CONSTRUCTION CANADA

Understanding Engineered Rainscreens

Moisture management for masonry assemblies

By Keith Lolley, CSI

When considering the numerous cladding materials on the market, it is important to keep in mind there are really only two types: those that absorb moisture and those that do not. Absorptive claddings include wood, fibre cement, adhered veneers, brick, and stucco; the non-absorptive category encompasses metal, glass, and vinyl. Although some claddings are non-absorptive, this does not mean water cannot enter the wall system. Expansion and contraction of the wall system over time will cause sealant and mortar joints to crack. Differential air pressure will allow moisture to be drawn into the wall system through these cracks.

Most commercial wall assemblies consist of a cavity wall design, which is designed to properly 'drain the rain' (Figure 1). These systems are typically designed with a backup wall, air space, and outer veneer. Moisture management components such as through-wall flashings (Figure 2), mortar deflections, and drainage devices at flashing locations are used to divert moisture entering the wall back to the outside.

One of the key elements to a cavity wall design is the air space between the outer veneer and inner wall system. In order for a cavity wall to function, this space needs to be free of mortar debris. A clear airspace means a clear path for drainage. Currently, a 51-mm (2-in.) cavity width is the industry standard for commercial cavity wall construction; however, with new energy codes—such as American Society of Heating, Refrigerating, and Air-conditioning

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Figure 1

Most commercial wall assemblies consist of a cavity wall design, which is designed to properly 'drain the rain.' This means a backup wall, air space, and veneer.

Figure 2

An example of a through-wall flashing product.

Engineers (ASHRAE) 90.1, *Energy Standard for Buildings Except Low-rise Residential Buildings*—there is a call for increased insulation.

This increase in insulation is causing wall space concerns because it also means an expansion of air space. In turn, this means it is less likely to become clogged with debris and function incorrectly. Cavity airspaces ranging anywhere from 51 mm to more than 102 mm (4 in.) are now being seen. This increased thickness inflates the wall system's overall cost, which in turn is making the cavity wall system less competitive compared to alternative design methods in the market, such as concrete tilt-up and insulated metal panel (IMP) assemblies.

Engineering the rainscreen

Although engineered rainscreen wall systems have been around for some time, there is still confusion as to the difference between a pressure-equalized rainscreen wall and a cavity wall. To clarify the confusion, the terminology must first be slightly modified. Pressure equalization is a lofty goal that is difficult to truly achieve. In reality, the goal is to create a pressure-moderated wall system. These systems are known as ventilated façades or modified rainscreen walls.

Differential air pressures between the inner wall and outside environment will draw moisture into the wall system's inner structure (Figure 3). A cavity wall system does little to prevent this from happening because it is a vented wall system, which means there is no convective airflow due to the lack of vents installed at the top of the wall system.

A pressure-moderated rainscreen is a ventilated wall system. It significantly cuts down on the differential air pressures drawing moisture into the building by allowing air into the wall system, neutralizing the pressure behind the cladding to that outside the wall system. As air is introduced into the cavity, it works its way up the wall and out through vents installed at the top of the wall.

The presence of the air/moisture/vapour barrier blocks air and moisture from penetrating the backer wall, allowing the introduced air to circulate in a convective fashion. This convective airflow removes excess moisture vapour while drying any residual moisture within the cavity at the same time (Figure 4).

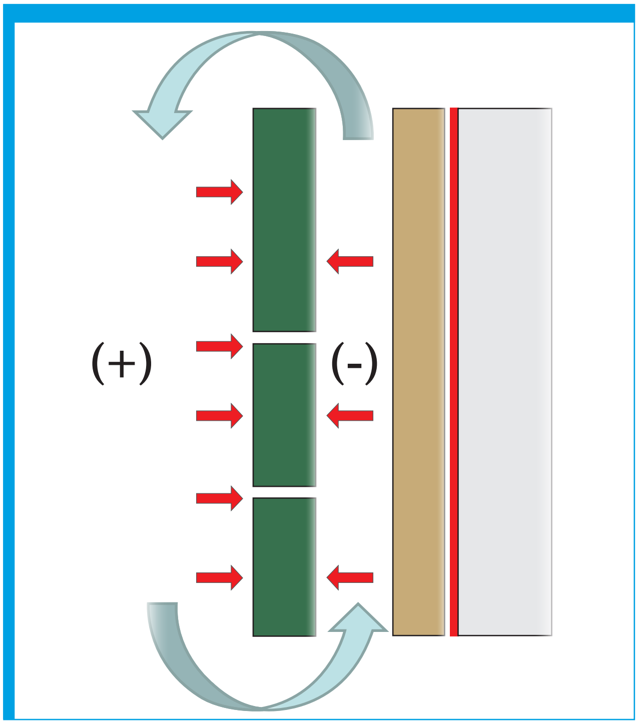
As shown in Figure 5, a typical pressure-moderated wall system consists of:

- backer wall;
- through-wall flashing;
- air/moisture/vapour barrier;
- outboard rigid foam insulation;
- clear vented air space with ventilation devices at the top and bottom of walls; and
- tough exterior cladding.

Since new energy codes are causing designers to increase the overall cavity depth, these wider cavities will take longer to neutralize because the wider the air space, the more air needed to enter for neutralization. By incorporating an all-wall drainage mat, the air space can be reduced without compromising its intended functionality.

For example, a 406-mm (16-in.) wide wall system with 51-mm (2-in.) rigid outboard insulation could have its 70-mm (2 ¾-in.) air space reduced to 44.5 mm (1 ¾ in.) to neutralize the air pressure quicker (Figure 6). More importantly, it also allows the

Figure 3



For ventilated façades, differential air pressures between the inner wall and outside environment will draw moisture into the wall system's inner structure.

designer to increase the R-value of the same 406-mm wide wall system. If increased insulation is not desired, the overall wall system can be greatly reduced and still drain and ventilate as intended.

A common misconception is using an engineered rainscreen drainage and ventilation mat adds cost to a building. (The same was said when air barriers came on the market years ago.) From a commercial standpoint, designing with an engineered drainage and ventilation mat narrows the air space, which reduces the size of many wall components and, in turn, costs.

Figure 7 uses through-wall flashings as an example. A typical cavity wall application has a mortar deflection usually 254 mm (10 in.) in height. To avoid mortar bridging atop these mortar deflections, it is recommended the through-wall flashing extend a minimum of 102 mm (4 in.) above the mortar deflection. When building with an engineered rainscreen wall, the all-wall drainage and ventilation mat eliminates mortar bridging issues and allows the flashing to only extend 204 mm (8 in.) up the wall, knowing the air/vapour barrier will be installed and shingled over the flashing.

As Figure 7 illustrates, the flashing costs are significantly reduced. For a typical 1524-m (5000-ft) long wall, the potential flashing savings are illustrated in Figure 8. Thanks to the proper drainage and ventilation associated with all-wall drainage mats, excess moisture will not be present within the wall system. This means significant advantages, such as:

- increased energy efficiency;
- reduced exterior surface staining and efflorescence;
- protection against the deterioration of interior finishes;
- reduced chances of toxic mould;
- promotion of good indoor air quality (IAQ);
- decreased overall maintenance needs;
- reduced corrosion of building materials; and
- increased lifespan of the building.

Sizing the space

As previously mentioned, the industry standard for a cavity

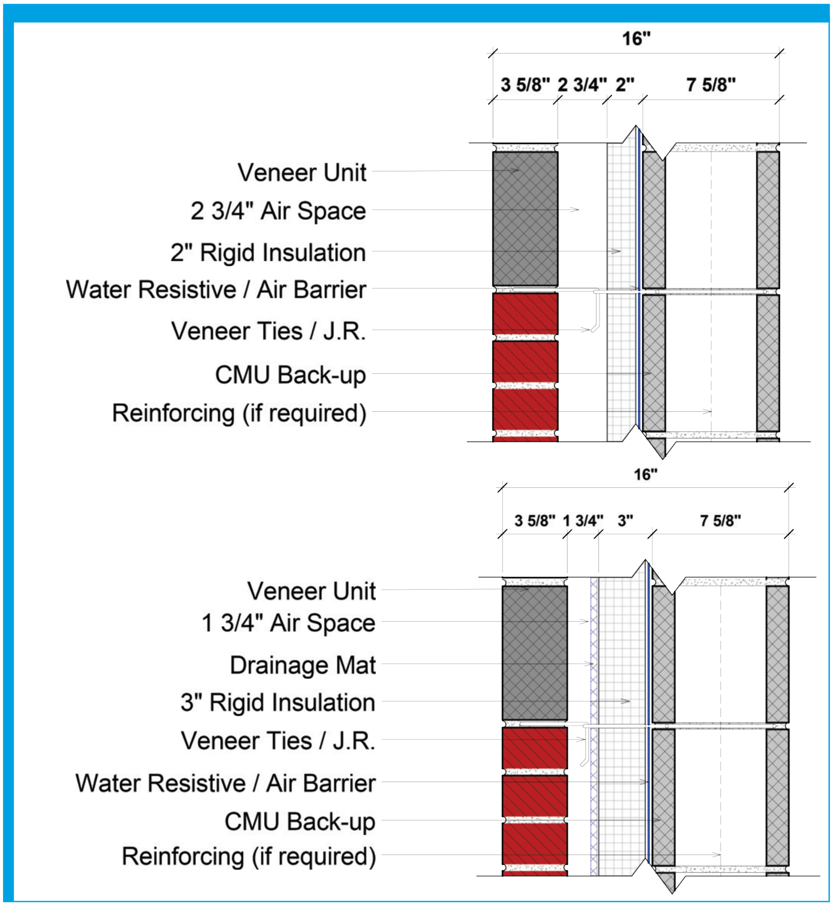
Figure 4

Convective airflow removes excess moisture vapour while drying any residual moisture within the cavity.

Figure 5

A typical pressure-moderated wall system.

Figure 6



By incorporating an all-wall drainage mat, the air space can be reduced without compromising its intended functionality. As shown above, 406-mm (16-in.) wide wall with 51-mm (2-in.) rigid outboard insulation could have its air space minimized, enabling it to neutralize the air pressure more quickly.

width is 51 mm (2 in.), but according to the Brick Industry Association's (BIA's) Technical Note 27, *Brick Masonry Rain Screen Walls*, the air space should not be less than 25 mm (1 in.) when outboard rigid insulation is being used. This means even though a 51-mm air space is recommended, the code minimum is half that.

When given the choice, walls are often built to code-minimum dimensions, leaving this smaller air space prone to excess mortar droppings blocking the path for moisture to exit the wall system. By building with an all-wall drainage mat, this cavity width will remain clear of mortar droppings, allowing the reduced airspace to still drain and ventilate effectively. When choosing an engineered rainscreen for masonry applications, one should specify a drainage mat with a filter fabric bonded to it in order to prevent the mortar or scratch coat from seeping through.

From a residential standpoint, wall systems are not designed with any air space at all (Figure 9). These designs leave trapped moisture nowhere to go, which often leads to rot, mould, and IAQ issues. Most homeowner's insurance policies will only cover a maximum $5000 for damage from moisture-related issues—this is frequently only a fraction of the renovation costs. Using an engineered rainscreen drainage mat in residential applications is like offering the cavity wall concept to homeowners, yet making it cost-effective for the residential sector.

Engineered rainscreen products are typically made from either a corrugated sheet, dimpled mat, or a random entangled net material (Figure 10) made from either polypropylene or nylon. These types of drainage mats are favourable for wall applications for numerous reasons. For example, the polypropylene or nylon makeup allows for mould and mildew resistance. The open entangled net design also allows for multi-directional drainage and ventilation. Some engineered rainscreen drainage and ventilation mats are also manufactured from recycled materials. It is important to ensure the engineered rainscreen drainage mat meets the requirements of UL 723, *Test for Surface Burning Characteristics of Building Materials*, and can handle freeze-thaw conditions.

It is important the capillary break created by these engineered rainscreens be at least 4.8 mm (3/16 in.) or greater according to ASTM E2925-14, *Standard Specification for Manufactured Polymeric Drainage and Ventilation Materials Used to Provide a Rainscreen Function.* This proper capillary break greatly reduces the bulk moisture reaching the water-resistant barrier as well as the transmission of surfactants contained within some cladding materials.

Again, when specifying an engineered rainscreen material for masonry applications, it is important 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 also allows the moisture to pass through and drain down the unobstructed channel. The filter fabric increases the sheer and tensile strength of the product while helping keep a uniform airspace for proper ventilation and drainage. It is also important the materials specified are resilient, lasting the life of the building.

Non-residential

In commercial applications, drainage mats should not be the same width as the air space. Oftentimes, a 25-mm (1-in.) air space is a nominal 25 mm (Figure 11). There needs to be enough space between the back of the brick and the drainage mat for the mason to put their fingers, making it easier to lay the brick or stone. Most excess mortar in the bed joints will be forced out of the wall, not fall within the cavity. Even 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.

In order to prevent mortar bridging due to capillary action, the drainage plane is recommended to be 10 mm (3/8 in.) or greater for commercial applications. In Section

> Although engineered pressure-equalized rainscreen assemblies are not new, there is still confusion as to their differences from cavity walls.

Figure 7

Cavity Wall Application		
Brick depth	92 mm (3.625 in.)	
Air space	70 mm (2.75 in.)	
Rigid foam insulation	50 mm (2 in.)	
Mortar deflection	254 (10 in.)	
Flashing height over mortar deflection	102 (4 in.)	
	568 mm (22.375 in.)	
610-mm (24-in.) wide flashing needed		
Typical 610-mm (24-in.) Flashing Roll Sizes	**Contractor price =**	**$2.90/sf.**
7.6 m (25 ft)	4.6 m^2 (50 sf) per roll	$145 per roll
18 m (60 ft)	11 m^2 (120 sf) per roll	$348 per roll
23 m (75 ft)	14 m^2 (150 sf) per roll	$435 per roll

Engineered Rainscreen Wall		
Brick depth	92 mm (3.625 in.)	
Air space	25 mm (1 in.)	
Rigid foam insulation	50 mm (2 in.)	
Mortar deflection replaced with 25-mm (1-in.) drainage mat		
Flashing height turn up on backer wall	203 (8 in.)	
	371.5 mm (14.625 in.)	
406-mm (16-in.) wide flashing needed		
Typical 406-mm (16-in.) Flashing Roll Sizes	**Contractor price =**	**$2.90/sf.**
7.6 m (25 ft)	3.1 m^2 (33.33 sf) per roll	$96.66 per roll
18 m (60 ft)	7.4 m^2 (80 sf) per roll	$232 per roll
23 m (75 ft)	9.3 m^2 (100 sf) per roll	$290 per roll

A common misconception is using engineered rainscreen drainage and ventilation mats add expense, but it narrows the air space, which reduces the size of many wall components and, in turn, costs.

Figure 8

	Cavity Wall System	Engineered Rainscreen Drainage Wall System
7.6 m (25 ft) = 200 rolls needed	$29,000	$19,332
18 m (60 ft) = 84 rolls needed	$29,232	$19,488
23 m (75 ft) = 67 rolls needed	$29,145	$19,430

Potential flashing savings for a typical 1524-m (5000-ft) long (lineal) wall.

9.27.2.2 of the 2010 *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 of the wall.

Industry involvement

Over the last few years, there has been a shift in the building industry toward all-wall drainage and ventilation materials. Organizations, such as the Air Barrier Association of America (ABAA), were one of the first to point out the importance of protecting the entire building envelope by using a system, not component approach. All-wall drainage and ventilation mats should be considered part of that system.

Last July, the Building Enclosure Moisture Management Institute (BEMMI) created the testing criterial that became the standard for ASTM 2925-14, which lays out the guidelines to specifying the correct type of engineered rainscreen drainage mat. The strict criteria include elements such as:

- heat aging;
- compression testing;
- surface burning;
- drainage efficiency;
- ultraviolet (UV) testing; and
- nominal thickness testing.

(It is important to note drainable house wraps are not engineered rainscreen drainage mats—they simply do not meet the requirements of ASTM E2925-14.

Both 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), make reference to drainage mats in the third and fourth editions of the *Installation Guide for Adhered Concrete Masonry Veneer*.

Major siding manufacturers are also putting these drainage mats in their installation instructions and technical details.

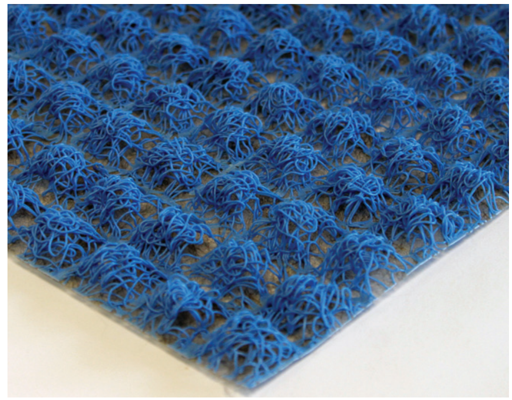
Points of consideration for specifying and using all-wall drainage mats include:

- total rainfall and frequency;
- wetting and drying cycles;
- wind and storm conditions;
- freeze-thaw conditions;
- temperature; and
- humidity.

Figure 9

From a residential standpoint, wall systems are not designed with air space.

Figure 10



Random entangled net material.

Figure 11

Often, a 25-mm (1-in.) air space is a nominal 25 mm.

It is recommended to use all-wall drainage mats in geographic locations receiving 508 mm (20 in.) or more of rainfall annually. In Oregon, it is becoming code for areas receiving upward of 1524 mm (60 in.) of rainfall a year to use all-wall drainage mats—such a requirement may also end up occurring in similar regions in Canada down the road.

Areas with high wind content are prime candidates for rainscreen drainage mats. As an example, an 80-km/h (50-mph) wind will exert 41.3 kPa (6 psi) on a wall's surface—enough pressure to force moisture into cracks of any size.

Conclusion

In summary, building with rainscreen technology allows moisture to drain and ventilate properly by reducing the amount of rainwater allowed to linger in a wall system. Building owners should see a significant decline in efflorescence, staining, structural decay, and poor IAQ, along with an increase in the building's lifecycle. All-wall drainage mats are cost-effective and have proven to be an effective way to improve the life and performance of a building.

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