BASIC WALL SYSTEMS AND THEIR MOISTURE CONTROL MECHANISMS

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In June 1962, the first sentence in J.K. Latta's *Canadian Building Digest* (CBD-30) article noted, "It has sometimes been stated that there would be no need for building research were it not for the effect of water in the wrong places." While Latta admitted the statement was an oversimplification, as building enclosure professionals, a large component of our profession is dealing with water in the wrong places, particularly in exterior wall systems.

The concept of keeping water out of the wrong places (that is, moisture control) can be summed up by the three Ds: deflection, drainage, and drying. From this perspective, exterior walls can be broken down into three types of systems, which are:

- face-sealed wall systems,
- drained/screened systems, and
- mass wall systems.

The focus of this paper is to discuss the fundamental moisture control mechanism(s) and the unique characteristics of each general wall system while also providing a brief synopsis of each system's benefits and drawbacks.

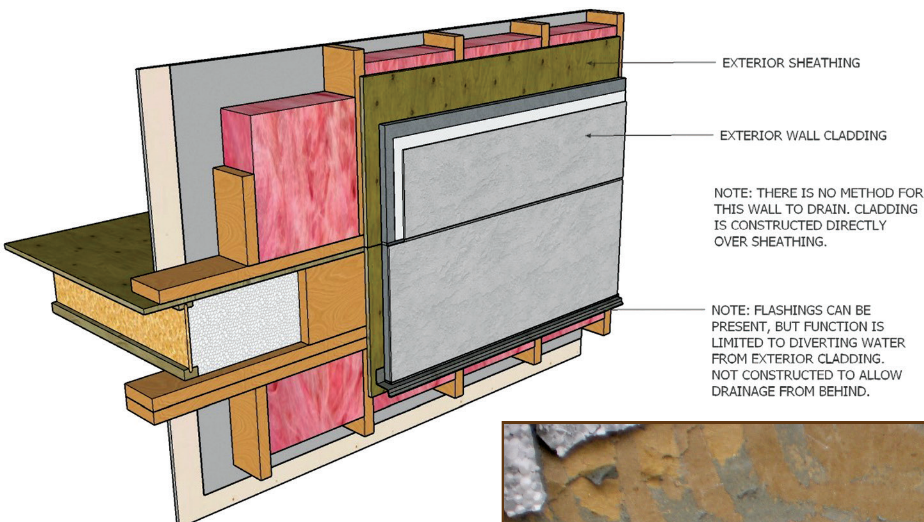

Figure 1 – Detail of a face-sealed cladding system.

FACE-SEALED WALL SYSTEMS

Face-sealed wall systems, often referred to as "perfect barrier" walls, principally

Figure 2 – Photo of a face-sealed exterior insulated finish system (EIFS) cladding. Note that the base of wall at the flashing is sealed and that there is no allowance for drainage behind the cladding system.

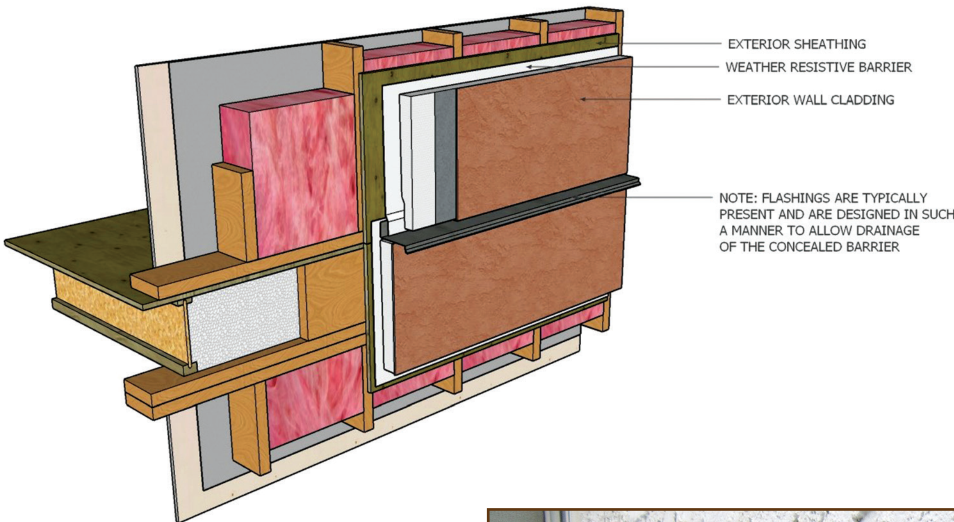

Figure 3 – Detail of a drained wall system with a concealed barrier.

Figure 4 – Photo of a cementitious stucco cladding system over a concealed barrier. Note that drainage is provided behind the cladding via the use of a weather-resistive barrier, lapped over the window head flashing to facilitate drainage.

rely on their cladding to deflect and resist bulk moisture penetration. As the barrier is intended to be perfect, there is no back-up weather-resistive barrier and no mode for incidental moisture to leave the wall assembly via drainage. This wall system can include older styles of exterior insulated finish systems (EIFS), precast concrete cladding systems, modular construction, and select stucco claddings. Examples of this wall system are shown in *Figures 1* and *2*.

Because there is no redundancy in this cladding system, face-sealed systems are "zero tolerance" with regard to bulk moisture penetration. This leads to complex detailing of interfaces that must ensure a 100% perfect seal at all joints and penetrations.

A commonly stated rule of thumb is that approximately 90% of bulk moisture is deflected by the cladding layer while the remaining 10% of moisture penetrates the cladding layer (that is, the "perfect barrier"). This is either due to imperfections in the materials used, material failures, interface and penetration seal failures, or the like. As there is no method to allow for drainage past the deflection layer (the cladding), this wall system is limited to relying on drying and durability to control penetrating moisture. Therefore, sealant installation, use of durable materials, use of materials that have storage capacity for moisture and allow drying, and overall cladding maintenance are critical for the system to perform.

One of the key benefits of this system is cost effectiveness in its installation. Major drawbacks include the constructability of a perfect barrier with imperfect materials and methods, and life cycle costs associated with maintaining joints, seals, and interfaces in perfect condition to resist moisture penetration.

DRAINED/SCREENED WALL SYSTEMS

Drained/screened wall systems still rely on the exterior facing cladding to deflect the majority of bulk moisture. However, differing from a face-sealed wall, these wall systems attempt to account for the inherent imperfections in materials, variances in quality of installation techniques, interface failures, and the like by creating a secondary drainage layer behind the cladding. This wall system can be further separated into two separate subgroups based on whether a vented cavity is present behind the cladding.

In the non-vented version, a concealed weather-resistive barrier (often something like building paper or sheathing paper) is located behind the cladding to drain any penetrating incidental moisture from the system. This weather-resistive barrier also has some tolerance for standing water against it, allowing cladding systems that cannot drain effectively to dry. However, as this drainage layer is not vented (that is, there is no provision for air movement of any significance behind the cladding), the effectiveness of the drying is less than that of a vented space. Common examples of this wall system include stucco and lath installed directly over building paper with no air space, and some wood, vinyl, and cementitious sidings, if the wall assembly is designed with no air space. Examples of this wall system are shown in *Figures 3* and *4*.

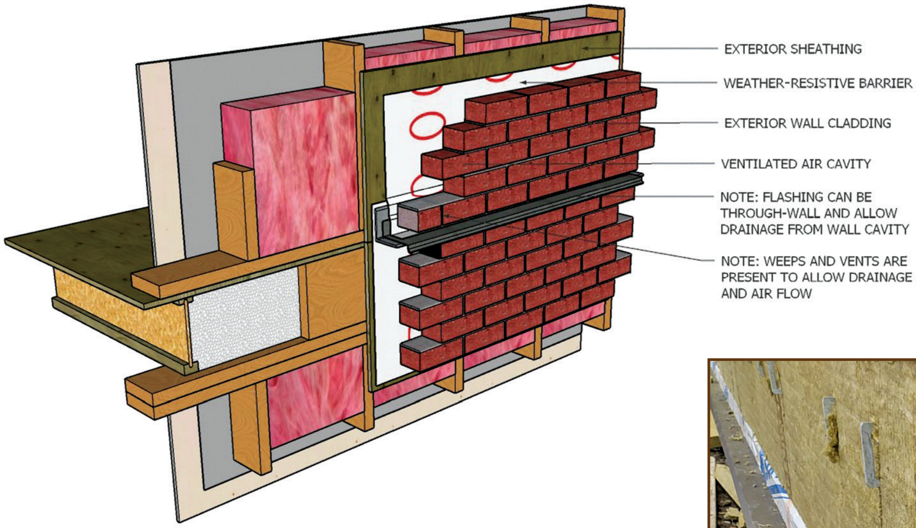

Figure 5 – Detail of a drained and vented wall system with a weather-resistive barrier.

Figure 6 – Photo of a cross section of a drained and vented masonry-veneer wall assembly under construction.

A drained wall, or vented rain screen system, is a "double wall" system where the outer assembly provides deflection from direct rain, and the inner assembly provides drainage of any bulk moisture that penetrates the outer assembly. Between the inner and outer assemblies is a vented air cavity that allows air to circulate, which will increase drying potential over a non-vented assembly. The inner assembly is sealed with a weather-resistive barrier (potentially sheathing paper, but also self-adhered membranes or liquid-

Figure 8 – Photo of a historic mass wall system.

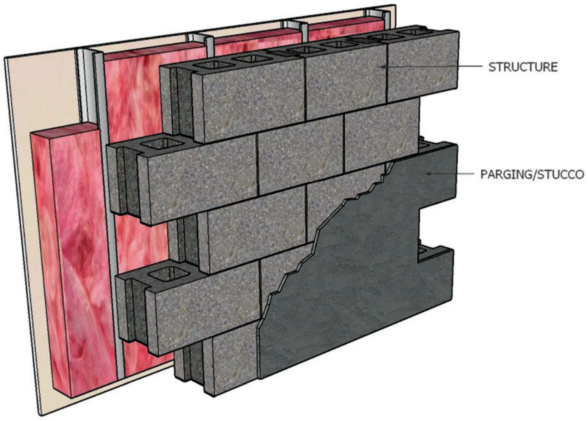

Figure 7 – Detail of a contemporary mass wall system.

applied membranes) to provide drainage for any water that may penetrate the outer assembly. Moisture is then directed out of the wall with through-wall flashings tied into the weather barrier.

Nearly any cladding can be designed as a drained assembly, including masonry veneer, stucco, EIFS, and sidings. The main requirement for this system is for the cladding to be offset from the wall sheathing, either with strapping, girts, ties, or other attachment systems, to create an air cavity. Further, for maximum effectiveness, venting must be provided at the top and bottom of the wall system to allow for air circulation and drying. The drained wall system has significant tolerance for water penetration through the primary cladding layer due to the vented air cavity. Examples of this system can be seen in *Figures 5* and *6*.

Unlike the face-sealed system, this wall system has the added redundancy of the concealed weather-resistive barrier to manage the imperfect deflection of the cladding via drainage and drying. This combination of bulk moisture controls is a key benefit as there is some tolerance for imperfect detailing and installation techniques—although it is important to note that it is not a cure for poor installation or lack of maintenance. One of the major drawbacks of this system is that if there is ever an issue with the concealed weather-resistive barrier, removal of the cladding will likely be necessary. A further potential drawback comes when retrofitting penetrations or interfaces after construction (such as installing new windows); however, with sufficient forethought during design and intelligent execution, retrofits can be easily managed. Despite the drawbacks, a drained/screened wall system is the wall system of choice from a moisture control point of view due to its effective utilization of the three Ds.

MASS WALL SYSTEMS

Mass wall systems are constructed of materials that have some capacity to store and release moisture (or dry) without being damaged. The mass of the wall itself is what protects the wall assembly. While the face of the wall deflects the majority of bulk moisture, any incidental moisture that penetrates the wall is stored in the wall material itself and slowly dries out over time. There is typically no weather-resistive barrier to allow for drainage within this system, and it relies exclusively on deflection and drying.

Typically, mass walls appear in historical buildings, such as sandstone buildings or parged/painted cementitious masonry walls. Modern buildings are sometimes deliberately designed and constructed in a similar fashion, especially when trying to emulate historical claddings. Examples of mass walls are shown in *Figures 7* and *8*.

Unlike a drained/screen wall system, this wall system has no provision for drainage should water penetrate the wall or cladding. Further, unlike a face-sealed system, this system has some tolerance for water penetration into it, as it is intended to dry out. This natural drying process can be interrupted by a variety of well-meaning “performance enhancements” or “restorations” that may be applied to these walls, such as certain sealers, coatings, membranes, or insulations. As this wall functions differently than other systems commonly built today, any modifications must be carefully planned, designed, and executed with proper accounting for the mass wall performance.

A key benefit of a mass wall system is its simplicity to construct and its tolerance for water penetration (provided it is designed and constructed adequately). However, like several historical practices, it can be costly in materials and labor to construct this wall system. Further, given the system's drying capacity, it can be at odds for creating an energy-efficient building as it may lead to higher energy bills—particularly on historical buildings.

In the quest for energy efficiency, it should be noted that any mass wall system that relies on drying as a moisture control strategy is either dependent on exterior sun and warmth, or interior warmth extending into the wall assembly. With older buildings especially, the air and heat loss through the exterior walls is a feature, not a bug.

CONCLUSION

Understanding how each type of wall system controls bulk moisture is critical to the building enclosure professional. Not only does it allow us to understand how to design a wall system, but it is also the effective implementation of these wall systems that allows us to keep water out of the wrong places.

REFERENCES AND FURTHER READING

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Marla Snoddon is passionate about helping people better understand their buildings and how to best construct, repair, and maintain them. Practicing as a building enclosure engineer, she has delivered consulting and design services for a wide range of new and existing buildings, including reserve fund studies, building enclosure (cladding, roofing, and window systems) condition assessments, and restoration projects. She is a building science consultant for Morrison Hershfield in Edmonton, Alberta, Canada.

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Johnathon Bain is a father, husband, engineer, mentor, mentee, pianist in training, youth rugby coach, cyclist, baker, and volunteer, amongst other interests. He focuses his professional practice working on the frontier of assessing, designing, and restoring environmental separations, particularly for existing buildings in Western Canada. He has executed and managed many projects including cladding, waterproofing, fenestration, historical, and roofing projects, as well as in-situ testing of building enclosures for water penetration and air leakage.

Study Shows More Women Employed in Construction Industry

A new study from Smart Asset used Bureau of Labor statistics to assess the workforce, comparing 2015 to 2019.

The number-three fastest-growing job for women in the United States was construction manager. In 2015, there were 49,400 in that position, while in 2019, there were 99,400, an increase of 101%. The number of female civil engineers increased from 45,400 in 2015 to 66,000, while the number of female construction laborers went from 47,800 to 71,800.

It was noted in the report that these statistics pre-dated the COVID-19 pandemic, and therefore do not reflect any subsequent drops of women in the workforce.

— Construction Dive and Smart Asset

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