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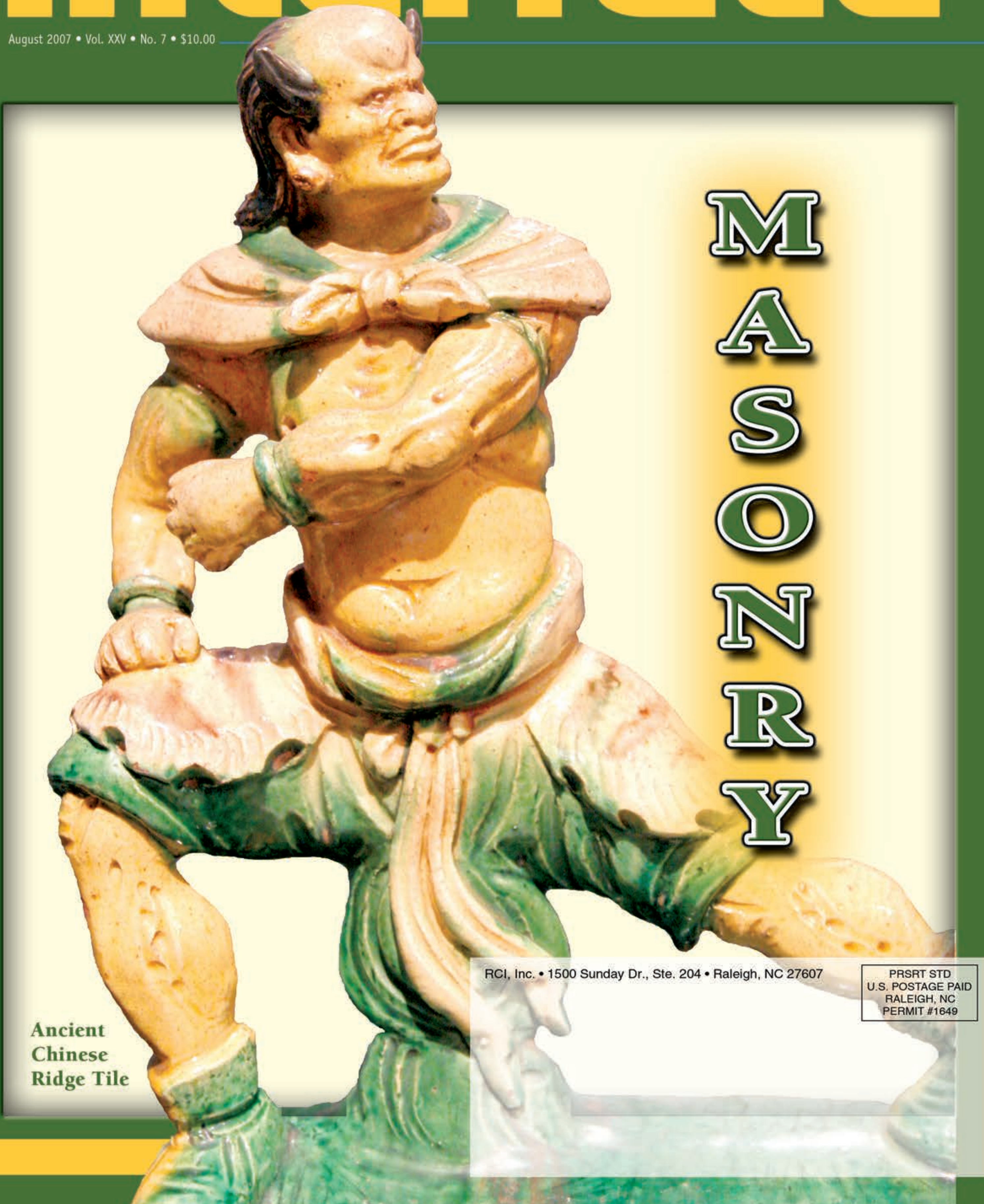

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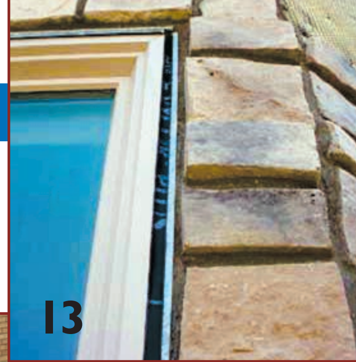


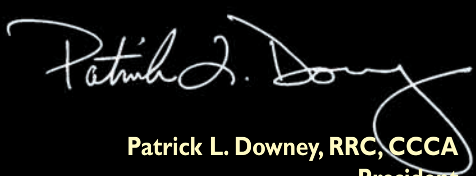
FEATURES

SPECIAL INTEREST

DEPARTMENTS

In This Issue: There's brick and block, tile, terrazzo, marble, stone, plaster, cement, and synthetic and concrete masonry units. It's all masonry and it's all here.

On The Cover: This roof tile sat on the ridge of a home in K'ang-hsi, China in the seventeenth century AD, where it served a purpose similar to medieval gargoyles and griffins on European homes – an attempt to ward off evil and as interesting decorative flourishes. The pictured tile is now in the Museum of Arts and Sciences in Daytona Beach, Florida, and was photographed there by Jeff Cramer, RRC. The warrior is Yen Lo, a guardian deity and "decider of life in Hades." See page 46.



Patrick L. Downey, RRC, CCCA
President

Two Committees and One Task Force TAKE ON NEW ROLES

Last month I spoke of the importance of volunteers in committee, task force, and leadership positions of RCI. There are many tasks our volunteers are working on that simply could not be undertaken without their expertise and enthusiasm. There are two committees and one task force that are working on projects that clearly illustrate this point.

First, allow me to explain the difference between task force and committee work. Task forces are created to deal with a specific undertaking and are disbanded when the work is complete. They typically operate within short time frames and have defined goals. Our *Manual of Practice (MOP)* task force is a current example of this type of mission.

Committees undertake work that is ongoing and expected to continue over a period of many years. The Education Committee, for example, has established a task force to create a new education offering on green roofing.

There has been an interest in developing a *MOP* that documents the role and procedures a consultant would be expected to follow in the practice of our trade. Originally, this was envisioned as a roof consulting practice; as the RCI mission has expanded, it has been broadened to include waterproofing and the building envelope.

Creating an RCI *MOP* is an essential step in formalizing the role we consultants are expected to play in the construction industry. Formalizing this role is particularly important to the way in which we present ourselves to outside agencies and institutions. The *MOP* will become the principal tool that defines who we are and what we do. If we do not define our role, others will be free to define it for us.

How many times have you been asked to respond to a request for proposal that lists the participants as "consultant," with no definition of who qualifies as a consultant? The RCI task force, chaired by Don Bush Sr., will take advantage of the process used in our registration programs. As some of our members may already know, all the RCI registration programs underwent a review and were brought into compliance with the National Organization for Competency Assurance (NOCA) standards that govern professional certifications.

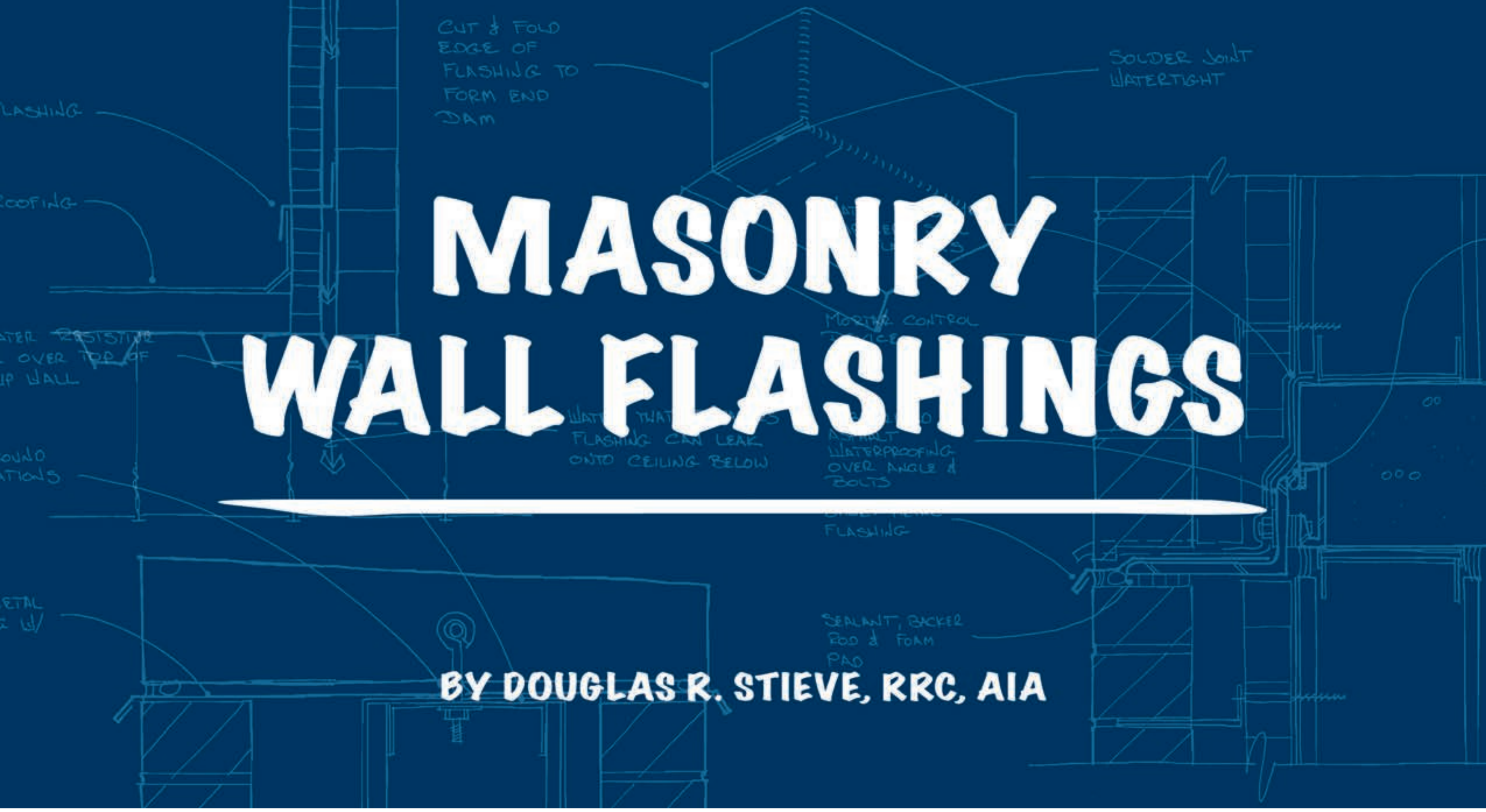
RCI expert groups underwent a role delineation procedure that looks at the things roof consultants, waterproofing consultants, and observers do in practicing their trade. We now test based on criteria that is role-based, not the more subjective review used in the past.

This same role delineation process can be used in creating an RCI *MOP* that defines roof consulting, waterproofing consulting, building envelope consulting, and construction observation. I can envision a point in time when we will have developed the manual that defines the role we play, an educational venue that teaches that role to our membership, and an examination procedure that recognizes individuals who demonstrate the mastery of these minimum standards.

The Education Committee, chaired by Tim Barrett, is in the final stages of development of the green roofing module. The course will provide our first comprehensive education program on garden roofing. Our current waterproofing course has included a discussion of green roof topics; however, the new offering will focus on what I like to call the "black arts" within green roofing. I encourage any of our members who work in this field to offer assistance to Tim. Specifically, he has requested photographs of green roofing that can be included in the course.

No discussion of committees would be complete without mentioning the work Tom Hutchinson is doing with the Building Envelope Committee. Tom will report to the Executive Committee in July on the progress this committee is making in coordinating RCI activities that deal with building envelope issues. Literally every aspect of the organization is being examined to assure this new undertaking is included in our member services.

I would like to conclude with a welcome to Walter Rossiter, the new RCI Director of Technical Services. He joins a fine staff that works behind the scenes; we are fortunate to have their dedication and service. The combined efforts of our volunteers and staff make this the successful organization it has become.



MASONRY WALL FLASHINGS

BY DOUGLAS R. STIEVE, RRC, AIA

Preventing water leakage through masonry façades in contemporary construction is primarily accomplished by the use of well-placed flashings. Masonry walls, which are largely composed of brick, concrete masonry units (CMU), cast stone, and other related units, typically absorb moisture and rain. The masonry industry understands that water penetration through the outer wythe of veneers will occur. This penetration has to be managed by flashings, which divert the water back to the exterior. Water can enter the wall system at numerous locations, including individual masonry units, mortar joints, the interface between the mortar and the masonry units, at the tops of walls, at cracks, and at penetration details such as windows, doors, and pipes. The purpose of this article is to discuss the design and installation of masonry wall flashings at several typical locations throughout a building.

Wall flashings are typically required at locations where the downward flow of water inside the wall would be obstructed or interrupted. Flashings are also used under masonry copings, sills, and other horizontal surfaces. In order to understand how masonry wall flashings work, it is important to first understand the different types of masonry walls.

Load-Bearing Walls

Older masonry buildings were constructed with thicker, solid, load-bearing walls. Water infiltration in load-bearing walls was resisted by the mass of the multiple-wythe wall and a few well-placed flashings. Load-bearing walls performed well as long as it stopped raining before water was absorbed all the way through the mass of the wall. Flashings in these walls typically occurred at junctures of roofs and walls and at parapet locations. Often, the flashings extended completely through the wall. These flashing materials were typically made of soft metals such as copper or lead. Sometimes, masonry ledges or projecting elements (often referred to as water tables) deflected water off the façade as it flowed down the face of the building.

Drainage Cavity Walls

Masonry veneer construction consisting of a single wythe of brick/masonry over a back-up wall system, which gained popularity in the 1950s, is a departure from thicker load-bearing wall construction. These walls accommodate inevitable water penetration through the masonry veneer with a drainage cavity. This cavity allows water to flow down the backside of the veneer. The water is then expelled from the cavity back out of the building by the flashings. For this type of wall to function properly, the drainage cavities have to be kept clear of mortar droppings and other blockage. Since water that penetrates the masonry veneer can flow unobstructed down inside the wall, the proper installation of the flashings is more critical than in a thicker masonry wall system.

Single Wythe Walls

Single-wythe masonry walls (one vertical row of masonry one unit in thickness) are predominantly constructed with CMU but can be constructed with brick. These walls do not include a drainage cavity. The cores of single-wythe CMU walls can be filled with reinforcing steel and grout. As such, they can also function as load-bearing walls. Water must be resisted at the outside face of these walls. Sometimes, water repellents and masonry sealers are used. Flashings are provided at the same locations as in veneer construction. However, single-wythe walls do not have a drainage cavity other than the inside voids in the CMU or brick. Therefore, water has many locations where it can be absorbed or can bridge across the width of the masonry veneer to the building interior.

Flashing Components

In order to understand how to properly flash a masonry wall, a review of terms both commonplace and specific to vertical walls should be given consideration.

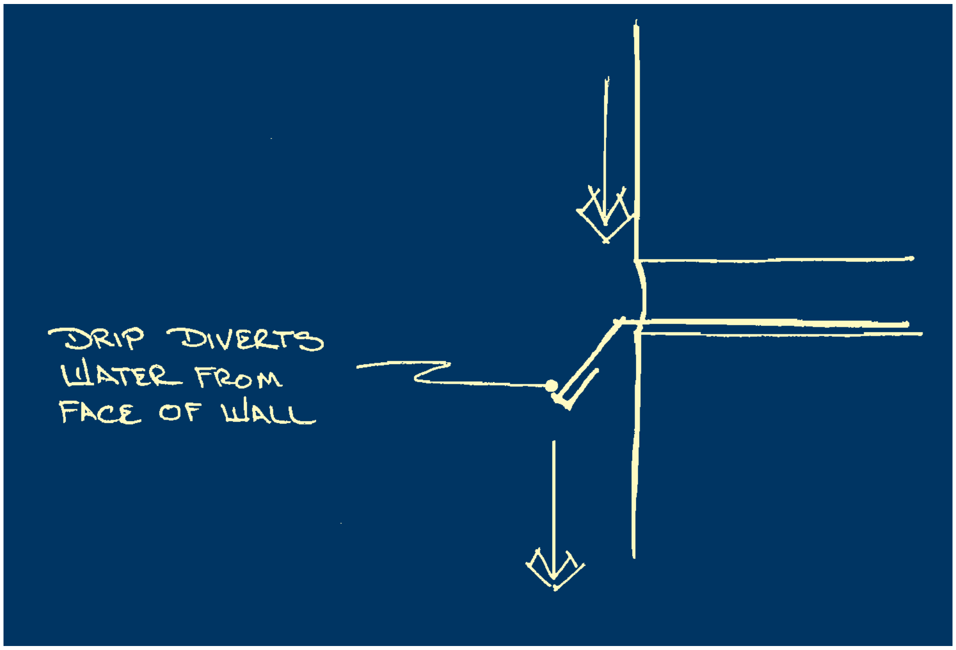


Figure 1

Drips

Drips are important because they divert water away from the surface of the wall (*Figure 1*). These become more critical with flat wall surfaces. Older buildings used masonry components such as ledges and water tables to divert water that flowed down the surface of the building away from the exterior walls. Many times, drips are opposed by the designer for aesthetic reasons. When flashings are specified to be terminated within the face of the masonry veneer and not "daylighted" to the exterior, water may flow off of the edge of the flashing and be retained within the wall.

Weeps

The most common types of weeps are plastic tubes and prefabricated plastic or mesh materials that are placed in head joints (vertical mortar joints). Effective weeps can also be provided by leaving head joints open. However, weeps also create openings where wind-driven rain can enter the wall and thus expose the flashing to more water. The wall flashings have to be installed well to prevent potential water intrusion from creating a problem. If the wall surface will be exposed to wind-driven rain, such as at upper stories of buildings or at coastal locations, the weeps should be turned downward or otherwise baffled to prevent water from entering. Plastic weep tubes with downward curvatures can be used. Prefabricated mesh materials placed in mortar head joints in lieu of mortar look nice on paper but have limitations in the field. During construction, masons often accommodate small dimensional tolerances in the length of a wall by varying the size of head joints. Therefore, some weep systems that are prefabricated to a specific size cannot accommodate these changes in the size of head joints.

End Dams

These are upturns that are constructed at the terminations of the flashing. End dams should be constructed wherever flashings terminate within a wall to prevent water from simply flowing off the side of the flashing within the masonry wall rather than being directed to weeps where it can flow out of the wall. End dams are constructed by cutting and folding the flashing material. Joints are soldered or sealed (*Figure 2*).

Joints and Laps

Locations where adjacent sections of flashing are joined are critical. Often, water can flow through the flashing at openings at lap joints. Laps in sheet metal should be either soldered or properly sealed, depending on the material being used.

Expansion joints in long sections of flashing are particularly susceptible to water infiltration and should be avoided whenever possible. They are usually only required at expansion or control joints in the wall and in some sheet metal flashing assemblies. If a large section of masonry is constructed on top of the flashing, the weight of the wall sitting directly on top of the flashing will resist differential movement between the metal and masonry. The usual distance between expansion joints can therefore be lengthened.

Materials

As with roofing systems, there are numerous materials that can be used to flash different components of a wall. Each has advantages and limitations, such as – but not limited to – durability, workability (ability to be formed and or soldered in the field), and cost.

Sheet Metal

For centuries, sheet metal has been widely used to flash masonry walls. Lead sheets similar to roof drain flashings were formed in various shapes within the walls. Copper was also common. The author prefers metals such as copper (16 and 20 oz.), lead-coated copper (16 and 20 oz.), and stainless steel (28 and 26 ga.). These metals have unique abilities in that they can be formed and soldered in the field and will not corrode excessively under normal circumstances. These metals can be field-formed into various shapes such as inside and out-

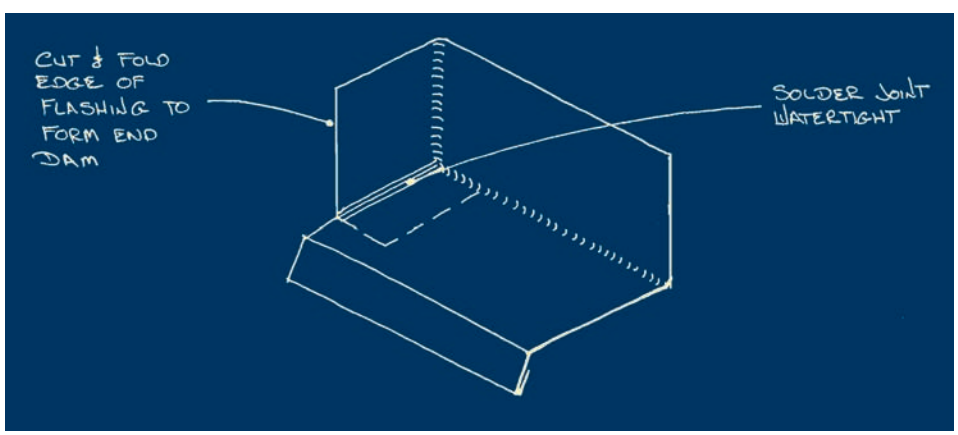


Figure 2

side corners, step flashings, or at unusual penetrations. Sheet metal is typically more durable than membranes and can withstand masonry being constructed directly on top of it.

Environmental and potential worker safety concerns have recently limited the use of lead and lead-coated copper. Combinations of zinc and tin are being used to coat copper and other metals replacing lead. However, many of these formulated products have not yet stood the test of time, and sheet metal workers may not be familiar with how such products have to be prepared or how they behave during soldering.

Galvanized steel can be a cost-effective alternative to copper and stainless steel. However, corrosion staining will occur at locations where the galvanized coating has been cut, such as at the ends of the metal, and where the material is breached, such as by fastener penetrations. There are also different types of galvanizing with different longevity rates.

Aluminum will corrode if it is placed in contact with fresh cementitious materials such as mortar, grout, stucco, and/or concrete and it is usually not specified for this type of construction. However, under certain conditions, painted aluminum can be used. The paint will protect the metal until the mortar cures. Aluminum can still not be soldered in the field, so connections are made with rivets or screws and sealed with elastomeric sealant. Therefore, avoid aluminum in masonry construction wherever possible.

Limitations of sheet metal include the cost of the material and labor costs required to form the flashing and to construct watertight joints. Also, sheet metal is not flexible. Fishmouths often occur at top vertical edges of the metal if the substrate is not perfectly straight. Additionally, lengths of sheet metal are often limited to sections that can be placed on a truck and delivered to the project site; therefore, more joints are usually required.

Copper Fabric Flashing

These are composite products where thin (3-, 5-, or 7-oz) copper sheets are laminated within bituminous products, paper facers, or other proprietary fabrics. They provide many of the benefits of sheet metal as stated above. The bituminous versions can be directly adhered to a variety of substrates in compatible mastic. Joints in the material can easily be formed, lapped, and sealed in mastic. Copper fabric is also flexible enough to conform to irregular substrates.

The bituminous versions cannot be exposed to direct sunlight, so the material cannot extend past the face of the masonry and form a drip. Therefore, a separate sheet metal drip is required.

Rubberized Asphalt Membranes

These self-adhering "peel-and-stick" membrane sheets are usually 40 mils thick and consist of rubberized asphalt bonded to a polyethylene film. A disposable release liner is provided on the exposed portion of the rubberized asphalt and is removed just prior to adhering the membrane. These membranes are flexible and can be formed around many penetrations. Cutback mastics and asphalt-blended polyurethane liquid membranes are used to seal penetrations. Masonry and wood substrates must be primed and the material should be installed wrinkle-free. Membranes designed for use in wall systems should be specified. Membranes designed for use as waterproofing materials can have asphalts with lower softening points, and the asphalt can flow off the backing film in the hot environment within an exterior wall.

Flexible Composite Flashing

These are combinations of various materials and are relatively new to the market. The compositions are similar to copper fabric flashing in that they exploit the advantages of each material. Many composite flexible flashings are sold in rolls of various widths between 12 and 48 inches. Roll lengths can be up to 300 feet. The variety of dimensions allows the material to be unrolled along the length of shelf angles and other long flashings, avoiding laps and joints in the flashing materials.

One such flexible composite flashing system is a combination of a proprietary ketone ethylene ester (KEE) polymer membrane with a pressure-sensitive adhesive. The 40-mil composite membrane has a release paper and is installed in the same manner as a self-adhered flashing. Another product is a vinyl ethylene film bonded to fiberglass reinforcement. This material is most often used with separate metal drip edges and is typically loose-laid and mechanically fastened to the substrate or set in mortar joints of the backup masonry. Special tapes and mastics are used to seal terminations and penetrations.

TYPICAL FLASHING LOCATIONS

Flashings are more common in drainage cavity and single-wythe walls. However, in the author's opinion, they can be just as important in thicker walls. The following descriptions and figures are generic in nature and should be modified and adapted for use in each particular building by a qualified design professional.

Base of Walls

This is probably the most common location that blocks the downward flow of water within a masonry wall. Locations where rising walls are constructed directly over occupied portions of a building are particularly vulnerable to water infiltration. Any water that bypasses the flashing will very likely result in an active water leak in the occupied space below (*Figure 3*). The wall cavity must not be blocked with mortar droppings, and the flashings and weeps must be very well constructed at these locations.

At the base of walls, a sheet metal flashing assembly that extends from the face of the backup wall through the masonry should be used to form a drip outside the wall. A sheet waterproofing membrane or water-resistive barrier is utilized to flash over the back leg of the metal flashing (*Figure 4*). Weeps are provided through the masonry veneer. A manufactured, mortar-control device is used to catch droppings at the base of the drainage cavity so that they cannot block the weeps. The open cavity below the flashing should be filled so that there is a solid backing under the flashing at laps. This action helps prevent the bottom piece of flashing from deflecting downward as the lap seam is created.

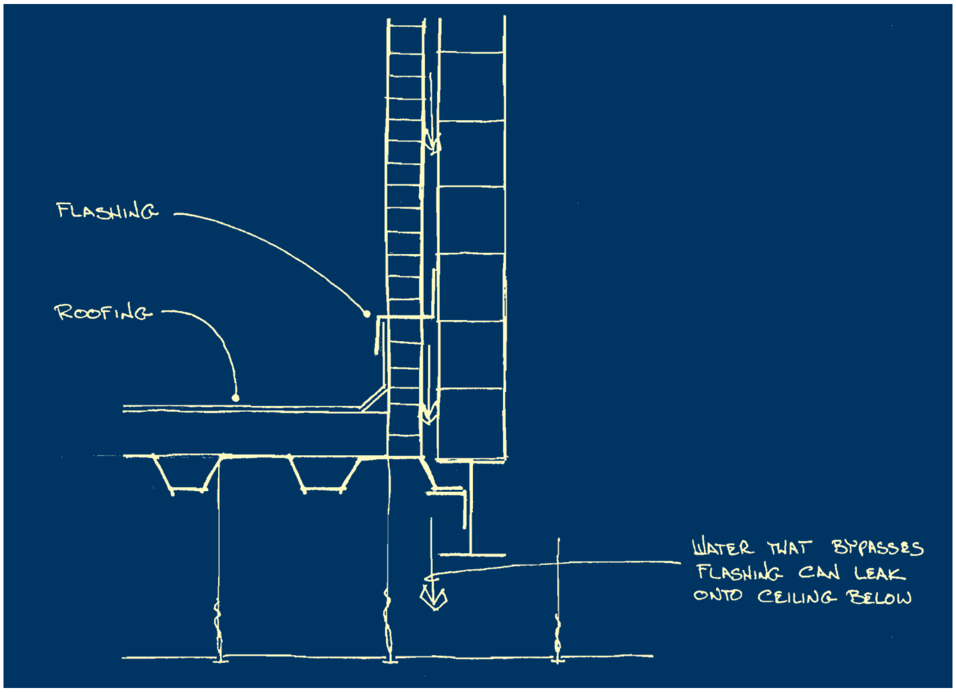


Figure 3

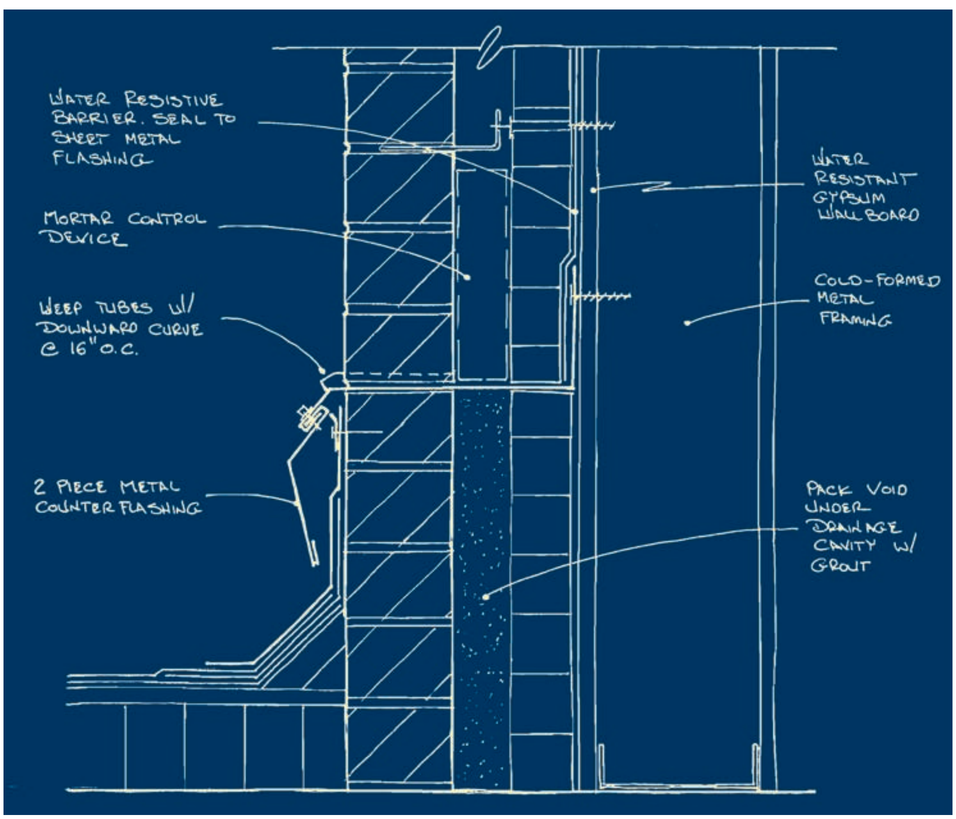


Figure 4

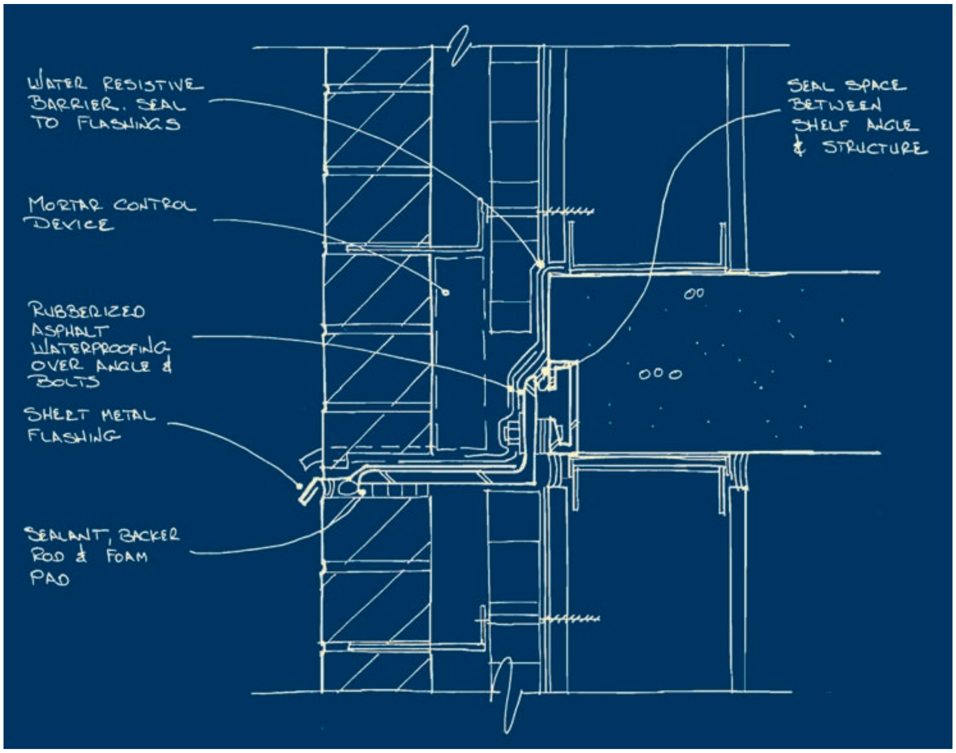


Figure 5

There are critical components of this detail that should not be overlooked, such as lap joints, expansion joints, door thresholds, and inside and outside corners.

Shelf Angles

Sometimes called relieving angles, these are locations where a structural angle is provided to carry the dead load of the masonry veneer. Buildings often incorporate continuous shelf angles that support the masonry veneer at heads of windows. Shelf angles are also found at floor lines of taller buildings. These locations are similar to those at the base of a wall. However, the flashing must form around the toe of the angle. Also, if the angle spans any considerable distance, it will most likely be either welded or bolted back to the structure of the building. A flexible flashing can be formed around the bolt heads (*Figure 5*).

Window and Door Heads

Flashings at window heads are very similar to those at shelf angles. There is usually a lintel or shelf angle that supports the masonry veneer above the window. However, the lintels are not continuous. It is therefore prudent to provide an upturned end dam at the end of the lintel. The intent of this practice is to prevent water from flowing off the end of the lintel, discharging water at the jamb of the window or door.

Window and Door Jambs

These locations, along with other penetrations through the wall such as mechanical louvers, create conditions in which water can potentially flow out of the drainage cavity migrating down the side of the window, door, or both, creating a leak. Sheet metal or flexible adhesive membranes can be used to create a dam to prevent water from flowing out of the drainage cavity and into voids at window and door jambs (*Figure 6*).

Window Sills and Door Thresholds

Locations below windows and doors – particularly at areas directly below the jambs – are vulnerable to water infiltration. These are locations where individual framing members of windows and doors intersect at an opening in the masonry veneer. Flashings at these locations should have an upturned back leg to prevent water from flowing off the back of the flashing. An end dam should also be provided to prevent water from flowing off the side of the flashing. If the window or door is near the base of the wall, the flashing should form a continuous envelope and be connected to the adjacent wall flashing.

Masonry Copings

Copings constructed with stone, precast concrete, or masonry should not be considered watertight. Water can penetrate through transverse joints in the copings or be adsorbed directly through the coping unit. Parapets are subject to increased vulnerability from freeze-thaw distress because they are exposed to the elements on three

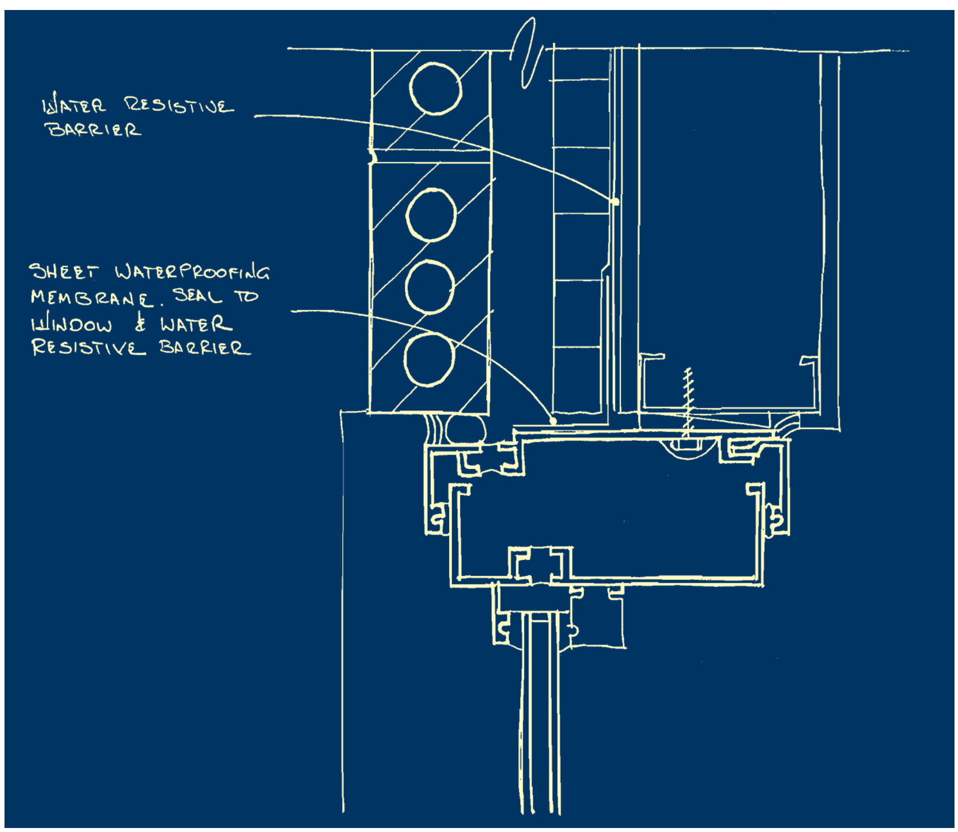


Figure 6

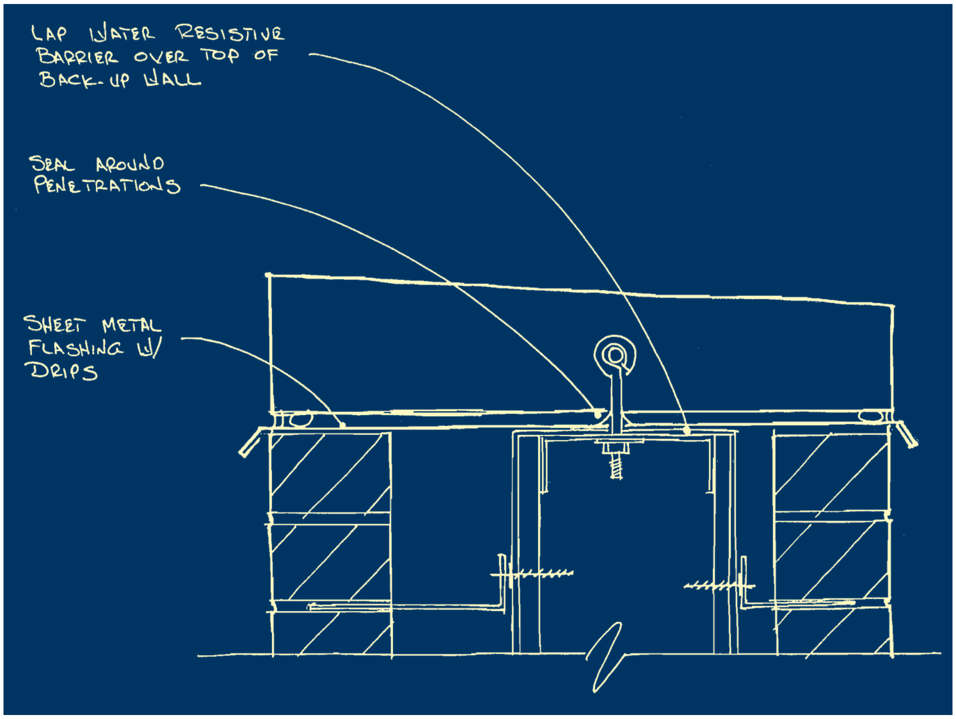


Figure 7

sides. A flashing should be provided directly under the coping to block water from flowing down through the wall. Dowels or other types of coping anchor penetrations through the flashings must be sealed (*Figure 7*).

Workmanship

Although masonry flashings can prevent water infiltration into buildings at certain locations, the overall workmanship of the mason has a large impact. One of the most common workmanship problems is mortar that falls down the inside of the drainage cavity. The mortar can harden and block the flow of water out of the weeps. Mortar droppings can also collect on wall ties and provide locations where water can bridge across the drainage cavity. Drainage composite materials are available. These mesh-like materials are placed at the bottom of the wall cavity and suspend the droppings, allowing water to flow around the hardened mortar. However, the mason still needs to avoid mortar spillage because if enough mortar is spilled into the drainage cavity, it will cover the top of the drainage composite.

Conclusion

Flashings are a critical component to the overall water management performance of masonry wall systems. The masonry industry and numerous consultants understand that water penetration through masonry veneers is unavoidable. This has created an emphasis on the effective management of the water penetration.

All parties, including the owner, designer, general contractor or construction manager, and sub-contractors, must be aware of the critical nature of these flashings. During the inevitable value-engineering process, modifications are often made that can either eliminate some of these flashing components or substitute materials that may not perform as well as originally intended. Designers must be knowledgeable enough to educate the owner as to the advantages and disadvantages of these proposed substitutions. There is also a coordination burden placed on the general contractor and/or construction manager and various subcontractors, as more and more portions of the exterior building envelope are constructed by different entities.

Douglas R. Stieve, RRC, AIA

Douglas R. Stieve, RRC, AIA, is a registered architect in the states of Connecticut, Massachusetts, New Jersey, New York, and Pennsylvania. He earned his BA in architecture from the University of Oklahoma and his RRC registration from RCI. Since joining Wiss Janney Elstner in 1991, he has specialized in building envelope failure diagnosis and repair. Projects in which Stieve has been involved have won awards from the National Trust for Historic Preservation, the New York City Landmarks Preservation Commission, and the Boston Preservation Alliance. He is a member of RCI, AIA, and ASTM and has served on the ASTM C15.02, Brick and Structural Clay Tile Committee; and ASTM C15.04, Research (Masonry) Committee.

Energy Performance Requirements in LEED Rating System to Increase 14%

The U.S. Green Building Council's membership overwhelmingly approved a new requirement for all LEED-certified projects to achieve at least two "Optimize Energy Performance" points within LEED, which will improve the energy performance of all LEED-certified green buildings by 14% for new construction and 7% for existing buildings.

All newly registered commercial LEED projects will be required to achieve the two "Optimize Energy Performance" points within LEED. The new requirement will reduce the environmental and economic impacts associated with excessive energy use and maximize energy performance of buildings through cost-effective, energy-efficient measures. To help projects achieve the new energy reduction requirements, a prescriptive compliance path is currently under development as an alternative to energy modeling. The two mandatory points will count toward a project's LEED certification.

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SYNTHETIC STONE VENEER –

How to Avoid Problems

By Edward L. Fronapfel, PE, and Brian Erickson, EIT

Stone has been used as a building material since the Stone Age and, unlike that period, it will not be an extinct construction material anytime soon. While natural stone is used in all aspects of home construction such as exterior wall claddings, in the early 1960s, companies began manufacturing synthetic or "fake" stones that replicated natural stones. Advancements in technology throughout the years have created more authentic artificial stones that continue to replace natural stones for use as exterior wall claddings.

Without advocating on behalf of the synthetic stone industry, the products it manufactures offer many advantages over natural stone. Advantages include lower cost, greater availability, a wide variety of colors and styles, lighter weight, quicker installation time, small waste factors due to custom pieces such as corners and water tables, repeatability, and reliability for the construction trades installing the products.

Regardless of the quality of the product used to "skin" a building, the quality of any exterior cladding ultimately depends on the quality of installation. This article will attempt to provide the information needed to ensure that stone veneer and related building components do not suffer failures related to improper installation and lack of detailing at important locations.

Why Problems Occur

If stone has been around and used as an exterior wall cladding for thousands of years, why have there been problems with it only recently? Water is the catalyst for nearly all problems associated with exterior wall claddings, including stone veneer. While the amount of rain and snow has not changed significantly through the years, the ability of a structure to "get wet" and allow for drying of the materials (moisture reservoir) has. In the past, homes were not built utilizing airtight methods, nor were they insulated very well, and therefore they were not very energy efficient. However, the advantage of this old system was that it allowed wet building components to "dry out" without damage.

The current emphasis on energy-efficient homes has created much "tighter" building envelopes, utilizing better air barriers and increased levels of insulation. In addition, the materials used to build these homes have also changed and become more susceptible to water damage, in many instances providing food for fungal growth. The increase in "tightness" and change in materials has led to a decrease in the building envelope's ability to absorb water and "dry out" without damage. Therefore, the industry's previous methods of installing exterior wall claddings such as stone with a drainage cavity or stone thickness that allowed a moisture reservoir must change and adapt to trends in the industry. This way, one can effectively control water and ultimately have a satisfied end user, avoiding costly damages and callbacks.

Unfortunately, the increase in water related problems associated with exterior veneers is not limited to an increase in the building envelope's "tightness" or a change in materials. Consider the following:

1. **Stone application is no longer a skilled craft.** Due to budget constraints and improperly used "value engineering," builders and developers will commonly award contracts to the lowest bidder. These low bidders generally do not lower their price based on material cost, which should be relatively similar among all bidders. Instead, they employ the cheapest labor available and reduce or eliminate supervision of the installation and review of the drawings, specifications, and other requirements. If the labor pool is not educated as to proper installation of the product, the result may be an unsatisfied client.
2. **Lack of information.** Many stone manufacturers currently do not publish adequate details to properly install the stone at terminations and other components. Additionally, many projects employ a "builder's set of plans," in which only a know-

ledgeable builder can determine the remaining details and coordinate this information to the subtrades on the project. Unfortunately, this means the detailing is often left up to the laborer in the field.

3. **The language barrier.** If English is not the primary language of many of the applicators, training then presents a problem that companies must consider. Even if the applicators possess a genuine concern and an "old-school" pride in their work, updated requirements and changes in waterproofing techniques may prevent them from installing the stone as instructed because of language barriers. Moreover, laborers may not be provided a meaningful way of presenting questions due to fear of retribution or perceived incompetence. One method that can help to overcome the language barrier is to supply adequate illustrated details that can greatly assist the applicator in properly installing the product.
4. **Lack of supervision.** Too often, the project superintendent will simply rely on the "stone guys" to get it right. And although upon completion of the project any installed stone veneers appear to be aesthetically functional, the performance of the system is set for failure. The general contractor needs to set supervision roles at a level that is consistent in order to provide the correct end product and not base oversight around the possible profit of the job.
5. **The slipping standard of installation.** This basically summarizes all the points above. "Value engineering," lack of quality information and details, unskilled workers, the language barrier, and a lack of supervision all result in a reduced standard of installation and stone veneer application with greater susceptibility to problems down the road.

So now that we know why these problems can occur, how can we avoid them?

How To Avoid Problems

We will attempt to break down the application of synthetic stone veneer from the sheathing to the weatherproofing systems. With the proper information provided, field superintendents and stone contractors can utilize this article and details when observing or supervising applicators to avoid costly callbacks and, possibly, court time.

It is important to point out that waterproofing details and characteristics of synthetic stone veneer are functionally similar to those of traditional stucco. The waterproofing details for stone should be better than those for stucco because the outer face of the stone field will generally allow a greater amount of water to reach the building papers and, therefore, the discharge points will need to handle greater quantities.

> WATER IS THE CATALYST FOR NEARLY ALL PROBLEMS ASSOCIATED WITH EXTERIOR WALL CLADDINGS, INCLUDING STONE VENEER.

At a minimum, stone installation should be treated in a manner similar to stucco. Stucco systems are not immune to water-related problems when they are installed improperly. However, there is currently a greater amount of information on stucco that is easily available for detailing and installing in a weather-tight manner. That information is also useful for stone installers, designers, and contractors.

Weather-Resistive Barrier and Drainage Plane

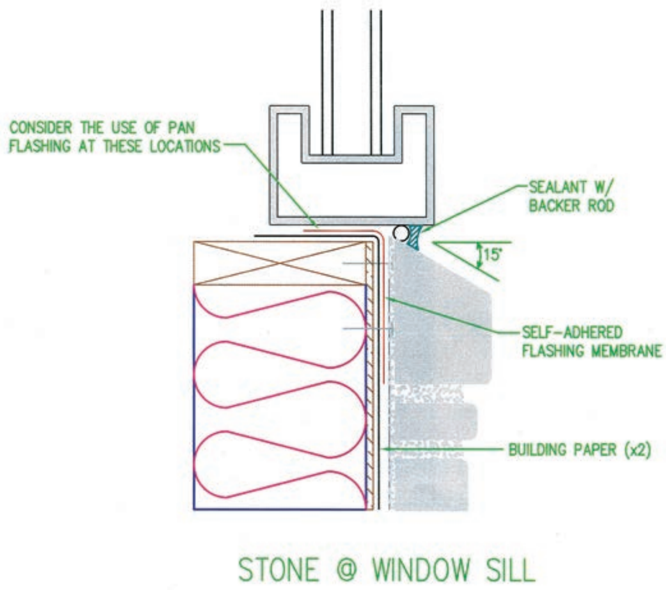
The installation of the weather-resistive barrier and drainage plane over the sheathing is the most important step in the application of stone veneer to prevent moisture intrusion issues. Before any wire lath (and certainly stone) is applied, a thorough and detailed review of the weather barrier should be performed. Do not assume the laborers in the field who installed the paper have taken the necessary steps to ensure the building is weatherproof. The building should function fully at this stage without veneer being installed; that is, the building is weathertight without stone veneer, as flashings will direct water to the exterior.

Here are some helpful hints to avoid costly repairs. It will save a lot more money to do it right the first time than to fix the building after the fact.

- Material selection: Currently, two layers of Grade D Kraft building paper (20-minute rating) is acceptable as the weather-resistive barrier behind adhered stone veneer. Our firm has observed multiple projects in which this weather-resistive barrier material does not hold up well behind adhered stone veneer and cannot handle repeated wetting and drying.

  There is a growing concern in the building envelope industry that Grade D paper disintegrates with repeated wetting and drying. With synthetic stone veneer (especially the dry-stack installation method), more incidental water typically reaches the underlying weather-resistive barrier than is true with stucco systems. This is due to the increased amount of separations in the grout between individual stones (the dry-stack method does not include grout at all) and the lack of proper sealant joints at terminations (to be discussed later). Use caution if selecting and applying Grade D building paper behind adhered stone systems. Using building felts or a combination of polymeric housewraps with building paper may withstand repeated wettings and dryings better than Grade D paper.

- Use a minimum of two layers of building paper or properly selected housewrap. The first layer, considered sacrificial, can bond to the scratch coat and lose its waterproofing ability or deteriorate altogether (see above). The second layer is the actual waterproofing layer.
- Water flows downhill when not restrained by other forces. Water will flow in a downhill direction on the



Detail 1

weather barrier. Make sure the weather barrier is installed to shed water onto the lower layer. It is surprising how often installers start applying building paper from the top down. Again, don't take this simple issue for granted.

- Watch the windowsills. Many times when a project comes to our attention as forensic engineers, our job is to determine if there's a problem with the stone veneer and any related damage. Generally, the first place to review and inspect is behind stones at the corner of an exposed windowsill. Damage found is often directly related to paper that is reverse-lapped at the windowsill, which allows water to penetrate the stone layer and flow behind the paper against the sheathing.

  An easy way to avoid this problem is to wrap the building prior to the windows and doors being set. Wrap the paper into the rough opening, using a self-adhering, modified bitumen flashing tape at the sill rough opening, and then set the window. (If this is done, watch the weather barrier at the window head to make sure it is not lapped behind the window frame. When a client complains about window leaks originating from the head, this condition of reversed head flashing is usually why.)

  In many jobs, the sequencing of the trades requires that the contractor install the windows prior to the building paper to get the building "dried in." The window installers typically apply their flashing tape around the window, setting the stage for a future flashing back-lap below the window. However, measures can still be taken to ensure there is a proper weather barrier application at the windowsill if the windows are set first. Strips of building paper slightly wider than the rough opening should be cut. Self-adhering modified bitumen (SAMB) should be applied into the rough opening and the cut section of paper should be attached to the SAMB (see *Figure 1*). When the rest of the weather barrier is applied, it can be easily integrated with the cut section of paper in shingle-lap fashion.

- Flashings are an integral component of the weather barrier and drainage plane. The building paper and flashings must all be integrated to shed water onto one another and eventually out of the system. This includes both sheet metal "Z"-type flashings and membrane-type flashings. Apply the knowledge that a drop of water should flow freely from the roofline to the foundation wall. If any areas are constructed that allow water the avenue to travel behind the weather paper, they should be corrected.
- Coordination between trades is also important. Typically, homes have more than one type of exterior cladding material installed. Therefore, problems often occur where the two claddings interface. Too often, a reverse lap or gap occurs in the weather barrier behind the interface. An easy way to avoid this is to have only one contractor apply the entire weather barrier around the building. That way, there's only one trade whose work has to be inspected. This also reduces finger pointing later. Another successful method is cutting a strip of building paper about 12 inches wide and attaching it to the sheathing where the two

Figure 1: Examples of precut sections of building paper under windows to ensure proper lapping.

Figure 2: The consequences of reverse lapping.

claddings interface. That way, the paper from the cladding below the interface can be slipped up behind the precut piece, similar to the window situation previously mentioned. Make sure that the trade knows the intent of the precut paper.

- Don't forget about the penetrations. A good idea is to strip in the penetrations with SAMB so they are sealed to the weather barrier.

The building should be weathertight, even without any exterior cladding applied. After the weather barrier has been applied and windows installed, imagine a heavy rainstorm occurring. Will any water be able to reach the OSB sheathing? Will any water be able to enter the building? If the weather barrier is applied correctly, all of the water should stay on the weather barrier and shed over the sloped horizontal flashing leg, over the drip leg of the flashing, and away from the building.

Do not move forward until it is absolutely certain that the building is weatherproof without any wall cladding. Once the stone is applied, the weather barrier is covered, along with any reverse laps, voids, etc. Again, it's much more expensive to find and correct problems later with the weather barrier, so get it right the first time.

Figure 3: Penetration integrated into drainage plane.

Trim Accessories

Trim accessories for stone? As discussed earlier, stone and stucco are functionally similar, especially their waterproofing characteristics. In fact, Eldorado Stone, a synthetic stone manufacturer, even states on its Web site, "Eldorado Stone requires the same flashing and waterproofing as stucco. (This includes the use of a weep screed.)" Also, Dennis McCoy states in a December 2004 article in the *Journal of Light Construction*, "I've been finding more and more cases of leaking and rot behind another material that is very similar to stucco: cementitious, manufactured-stone veneer."

These authors absolutely agree. As mentioned earlier, the waterproofing requirements for synthetic stone veneer should be equal to or better than traditional stucco because the likelihood of water reaching the weather barrier is significantly higher, especially with "dry stack" stone applications.

Trim accessories include expansion joints, control joints, casing beads, and weep screeds (casing beads with weeps). They are typically manufactured of galvanized steel or vinyl. The following text separates the trim accessories and then provides recommendations for each.

Expansion Joints

Expansion joints are typically required at floor lines and at changes in substrates. For example, if the OSB sheathing terminates at a foundation ledge but the stone continues, install an expansion joint there. Expansion joints should still be installed at floor lines. Wood shrinks due to the climatic interaction of the original moisture content – either drying or wetting to the climatic elements – and the sheathing moves under structural loads. These loads may include inward or outward deflections between "height over 240" to "height over 480." [In a 10-foot section (or 120 inches), the wall may deflect between 1/4 and 1/2 inch.] A gable wall attached to a non-gable wall will have differential deflections located at the stiff points versus the non-stiff points. Foundations on soils with variable properties of expansion or contraction may result in differential movement. When in doubt, consult the architect and engineer on the areas that are most susceptible to the substructure's moving and affecting the product.

Control Joints

Control joints are typically used to "control" the cracking within the stucco itself. If control joints are not installed, the stucco will create them. Stone is not different, as it incorporates a monolithic cementitious scratch coat. Some accessories may not match the surrounding façade perfectly, but they would look better than missing stones or cracked grout. Joints can be installed in the scratch coat and the stones affixed over them with a side unbonded (limited to length of bonding). This method of concealing the joint should be designed by the engineer or architect.

Casing Beads

Use casing beads around windows, doors, and any other straight terminations

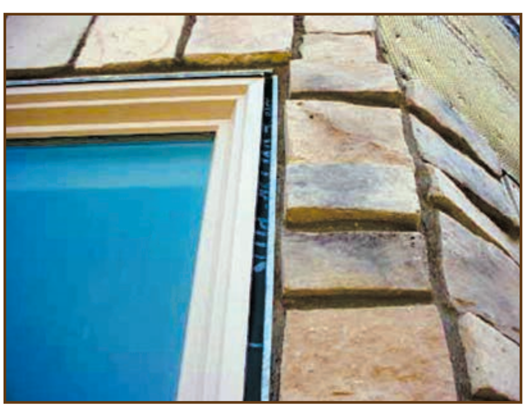
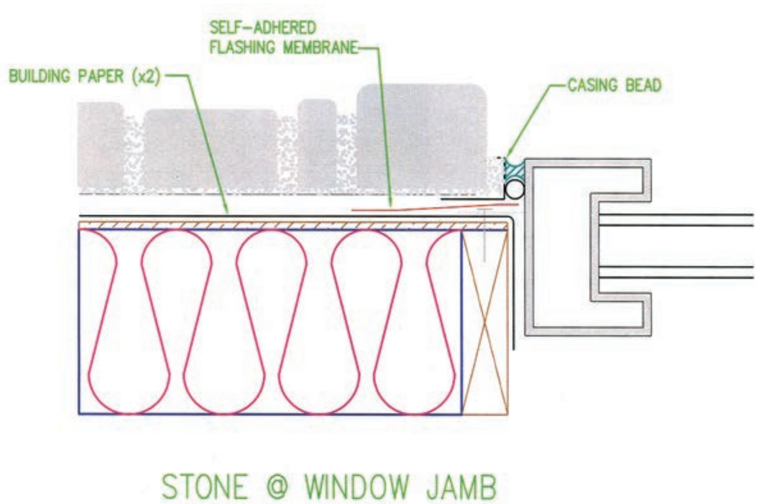


Figure 4: Trim accessory used at window jamb.



Detail 2

in the stone veneer. Utilizing casing beads at terminations provides many benefits:

- Sealant joint widths are set to a uniform dimension, allowing sealant trades to apply standard backer rod sizes and standard work procedures at the sealant face.
- The sealant joint substrate is a nice, uniform surface. This helps the client maintain the sealant in the future.
- Stone and grout are isolated from dissimilar materials. We all know about coefficients of thermal expansion – materials expand and contract at different rates. It is unfortunately common practice to use grout as a sealant around window and doorframes. When the windowframe expands, it exerts a force on the surrounding grout and usually the grout will crack, which allows more water to reach the weather barrier and travel to the corners of windowsills. So instead of butting different materials directly against each other, let them expand.

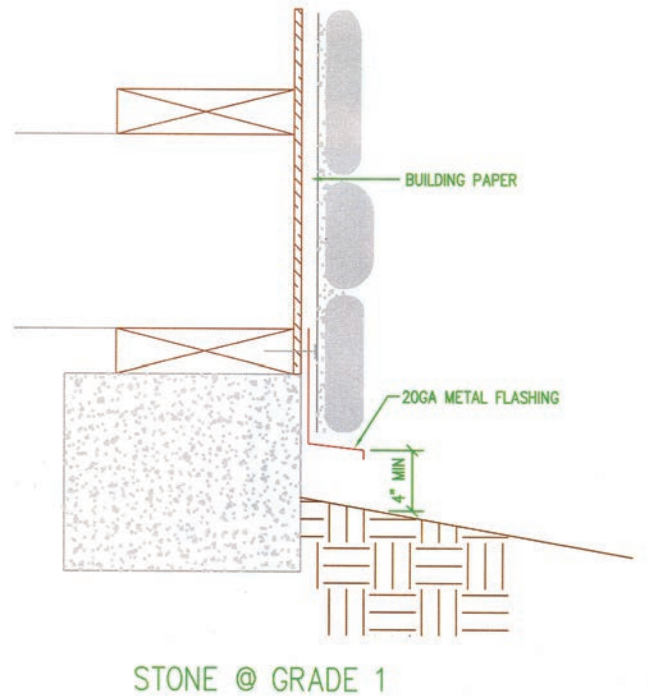
Do not use grout as sealant. By installing casing beads, dissimilar materials are separated and sealant can be used to prevent water from reaching the weather barrier.

Weep Screeds

A weep screed is a casing bead with weep holes. In stucco applications, weep screeds are installed at grade and other horizontal interruptions where drainage of the system is desired. There is discussion that the weep holes are for the installation of the lathe; however, during water entry and exit, the holes function quite well to provide a path for water exit. Sloped screeds do not require weep holes. While using weep screeds with stone is a good idea, they may not be necessary. Consider using heavy-gauge galvanized flashing at horizontal interruptions, such as grade and paved surfaces. The key is to provide drainage at the interruptions.

At-Grade and Paved Surface Terminations

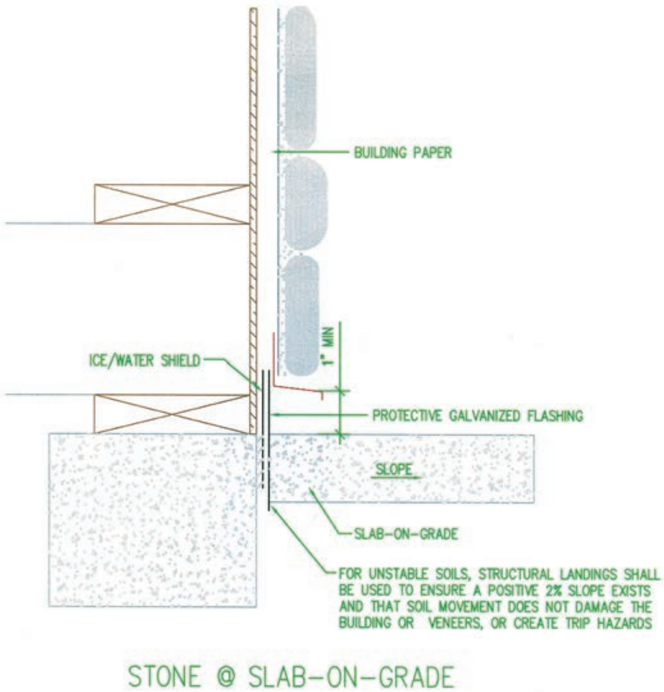
Why do building codes require stucco to terminate a minimum 4 to 6 inches from finished grade and 1 to 2 inches from concrete flatwork? This is to prevent water absorption from the grade areas, allow some drip protection, provide for protection from insects, and prevent landscape materials from contacting the veneers. Also, by separating the stucco from paved surfaces, problems with differential movement between the flatwork and the stucco can be avoided. Stone is no different. Many manufacturers require at least a 4-inch clearance to finished grade. That 4 inches assumes that the material has spanned over the foundation wall to sill line interface. This overlap of product is good for the minimization of air loss in the tightening of the building and provides an aesthetic band. It also provides for a system that drains away from the foundation rather than onto the horizontal edge of the top of the foundation.



Detail 3

At-Grade Terminations

There are three important things to remember for grade terminations:



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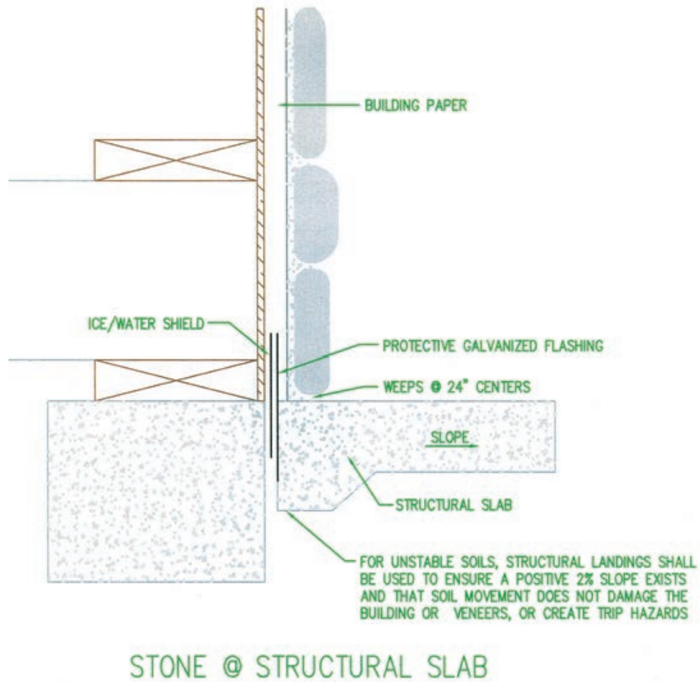


Detail 5

1. Extend past the plate a minimum of 2 inches.
2. Withhold the stone a minimum of 4 inches from finished grade.
3. Allow the system to drain.

The provided details illustrate two options for stone terminations at grade. Both options involve waterproofing and protecting the interface between the plate and foundation. Utilizing a strip of SAMB with a galvanized protection flashing works great in this application. The first option utilizes an angle to act as a shelf with weepage provided at 24-inch centers. Too often, the bottom stone is susceptible to disbonding from either snow buildup or water flowing down the system and a lack of drainage at the base. The angle will help support this last stone to better avoid disbonding problems. Plus, consider the differential movement between the plate and sheathing termination and foundation.

The second option involves utilizing a heavier gauge flashing, 20 gauge vs. 24 gauge, attached only to the plate to limit problems associated with the differential movement. Both options require weepage or a method of drainage to be provided. Weeps should be provided at tight spacing because the system is moisture-managed, not a drainage-plane system that would typically require a spacing between 24-inch and 32-inch centers.

Paved Surface Termination

This is the trickiest area to flash and seal correctly because the paved surfaces, such as concrete patios, sometimes are poured incorrectly directly against the top of the foundation wall. Prior to pouring the concrete, apply a strip of SAMB with a protective galvanized flashing over the plate/sheathing-to-foundation interface. Then, if a slab-on-grade surface is recommended per the soils report, a minimum of 1-inch clearance must be provided between the stone termination and concrete to account for possible differential movement such as frost heave. If a structural slab is called for, then the differential movement is minimal and thus less clearance to the system can be provided as long as the water that is in the system can get out onto the concrete surfaces. Weepage should be provided for both options and the paved surface should be sloped away from the structure to avoid ponding water against the interface.

DO NOT MOVE FORWARD UNTIL IT IS ABSOLUTELY CERTAIN THAT THE BUILDING IS WEATHERPROOF WITHOUT ANY WALL CLADDING.

Lath

The lath is the substrate to which the stones are adhered. Two general options exist for the lath behind the stone: 1) 2.5-lb, diamond-mesh, expanded metal lath; or 2) 18-gauge, woven-wire mesh. Both options must be galvanized. Greater adhesion capability is seen with the diamond mesh, but it must be ensured that the cups are pointed upward. One small mistake such as that can equal a large callback due to disbonded stones.

Whichever lath is chosen for installation, it should be fastened at 6-inch centers through the studs, penetrating a minimum of 1 inch into the studs. The stud locations can be marked on the foundation wall prior to the installation of the building paper to aid the installers in hitting the studs. This allows the lath to move independently of the sheathing (remember the one-eighth-inch joints between sheathing panels). Finally, be sure to overlap the ends of the lath.

Stone Application

The first decision during actual stone application is whether or not a scratch coat should be installed over the lath. While some stone manufacturers require a scratch coat, others are somewhat vague with their requirements. So what should be done if the manufacturer's instructions are vague? In this case, one should apply a scratch coat over the lath. The scratch coat will completely cover the weather barrier and will provide a solid substrate for subsequent stone application. Some manufacturers require that the stone be installed before the scratch coat has fully cured, and these authors agree. This may limit the amount of scratch coat that can be installed at one time, but the increased adhesion may be worth the potential increase in application time.

The second decision involves application techniques due to weather conditions at the time of installation. If the synthetic stone veneer is to be applied during either very hot or very cold temperatures, special measures should be taken to ensure the stones are securely bonded.

Hot Weather

During hot weather (generally above 90˚F), mortar will surface cure more quickly, which can cause it to become brittle. Also, the stone itself may be very dry and, therefore, want to absorb the water in the mortar, again negatively affecting adhesion. So if the stones will be applied during hot conditions, dampen both the scratch coat and stone prior to application. By wetting both surfaces to receive mortar, the mortar can cure at a more natural rate, and accelerated dehydration will be avoided.

Cold Weather

Mortar contains water. Water freezes at 32˚F. Mortar can take 14 days to fully cure. Do not apply stone if the temperature will fall below 32˚F during the curing period. If this cannot be avoided, tent and heat the area. While this will most likely increase the initial cost of application, it will probably save money down the road due to fewer callbacks and increased customer satisfaction.

Application Methods

There are two basic installation methods for stone application, and both relate to the joint size between stones.

Traditional Grouted Joint Method

This method of stone application leaves approximate 1/2-in to 3/4-in joints between the stones that are later grouted. This more traditional method prevents a greater amount of water from reaching the scratch coat or lath and, subsequently, the stone's point of adhesion. It is preferable to start from the top and move downward to avoid mortar from spilling onto already-applied stone courses.

Dry Stack Method

The dry stack method involves stacking and butting the stones from the ground up directly against one another. Therefore, there are no joints to grout between the stones.

Exercise caution if the dry-stack method is to be used in cold climates. Many disbonding problems are seen with dry-stack stone in cold climates, such as the Rocky Mountain region here in Colorado. Because the joints between stones are not grouted, rain and snow can easily travel to the scratch coat (point of adhesion) and the weather barrier. Also, because every stone is slightly different in shape, some may protrude past others and act as a gutter that captures water and channels it toward the scratch coat and weather barrier. Therefore, water that travels against the adhesion point can cause disbonding through freeze-thaw cycles. The same problem occurs near grade where snow can build up against the dry-stack stone.

Figure 5: Worst-case scenario. Note missing scratch coat between stones.

The worst scenario we have seen occurred when the dry stack method was chosen in a cold climate and no scratch coat was applied. Plus, it appeared the installer "value engineered" the amount of stone and left joints between them. Needless to say, disbonding is a major ongoing issue, among many others.

If synthetic stone veneer is to be applied in cold climates, if at all possible, avoid the dry stack method. If the dry stack method is used, at least use a scratch coat to avoid copying this "worst case scenario."

Specialty Stones

Most manufacturers create stones specifically for use at locations such as windowsills, water tables, and interior and exterior corners. The windowsill and water table stones are typically manufactured with slope to shed rain and snow off the surface. Regardless, if specialty stones are being used at windowsills and water tables, the stone course should be sloped a minimum of 15 degrees to shed water away from the joint above. This is especially important at windowsills where the weather barrier behind the stone can be susceptible to problems.

The same worst-case scenario also involved an absence of flashing membranes around the window, the building paper was back-lapped at the sill, and the stones at the sills were dead-level or even negatively sloped. When snow collected on the sill, it melted inward and traveled behind the building paper. Not surprisingly, the gypsum sheathing under windows deteriorated, and mold growth was occurring.

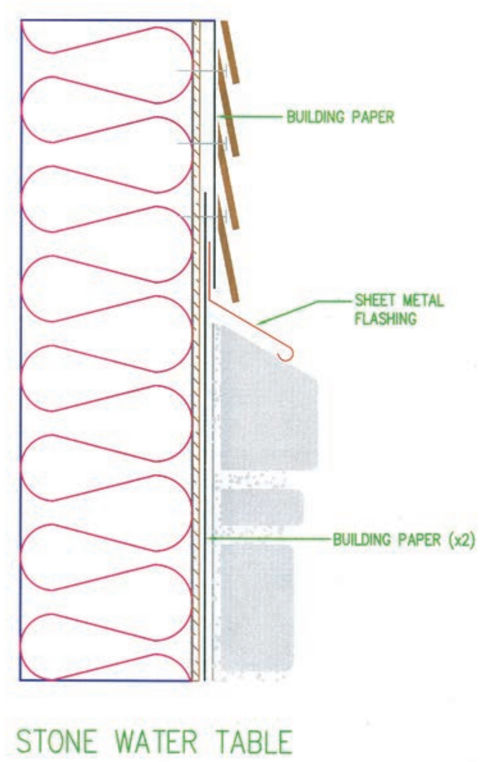
Rain has the same effect. If the water on the exterior face can be managed, then the proper interior side of the veneer will have a fighting chance. Remember that this system is a moisture-managed system, not a drain plane system, and large amounts of water cannot be handled by the paper layers without eventual deterioration.

Dissimilar Façades and Water Tables

As stated earlier, most façades do not consist entirely of one type of veneer. The horizontal interface between two façades is sometimes referred to as a "water table." It is common to use stucco or siding above stone. It is also common to find improperly installed weatherproofing at the water table interface. The lack of coordination between trades, which corresponds to a lack of the prime contractor's oversight on the job site, is the primary cause of problems at this interface. Determination of the responsible trade for installing the water table flashing must be spelled out in the contracts. A good deal of post-construction fingerpointing occurs when this area fails. Define it up front and avoid this issue.

Here are two helpful hints to avoid problems at the water table interface:

1. The drainage plane and weather barrier should be continuous behind the interface.
2. Don't let water get behind the lower façade. Shed the water onto the surface of the lower façade. This can be accomplished by sloping the stone and utilizing a sheet-metal flashing



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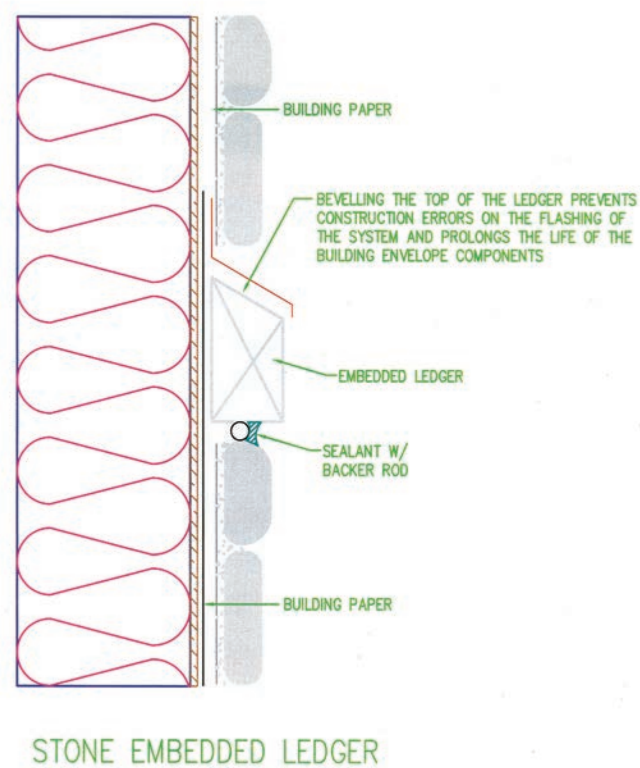

Detail 7

that extends from behind the stucco over the sloped stone piece. The flashing must be sloped as well.

> SYNTHETIC STONE VENEER IS HERE TO STAY... WITH IMPROVED MANUFACTURING TECHNIQUES, ALMOST ANY STONE ARCHITECTURAL "LOOK" CAN BE ACHIEVED AND APPEAR COMPLETELY NATURAL.

Embedded Ledger Boards

It is common to see the ledger board embedded in the field of the stone. Unfortunately, this condition promotes premature deterioration of the ledger board due to a lack of flashing and waterproofing. Mortar absorbs water and acts as a sponge. When the ledger board is constantly in direct contact with a wet sponge, it will rot out much faster.

An easy way to avoid this problem is to isolate the embedded ledger board from the mortar and flashing over the top to shed water to a surface below. The top edge of the ledger board should be beveled and the flashing should be positively sloped to avoid ponding water. Below the ledger board, it is best to install a flashing that extends from behind the ledger board over the stone below. This way, when the ledger board is replaced, it will not damage the surrounding stone. Another option would be to seal the interface between the bottom of the ledger and the top of the stone.

Roofs

The kickout flashing may be the most important piece of flashing on the building that has to transition between surface products. After the windowsills, the second most common error is when a kickout (or diverter) flashing at rake wall terminations is missing. Without the kicker flashing, the water is channeled into the stone veneer, which not only increases the likelihood for debonded stones, but also ultimately allows excess water into the moisture-managed system. Further, it is common to cut the building paper around the rake termination, so not only is the water directed into the stone veneer, but also behind the weather barrier. Make sure kicker flashings are installed and make sure the weather barrier is continuous behind the flashing to catch any incidental water.

Maintain clearances above the roofline similar to the clearance above the concrete and asphalt at the first-floor level. Installing a trim accessory such as a weep screed can be useful for setting the stone clearance height prior to the actual stone application.

Protective Coatings

Some homeowners want to install a clear waterproof coating over the stone veneer, wishing to protect the stone from weathering. If this coating is planned for the home, it must be a vapor-permeable coating, such as a silane or siloxane. If an impermeable coating is installed, the natural drying ability to the exterior is reduced. Combined with walls full of insulation and an interior vapor retarder, deficiencies that allow water behind the stone result in a wall that cannot dry to the interior or exterior. Moisture-sensitive building materials (i.e., wood) will deteriorate even faster. A coating will not save the system if the underlying materials have been improperly installed.

Summary

Stone is functionally similar to stucco; even stone manufacturers disclose this. Stone requires equal or better weatherproofing details than stucco, especially when dry-stacked. If the architect or client insists on the dry-stack look in a cold climate, then greater attention to waterproofing details, application techniques, and manufacturer requirements must be adhered to in order to avoid costly callbacks. It all starts with a proper weather barrier. This is the most important step in any façade installation, especially stone.

Synthetic stone veneer is here to stay. Stone has been used as a building material since man moved into caves and called them home. Synthetic stone is a product that will continue to be utilized in the construction of buildings. With improved manufacturing techniques, almost any stone architectural "look" can be achieved and appear completely natural. Unfortunately, waterproofing techniques and the skill of application have not caught up with the improved stone manufacturing techniques and "tighter" construction practices.

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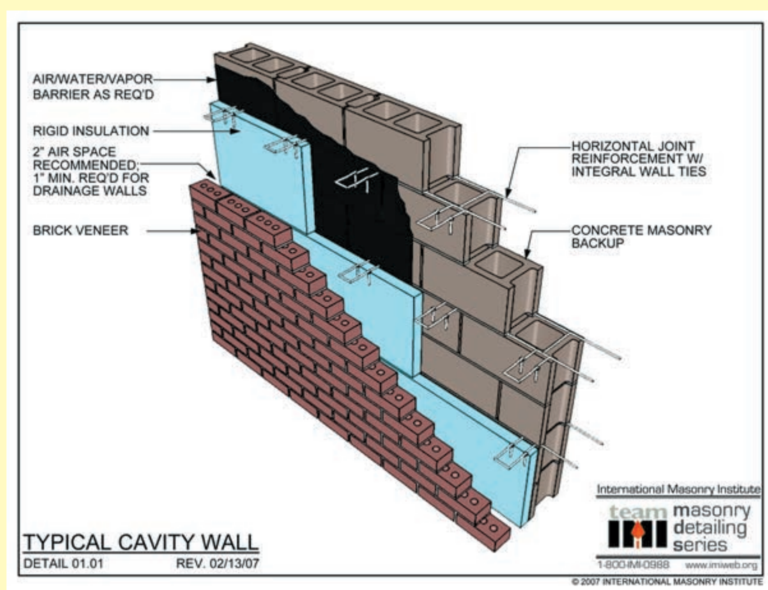
INTERNATIONAL MASONRY INSTITUTE

The International Masonry Institute (IMI) is a strategic alliance between the International Union of Bricklayers and Allied Craftworkers (BAC) and their signatory contractors to promote quality masonry construction. IMI offers free technical assistance to the design and construction communities, as well as training for craftworkers and professional education for masonry contractors.

IMI's network of 12 regional centers and the National Training Center (currently being constructed in Bowie, MD) offer training at all career levels (from apprentice to supervisor) in all the masonry crafts: brick/block, tile, terrazzo, marble, stone, restoration, plaster and cement, plus new products and systems.

A masonry detailing series may be found at www.imiweb.org. The interactive details give designers easy-to-use, practical solutions for their masonry projects, with drawings, images, narratives, animations, and more. Learn more at **www.imiweb.org** or **www.bacweb.org** or call 1-800-IMI-0988 or 1-888-880-8222.



Page 23
Full Page Ad
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A HOUSE OF BRICK:

Water Repellents and Elastomeric Coatings

By Wei Lam and Jonas Hawk

When the third little pig built his famous house of brick, he had only wind resistance in mind. The well-known children's tale leaves out any mention of whether our wise little friend specified a water repellent or elastomeric coating for his masonry project. Obviously, he made a well-informed decision, because, as we all know, he lived happily ever after.

Today, the problems resulting from construction defects and water penetration are at the forefront of issues faced by the industry. Water-repellent and coating applications are frequently recommended for masonry walls without adequate consideration of the issues that will make the application a success or failure. Failures are frequently attributed to accumulation of moisture behind the masonry once a treatment has been applied. A sound decision whether to include these products in new or existing construction should be based on an understanding of the substrate properties, available product classes, and the potential risks of an inappropriate selection or application.

Building envelope (BE) professionals in today's construction industry are frequently the source that architects, owners, and contractors turn to for answers on these products. BE professionals, in turn, encounter an increasingly complex array of products and information when it comes to masonry wall construction and moisture management. Countless commercial water-repellent and waterproofing products for masonry have been introduced in the past 30 years. The products include those with formulations and physical properties that vary widely, though they are frequently classified in similar groups. The specification and use of these products are debated, and much has been written about proper selection. While many projects may benefit from the application of a properly selected repellent or waterproofing material, there are cases when these products may exacerbate existing problems or create new ones.

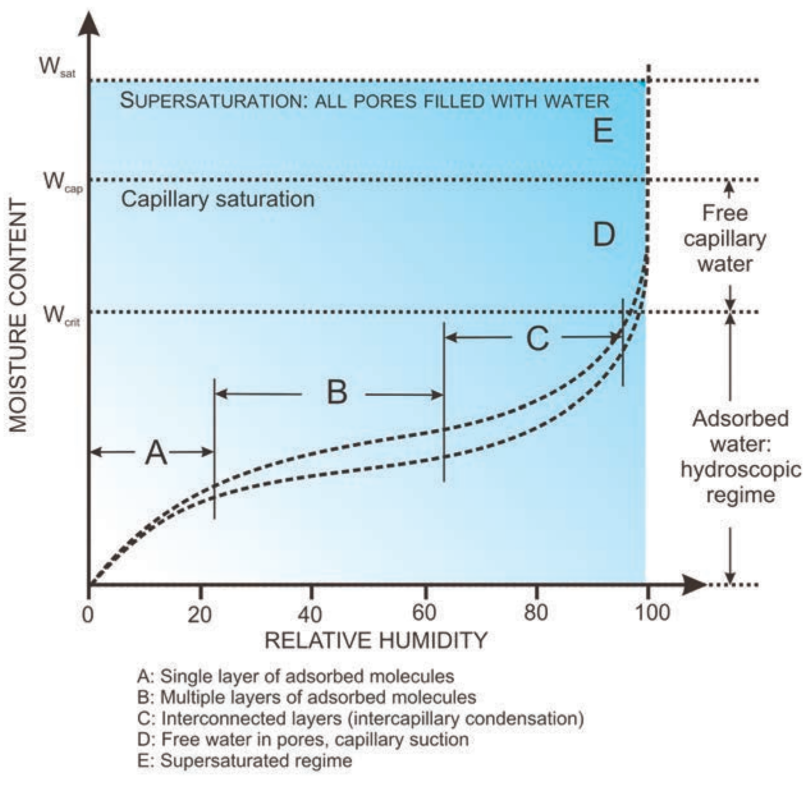


Figure 1: Moisture storage function (Straube et al. *2003).*

Wetting, Storage, and Drying of Masonry

While a detailed discussion of moisture storage and transport mechanisms in porous materials reaches beyond the scope of this article, these concepts are central to understanding how coatings and penetrating sealers affect these functions. Masonry used for exterior cladding applications may include clay brick, natural

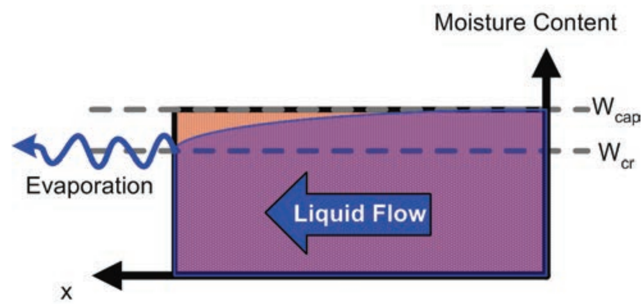


Figure 2a: Stage I drying (Roppel 2003).

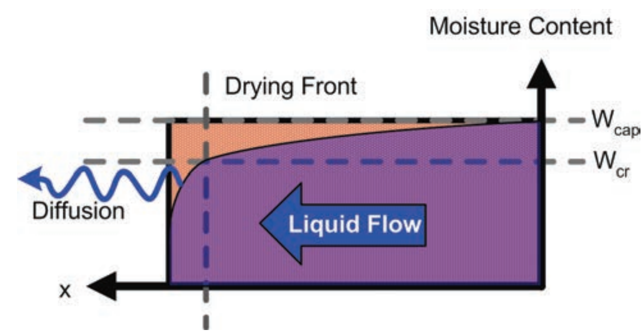


Figure 2b: Stage II drying (Roppel 2003).

stone, cast stone, concrete masonry units (CMU), architectural precast, or exposed cast-in-place concrete. While varying in degree, all of these materials are considered porous and have internal surface areas that are able to store and transport considerable amounts of moisture within their pore structures.

Storage

Most masonry types may be considered hygroscopic, meaning they have moderate affinity to attract and adsorb water vapor. Moisture exists in an adsorbed phase (adsorbate) when water vapor molecules are attracted to a surface by polar forces. Hygroscopic materials attract water vapor in this way until they reach a dynamic equilibrium and water content that varies with material properties, temperature, and relative humidity. As the relative humidity approaches 100%, water molecules begin to interconnect, and masonry materials begin to store water by capillary condensation, surface tension, and containment. Plotting moisture content versus the relative humidity results in sorption isotherm diagrams.

Over the years, several scholars have further defined regimes in these diagrams to differentiate mechanisms and phases of stored moisture. This includes the definition of water contents associated with critical saturation (W_{crit}), capillary saturation (W_{cap}), and supersaturation (W_{sat}). See *Figure 1*. [Straube *et al.*, 2003].

Transport

Moisture is transported through a porous material in the same phases as moisture storage: as adsorbate, vapor, or liquid. The forces driving each phase into a porous material are different. Adsorbed water relies on mass concentration gradients at the pore walls. Vapor is driven by differentials in vapor pressure. Liquid water transport can be governed by gravity, wind, hydrostatic, and capillary forces.

The primary wetting mechanism of masonry is capillary attraction from contact with liquid water. Rainwater, condensation, and groundwater are the primary sources of water available for capillary suction. Other wetting mechanisms include capillary condensation and absorption of vapor molecules. Water repellents and waterproof coatings will both decrease the potential from capillary suction and, depending on their formulation, may also act against other mechanisms of wetting.[1]

Moisture is removed from hygroscopic materials through drainage, evaporation, and desorption. Oversaturated materials will drain by gravity until the capillary saturation moisture content is reached. The remaining moisture is removed by evaporation and desorption, which results in two distinct drying stages. *Figure 2* illustrates these stages. In the first stage, liquid water will flow by capillary conduction to the surface to replace the evaporated moisture. In the second stage, unsaturated flow and desorption begin once the material is no longer saturated. The rate of free water evaporation (Stage I) is usually much higher than the rate of desorption (Stage II) [Hall *et al.*, 1984]. Stage II drying occurs at a slower rate for two reasons:

1. Resistance of vapor flow occurs between the exterior surface and the drying front.
2. The vapor pressure gradient is less at the drying front compared to evaporation at the exterior surface.

The location at which liquid water ceases its flow in the material is called the drying front. When porous materials are treated with hydrophobic materials such as penetrating sealers, the drying front starts at the penetration depth of the sealer because liquid flow to the surface is interrupted. Therefore, the penetration depth of the sealer will influence the drying rate of the porous material because drying will start at this depth and occur at the Stage II drying rate as seen in *Figure 3*. When impregnated porous materials are near saturation, the drying rate can be much lower compared to the drying rate of untreated masonry near saturation.

Water Repellents And Elastomeric Coatings

While there continue to be debates and a lack of consensus when it comes to the terminology and nomenclature used to describe specific water-repellent and waterproofing treatments, a useful way to consider the range of products has been proposed by Mailvaganam and Straube. The classification is based on the surface interaction

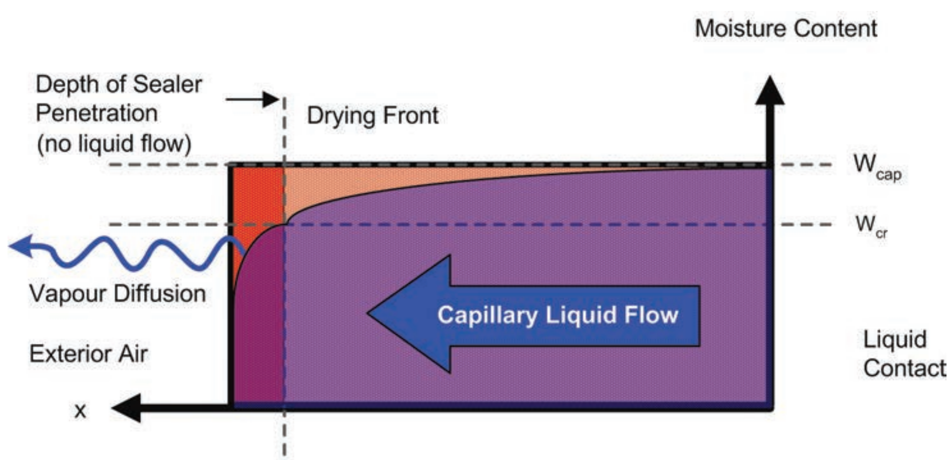


Figure 3: Drying of impregnated masonry [Roppel 2003].

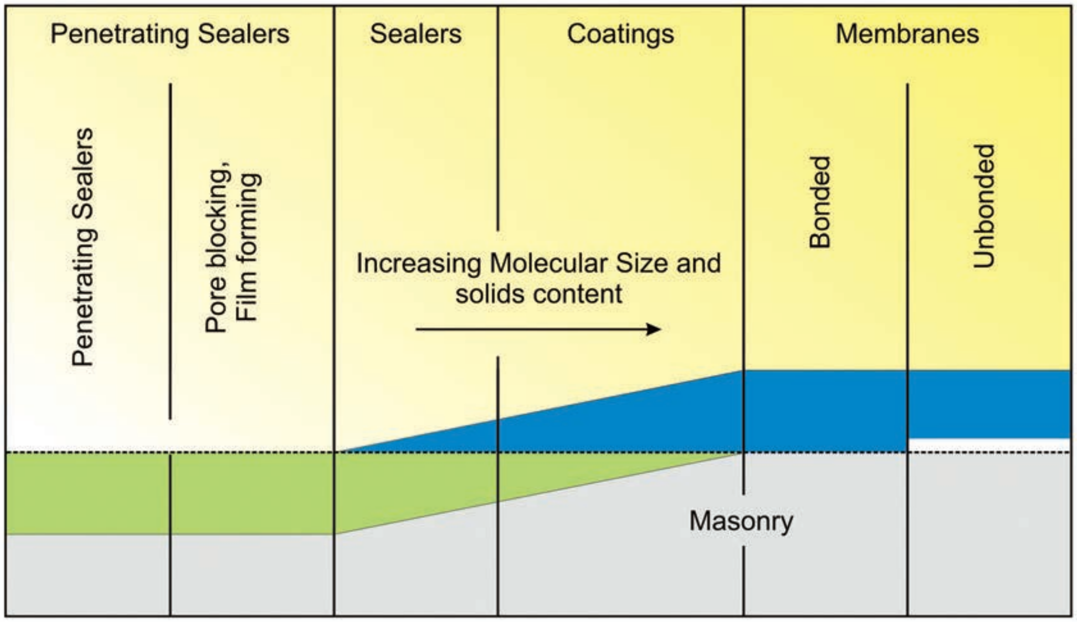


Figure 4: Waterproofing treatment types (adapted from Straube, 1997, and Mailvaganam, 1992).

and thickness of the treatment as illustrated in *Figure 4*. Most products considered for above-grade masonry wall treatments can be classified in the range between penetrating sealers and coatings. An important consideration with this classification is that the same generic product may behave in fundamentally different ways, depending on formulation and surface conditions. Industry has consolidated these products into three major classes: water repellents, elastomeric coatings, and cementitious coatings.

Water Repellents

Most water repellents in today's construction market are formulated to slightly penetrate the surface of the masonry and to have little effect on the appearance of the surface. While formulated to penetrate, some products may leave a very thin clear or semi-opaque film, depending on formulation and substrate properties. Small molecular size, low viscosity, and high solvent content improve penetration into the masonry pore structure. Modern water-repellent treatments will be more vapor-permeable (breathable) than elastomeric coatings or waterproof membranes. However, any repellent will have some limiting effect on the vapor transmission compared to an untreated surface. Water repellents that do not exhibit good vapor permeance have contributed to substantial failures. The vast majority of available water-repellent products for above-grade masonry walls are formulated from modified silanes, siloxanes, and blends of these suspended in water or solvent-based carriers. Other products include silicates and methyl siliconates, though these are less frequently used due to their tendency to cause undesirable staining or discoloration of surfaces.

Smaller molecular size allows silanes to penetrate deeper than siloxane molecules. Silanes react with moisture in the substrate, aided by the alkalinity of the substrate. In carbonated concrete and other neutral masonry materials such as clay brick, a primer or integral catalyst may be required. The relatively volatile nature of silanes requires a percentage of solids of 40% or greater in most formulations to account for evaporative losses that occur before the catalysts take effect. If environmental conditions evaporate moisture and solvent carriers prematurely, the effectiveness of silane-based products may be affected. Exposure to rainfall shortly after application may also result in leaching of silanes and result in ineffective application.

While similar to silanes, siloxanes have a larger molecular size. This quality inhibits their ability to penetrate masonry surfaces. Siloxanes react with moisture in the substrate, but, unlike silanes, do not require a

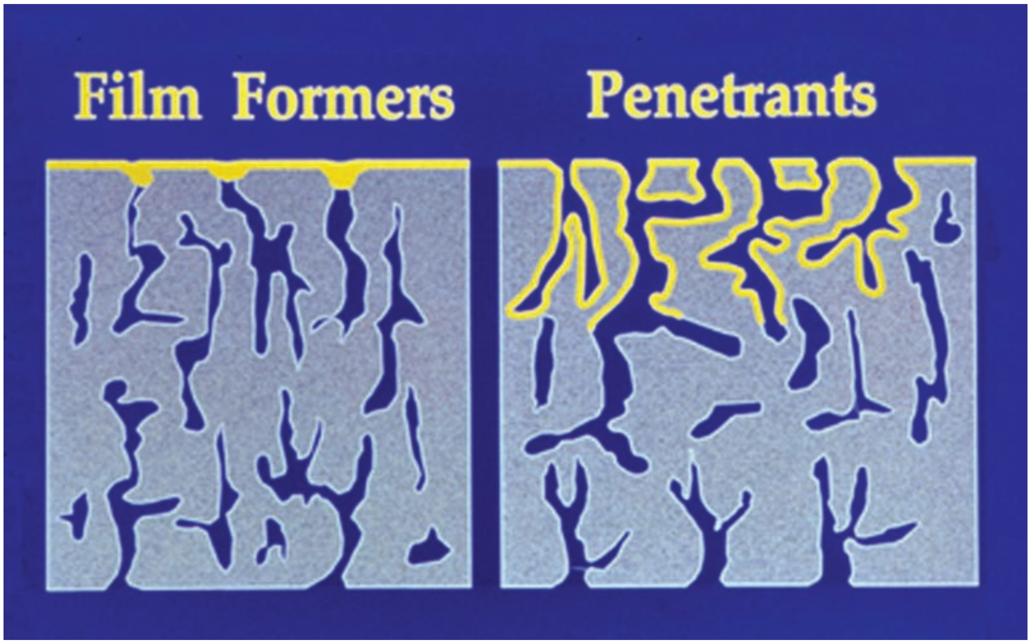


Figure 5: Film formers vs. penetrants (Graphic courtesy of Prosoco).

high pH to catalyze. This makes them well suited for neutral masonry such as brick or carbonated concrete. Because they are less volatile and create less of a concern with evaporation, siloxanes are provided in formulations ranging from 10 percent to 15 percent solids. Siloxanes are frequently blended with silanes to take advantage of the unique properties of each. This can be seen in blends specifically formulated for clay brick, in which the silane reacts with lime in the mortar and the siloxane penetrates the pore structure of the brick. Because siloxanes readily react with silica, they form a strong bond with glass, and proper care should be taken to mask areas of application.

Elastomeric Coatings

Properly applied elastomeric coatings become well bonded to the masonry surface, usually by a combination of penetration into the pore structure, mechanical keying, and – to a lesser degree – intermolecular attraction. The majority of available elastomeric coatings for use on above-grade masonry walls are formulated from acrylics, polymer-based cementitious products, or silicones. The breathability of these products varies greatly but is generally less than that of penetrating water repellents. Because coatings are exposed on the surface of the masonry, they are subject to deterioration by UV rays and other environmental conditions.

Acrylics form a film on the surface of the masonry and generally have moderate ability to bridge smaller cracks that form after the coating has been applied. With a smaller molecular size, acrylic polymers permit good penetration with low-solids formulations. High-solids formulations result in surface coatings. Acrylics may significantly limit the vapor permeance of masonry, especially when coatings become thicker.

Silicone-based elastomeric coatings typically offer exceptional crack-bridging qualities while limiting vapor permeance. Silicone molecules (the largest when compared to silanes and siloxanes), have the least penetration into masonry pore structure. Penetration of the silicone molecule is a function of the solvent used. Bonding of silicone elastomerics to masonry is primarily through mechanical keying and intermolecular forces. Silicone resin coatings are not compatible with other types of polymer coatings and require recoating in like kind.

What Can Go Wrong

Water repellents and elastomeric coatings can significantly reduce the amount of wetting that masonry walls experience. However, these products may also be considered for reasons other than their ability to limit wetting and resulting deterioration. These include: change of appearance, graffiti and dirt resistance, and consolidation of deteriorating materials. Regardless of the purpose, they will also limit the drying rates of masonry, potentially allowing water to accumulate behind the surface and accelerate moisture-related problems.

Many failures associated with penetrating water repellents and elastomeric coatings can be linked to a disregard for the other sources of wetting not mitigated by the application of these products. Faulty application of flashings, obstructed drainage paths, excessive air exfiltration (warm interior air escaping and condensing on the back of masonry), building geometry, poorly formed masonry joints, and improperly located irrigation are a few examples of other sources of moisture that should be considered. Frequently, one or more of these conditions comprise greater sources of water penetration than the porous masonry surfaces.

In cold climates, moisture accumulation can lead to accelerated freeze/thaw deterioration. Freeze/thaw can result in severe cracking and spalling of brick masonry. Theories of freeze/thaw damage are debated, but there is general agreement that inclusion of water repellents may only exacerbate the problem in northern climates.

Cementitious Coatings

Polymer-based or modified cementitious products are specified to replace traditional parging or mortars. They can offer improved strength, water repellency, adhesion, and density over normal materials. The application of a cementitious coating can drastically change the appearance of masonry walls, giving them the appearance of Portland cement plaster (stucco). These products can be applied in thin layers but are more susceptible to cracking, given their limited elastomeric properties. Cementitious coatings offer greater vapor permeance than most elastomeric coatings.

Figure 6: Faulty flashing leads to moisture accumulation and permanent freeze/thaw damage at roof interface.

Figure 7: Freeze/thaw brick and parge coating failure.

Figure 8: Workers remove sealer blush from a Southern California office building. Sealer blush results from using film-forming sealers on masonry. As water tries to evaporate out of the masonry, it is blocked by the film former. Eventually, the escaping water vapor breaks the sealer bond in spots. Where the sealer has debonded, more water from rain or other sources soaks in, leading to further debonding and more widespread sealer blush. The condition, as shown here, is correctable only by removing the failed coating, which can be expensive. (Photo courtesy of Prosoco.)

In warm and mixed climates, accumulation of moisture and the differences in vapor permeance between masonry and coatings can lead to adhesion failures caused by osmotic blistering and evaporation of water below the coating. Maintaining a balance between wetting and drying of masonry is critical for long-term performance.

The development of efflorescence on a masonry wall commonly leads owners and builders to consider water repellents. Efflorescence is caused when water-soluble salts are carried through masonry and deposited on the surface. Unless the source of water penetration is addressed, addition of a water repellent may force the salts to be deposited below the surface of the brick as water evaporates. This condition, known as subflorescence, can cause brick to spall.

When drying is prevented from occurring on the exterior side of a masonry wall, moisture may become trapped within those walls lacking properly installed vapor retarders. In humid climates, this scenario can quickly turn into one involving mold and mildew.

Selection Considerations

- Identify masonry materials and verify selection of treatment with the manufacturer. Brick, stone, CMU, glass fiber reinforced concrete (GFRC), and architectural precast all have unique properties that will react differently to similar treatments. Manufacturers may offer testing of substrates with various products to determine effectiveness of application and staining potential.
- Before committing to masonry waterproofing treatments, review all possible sources of moisture into the masonry, and determine first if they can be mitigated. Consider whether any wall properties will contribute to a negative imbalance in the wetting and drying of the masonry if a treatment is applied. Select the most breathable treatment that provides the desired level of water repellency.
- Specify products that come prediluted to prevent field batching that may result in improper dilution and

Figure 9: Efflorescence from rainwater penetration can quickly mar a beautiful new masonry façade. (Photo courtesy of Prosoco.)

Figure 10: Single-wythe CMU: Interior view of integrally waterproofed CMU block and mortar. The head joints were not properly consolidated and did not prevent the passage of water during high wind events.

use of contaminated water.

- Local and federal environmental codes regarding volatile organic compounds (VOCs) have become much more stringent in the past decade. Verify with the manufacturer that selected treatments are in compliance with local environmental requirements.
- When reactive repellents are specified (i.e., silanes), evaluate carbonation of the substrate to ensure that the application does not require a separate primer or catalyst. Ensure that the surfaces are clean and compatible with the materials to be applied.
- Formulations of water repellents vary among manufacturers. Products with similar percentages of solids may provide significantly different performance and final appearance. When substitutions are made, ensure that manufacturers verify that their products meet all of the physical and chemical properties of the specified materials.
- Consider the climatic conditions recommended by the coating manufacturer. Typically, temperatures between 40˚F and 100˚F are required. Application on windy days should be avoided when possible.
- Study related performance standards for materials. These include ASTM specifications and test standards for key physical properties. Knowledge of field evaluation methods is also helpful. RILEM/MAT tube testing and localized permeability testing provide comparative data on wetting through treated versus untreated masonry. Various methods for coating adhesion evaluation are also available.
- Utilize manufacturers' technical support services and local technical representatives. Some manufacturers offer project-specific material and compatibility testing. Local technical representatives may have more firsthand knowledge of what has worked and what has failed in a given market.

Summary

A new client recently stated that his approach to water-repellent applications in the past followed the age-old saying, "When in doubt, leave it out." As building envelope professionals, our recommendations should be based on a careful consideration of the specific project conditions and available materials. In many cases, any doubt about

ROOF KNOWLEDGE ASSESSMENT

Test your knowledge with the following questions developed by Donald E. Bush Jr., RRC.

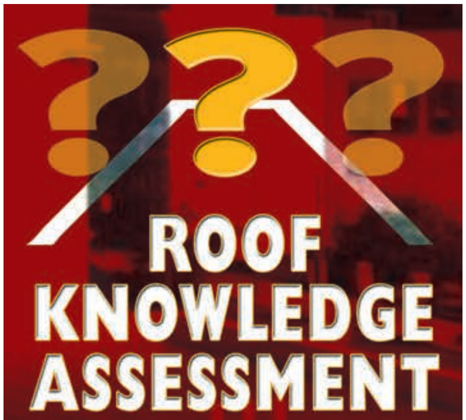
1. **When designing or reviewing a design of a commercial building, which part of the building envelope must be considered?**

2. **When considering moisture control requirements for non-vented spaces, must an approved vapor retarder be provided?**

3. **When considering moisture control requirements for non-vented spaces, are there any exceptions regarding the application of an approved vapor retarder?**

4. **The maximum solar heat gain coefficient (SHGC) and the thermal transmittance (U-factor) of window assemblies and glass doors located in the building envelope shall be based on the window projection factor. What is the window projection factor?**

Answers on page 32



Answers to questions from page 31:

1. **Walls, roof assemblies, floors, glazing, and slabs on grade that are part of the building envelope for buildings where the window and glazed door area is not greater than 50% of the gross area of the above-grade walls. Buildings with more glazing shall meet the applicable provisions of ASHRAE/IESNA 90.1.**

2. **All framed walls, floors, and ceilings not vented to allow for moisture to escape shall be provided with an approved vapor retarder having a permeance rating of 1 perm or less. The vapor retarder shall be installed on the warm-in-winter side of the insulation.**

3. **Exception 1: Buildings located in Climate Zones 1 through 3.**
   Exception 2: In construction where moisture or its freezing will not damage the materials.
   Exception 3: Where other approved means to avoid condensation in unventilated, framed wall, floor, roof, and ceiling cavities are provided.

4. **The window projection factor shall be determined by the equation:**
   PF = A/B, where:
   PF = Projection factor (decimal)
   A = Distance measured horizontally from the furthest continuous extremity of any overhang, eave, or permanently attached shading device to the vertical surface of the glazing.
   B = Distance measured vertically from the bottom of the glazing to the underside of the overhang, eave, or permanently attached shading device.

   Where different windows or glass doors have different PF values, they shall each be evaluated separately, or an area-weighted PF value shall be calculated and used for all windows and glass doors.

Reference: ***International Energy Conservation Code***

the suitability of repellent or coating applications can be addressed by analysis of the associated risks and benefits. The amount of information and products offered can make this a daunting task. By gaining a better understanding of moisture transport and storage theory in masonry, available product classes, and the associated risks of inappropriate selection and application, the consultant is in a position to make an informed recommendation for the client.

While there are several factors that can result in failed applications of repellents and coatings, accumulation of moisture behind the masonry is one that can result in long-term permanent damage to the façade and structure. When used, water repellents and coatings should be selected to minimize this risk and maintain an appropriate balance between wetting and drying.

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[1] Roppel, 2003
[2] Straube, 1997

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Page 33
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SINGLE-PLY ROOFING – 50 YEARS

Half a Century of Experience, But What Have We Learned?

By Dick Fricklas

A somewhat altered version of this article was first presented at the 25th Annual Convention of SPRI (representing the Single Ply Roofing Industry) in Rancho Bernardo, California, on January 13, 2007. Reprinted with permission.

Single-ply and modified bitumen roofing currently hold a two-thirds share of the U.S. commercial roofing market. This reflects remarkable growth, considering that these systems began just 50 years ago with a zero market share (see *Figure 1*).

What might the goals be for the next few years?

- Reduce liability.
  - — Develop better products.
  - — Enhance contractor quality control and product education.
- Increase productivity.
  - — Simplify installation.
  - — Offer systems that are more forgiving of weather conditions during application.
  - — Prefabricate roofing panels with factory-installed nailing tabs so that fewer seams must be made in the field (*Figure 2*).
- Increase profitability through productivity gains.
- Help meet the country's energy and environmental needs.
  - — Use less energy to produce product.
  - — Develop more energy-efficient roof systems.
- Improve sustainability.
  - — Offer systems that are easily repaired and more durable.
  - — Offer systems that are recyclable.
  - — Offer systems that are easier to inspect.

Right: Figure 1: Single-ply roofing systems offer proven durability and versatility.

Figure 2: Factory-installed nailing tabs mean fewer seams to seal in the field..

BUILT-UP ROOFING (BUR) – WHAT IS ITS FUTURE?

BUR today encompasses:

- Hot-applied,
- Cold process, and
- Self-adhered roofing.

BUR systems rely heavily upon field workmanship. Even a two-inch error in application markedly reduces membrane integrity (*Figure 3*). BUR requires intensive field labor due to the use of multiple layers during application. The field-spread bitumen provides the waterproofing, so skips and voids cannot be tolerated (*Figure 4*). Bituminous BUR is heavily dependent upon the availability of petroleum for producing asphalt, and the price trend has been upward. Cold-process and self-adhering systems are likely to continue to be specialty systems where fumes from the kettle or mop, difficult access, or odd roof shapes not con-

Figure 3: With just a 2-inch head lap, good workmanship is essential to performance of the roofing plies.

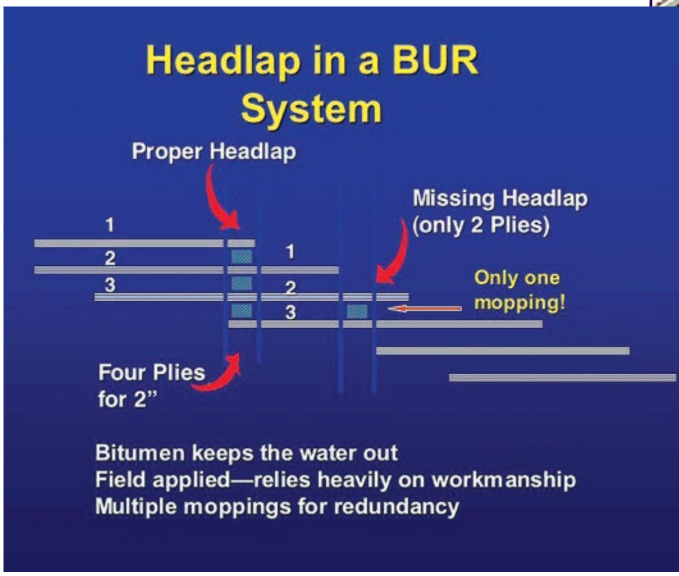


Figure 4: The field-applied bitumen serves both as adhesive and waterproofing agent.

ducive to conventional hot application are issues.

MODIFIED BITUMINOUS ROOFING (MB)

Polymer-modified bituminous roofing (MB) takes advantage of the industry's experience with built-up roofing. Use of selected reinforcements and polymer additions yields higher performance membranes, even though fewer layers are used. MB sheets are coated under factory quality control, whereas BUR systems require field application of bitumen for water resistance. Most MB systems use just two or three layers, compared to the three to five layers needed in a conventional BUR. As a result, both labor and materials are reduced when MB is used.

Generally, MB systems use factory-applied granules or metal foil surfacing for appearance and UV protection, rather than the field-applied flood coat of bitumen and gravel of BUR systems. Ironically, the superior toughness and conformability of MB materials have extended the life of built-up roofing systems by providing superior flashing performance.

Potential problems of MB systems:

- Slippage when installed in hot asphalt.
- Blisters from voids or entrapped moisture.
- Torch application of MB systems is very effective but raises fire concerns (*Figure 5*).
  - — Insurance may be a problem for contractors who do torch applications.
  - — Some MB manufacturers are providing the requisite insurance as a service for their contractors.
  - — A certified torch-applicator program should be in place, and only CERTA-trained applicators should be permitted on torch-down projects.

Current Issues with Modified Bitumens

- Better definitions are needed of the pros and cons of APP vs. SBS-polymer modifiers.
- Identification of which reinforcements are best for which applications – e.g., glass fiber mat, polyester/glass scrim, or fabric hybrids is needed.
- The difference between a "hybrid-BUR-MB" – where multiple BUR layers are installed in hot asphalt, followed by a MB cap-sheet – and a system in which MB sheets are used for all layers should be identified.

Figure 6: One layer of polyester mat laid in hot asphalt is a non-conventional single-ply roof membrane.

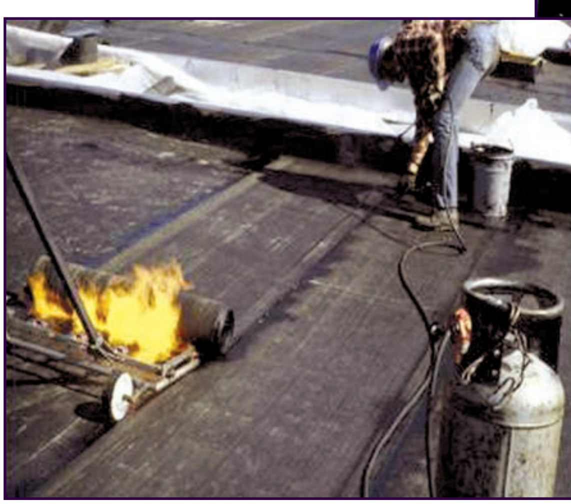


Figure 5: Multiple torch-heads allow rapid application of MB systems.

- Identify whether or not a heavy, one-ply polyester membrane laid in hot asphalt is actually a single-ply system (*Figure 6*).

Major milestones in MB and single-ply have already been reached, such as:

- *Interim Criteria for Polymer-Modified Bituminous Roofing Membrane Materials*, published by the National Institute of Science and Technology (NIST), February 1989.
  — There has been a lack of acceptance on the proposed minimum strain energy of 3.5 pound-inches per inch for MB.
- Many ASTM and ANSI standards have been issued and most have been accepted by building code officials.

WHAT CAN WE LEARN FROM HISTORY?

The first generation of single-ply polymeric materials appeared in the 1950s, primarily from Europe. Perhaps the higher costs of energy in Europe at that time, particularly in petroleum products, triggered earlier experimentation with polymeric-based systems.

Polyisobutylene (PIB)

One of the first new products was based upon polyisobutylene (PIB). PIB is very similar to butyl rubber (which is a co-polymer of isobutylene, but with small amounts of isoprene), except it lacks conjugated double bonds needed for vulcanization. (This is similar to EPDM, where the "D" represents a diene, a monomer with at least two double bonds). Since PIB has no UV-vulnerable double bonds, it possesses an extraordinarily high degree of ultraviolet resistance. PIB sheets in Germany were first used as UV screens for asphaltic roofs. Low-molecular-weight PIB products were also used in adhesives and even introduced as additives to improve the low-temperature flexibility for other polymers.

Figure 7: Polyester fleece replaced neoprene-bonded asbestos backer materials.

The first PIB products introduced into the U.S. market were only 45 mils thick (1.1mm), as compared to the previously successful European product at a thickness of 250 mils (plus a membrane beneath). This pattern of taking successful European products and modifying them to make them more competitive for the U.S. market continues today.

The PIB products incorporated the use of factory-bonded backer materials, both as fire barriers and to separate the polymer from the substrate. Solvent-based cold adhesives were used as lap sealant, flashing adhesive, and deck adhesive. Since Volatile Organic Compound (VOC) regulations did not yet exist, there was no problem with the use of volatile hydrocarbon solvents. Versions of the PIB membrane included asbestos-paper-backed product for membrane, a scrim-backed material for flashings and expansion joint covers, and a nonreinforced film for forming pipe flashings, inside and outside corners, and the like. This practice of multiple versions is still used today with EPDM products.

The backing for PIB membranes ultimately shifted from latex-bonded asbestos paper backer to polyester fleece (*Figure 7*) in order to achieve greater toughness and to improve isolation for the substrate. The early PIB materials tended to creep (cold flow), resulting in thinning and, ultimately, cracking. Incorporating the flexible fleece helped. Blending PIB with ethylene-vinyl-acetate (EVA) assisted in both forming and reinforcing the PIB, and this PIB-EVA blend is the only one still manufactured today. While PIB was originally compounded as a black sheet, currently it is produced in white and does not require a field-applied color coating.

The PIB systems were the first to offer a selvedge of factory-applied splice tape. This has since been adopted for EPDM systems. Because of the potential for wicking of the fleece backing, "wet" sealants are required at "tee" joints and other points where the polymer selvedge is absent.

PIB is a difficult polymer to process. It is also relatively expensive compared to the polymers used in most other single-ply membranes. While some PIB remains in the U.S. market, other polymers, such as EPDM, TPO, and PVC, have generally displaced it.

Early Research on Single-ply Systems

Maxwell Baker of the National Research Council of Canada authored a *Canadian Building Digest* in 1964 entitled "New Roofing Systems." Baker pointed out the dangers of too much enthusiasm for "new" products "without regard for the fact that they are still vulnerable to building movement, trapped moisture, and workmanship errors. In addition, new factors are introduced such as a dependency upon thin layers of adhesive and narrow joints." (See *Figure 8*.)

In 1966, Tom Boon and Bill Cullen of the National Bureau of Standards (NBS – now NIST) issued *Report #9381, Progress Report on Exposure of New Roofing Systems*. Their field exposures included butyl rubber, Tedlar®, Monoform® (asphalt emulsion with glass fiber reinforcing), PIB, and several liquid systems such as Neoprene-Hypalon®.

The Tedlar® roofing membrane (polyvinyl fluoride) tested was just two mils thick. It was factory laminated to a backing – generally, Neoprene-latex bonded asbestos paper (hence the designation "TNA 200®," for Tedlar-Neoprene-asbestos, 2 mils). The TNA-200® could be installed in the field using latex adhesive or applied in hot asphalt. The critical lap joints were sealed with a pressure-sensitive Tedlar® tape. Unfortunately, this tape tended to creep, resulting in a "zebra" effect. It was very difficult to get tape and patches to stick to Tedlar®, since it is very much like Teflon®.

Years later, a Tedlar® film laminated to a nitrile rubber sheet (*Figure 9*) was successfully introduced as an expansion joint cover. Since the nitrile-rubber base has excellent oil resistance, the cover could be embedded in asphaltic mastic. The Tedlar® provided UV protection for the nitrile rubber. Splices were tricky, with Neoprene splice covers embedded in a moisture-curing urethane adhesive. A weakness of the system was that if the Tedlar® film was nicked or scratched during or after installation, it could easily tear, exposing the Neoprene to UV attack.

Korad®, a thin acrylic film, was also introduced into the roofing market. The innovation in this case was to factory-bond the Korad® to plywood or OSB roof decking. In the field, the panels were nailed to

Figure 8: A major innovation in roofing was the offering of contractor applicator schools.

Figure 9: Tedlar® film provided weather protection for the acrylonitrile (rubber) membrane.

Figures 10A (left) and 10B (below): Dulles Airport required a flexible roof membrane to withstand expected structural movement.

rafters, with Korad® tape both covering the fasteners and sealing the panel joints. This art has reappeared in several versions, usually with insulated deck panels faced with polymer-coated metal.

Early Versions of Elastomeric Roof Systems

The first major U.S. application of an elastomeric, single-ply roof was at Dulles Airport (*Figure 10*). Due to the unusual building design, the roof membrane had to be extremely flexible. Sheet Neoprene was installed, followed by liquid Hypalon®. In the years that followed, many all-liquid Neoprene-Hypalon® systems were applied to continuous substrates such as thin-shell concrete, taped-plywood decks, and as a coating system for sprayed-in-place polyurethane foam (SPF).

Neoprene rubber could be produced and shipped as either a vulcanized roofing sheet or in a semi-cured state. Semicured was very handy for flashings where conformability was critical (*Figure 11*). Vulcanized rubber has a memory and does not permit stretching to conform to inside and outside roof corners or other odd shapes. This semi-cured Neoprene solved many problems – not only for Neoprene roofs, but for prototype EPDM and butyl roofs as well. Unfortunately, this Neoprene cross-linked to an elastomer upon aging, eventually over-curing and becoming especially brittle on south-facing exposures. Development of uncured EPDM or the use of factory-vulcanized EPDM membranes solved most of these problems. Factory premanufactured inside and outside corners and witches' hats have been highly successful in solving those conformability issues.

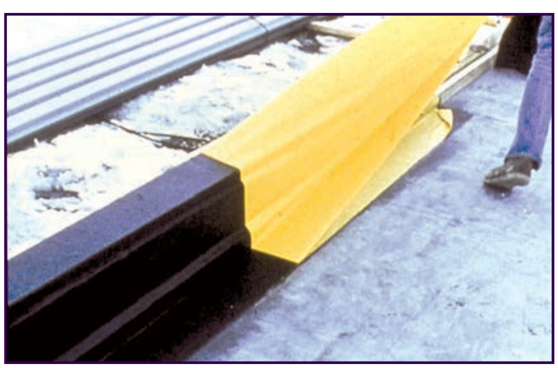


Figure 11: Uncured neoprene sheeting provided the conformability needed for flashings and penetrations.

Liquid Elastomers

Many other liquid-elastomeric roofing systems have been introduced over the years. Most required multiple coats to avoid pinholing and are only available at relatively low solids. Several had inadequate fire resistance for roofing applications. Since sprayed-in-place polyurethane foam always requires a protective coating, silicone, urethane elastomer, and acrylic coatings have filled this niche market very well. (On flat roof surfaces, aggregate has also been used as a UV screen.)

Thermoplastics

Interest in weldable thermoplastic systems surged in this country as the single-ply market developed. Most of the technology originated in Europe. Some thermoplastic systems were based upon nonreinforced PVC films. They were offered as very thin films – as thin as 32 mils (0.8 mm). Unfortunately, some of these early PVC systems were poorly compounded. Many suffered from severe shrinkage and embrittlement.

Curiously, it was observed that ballasted PVC roofs were failing faster than roofs that were exposed to the weather. One theory was that the sediment associated with the ballast was drawing out the plasticizer from the PVC compound. Thicker sheets should retain the plasticizer longer, since the loss is a surface-related phenomenon. Today, manufacturers offer few, if any, nonreinforced systems. Mechanically fastened systems represent the largest market segment.

Compatibility between PVC compounds and substrates is very important. Direct contact with expanded styrene foam insulation could lead to plasticizer extraction. Volatiles from an underlying coal-tar pitch roof could migrate into the PVC. Foil air barriers evolved as a necessary component of the assembly as a means to isolate the system components. Various "slip-sheets" are still used today to isolate the new PVC membrane from contacting soft bitumen or

Figure 12: Various slip sheets have been used with plasticized PVC membranes.

recently applied asphaltic patches (*Figure 12*).

One notable innovation of these early PVC systems was to incorporate polymer-coated metal for edging and flashing. This turned flashing details around, with the metal flashings installed first and the membrane bonded to the preformed metal edging, coping, or flashing (*Figure 13*).

Figure 13: Polymer-coated metal flashings anchor this PVC roof membrane system.

In 1990, a bulletin was published jointly by NRCA and SPRI warning about premature embrittlement and the dangers of even walking on an older PVC membrane. The bulletin noted that the reinforced sheets were less vulnerable to the shattering phenomenon. Impact damage on brittle PVC roofs can be profound and has led to the use of thicker membranes and denser substrates in hail-prone regions.

Recent evidence has shown that some properly compounded PVC membranes are lasting well over 20 years. They are still weldable (repairable) after all that time and may be suitable for recycling at the end of their life. Most can meet EnergyStar® reflectivity requirements, opening up new opportunities on the West Coast where white mineral-surfaced cap sheets have traditionally dominated this wood deck market.

Chlorinated polyethylene (CPE) sheets were designed to use less plasticizer than PVC, but in many cases the CPE was found to be harder to weld, a poor trade-off (*Figure 14*). Currently, there are a number of successful PVC systems that either use superior plasticizer systems or which are compounded with other polymers such as ethylene-vinyl acetate (EVA) or ketone ethylene ester (KEE) to achieve the needed flexibility and durability, while pure CPE sheets essentially have vanished. Chem-ply® was an early CPE system that used flexible open-cell foam as a backing. The idea was that the foam could vent pressure laterally to avoid blistering, as well as serve as a separation barrier. Unfortunately, the foam disintegrated with age, and the Chem-ply® exhibited less-than-favorable weathering performance.

SYSTEM TESTING OF SINGLE-PLY ROOFING SYSTEMS

Dr. Bas Baskaran of the National Research Council of Canada has documented the "weakest-link" approach to mechanically fastened roof systems. Double welds distribute stress under wind loading, achieving higher wind ratings. Seam failures should be dramatically reduced when the wider double weld is incorporated. Properly selected fasteners, stress plates, and air barriers also resolve weak link issues.

With reinforced sheets, there is always a concern that water will wick into exposed edge fibers, causing film delamination. Some sheets use a selvedge of nonreinforced polymer, while others require a wet sealant at all cut edges (*Figure 15*).

By 1978, single-ply systems had made enough penetration into the commercial roofing market for the National Bureau of Standards to publish "Elastomeric Roofing: A Survey." This document suggested tests and standards that ought to be employed in evaluating the new roof systems. One item mentioned was the high degree of chalking (surface erosion) of some liquid-applied and Hypalon® systems. Algae attack was also reported in semitropical climates.

USING FOAMED PLASTIC INSULATIONS WITH SINGLE-PLY SYSTEMS

Polystyrene foam (EPS) has proven to be a very economical insulation for nonbitumi-

Figure 14: Lead weights have been stacked on this seam welder to improve CPE seam fusion.

nous roofing systems. However, because styrene dissolves in aromatic and aliphatic solvents, vapors from solvent-welded membrane laps, solvent-based flashing cements, and cold-applied membranes can collapse the cells of the foam (*Figure 16*). On a sunny day, EPDM can absorb enough heat to cause cell deformation if the black rubber is not promptly covered with ballast.

Low-density polystyrene boards are also subject to stress relaxation in mechanically attached systems. Most membrane manufacturers require the use of higher density foam (>1 pcf) to minimize this phenomenon. A research paper by Dr. René Dupuis for SPI recommended that EPS boards be heat-treated prior to shipping to a job, as the installed boards could otherwise shrink the first time the roof heats up.

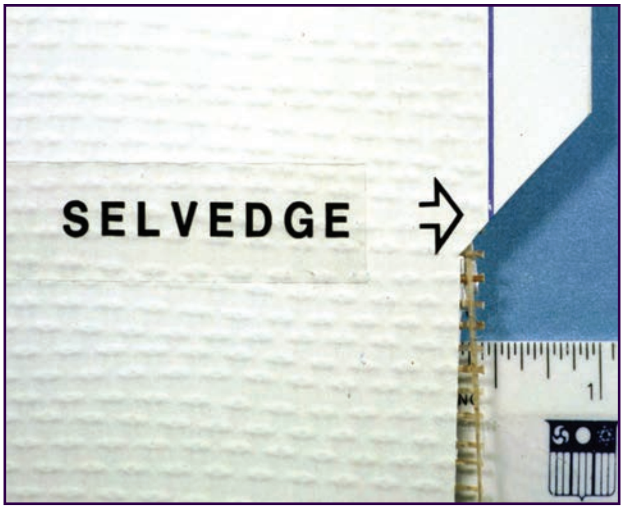


Figure 15: Selvedge region with no scrim to avoid wicking of water.

Figure 16: Cells of polystyrene foam have collapsed from solvent vapor attack.

Recent Developments in Attachment and Joining of Single-Ply Systems

Attachment methods vary widely with single-ply systems. Hot asphalt, applied in a serpentine pattern, provided about 50 percent adhesion; controlled spot attachment or sprinkle mopping, likewise (*Figure 17*). Parallel ribbons of adhesive date back to the 1960s, but at the end of a run where the applicator made U-turns, these areas were often deficient in adhesive.

Fleece-backed sheets facilitate adhesion with asphalt, low-rise foam, and solvent adhesives. A new generation of self-adhering sheets has been introduced just recently. Problems this author anticipates with the self-adhering sheets include limited shelf life, disposal of the release film, and special treatment at penetrations, tee joints,

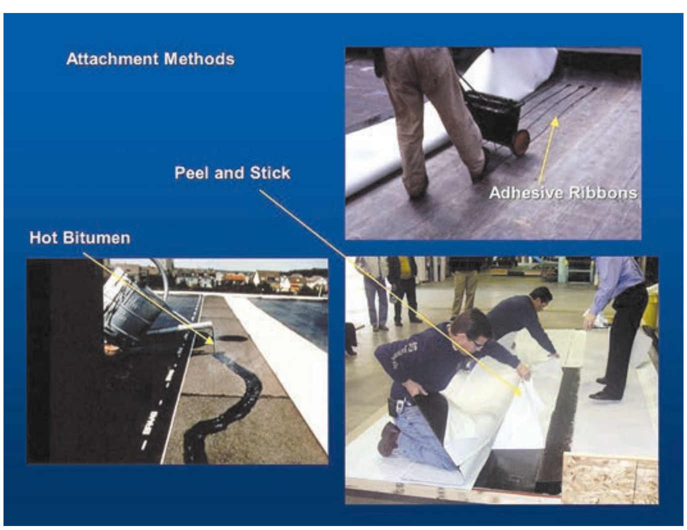


Figure 17: Attachment methods for single-ply systems have included adhesive ribbons, serpentine application of hot asphalt, and self-adhesive systems.

Figure 18: Examples of some of the nonpenetrating mechanical fastener systems that have been tried.

Figure 19: Edge restraint strips have reduced the tendency towards shrinkage and tenting of single-ply membranes.

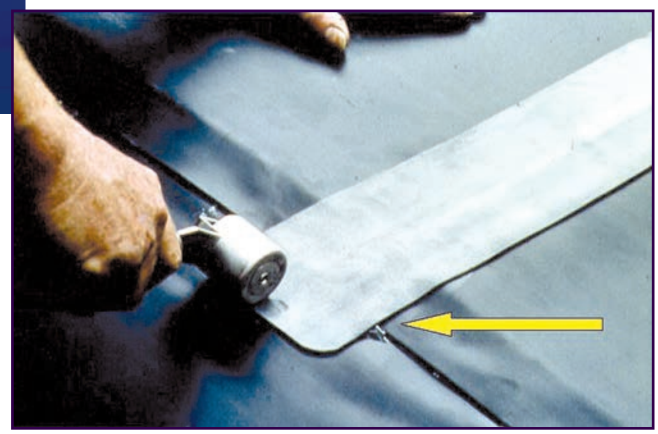


Figure 20: Illustration of the use of wet sealant on both sides of the batten.

and intersections. Substrates need to be smoother, drier, and cleaner than with any other roof system.

Consultants may remember attempts with "nonpenetrating" fastener systems. The idea was that every hole in a membrane is a potential leak, so these buttons and tracks would provide "hold down," while leaving the membrane intact (*Figure 18*).

For various reasons, most are gone, but the in-the-seam methods and batten seams appear to work just fine. Perhaps the double welds and edge-restraint systems now used reduce the shrinkage and tugging at the fastener stems (*Figure 19*).

The use of primers and splice washes is still a good idea. Talc-free elastomers help, but we are still totally reliant upon our ability to successfully seal narrow joints for watertightness. While solvent-based seam adhesives are still used, the butyl-tape systems have been widely adopted and apparently are very successful.

Figure 21: In retrofitting older EPDM roofs, all flashings are generally replaced and target pieces are added at all critical joints.

Tee joints are always critical. In some systems, butt endlaps are used, followed by a batten cover that extends beyond the side lap (*Figure 20*). Other manufacturers are going to "target patches" at the tee joints as an extra line of defense (*Figure 21*).

Consultants may also recall that the implementation of in-seam sealant application (*Figure 22*) gave extra protection against moisture migrating either from below the membrane or from a poorly sealed side lap.

50 YEARS - WHAT HAVE WE LEARNED?

We have learned a great deal. We can offer durable sheets with adequate mil thickness, which are well-positioned in terms of energy conservation, sustainability, and economy.

With the help of SPRI, ANSI, and ASTM, product and test standards have been developed. Single-ply systems are mainstream in both designers' and building owners' eyes. Accessories such as walkways and premolded pipe fittings have solved many of the problems of the bituminous world and

Figure 22: Use of in-seam sealant as extra measure against water penetration.

Figure 23: Polyepichlorohydrin rubber was used in this roof bay in order to resist oil contamination.

Figure 24: King-sized ballast on this roof!

continued evolution of these systems can be expected.

Specialized sheets for chemical and oil resistance are available (*Figure 23*). New versions of single-ply roofing suitable for vegetated roofs are certain to appear.

Perhaps the reader has never seen a ballasted roof like that shown in *Figure 24*, but who knows what form our next generation of single-ply systems will take?

WHAT DO WE STILL NEED TO ACCOMPLISH?

In the presence of product and systems evolution, the key parameter of performance is perhaps the most readily discernable benchmark by which all roof assemblies are measured. Manufacturers promoting new and improved roof components and accessories should strive to provide the end user with comparative performance criteria based upon level of performance.

Some years ago, our European colleagues published articles on the FIT system. This system is an entirely different approach from that in the U.S. The first step in this performance approach is to describe the structure and how the roof is to be used. Industry experts have quantified what levels of fatigue, heat, or impact resistance are needed for a roof system intended to serve in an exposed position, such as a protected roof or a vegetated roof. A roof with a lot of roof traffic, for example, might require a Level Four impact and puncture resistance, while a protected membrane roof might get by with just a Level Two.

Once performance levels are established and the roof described, one need only to search for those systems that meet these levels of performance. Perhaps a 90-mil EPDM would work, but so might a polyester-reinforced MB, a 60-mil reinforced PVC, etc.

Much of this work has already been done and published by the RILEM 74-SLR/CIB W.83 Joint Committee on Elastomeric, Thermoplastic, and Modified Bitumen Roofing in its report, "Performance Testing of Roof Membranes." ASTM has already implemented some of these new tests. Wouldn't it be great if in this decade SPRI joined forces with RCI, ARMA, and NRCA to actually implement this performance concept?

Life-cycle Costing

In closing, there is still another area in which we need to do a better job: the validation of roof life, life-cycle costing (LCC), and sustainability. In just the past couple of months, articles have appeared "proving" that a metal roof – or polyurethane foam – or PVC – has the lowest life-cycle cost. Who is right, and based upon what?

Unfortunately, there are many variables that must to be estimated in LCC analysis. In addition to strictly financial considerations, we must now consider "carbon-footprints," total energy consumption from birth to death, recycling, urban heat islands, toxicity, VOCs, ozone holes, and the energy/petroleum status.

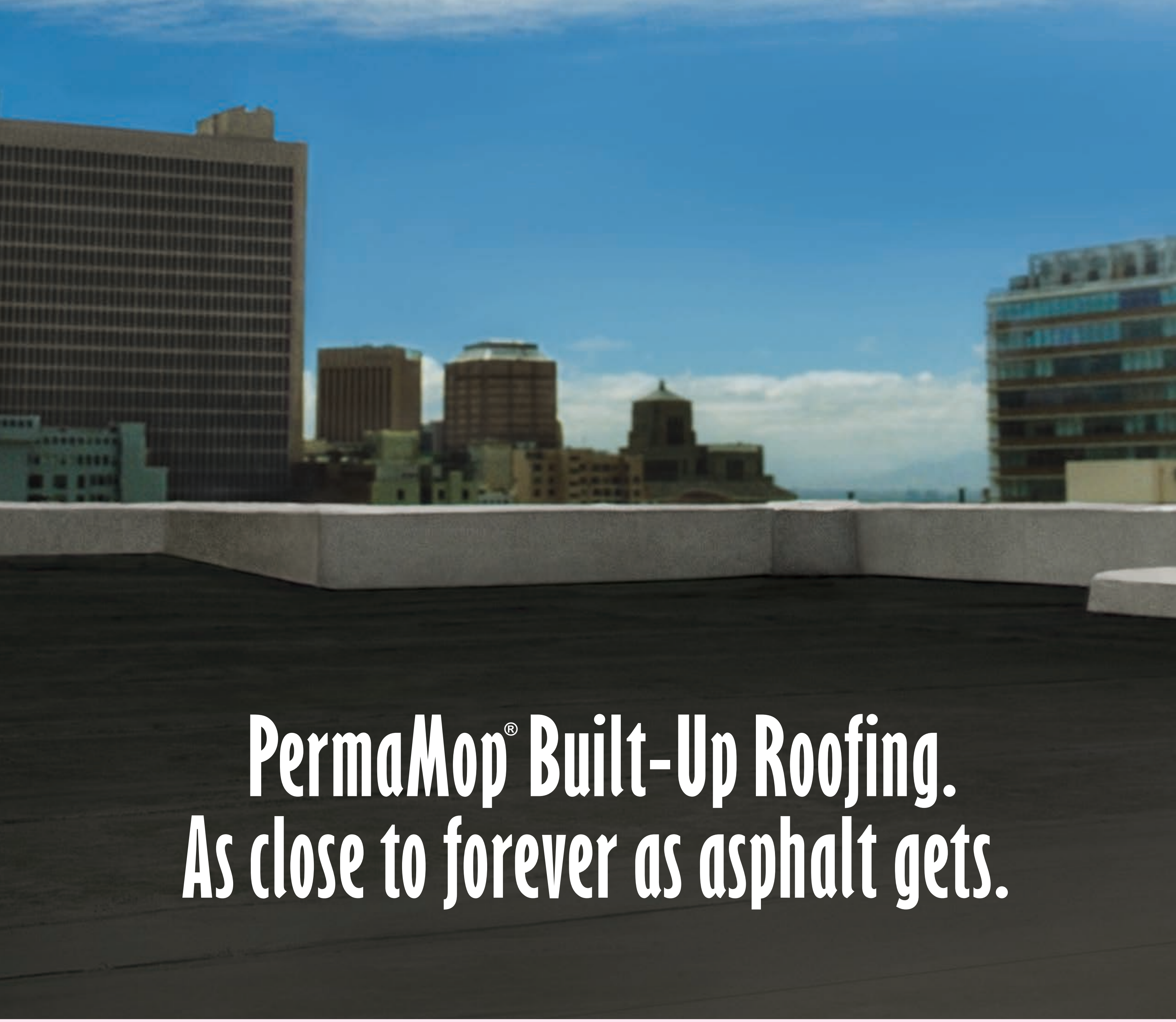
Are We There Yet?

Hopefully, we soon will be able to chart these turbulent waters so that the specifier, consultant, building owner, or government agency can make more rational decisions. There is no single roof system that can do it all. Defining the performance requirements for each roof and building is possible and needs to be further explored. We have the experience and resources to define the minimum requirements for every roof – we just need to do it!

In this past half-century, we have learned a great deal. Our actions over the next few years could enable us to apply this knowledge to determine the most appropriate systems for any given set of conditions.

Dick Fricklas

Dick Fricklas is an author, journalist, and educator. He served as technical director of the Roofing Industry Educational Institute (RIEI) from 1979 until his retirement in 1996. With his coauthor, Bill Griffin, Dick last year completed the fourth edition of the *Manual of Low-Slope Roof Systems* for McGraw-Hill. He is a contributing editor for *RSI* magazine, a web columnist for *Buildings.com* Web magazine, and a contributor to *Interface* journal. Dick holds a B.A. from Hofstra University and a master's in physical chemistry from Rutgers University. His honors include the William C. Cullen and Walter C. Voss awards from ASTM, the J.A. Piper Award from NRCA, the James Q. McCawley Award from the MRCA, and Lifetime Achievement Awards from the Educational Foundation of the Institute of Roofing and Waterproofing Consultants and the Colorado Roofing Contractors Association. He is an honorary member of RCI. Dick and his wife of 49 years, Anita, reside in Centennial, Colorado.



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ACOUSTICS PIPE INSULATION  ROOFING SIDING

CHINESE ROOF RIDGE TILES

This roof tile, which lined the ridge of a home in the Ch'ing Dynasty (17th century AD) in K'ang-hsi, China, is representational of the "guardian king." It was made of biscuit pottery with san ts'ai (three-color) glaze. Totems such as this were used to appease and/or frighten evil forces from the home.

This roof tile, from a 17th century (Ch'ing Dynasty) roof in K'ang-hsi, China, is of Yen Lo, a guardian deity and "decider of life in Hades." It is made of stoneware with three-color lead glaze.

Photos taken at the Museum of Arts and Sciences, Daytona Beach, Florida. Courtesy of Jeff Cramer, RRC.

Construction and the Economy

Construction Earnings Up; "Hot Spots" in Construction Released

By Ken Simonson

Average hourly earnings for construction workers reached $20.95 in June, seasonally adjusted. This was an increase of 92 cents (4.6%) from a year earlier and is 21% higher than the average for all private-sector production and nonsupervisory workers, whose wages rose 3.9% over the 12-month span to an average of $17.38 per hour. Architectural and engineering (A&E) services employment, a harbinger of future construction demand, increased 2,700 for the month and 51,000 (3.7%) over 12 months.

The monthly survey of the Institute for Supply Management (ISM) for June noted that among inputs significant to construction, building materials, copper wire, and roofing were up in price.

"Office rents are skyrocketing across the nation," the *Wall Street Journal* reported, noting the first quarter as the sharpest quarterly increase since the third quarter of 2000. *The Journal* continued, "Nationwide, the office-vacancy rate, at 12.7%, is the lowest since the third quarter of 2001.... But rents are jumping even in markets such as Boston, San Francisco, and downtown Los Angeles, where office-space supplies aren't quite as tight....Relatively cheap space is still up for grabs in most markets in the Midwest and South. [Rents] in Chicago...are actually slightly below what they were in 2000 because so many new office buildings are going up in the city," says Michael Flynn, executive vice president of NAI Hiffman, a real-estate services firm.

Two general indicators of likely "hot spots" for local construction activity were released. The Bureau of Labor Statistics reported on employment by metro area from May 2006 to May 2007. The largest percentage gains were in Gulfport-Biloxi, Mississippi (an area recovering from Hurricane Katrina, which struck in August 2005), 10.2%; Provo-Orem, Utah, 5.7%; Jacksonville, North Carolina, 5.3%; Madera, California, and St. George, Utah, 5.2% each. The largest percentage losses were in Atlantic City, New Jersey, and Janesville, Wisconsin, -2.1% each; Flint, Michigan -2.3%; Elkhart-Goshen, Indiana -2.5%; and Anderson, Indiana, -3.7%.

Ken Simonson

This series on the economy and its impact on the construction industry was prepared by Kenneth D. Simonson, chief economist for the Associated General Contractors of America (AGC). Before joining AGC, Simonson spent three years as senior economic advisor in the Office of Advocacy of the U.S. Small Business Administration and 13 years as vice president and chief economist of the American Trucking Association. Simonson may be reached at simonsonk@agc.org.

Industry News

To submit an industry news item to *Interface,* e-mail it to **kammerman@rci-online.org** or mail it to **RCI, *Interface* Journal, 1500 Sunday Drive, Suite 204, Raleigh, NC 27607.** Note: News must fit journal requirements in order to be published.

WMC&T Employees Earn LEED™ AP

Several personnel of Water Management Consultants & Testing, Inc. (WMC&T), in Destin, Florida, have been awarded the title of LEED Accredited Professionals (LEED™ AP) by the U.S. Green Building Council, which promotes environmentally responsible buildings. For more information on WMC&T, visit **www.watermc.net**.

ABC Purchases Ashley Aluminum

ABC Supply Co. Inc. has finalized its purchase of substantially all the assets of Ashley Aluminum LLC. Ashley Aluminum's 48 branches in Florida, Texas, Alabama, and Georgia are now part of ABC Supply's Town & Country Industries division. ABC Supply, currently celebrating its 25th anniversary, is the largest wholesale distributor of roofing in the United States and one of the nation's largest distributors of siding, windows, and other select exterior building products. Headquartered in Beloit, Wisconsin, ABC Supply operates more than 350 branches in 45 states and the District of Columbia.

CertainTeed Plant Now Largest Roofing Plant in the World

CertainTeed has culminated two years of construction with the official dedication of a new four-wide laminated roofing shingle production line at its plant in Oxford, North Carolina. The plant employs more than 200 people and is adding 55 new jobs with the expansion. The facility already manufactures a number of architectural shingles, has been consistently ranked as one of the safest roofing plants in the U.S. for the past 10 years, and has been honored internationally for safety by CertainTeed's parent company, Saint-Gobain.

NRCA Releases Membrane Manual

The National Roofing Contractors Association (NRCA) has released the *NRCA Roofing Manual: Membrane Roof Systems – 2007.* The 530-page manual updates and replaces the membrane roof system portions of the *NRCA Roofing and Waterproofing Manual, Fifth Edition.*

Firestone Donates to Scholarship Program

Firestone Building Products Company recently donated $5,000 to the Davis Memorial Foundation, the scholarship program administered by the Western States Roofing Contractors Association (WSRCA). Firestone presented the check during the 33rd Annual WSRCA Convention and Trade Show held June 3-6 in Las Vegas, Nevada. Firestone has contributed more than $45,000 to the program since its inception in 1996, including this year's contribution.

Berger Buys Royal Apex

Berger Building Products, Inc. (a Euramax International, Inc. company) has entered into an agreement to purchase substantially all the assets of Royal Apex Manufacturing Co. Royal Apex's operations will be integrated into Berger. Euramax is an international producer of specialty coated coils, metal wall and roof systems, metal and vinyl rain-carrying systems, soffit and fascia systems, roofing accessories, aluminum and vinyl windows and doors, etc.

EcoStar™ Introduces Seneca Plus Tiles

EcoStar™ introduces its newest roofing product – Seneca Plus tiles. Complementing EcoStar's Seneca Cedar Shake Tiles, Seneca Plus tiles are thicker and replicate the look of thick, hand-split cedar shakes. Seneca Plus tiles are manufactured at varying widths of six, nine, and 12 inches, and feature a thick cut that creates the natural appearance of traditional cedar shakes. Like all of EcoStar's premium steep-slope roofing tiles, Seneca Plus tiles are available in nine different colors.

Berger Has New Ridge Vents

Berger Building Products, Inc. introduces Pro-Master Highpoint Series 5 and Series 7 Ridge Vents. Both are backed by a 40-year limited warranty. For more information, visit **www.bergerbros.com**.

Sarnafil G476 Introduced

Sika Sarnafil Inc. announces that its Sarnafil G476 waterproofing membrane is now available in a 6.5-ft.-wide, self-adhered format. The Sarnafil G476 SA waterproofing membrane is a 120-mil-thick composite sheet composed of a 60-mil vinyl waterproofing membrane and a 60-mil, impermeable, closed-cell, foam-backing layer coated with a pressure-sensitive adhesive. The flexible, foam-backing layer conforms around minor irregularities in the substrate and provides a cushion for the waterproofing membrane. Seams are hot-air welded.

Firestone Welcomes Sterrett

Firestone Building Products Company welcomes Bob Sterrett as plant manager of its TPO plant in Las Vegas. Construction of the 256,000-square-foot facility began late last year, and an opening is scheduled for the third quarter of 2007. The new facility will bring Firestone's total TPO membrane production lines to five. With 25 years of experience, Sterrett brings a solid knowledge of the polymer industry to his new role at Firestone. Sterrett's experience includes serving as manager of maintenance and engineering, plant manager and production manager at Solvay Engineered Polymers.

CCM Purchases Premier Building Systems

Carlisle Construction Materials (CCM) recently announced the acquisition of Premier Building Systems, a subsidiary of Insulfoam. The acquisition was part of Carlisle's purchase of Insulfoam from privately held Premier Industries of Tacoma, Washington, in April 2007. Premier Building Systems is North America's largest manufacturer of structural insulated panels (SIPs), building panels used in the construction of walls, floors, and roofs in residential and commercial buildings.

More *Industry News* on page 54

INDUSTRY NEWS

To submit an industry news item to *Interface*, e-mail it to kammerman@rci-online.org or mail it to RCI, *Interface* Journal, 1500 Sunday Drive, Suite 204, Raleigh, NC 27607. Note: News must fit journal requirements in order to be published.

Carlisle SynTec Opens Las Vegas Warehouse

Carlisle SynTec recently announced that United Building Products has opened a new distribution warehouse in Las Vegas, Nevada. United Building Products is Carlisle's exclusive manufacturers' representative and distributor for southern Nevada. Located at 4120 W. Windmill Lane, Suite 105, Las Vegas, Nevada, 89139, the new facility is managed by Jeff Poe and Johnny Yancy.

Spartech Offers New Skylight Protection

Spartech Corporation introduces Ultratuf® CX-D sheet, a high-impact-resistant, thermoformable copolyester for skylights that offers both UV protection and toughness. The Miami-Dade County Florida Building Code Compliance Office has issued a notice of acceptance for its use in high velocity hurricane areas.

FREE ROOF REPAIRS FOR SERVICEMEN

★ ★ ★

The National Roofing Contractors Association (NRCA) will be working with Washington, D.C.-based Rebuilding Together® and its 235 local and state affiliates to provide roof system repairs for military service members, veterans, and military families through two new partnership programs – Heroes at Home and Serving Those Who Serve.

Rebuilding Together is NRCA's national charity partner. Heroes at Home is a proprietary program of Sears Holdings Management Corp., Hoffman Estates, Illinois, created in partnership with Rebuilding Together in response to the need to assist military families facing hardship. Serving Those Who Serve (a partnership between Rebuilding Together and Calabasas, California-based Countrywide Financial), was developed to meet the needs of injured soldiers and veterans returning from Operation Enduring Freedom in Afghanistan and Operation Iraqi Freedom. Both programs focus on making necessary repairs, improvements, or modifications to veterans' and soldiers' homes.

To donate roofing materials or labor or for more information, contact Kaylee Alberico, NRCA's communications assistant, at (847) 493-7592 or kalberico@nrca.net.

CLASSIFIEDS

Find more classified ads online at:
www.rci-online.org/mem-rcitems.htm

Calendar of Events

Red print: RCI EVENT or STAFF-INSTRUCTED CLASS
Blue print: RCI CLASS – NON STAFF-INSTRUCTED
Green print: RCI CLASS – DELIVERED by AFFILIATED CHAPTER
Purple print: RCI-AFFILIATED CHAPTER or REGION EVENT
Black print: INDUSTRY EVENT

Calendar subject to change without prior notice.
Visit **www.rci-online.org** for schedule updates.

AUGUST 2007

2 RRC Review and Update
Chicago, IL

2 Region II Meeting
Atlanta, GA

3 RRC Review and Update
Atlanta, GA

10 Region I Meeting
Albany, NY

17 *Applications due for 11/17/07 RRC exam*

17 Region III Meeting
Detroit, MI

23 Mid Atlantic Chapter Meeting
Charlottesville, VA

23-24 Advanced Waterproofing
Los Angeles, CA

27 Western Canada Golf Tournament and Board Meeting
Northview, Langley, BC

SEPTEMBER 2007

5 *Applications due for 10/20/07 RRO exam*

6 RICOWI Roofing Seminar

7 RICOWI Membership Meeting
New Orleans, LA
Info: www.ricowi.com

7 Chicago Area Chapter Meeting

11-12 Professional Roof Consulting
Chicago, IL

13-14 Wind and Drainage
Chicago, IL

15 RRC Exam *(applications due 6/15/07)*
Chicago, IL

13 Carolinas Chapter Golf Outing

14 Region IV Meeting
San Francisco, CA

19 Region III/Gulf Coast Chapter Meeting
Houston, TX

17-18 Exterior Walls Technology & Science
Chicago, IL

17-18 Professional Roof Consulting
Humber College, Etobicoke, ON

20 Great Lakes Chapter Meeting
Oak Park, MI

20 Western Canada Chapter meeting
Langley, BC

21 Ontario Chapter Meeting

21-22 Mid-year Board of Directors Meeting
Phoenix, AZ

24-25 Roof Technology & Science II
Downey, CA
Delivered by RCI SoCal Chapter
Info: www.rcisocalchapter.org

25 *RRO applications due for 11/9/07 exam*

OCTOBER 2007

3-5 Metalcon International
Las Vegas, NV
Info: www.metalcon.com

3-4 Wind and Damage
Humber College, Etobicoke, ON

5 Advanced Thermal & Moisture
Humber College, Etobicoke, ON

18 Western Canada Chapter Meeting
Langley, BC

18 Mid Atlantic Chapter Meeting
Maryland

17 Roof Asset Management
Dallas, TX

18-19 Rooftop Quality Assurance
Dallas, TX

20 RRO Exam *(applications due 9/5/07)*
Dallas, TX

19 Ontario Chapter Meeting

20 Great Lakes Chapter Meeting

21-25 SMACNA Convention
Las Vegas, NV
Attn: www.smacna.org

24 *Applications due for 12/8/07 RRO exam*

24-26 Midwest Roofing Contractors Association
Nashville, TN
Info: www.mrca.org

25 Region II & III Meeting
Nashville, TN

NOVEMBER 2007

8-9 Symposium on Building Envelope Technology
Boston, MA

8 Carolinas Chapter Meeting

9 Region III/Ohio Valley Chapter Meeting
Indianapolis, IN

9 RRO Exam *(applications due 9/25/07)*
Charleston, SC

13-14 Roofing Tech and Science I
San Francisco, CA

15-16 Roofing Tech and Science II
San Francisco

15 Western Canada Chapter Meeting
Langley, BC

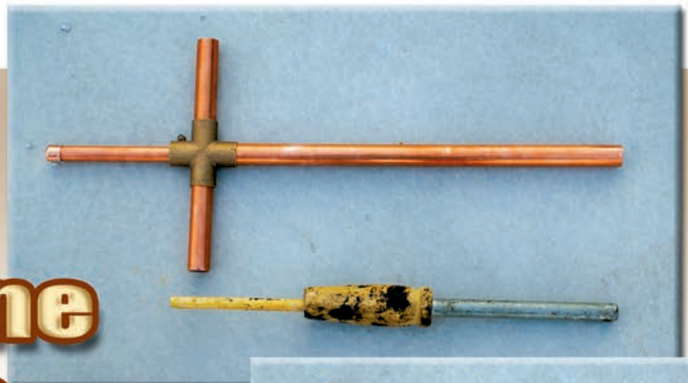
14 Advanced Thermal & Moisture
Raleigh, NC

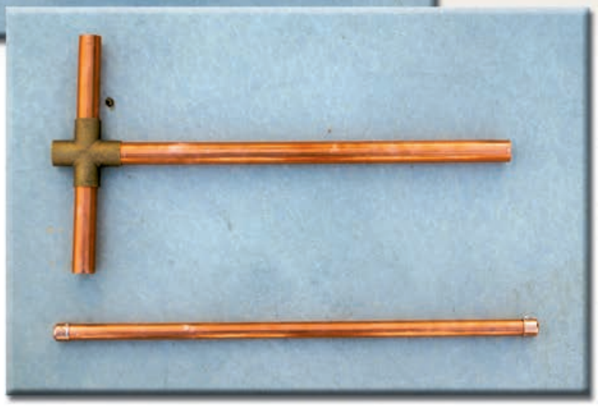
15-16 Professional Roof Consulting
Raleigh, NC

15-16 Rooftop Quality Assurance
Humber College, Etobicoke, ON

ADVERTISERS' INDEX

Removing Polyurethane Foam Cores





BY

DONALD R. MAPES, RRC

Anyone who has ever taken multiple, small cores of an existing, sprayed-in-place polyurethane and coating roof system will understand the difficulty with removing clean, small cores of the foam.

Following is one method of making and using a durable and inexpensive core tool specifically for sprayed-in-place polyurethane and coating roof systems.

Start by obtaining a 24-inch length of 3/4-inch copper pipe, a 3/4-inch brass "cross" fitting, and a 14-inch length of 5/8-inch thick dowel stick. All this is available at most hardware stores.

Next, cut the 3/4-inch copper pipe into one 12-inch and two 6-inch pieces.

Solder the 12-inch length of copper pipe into any of the four openings of the "cross" fitting.

Solder the two 6-inch pieces of copper pipe in the adjacent "cross"-fitting openings on either side of the 12-inch copper pipe.

Using a file, remove any sharp ends on the two 6-inch pipes that form the handle of the tool.

Again, using a file, sharpen the inside and outside of the end of the 12-inch copper pipe that is the core tube.

Grasping the 6-inch handles, one in each hand, push the 12-inch core tube into the polyurethane foam to be sampled. Insert the core tube to whatever depth desired.

Remove the core tube from the polyurethane foam. Insert the 5/8-inch dowel stick into the top opening of the brass fitting and push the extracted core out of the core tube.

DON'T MISS the (occasional) articles in "Tricks of the Trade for RCI Consultants." Upcoming "tricks":

- How a "Wonderbar" Can Prevent Falls.

Please submit your own "Tricks of the Trade for RCI Consultants" to Kristen Ammerman at kammerman@rci-online.org.

Outside Back Cover - Cover 4
Full Page Ad
4-Color
GAF
Pick-up from April/May ‘07, OBC (Cover 4)
“Diamond Pledge”