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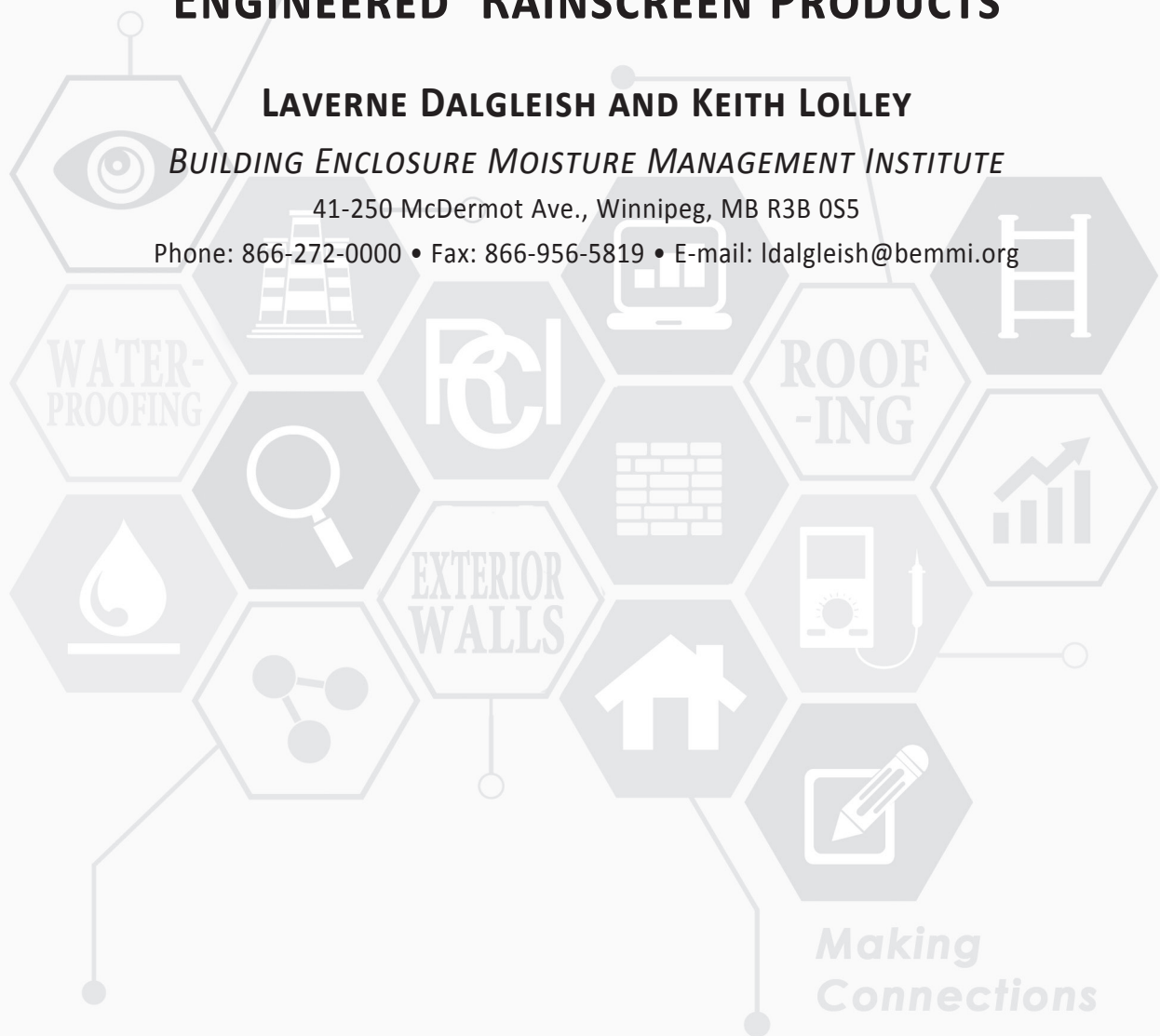
DESIGNING AND BUILDING RESILIENT WALL SYSTEMS WITH ENGINEERED RAINSCREEN PRODUCTS

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ABSTRACT

Moisture management is the single most critical function in designing and constructing a building. Today owners want buildings that are resilient, efficient, and durable. This presentation covers the key benefits and requirements to building a resilient wall assembly and explores the use of engineered rainscreen technology to do so. The presentation will cover how an engineered rainscreen functions and how this technology can be used to build a resilient wall assembly. The new standard, ASTM E2925 – 14, *Standard Specification for Manufactured Polymeric Drainage and Ventilation Materials Used to Provide a Rainscreen Function*, will be introduced and explained. The paper will show how a rainscreen wall can improve upon traditional construction methods and how it can be designed and constructed to produce a resilient wall assembly.

SPEAKER

LAVERNE DALGLEISH — BUILDING ENCLOSURE MOISTURE MANAGEMENT INSTITUTE

LAVERNE DALGLEISH is an internationally recognized speaker. He travels all over North America to give presentations on the benefits of using rainscreen products to build resilient wall assemblies. This education mission includes working with standards development organizations, training and education groups, government policy departments, and quality assurance program developers for the construction industry. Dalglish has given presentations at many of the big conferences, including Construct and Better Buildings: Better Business, Illinois and Wisconsin.

NONPRESENTING COAUTHOR

KEITH LOLLEY — BUILDING ENCLOSURE MOISTURE MANAGEMENT INSTITUTE

KEITH LOLLEY is a graduate of Southern New Hampshire University with a bachelor's degree in business management. He has been involved in the construction industry for 17 years and is the vice president of Advanced Building Products while holding a seat on the board of directors for the Building Enclosure Moisture Management Institute (BEMMI).

DESIGNING AND BUILDING RESILIENT WALL SYSTEMS WITH ENGINEERED RAINSCREEN PRODUCTS

Over the years, there has been a tremendous amount of innovation in the building community. There are more product options available to designers and installers than ever before. We see and read the words “innovative” and “sustainable” in numerous print ads and in manufacturers’ literature, yet with all these innovations, why do a majority of the buildings built now not hold up as well as buildings built 80 years ago?

Keep in mind that the word innovative means new, not necessarily better. In today’s competitive market, steps are taken to decrease costs while still trying to maintain the look and feel of building materials that built our history. For example, a very popular veneer is manufactured stone. Although the product looks very similar to real stone, it is not real stone. It will not have the same characteristics of real stone, and that is all right. We just need to know the correct measures that need to be taken to increase the longevity of the new materials being used today. So when it comes to innovation, the key is to identify a potential problem with the current system or product and figure out how to improve upon it.

According to ASTM reports, roughly 90% of all wall failures are the result of moisture-related issues. This is a real problem. This paper will tackle the moisture issue and offer up innovative solutions to fix this problem.

Moisture damage comes in many forms. The most noticeable is the degradation of exterior finishes, such as the peeling of paint from cladding or the formation of white salt-like substances on masonry veneers, known as efflorescence. Although these signs of moisture are eyesores, they are not harmful per se to the building owner or occupants. The harmful elements will be found inside those wall structures. Toxic mold that leads to poor indoor air quality can physically harm the building’s occupants. The presence of moisture can cause the corrosion of metal reinforcing and greatly reduce the energy efficiency of

the building, as well. If not detected and remediated, these issues can further lead to rot and structural failure. So how do we eliminate moisture from getting into the wall system? Before we answer that question, we need to first ask ourselves how moisture gets into wall systems (*Figure 1*).

Three conditions are required for moisture to be able to move through a wall system:

- A moisture source
- An opening or path for moisture to enter
- A driving force to move the moisture through the opening

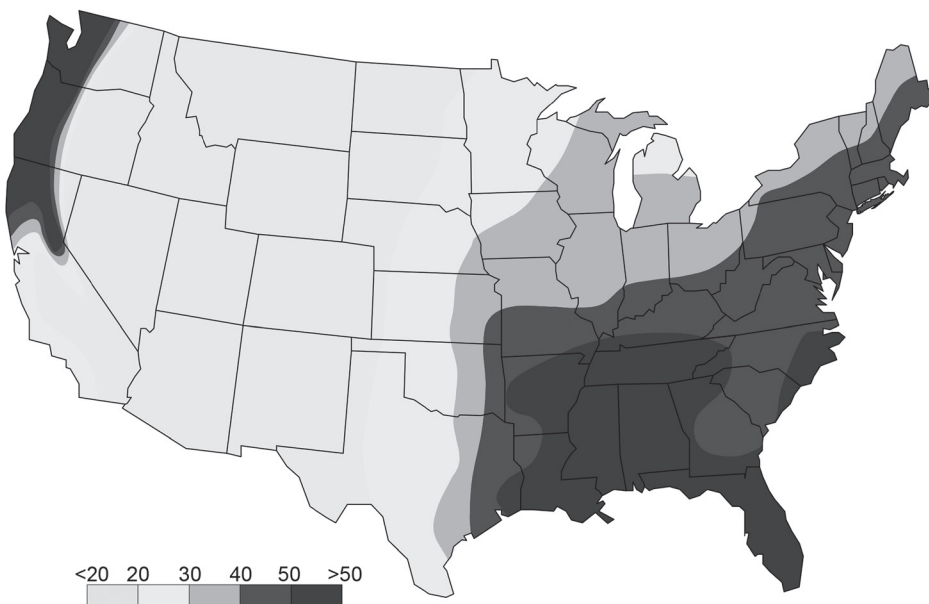
All three of these factors must be present in order for moisture to find its way into a wall system. Typical sources of moisture are rain, snow, and wind. Designers in geographical areas that receive 20 inches or more of rainfall annually need to be mindful when designing wall structures. Coastal areas and areas prone to tropical storms are in the high-risk zones. The map in *Figure 2* indicates which areas in the United States

are most prone to excess rainfall on an annual basis.

When it comes to wind, we need to focus on these geographical areas, since rain doesn’t typically just fall straight down. Wind-driven rain can have a significant hor-



Figure 1 – How does moisture get into a wall system?

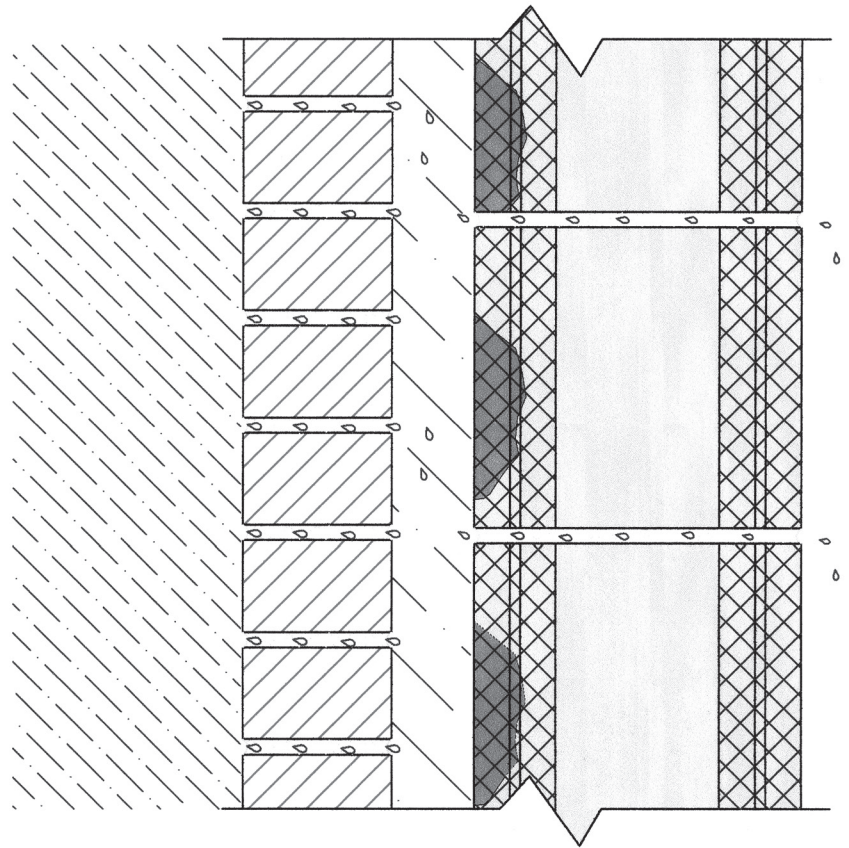


Annual Precipitation (in.)

Figure 2 – Annual precipitation in inches.



Figure 3 – An incorrectly installed downspout caused major moisture damage.



Moisture Migration

Figure 4 – Moisture migration.

horizontal velocity. For example, an 80-km/h (50-mph) wind exerts 41.3 kPa (6 psi) of pressure on a wall's surface. This is enough pressure to force moisture into a crack of any size. Coastal areas are some of the most prone areas for excessive windfall.

Snow is another factor that needs to be taken into serious consideration. For example, New England can receive a large amount of snow and especially ice buildup over the course of a winter, causing considerable damage to a wall system. Since these areas are known for strong temperature fluctuations, where warm summers call for air-conditioned spaces and cold winters call for heated spaces, walls must be designed to handle the moisture intrusion coming from the exterior and the interior.

Other sources of moisture we cannot forget about are man-made. Lawn sprinklers, for example, need to be installed and maintained to be sure the water is aiming away from the wall, not hitting the side of the wall for multiple hours every day.

Downspouts are another issue. The wall in *Figure 3* has tremendous moisture damage. The downspout was installed incorrectly, shedding all moisture directly at the wall.

For leakage to occur, there must be an opening in the wall...anywhere in the wall. People are often quick to assume moisture penetration only happens at wall openings, such as window and door locations. The truth is, windows, doors, vents, and cracks caused by differential movement, and the basic porosity of building materials are all potential entry points for moisture. Once the opening exists, moisture will be driven into the wall via kinetic forces, gravity, capillary action, surface tension, pressure gradients, and diffusion (*Figure 4*). Not all of these sources must be present for moisture to enter a wall system. Unlike the three conditions mentioned earlier, only one has to be present in order to move moisture into the wall envelope and cause significant damage.

The momentum or force of wind-driven raindrops carrying moisture through cracks

is known as a kinetic force. Gravity becomes an issue when poor design elements are present. An example would be poor flashing installation that causes moisture to build up within a wall and not drain out. The gravitational pull will force moisture back into the wall system via cracks and openings. All flashings should be installed with a drip edge, which slopes moisture away from the building to help prevent gravity from working against the wall system. Unfortunately, this isn't always the case.

Capillary action also plays a major role in moisture intrusion. This force allows moisture to cling to horizontal and vertical surfaces and work its way into the smallest of cracks in the cladding. The smaller the crack, the more detrimental it can be to the wall system. Small fissures create a greater suction effect, drawing moisture into the wall system. We all learned of capillary action at a very young age when we would visit the doctor for our annual checkup. Part of the visit was having blood drawn.

Back then, the nurse would prick our finger and use a small glass tube to extract a blood sample. As we watched the blood rise up into the glass tube, capillary action was taking place. Remember how small the tube was? The same concept applies for cracks in siding materials. In porous materials, capillarity is often the main force for water penetration. Moisture is driven through the cladding and held until additional wind pressure, gravity, or kinetic energy can drive the moisture completely through the wall (Figure 5).

When we speak about porous materials, we are basically talking about claddings that consist of stucco, brick, stone, wood, brick veneer, stone veneer, composite siding, fiber cement siding, and concrete block. Below is a breakdown of the market share each siding has.

- Fiber cement siding – 15%
- Stone veneer – 12.9%
- Brick veneer – 11.1%
- Stucco – 11%
- Vinyl siding – 9.6%
- Brick – 9.5%
- Stone – 9.1%
- Wood – 8.3%
- Composite siding – 4.9%
- Concrete block – 3.7%
- Metal siding – 2.2%

All of these sidings, with the exception of metal and vinyl, are considered absorptive claddings. That means roughly 85% of all claddings used in construction today have the ability to allow moisture to be absorbed and passed through them and into the wall system. The other nonabsorptive claddings, which account for roughly 15% of the market, are still prone to moisture-related issues. These non-absorptive claddings are susceptible to the expansion and contraction of building materials like any other cladding. Over time, this movement can create gaps for moisture to enter. Sealant joints can break down, giving a pathway for moisture intrusion, as well. Here is a prime example of moisture getting trapped behind cladding. Once moisture finds a pathway into a wall system, there is little chance

it will just simply go away, which means restoration work is eminent. The cost of restoration due to moisture-related issues can cost anywhere from \$5,000 to over \$300,000, depending on its severity. The cladding, weather-resistant barrier, flashings, insulation, and structural framing often all need to be replaced. Unfortunately, homeowners' insurance does very little to help in the reimbursement due to moisture-related issues. Most insurance policies will only cover a maximum of \$5,000 under their "fungi, wet or dry rot, or bacteria" clause (Figure 6). This often will not cover the cost of removing the damaged building materials, let alone replacing the materials that will be involved. Poor indoor air quality (the result of toxic mold growth) will soon follow, which could harm the building's occupants. We have seen this happen in numerous schools across the country. Building maintenance will increase, while the actual lifespan of the building will do just the opposite. We have seen structural components rust to the point of failure, as well.

Now that we know the common elements of moisture and which cladding materials are absorptive and which are not, we need to take a look at solar-driven

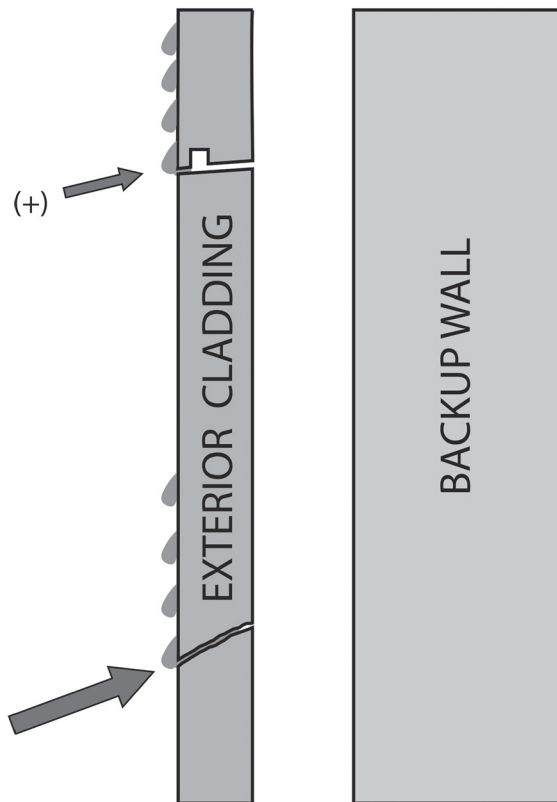


Figure 5 – Capillary action.

moisture. Moisture can cause havoc in a wall system while the sun is shining. Often the external wall temperature is warmer than the interior room temperature. Dark-

SECTION I – PROPERTY COVERAGES ADDITIONAL COVERAGES

The following Additional Coverage is added:

12. "Fungi", Wet Or Dry Rot, Or Bacteria

a. The amount shown in the Schedule above is the most we will pay for:

- (1) The total of all loss payable under Section I – Property Coverages caused by "fungi", wet or dry rot, or bacteria;
- (2) The cost to remove "fungi", wet or dry rot, or bacteria from property covered under Section I – Property Coverages;

Figure 6 – Homeowners' insurance does little to reimburse for moisture-related issues.

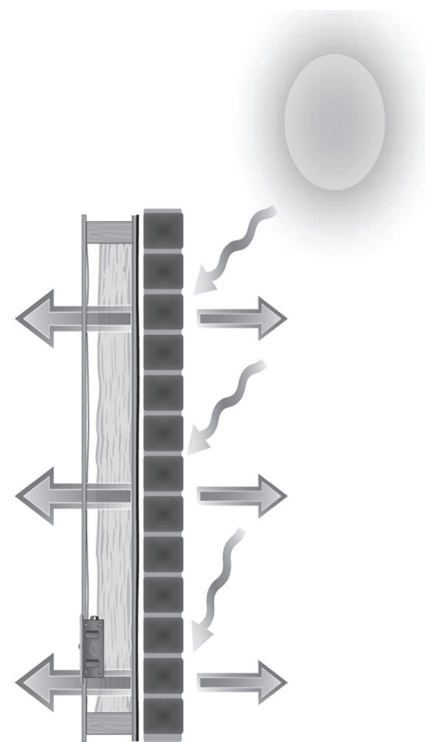


Figure 7 – Solar-driven energy can evaporate some surface air moisture, but it also pushes moisture inward.

Figure 9 – Structural rot leads to toxic mold.



Figure 8 – Weather-resistant barriers installed directly against sheathing does little to help moisture drain out of the wall.



colored paint on the exterior veneer, for example, can help increase the temperature difference between the outside and inside of a structure. This solar-driven energy can evaporate some surface area moisture, but it also pushes moisture inward (Figure 7). Take, for instance, the vapor pressure in cement cladding. It can be greater than 16,000 Pa, while the interior vapor pressure is only 1,300 Pa. When this vapor is driven into the wall system, it can condense inside the wall, causing damaging effects. In most cases, the building owner is completely unaware as to what is happening within his or her wall system.

Numerous wall failures have been reported when absorptive claddings are installed over wood- or steel-framed walls, because the claddings are installed directly up against the weather-resistant barrier that is directly up against the sheathing. There is very little ability for proper drainage

and no ability for ventilation. The weather-resistant barrier helps prevent moisture from saturating the sheathing, but it does very little to help moisture drain down and out of the wall like a vented wall assembly (Figure 8).

Inward solar vapor drive and the lack of a well-defined capillary break within the wall system have been the root cause for many of these moisture problems. In some cases, a small drainage space is provided by a second layer of building paper along with flashing components; however, the control of inward vapor drive is still a concern. The two layers of building paper are very permeable; and masonry claddings, for instance, are very porous and prone to hold significant amounts of moisture. After a long period of rain or even short periods of substantial rain, the sun will drive the trapped moisture already saturated in the cladding further into the wall system. The result is condensed moisture on interior surfaces once contact is made with the inside air-conditioned surfaces, causing structural rot and toxic mold (Figure 9).

When it comes to mold, there are many different forms. Here is an example of how quickly mold spores can germinate.

Aspergillus restrictus, a common form of mold, present in a wall with a relative humidity of 80%, will take roughly seven days to germinate. It will then multiply by an alarming rate of 0.5 millimeters per day. Imagine what the inside of that wall would look like after twelve months. This proves that mold, mildew, and rot are not just seen in older buildings. In fact, the National Association of Homebuilders has conducted numerous case studies showing residential dwellings with severe mold and rotting issues within the first three to five years of being built.

At this point, we have established that moisture is the problem and reviewed various ways moisture enters the wall system. So let's go back to our original question. How do we eliminate moisture getting into a wall system? The answer is...we don't. We need to realize that although it is aesthetically pleasing and what everyone sees when looking at a building, the main point of a cladding is to be the first line of defense against Mother Nature. It should protect the inner structure from most moisture intrusion. It is up to us, the building professionals, to figure out the best way to handle any excess moisture that gets past the cladding. We cannot stop Mother Nature, but can we design our walls to control Mother Nature better?

Dating back to Roman times, walls were simply built thick enough so moisture would never actually make it all the way

through. Many years later, that concept became known in the masonry industry as barrier wall construction. They were right for the most part. Moisture didn't make it all the way through, but the walls were never completely dry, either. Over time, the presence of moisture would work against the barrier wall design and its mortar joints, causing failure. This type of building was also very labor-intensive and expensive.

The next design to handle moisture migration came in the form of a cavity wall, often referred to as a drainage or vented wall. For decades in commercial construction, the cavity wall design has been the go-to design to "drain the rain." These wall systems do very little to prevent moisture from entering the wall system, but they are designed to handle the moisture infiltration when it happens. Cavity walls consist of a backup wall made up of either block or possibly sheathing with a steel-stud structure. Through-wall flashings are then fastened to span from the backer wall to and through the outer veneer—hence the term "through-wall flashing." These flashings are placed at the base of the wall and at any obstruction throughout the wall. These through-wall flashings are often made of metal to hold their shape and allow moisture to drain down and out of the wall system while not allowing penetration to the interior (Figure 10).

A key component to cavity-wall applications is a clear airspace. Often, excess mortar will drop into the cavity during construction. If a mortar-deflection device is not used, the drainage channels at the base of the flashing can become clogged, leaving moisture no way to escape. Mortar deflections are simply placed at all through-wall flashing locations and act as a

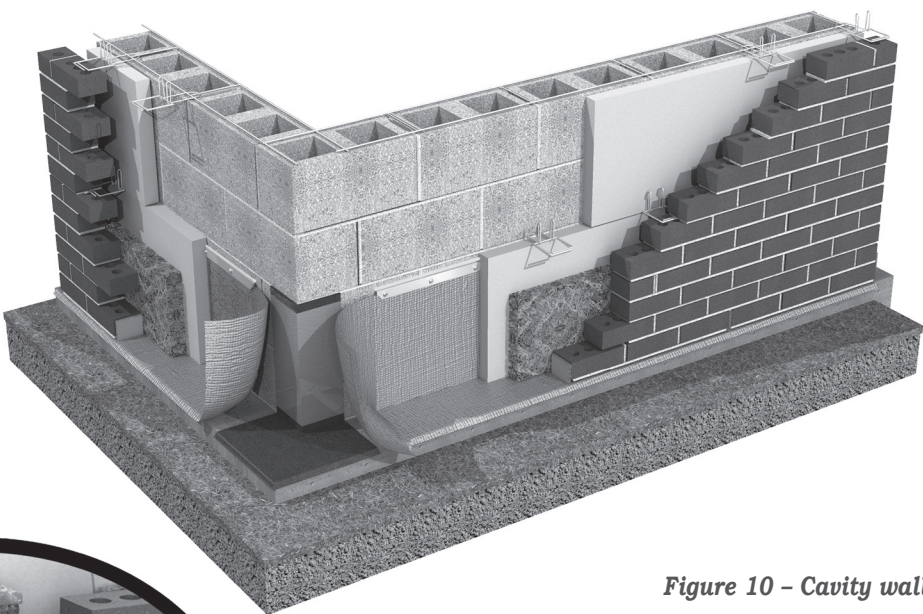


Figure 10 – Cavity wall.

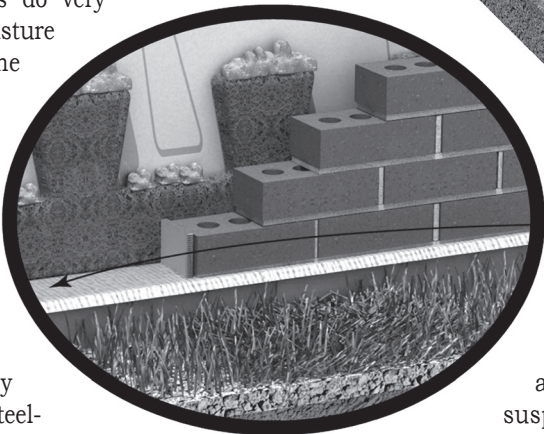


Figure 11 – A key component to cavity-wall application is a clear airspace.

mortar break-up system. Once these mortar droppings are broken up and suspended by the mortar deflection, they will harden into almost rock-like formations, allowing moisture to drain down, around, and out of the wall at weep locations. The key to cavity-wall construction is the airspace. This airspace allows gravity to work with builders, not against them, as previously mentioned. Moisture that enters can drain down and out of the wall system (Figure 11).

Commercial building codes currently allow for a minimum airspace of 25.5 mm (1 in.); however, most designers call for a 51-mm (2-in.) cavity width to protect the

airspace from being clogged with mortar debris. New energy codes, such as the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) 90.1, *Energy Standard for Buildings Except Low-Rise Residential Buildings*, and the International Energy Conservation Code (IECC) 2009, call for increased insulation. This is causing wall space concerns. Cavity airspaces ranging anywhere from 51 mm (2 in.) to more than 102 mm (4 in.) are being seen. The concept is that a wider air space will reduce the ability for mortar to bridge and clog the air space. Keep in mind, a wider cavity inflates the overall cost of a cavity-wall system. Take through-wall flashings, for example (Figure 12).

The best approach to help reduce moisture intrusion in a wall assembly is to build with a ventilated wall, also known as a

Cavity Wall Application	Inches	Typical Flashing Sizes	Sq. Ft. Per Roll	Price to Mason \$2.90/sq. ft.
Brick depth	3.625			
Airspace	2.75	24 in. x 25 ft.	50 sq. ft.	\$145.00 roll
Rigid foam insulation	2	24 in. x 60 ft.	120 sq. ft.	\$348.00 roll
Mortar deflection	10	24 in. x 75 ft.	150 sq. ft.	\$435.00 roll
Flashing height over mortar deflection	4			
24-in.-wide flashing needed	22.375			

Figure 12 – A wider cavity inflates the overall cost of a cavity-wall system.

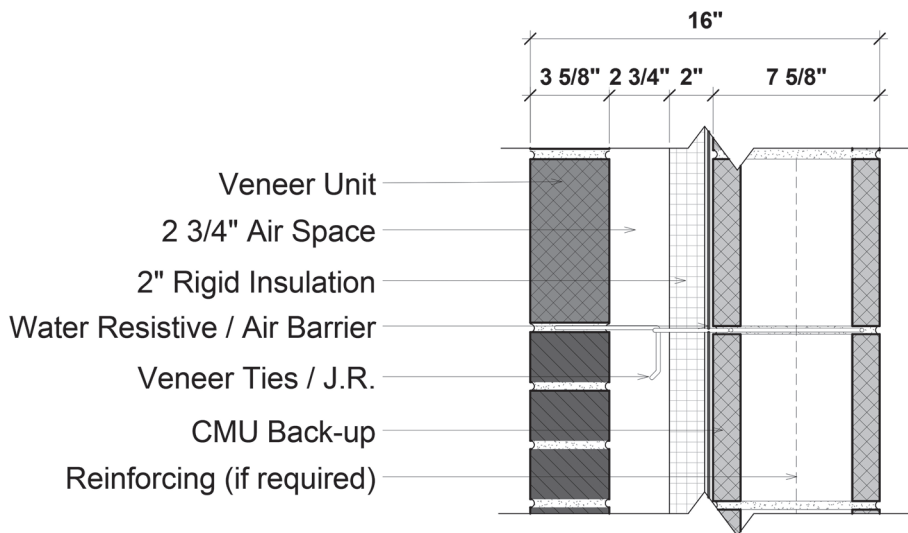


Figure 13 – Pressure-moderated engineered rainscreen wall.

pressure-moderated engineered rainscreen wall (Figure 13). Often, these wall systems are called pressure-equalized rainscreen walls. Pressure equalization is difficult to truly achieve. The goal should be pressure moderation. Air pressure differences across the building envelope can create suction, which draws moisture through the available cracks within the cladding. Air movement due to the pressure differences can carry water droplets directly into the wall system. Pressure differences across the building envelope can result from static pressures that are relatively constant and act on all sides of the building in the same way at any given height.

Wind is the main concern when it comes to pressure differences on an exterior cladding. Air pressure due to wind is typically positive on the windward side of a building and negative on the leeward side. Wind will never be constant. Gusting winds will

always keep the air pressures on the windward and leeward sides of a wall system out of balance.

The further away from neutral these two air pressures are, the more moisture is driven into the wall system. By designing the wall with a capillary break and vents on the top and bottom of the wall, a ventilated wall system is created. Air is introduced into the wall system and circulates in a convective fashion to allow for proper air-pressure moderation, which helps neutralize the pressure differences between the inside and outside environments, in turn reducing the amount of force that allows moisture to be drawn into the wall (Figure 14).

There are differences between a cavity wall and a rainscreen wall system. Although both have airspace, a cavity wall is a vented wall system, which means it allows some air in, but cavity walls do not allow for convective airflow. There will always be a pressure

differential between the outside and inside of the wall system. A pressure-moderated rainscreen wall system is a ventilated wall system and will significantly reduce the differential air pressures that draw moisture into the building. It allows air into the wall system, which neutralizes the air pressure behind the cladding relative to the air pressure outside of the

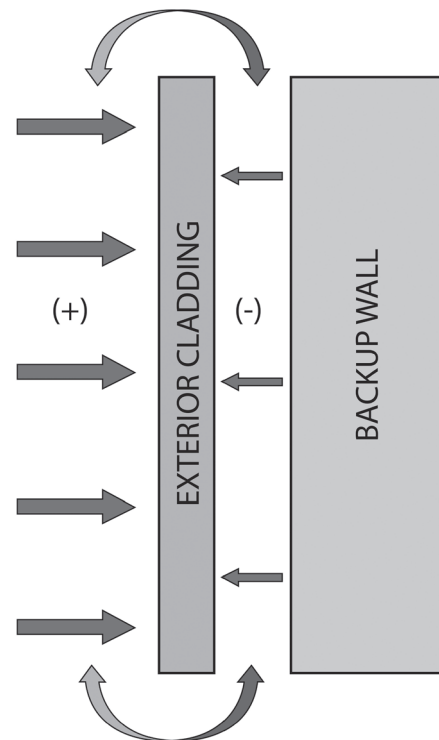


Figure 14 – Designing the wall with a capillary break and vents on top and bottom creates a ventilated wall system.

wall. The key with these rainscreen walls is the capillary break. The wider the airspace, the more air needed to enter the wall system for proper neutralization. Moisture travels in the air, so it is important not to have the airspace too wide. First, it will take longer to neutralize the air pressure because it will take time for the additional air to enter the wall system; and secondly, moisture travels in the air, which means additional moisture will be allowed into the wall system. Designing with an engineered all-wall rainscreen will reduce the airspace while allowing the wall system to perform as intended (Figure 15).

Due to solar heating (buoyancy of warm air) and pressure differential, air rises up the wall and out through vents installed at the top of the wall. The presence of the air and water barrier blocks air from penetrating the backup wall, allowing the introduced air to circulate in a convective fashion. This convective airflow removes excess moisture vapor while drying any residual moisture within the cavity at the same time (Figure 16).

Where cavity walls fight moisture by designing for drainage and only drainage, pressure-moderated rainscreen wall

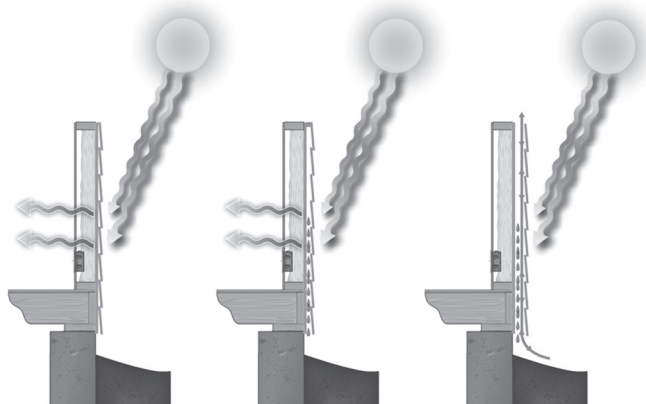


Figure 15 – Designing with an engineered all-wall rainscreen will reduce airspace while allowing the wall system to perform as intended.

systems recognize the drying factor to be equally important to moisture protection. Engineered rainscreen wall systems (Figure 17) typically consist of:

- Backer wall
- Through-wall flashing
- Air/water barrier
- Outboard rigid-foam insulation
- Clear vented airspace with ventilation devices at top and bottom of wall
- Exterior cladding

Looking at the wall components of a pressure-moderated rainscreen wall, pay close attention to two of the categories. First let's look at the air/water barrier. What is the difference among house wraps, water-resistive barriers (WRBs), and building paper? There are more and more of these coming on the market, making it very difficult to know which is right for each particular situation. To make it a little more difficult, there are really no standards to compare one product to the others. The International Residential Code (IRC) calls for the use of WRBs. Most local building codes follow the IRC guidelines, but varying regional practices have led to varying interpretations by builders nationwide.

There is not one solution for all building climates. What works year-round in Massachusetts might not be necessary in Louisiana. What needs to be closely reviewed is the location of the job and the type of exterior cladding being used.

WRBs are designed to prevent air and water from entering the wall system. These products act as a protective shell that will not let water pass from the cladding into the backup wall, but they do let vapor from within the wall escape to the outside. When used as an air barrier, WRBs help reduce utility costs by reducing air infiltration.

So what is classified as a true WRB? The most commonly known WRB is felt or building paper, often referred to as Grade-D Kraft paper. These WRBs are saturated with asphalt to increase the strength and resistance to water penetrations. These products are rated based on the amount of time it takes to wet the opposite side of the paper. For example, 60-minute paper takes one hour to become saturated all the way through. This type of technology is all right, but should only be used as part of a system and not as a stand-alone solution for moisture protection.

Felt paper has been around for a very long time and is often used as part of a two-layer system that includes the Grade-D paper previously mentioned. The newer felt products on the market weigh less than previous versions, and, in turn, are less absorbent. The newer felt products tend to wrinkle when they get wet, which creates minor drainage channels that, when used in a two-ply approach with Grade-D paper



Figure 16 – Convective airflow removes excess moisture vapor.

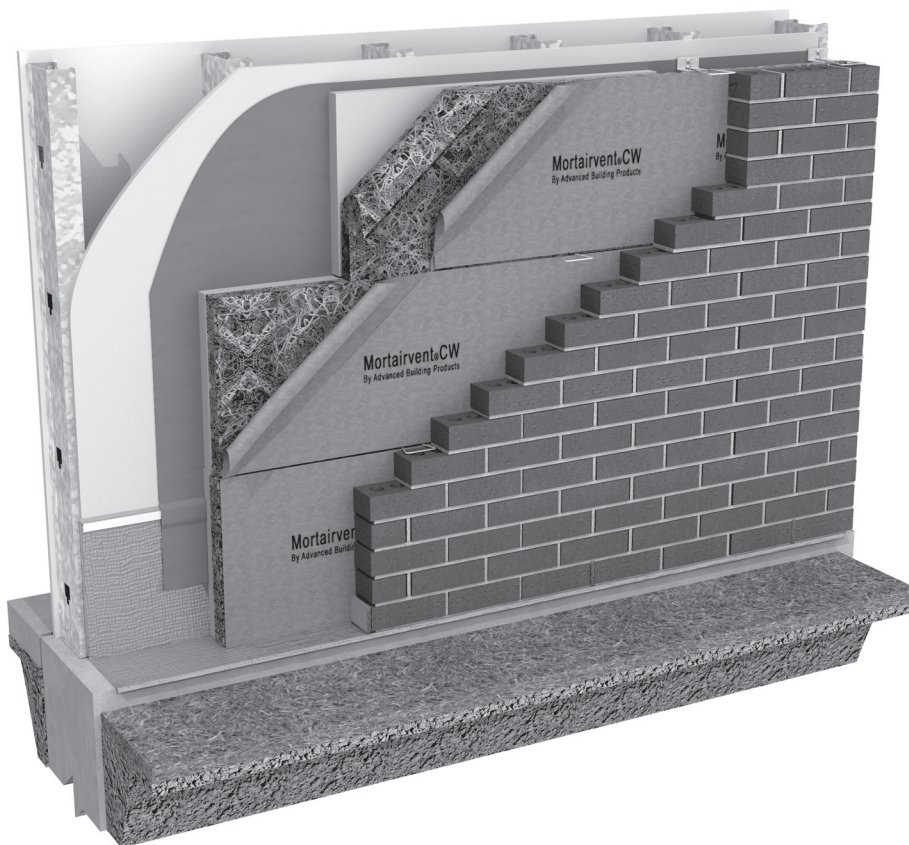


Figure 17 – Engineered rainscreen wall system.

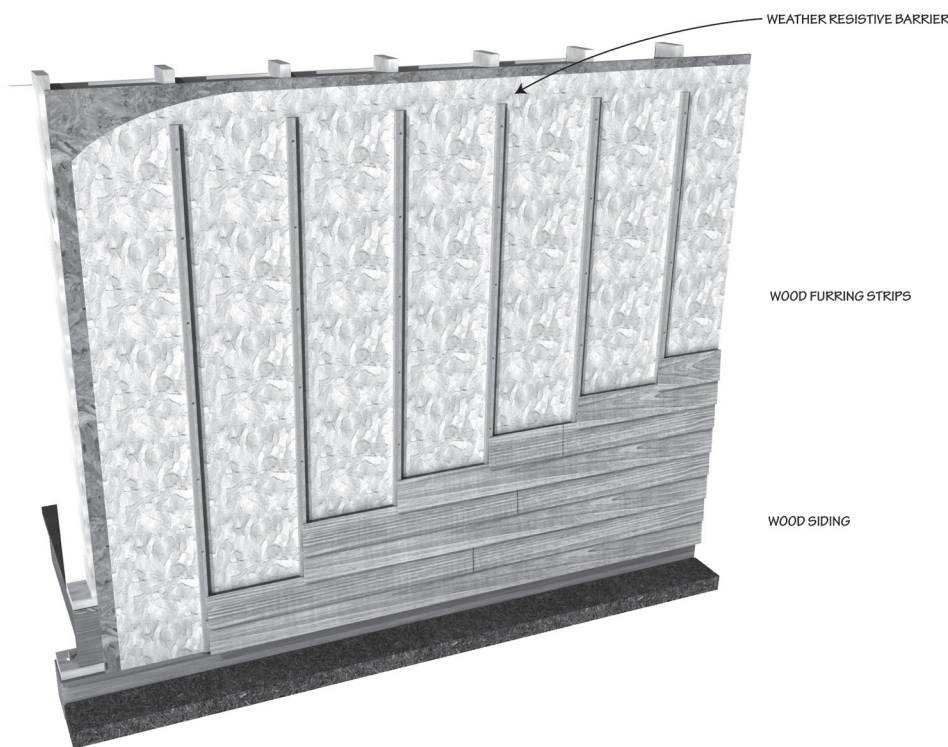


Figure 18 – Nailing wood furring strips over wall studs and sheathing does not allow for cross-ventilation.

in masonry applications, can create a small degree of positive drainage.

House wraps are designed to simply block moisture from reaching the sheathing. They are water-resistant on the outside and allow water vapor to pass through the building envelope if need be. As moisture moves through the various siding materials, it extracts surfactants, such as oil, plasticizer, colorant, resin, oil, and detergents. House wraps can eventually lose repellence and allow water to soak through to the underlying sheathing.

The newest version of a house wrap on the market is called a “drainable” house wrap. These products are multifunctional. They have all the features of a true house wrap, but with a built-in drainage space created by wrinkles, grooves, or specific stencil designs. Although enhanced house-wraps outperform the products previously mentioned, they cannot be used as a stand-alone weather-resistant barrier for masonry applications without installing a sacrificial layer to prevent mortar from clogging the drainage channels.

There is a much more efficient system on the market today: engineered rainscreen drainage mats. Drainable house wraps are designed to do a better job of draining bulk water compared to most house wraps or

building papers; however, they do not solve the problem of drying moisture that remains behind the cladding. Engineered rainscreen drainage and ventilation mats should be used in areas of the country prone to wind-driven rain, excessive rainfall amounts, and geographical areas consisting of higher temperatures and—more importantly—higher

humidity. Engineered rainscreen mats should be installed across the entire surface area of the wall in conjunction with a weather-resistant barrier. This system has a proven effective track record. The airspace is typically $\frac{1}{4}$ to $\frac{3}{4}$ in. between the back of the cladding and the face of the WRB for residential applications. These smaller capillary breaks allow a limited amount of air into the wall system, which neutralizes the air pressure quicker, while also promoting proper drainage and ventilation. The basic laws of physics say an air space of 4.75 millimeters in depth will provide the proper capillary break needed to prevent moisture from bridging from the back of the cladding to the weather-resistant barrier.

There are two ways to create this proper ventilated airspace. The most traditional way in the past was by nailing wood furring strips over wall studs and sheathing after applying a building paper. This process is very labor-intensive and does not allow cross-ventilation within the wall system. Plus, the wood-to-cladding contact can be as much as 15% of the walls’ total surface, giving (Figure 18) trapped moisture that much more room to hide.

Newer (“innovative”) but proven-effective products now on the market are rolled engineered drainage and ventilation mats (Figure 19). These products create a uniform and continuous fixed space behind the cladding. They are proven to drain and ventilate the wall system. They moderate the air pres-

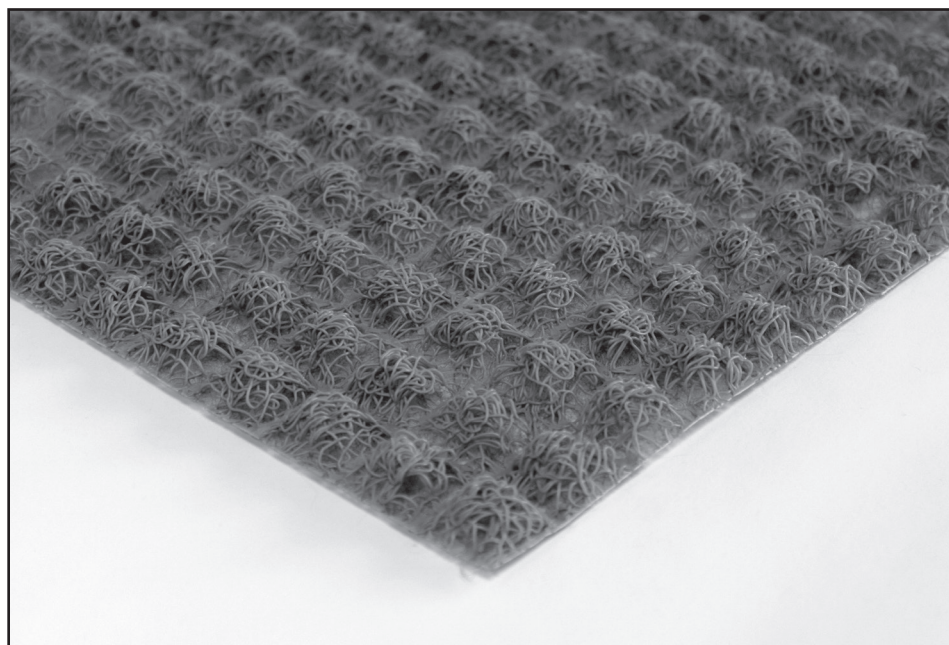


Figure 19 – Rolled engineered drainage and ventilation mats.

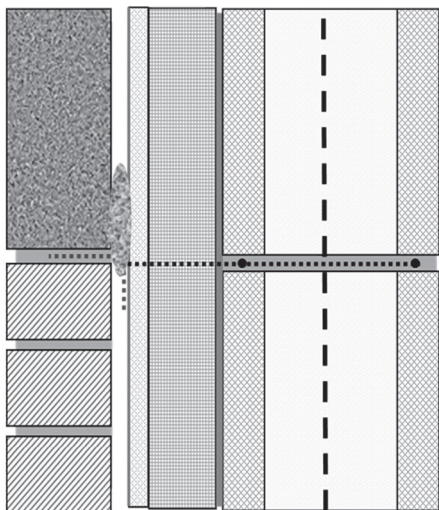


Figure 20 – The filter fabric allows the moisture to pass through and drain down the obstructed channel.

sure behind the cladding and provide the required capillary break needed. Engineered rainscreen drainage mats are easy to install and have proven to reduce efflorescence, protect against deterioration, help prevent mold, improve indoor air quality, decrease maintenance, and increase the lifespan of the building.

Rolled engineered rainscreen drainage and ventilation mats are typically made from a corrugated sheet, a dimpled mat, or a random entangled net material made from either polypropylene or nylon. It is important, for obvious reasons, that the drainage mat material be mold- and mildew-resistant.

Since most buildings are not perfectly square, these drainage mats will be cut on jobsites to fit various voids. The drainage mat specified should have a multidirectional drainage and ventilation path.

These products will be in contact with different types of building materials, such as sealants, tapes, and possibly paint. The drainage mat should be resistant to known chemicals often found on jobsites. These engineered rainscreens need to last the life of the structure, as well. It is important that the products can hold up to wide temperature swings. For example, engineered rainscreen products being installed on the coast of Maine need to be able to handle various freeze/thaw cycles.

One of the most important aspects of an all-wall drainage mat is the Class-A fire rating. It is very important that the product specified have this distinction. Not all engineered rainscreen products meet ASTM

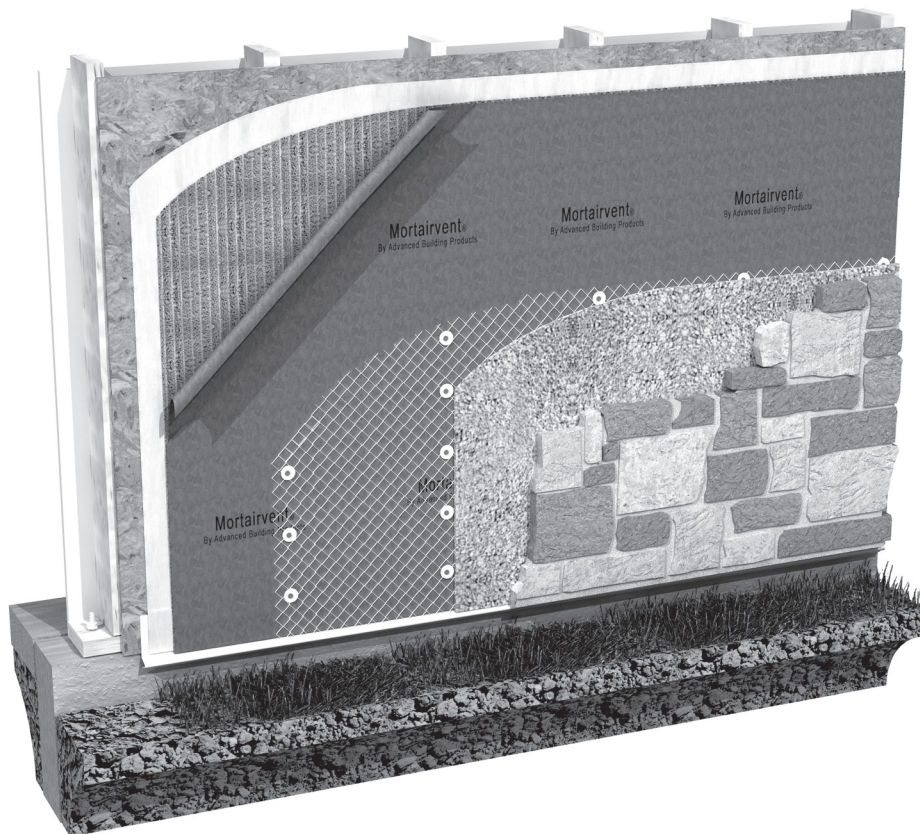


Figure 21 – For masonry applications, materials must be resilient.

E84, so be mindful.

Designers and builders often prefer to incorporate green products in their buildings (green meaning environmentally friendly). Most engineered rainscreen drainage and ventilation mats have recycled content, qualifying for LEED credits.

It is important that the capillary break created by these engineered rainscreens be a minimum of $\frac{3}{16}$ in. or greater, according to ASTM E2925-14. This proper capillary break will greatly reduce the amount of bulk moisture reaching the WRB and will reduce the transmission of surfactants contained within some cladding materials.

When specifying an engineered rainscreen material for masonry applications, it is important that the drainage mat have a filter fabric bonded on one side. This filter fabric not only acts as a mortar deflection, blocking the mortar, but allows the moisture to pass through and drain down the unobstructed channel (Figure 20). The filter fabric increases the sheer and tensile strength of the product while helping keep a uniform airspace for proper ventilation and drainage. Again, for masonry applications, it is important for the materials specified to be resilient, no matter what the climate

may bring (Figure 21). These all-wall products should be expected to last the life of the building.

In commercial applications, drainage mats should not be the same width as the air space. Often, a 25-mm (1-in.) airspace is a nominal 25 mm. There needs to be enough space between the back of the brick and the drainage mat for the mason to fit his fingers, making it easier to lay the brick or stone. Most excess mortar in the bed joints will be forced out of the wall, rather than falling within the cavity. Even if there is a slight mortar buildup, the excess mortar will be met with resistance due to the bonded filter fabric, forcing the excess mortar to the outside of the veneer. If there is a slight mortar buildup, the filter fabric will allow the moisture to drain through and down the wall to its exit point.

Building with an engineered drainage and ventilation mat in masonry applications will allow the cavity size to be reduced, leaving the designer with two options. As seen previously in Figure 13, the air space is 2.75 in. thick. The overall wall thickness is 16 in. By installing an all-wall engineered rainscreen, the cavity can be reduced, along with the entire thickness of the wall, and

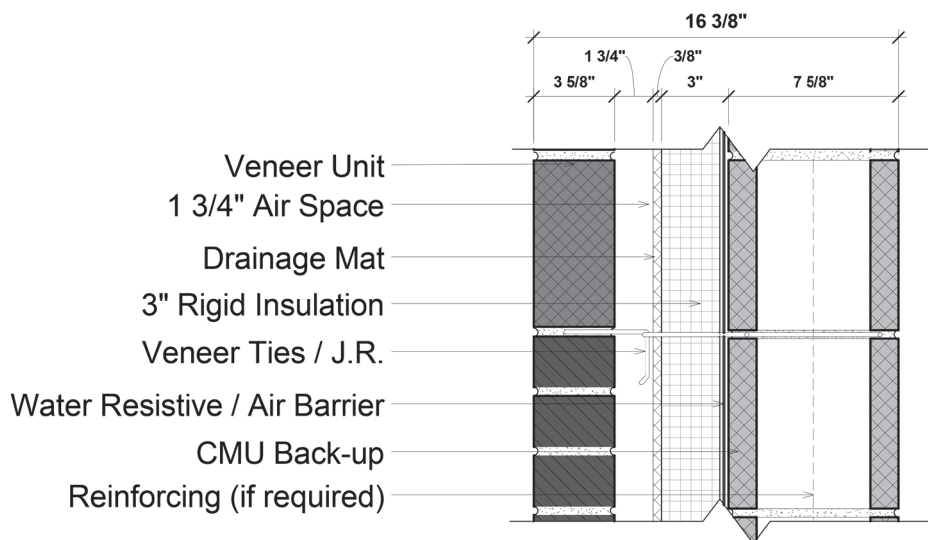


Figure 22 – The designer also has the ability to keep the wall dimensions the same, but increase the R-value of the wall by 33%.

still have the proper drainage and ventilation needed. The designer also has the ability to keep the wall dimensions the same, but increase the R-value of the wall by 33% (Figure 22).

Earlier we discussed a through-wall flashing cost breakdown of a cavity wall. Figure 23 shows the same wall thickness, but built with engineered rainscreen technology. If increased insulation is not desired, the overall wall width can be greatly reduced and still be drained and ventilated as intended.

A common misconception is that using engineered rainscreen drainage and ventilation mats will add cost to a building. The same was said when air barriers came on the market years ago. It is important to realize the long-term benefits that come with this type of wall system.

From a commercial standpoint, designing with an engineered drainage and ven-

tilation mat gives the designer the ability to narrow the air space, which will reduce the width of the various building materials. The first two graphs show that a cavity wall would need a 24-in.-wide through-wall flashing, whereas, an engineered rainscreen wall would need a 16-in. through-wall flashing. Figure 24 shows the cost savings based on a 5,000-lineal-foot wall.

What are other benefits to building with engineered rainscreen drainage mats?

- Reduction in staining and efflorescence
- Protection against deterioration of interior finishes
- Mold prevention
- Promotion of good indoor air quality
- Decrease in overall maintenance of the building
- Decrease in corrosion of building materials
- Increase in life-span of the building

INDUSTRY INVOLVEMENT

Over the last few years, there has been a shift in the building industry towards engineered rainscreen drainage and ventilation materials. Organizations such as the Air Barrier Association of America were the first to point out the importance of protecting the entire building envelope by using a system, rather than a component approach. From a commercial standpoint, engineered rainscreen drainage and ventilation mats help complete that system.

Building codes have also increased awareness of proper drainage. For example, in section 9.27.2.2 of the 2005 National Building Code of Canada (NBC), it clearly states there needs to be “a drained and vented air space not less than 10 mm deep behind the cladding, over the full height and width of the wall.”

Section 602.1.9 of the National Green Building Standard calls for “a) a system designed with minimum ¼-inch air space exterior to the water-resistive barrier, vented to the exterior at top and bottom of the wall and integrated with flashing details. OR b) a cladding material or a water-resistive barrier with enhanced drainage, meeting 75% drainage efficiency determined in accordance with ASTM E2273.”

Section R703.2 of the International Residential Code (IRC) and section 1404.2 of the International Building Code (IBC) both call for a means to drain water that enters the assembly.

Stucco and manufactured stone applications are seeing the value of a drained cavity created by these all-wall drainage mats, as well. The cavity created by these drainage mats gives a cavity wall concept without the cost of a true cavity wall system. Organizations such as the Masonry Veneer Manufacturers Associations (MVMA)

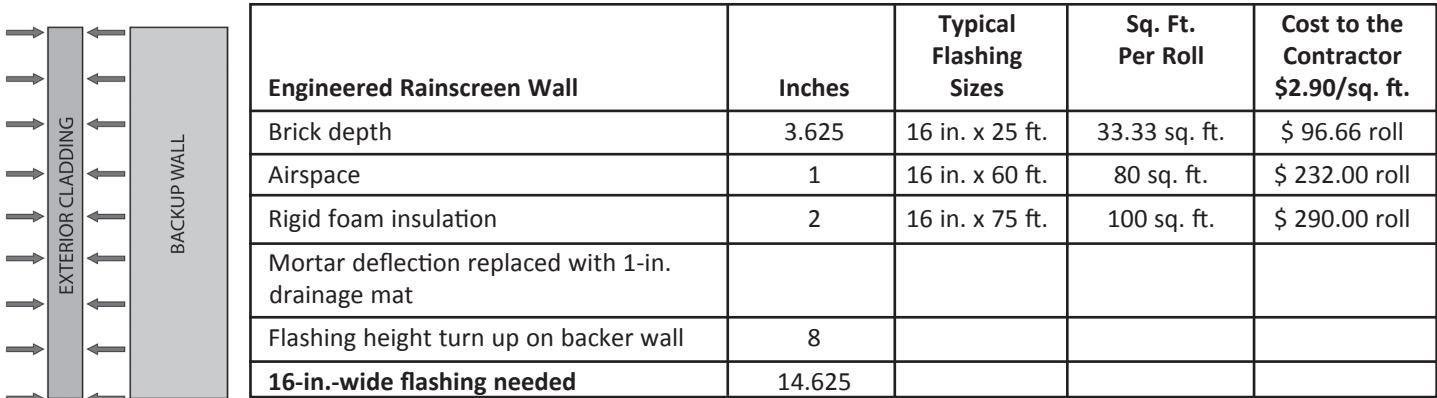


Figure 23

make reference to drainage mats in the third and fourth editions of the *Installation Guide for Adhered Concrete Masonry Veneer*. Major siding manufacturers are putting these drainage mats in their installation instructions and technical details, as well.

In 2009, the Building Enclosure Moisture Management Institute (BEMMI) was formed by four leading industry organizations: Advanced Building Products, Benjamin Obdyke, CavClear, and Cosella-Dörken. BEMMI was formed to bring awareness and—more importantly—solutions to moisture-related issues in wall construction. This organization presents to architectural firms and national trade shows across the country to educate the industry on the importance of building with rainscreen technology.

As briefly mentioned earlier, ASTM E2925-14, *Manufactured Polymeric Drainage and Ventilation Materials Used to Provide a Rainscreen Function*, lays out the guidelines for specifying the most effective type of engineered rainscreen drainage mat. The criteria to meet ASTM E2925-14 focus on eight key elements. Let's go through each test one by one.

Heat aging – ASTM D3045 is intended to define exposure conditions for testing the resistance of plastics when exposed solely to hot air for extended periods of time. ASTM D3045 tests specifically for flexural properties, brittleness, strength, elongation, and plasticizer migration.

Compression testing – ASTM D6108 tests for stress at a given strain, compressive strength, and modulus of elasticity. This test is applicable for recycled plastics and virgin resins.

Surface burning – ASTM E84 tests for the burning characteristics of various building materials. This particular test, in regard to all-wall drainage and ventilation mats, tests for flame spread, smoke density, and whether the material will melt, drip, or delaminate. If so, the continuity of the flame

	Cavity Wall System	Engineered Rainscreen Drainage Wall
25 ft. = 200 rolls needed	\$ 29,000	\$ 19,332
60 ft. = 84 rolls needed	\$ 29,232	\$ 19,488
75 ft. = 67 rolls needed	\$ 29,145	\$ 19,430

Figure 24

front is destroyed, resulting in a low flame-spread index.

Nominal thickness testing – ASTM D5199 tests for compressibility and rebound characteristics. This test method determines nominal thickness, not minimum thickness.

Drainage efficiency – ASTM E2273-03 tests for water penetration.

Immersion test – ASTM D5322-98 tests for the chemical resistance of a geosynthetic when in contact with liquid waste. This test does not establish, by itself, the behavior of geosynthetics when exposed to liquid.

Short-Term Compression – ASTM D6364-06 is a single-plane test to show compressive behavior, but does not reflect the installed performance of the synthetic drainage system.

Ultraviolet (UV) testing – ASTM G154-12a tests the effects of the UV portion of sunlight, moisture, and heat when materials are left exposed for long periods of time.

There are many options on the market today to help prevent moisture intrusion in a building envelope. Pressure-moderated rainscreen wall systems to date are the most effective design, not only to handle moisture intrusion, but also to help reduce moisture intrusion. The airspace technology is crucial for both residential and commercial applications. Proper draining and drying can be achieved now in the residential sector by basically creating a cavity-wall concept for homeowners without the true cost of a cavity-wall system. On the commercial side, wall space issues are no longer as concerning when utilizing the proper all-wall drainage mat, depending on the application.

With any new product or technology, it

takes time to test and prove its effectiveness in the field. Engineered polymeric drainage and ventilation mats have been in the field long enough now to prove their worth. Be mindful when specifying or building with these products that they do what the manufacturer claims they do. In order to meet ASTM E2925, the product needs to pass all the criteria, not just one or two of the criteria.

We spoke about a ¼- or ⅜-in. engineered rainscreen being sufficient for residential applications. From a commercial standpoint, a drainage mat ranging from ⅜ in. up to 1.6 in. works well for cavity wall applications ranging all the way up to a 2-in. airspace. Remember, commercially speaking, do not specify a drainage mat that is the exact same width as the cavity. Construction will never be perfect. There will always be unforeseen curveballs. It is important that we know this and design products to help the contractor build a better wall. Using engineered drainage and ventilation mats are the next step towards building healthier walls.

Remember to ask the following questions before designing or installing your next project:

- What is the total rainfall and frequency in the area being built?
- What are the wetting and drying cycles?
- Is the structure being built in a high wind and storm area?
- How often will the area experience freeze-thaw conditions over the course of an average year?
- What are the average temperatures where construction is to take place?
- Is this a humid zone?

Taking your time to choose wisely means never having to do it over again. 