before applying the head flashing, a flap needs to be cut in the house wrap so that the head flashing can adhere directly from the nail fin at the head onto the wall sheathing (*see Photo 29*). Once the flap is folded back down over the head flashing, water draining down the wall above the window will drain outside, not behind the head flashing.

The flashing in *Photo 32* is applied over the top of the nail fin below the window. This is a mistake. The sill flashing goes on *before* the window is installed.

SITE PROBLEMS

Along with roof and wall details, poor site drainage can cause an enormous quantity of water to get into structures. Builders can best prevent drainage problems using proper site selection and grading to keep runoff away from the building and then by installing good perimeter drainage to carry groundwater away. Designers should set grade high enough for proper drainage.

POOR DRAINAGE DESIGN

In the coastal subdivision pictured in *Photo 33*, water running off of one series of houses drains right into another. There is not enough natural drainage away from the lower structures to prevent subslab moisture accumulation.

MAINTAINING DRAINAGE

Water problems can often be traced to poor drainage around the home. Exterior water problems can easily create interior moisture problems. *Photo 34* illustrates a

Photo 32 – Improper sill flashing.

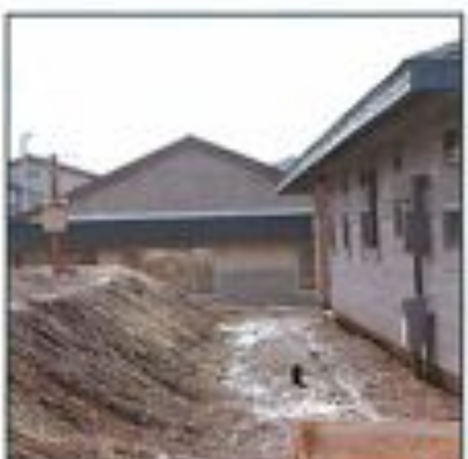

Photo 33 – Poor drainage design.

Photo 34 – Disconnected downspout.

Photo 35 – The owner factor.

disconnected downspout. Water that runs off the roof is being funneled near the foundation, which can create a tremendous moisture load at the foundation.

THE OWNER FACTOR

This sprinkler is pouring over 100 gallons per hour of water onto the wall depicted in *Photo 35*. This is an "unexpected design condition" and exemplifies why redundancy with flashing and WRBs is so important. The only way to avoid problems caused by the owner irrigating this wall is to make sure a WRB behind the brick is impeccably detailed, a drainage cavity and weep holes remain open, a backfill that drains well was installed, and there is good perimeter drainage.

SUMMARY

Water intrusion problems are one of the leading causes of callbacks and building failures. Preventing water intrusion starts with good design and ends with proper installation and maintenance. It is important that wall systems have the capacity to drain and dry to prevent moisture buildup that leads to decay and damage.

1. Design and construct the roof and wall assemblies to deflect water. The better an assembly deflects water, the less water has to drain from the assembly.
2. Design and construct roof and wall assemblies so they have the capacity to drain freely and quickly. The faster the assembly drains, the less water there is to be absorbed by hygroscopic building materials. Install premolded, prefabricated kickout flashings at roof-wall intersections to divert roof water away from wall assemblies.
3. Design the roof and wall assembly so that they have the capability to dry as quickly as possible.
4. Design and detail the water-resistive barrier to be properly integrated with flashing at all penetrations. Employ ASTM flashing standards for window and door installations.

CONCLUSIONS

It is critical that designers, contractors, and installers be trained to identify potential water intrusion design problems and faulty installations. Designers should consider proactive moisture management strategies up front in the design process.

Contractors and inspectors should develop and follow a moisture management checklist. They should be trained on proper installation techniques of flashing, roofing, kickout diverters, and water-resistive barriers and on the ways in which roofing and wall materials interface to shed and drain water.

Contractors should have detailed inspection protocols that field crews follow diligently. Develop a training and evaluation program that trains workers how to properly install building components to eliminate leaks.

Develop a training and inspection program with log books to identify, document, and rectify construction mistakes before they are covered up.

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The information in this article is intended for professionals. Field conditions vary and dictate the need for diligent water management strategies. The author makes no warranty of any kind, expressed or implied, with regard to the information contained in this article.

Steve Easley

Steve Easley, principal of Steve Easley & Associates, is a construction consultant specializing in solving building science-related problems out of his offices in Danville, CA. His services include jobsite quality analysis, design review, educational seminars, mediation, and product consulting. Easley has more than 30 years of industry experience, has performed thousands of jobsite quality surveys, and has presented numerous building science seminars worldwide. He authors a monthly column in *Green Building Magazine* and has published numerous articles in industry publications. Easley has also cohosted hundreds of TV and radio programs, including over 100 shows on the Discovery Channel's *Your New House*. He was a professor of building construction and contracting with tenure at Purdue University for ten years and is on the board of directors for the Electric and Gas Industries Association. Interested individuals can view his best-practice building science videos at www.codecollegenetwork.com.