



Getting to the Bottom of Moisture Management

By John H. Koester

There are numerous factors/phenomena that create misunderstandings that result in improper or inadequate moisture management design for the exterior building envelope. Let's take a look at two of them, gravity and temperature.

It's the lowest point that's the wettest. Why, because that's where the water is! (see figure 1) That's because of the influence of gravity. Now the low point of an exterior wall system of a building doesn't necessarily have to be the top of the footing (see figure 2) or the top of the stem wall. (see figure 3)

Figure 1

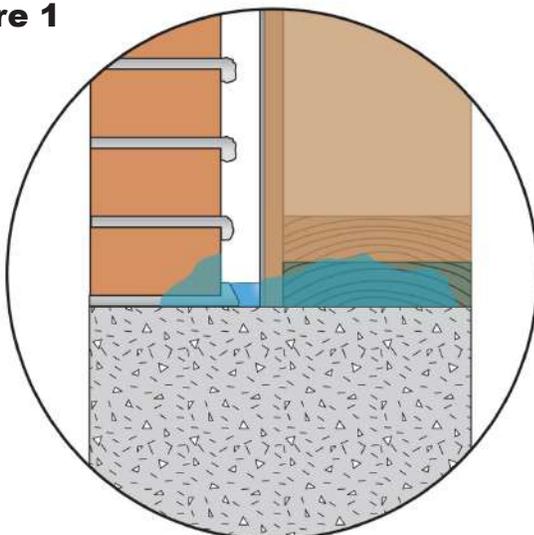


Figure 2

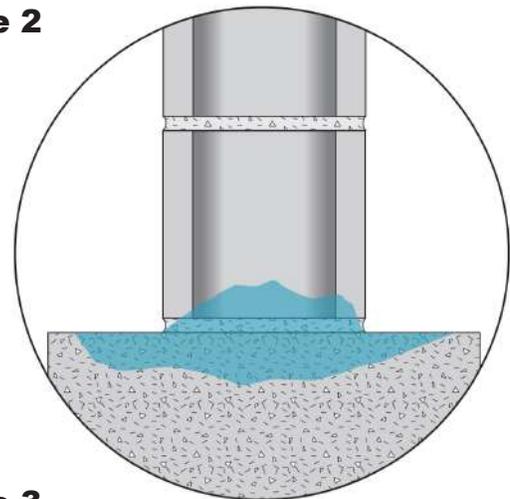
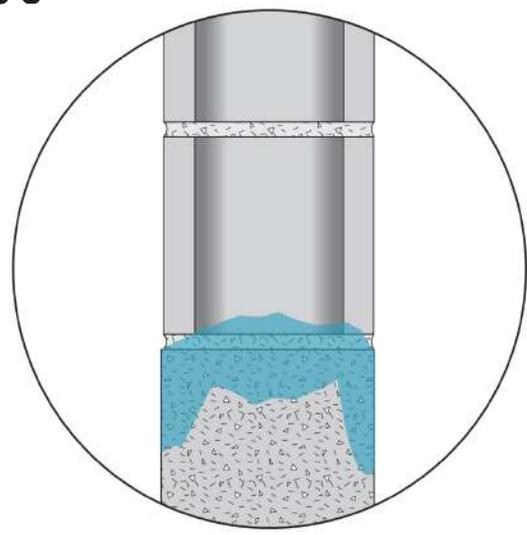


Figure 3



A low point in an exterior building envelope is a location that stops or slows moisture in liquid form from proceeding in a gravity-induced downward direction. Sometimes this is intentionally done with a designed flashing system and sometimes it is just the result of other components of the exterior building envelope system coming together to stop or seriously slow the downward path of liquid water. (see figure 4 and figure 5)

Figure 4

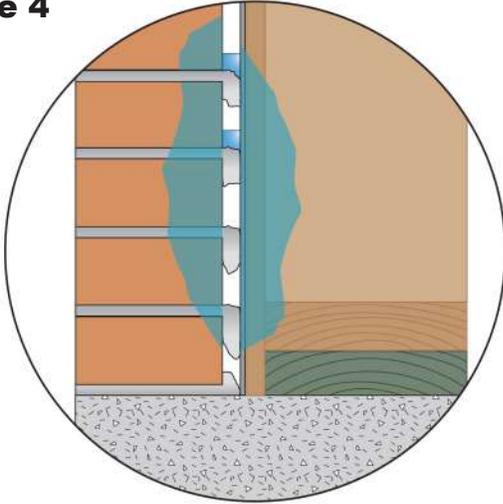
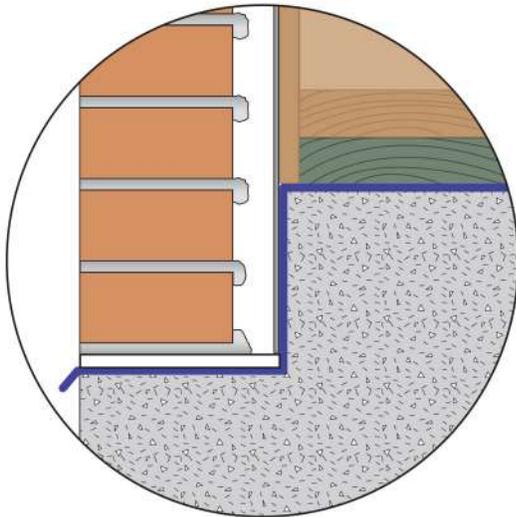


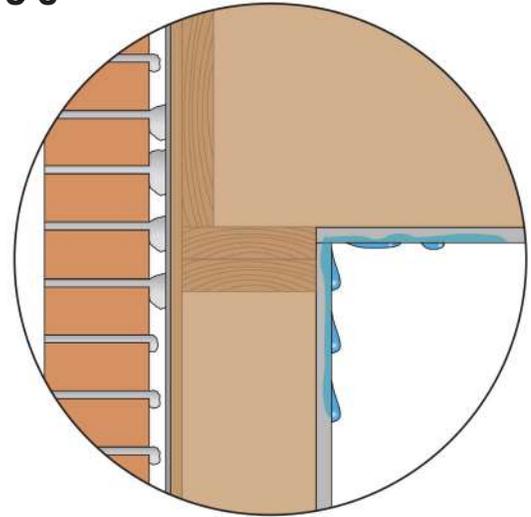
Figure 5



It's the highest point that's the wettest. Why, because that's where the water is! (see figure 6) That's because of the influence of temperature. Everyone, or at least I hope every construction professional, can understand why a low point of a construction detail would be the wettest, but why would a high point/ the top of a wall system be the wettest? The answer is found in the fact that H₂O can be in three forms: a solid (ice), a liquid (water) and a gas (water vapor).

You look up at the top of a wall where it meets the ceiling and you see a water pattern on the interior finished surface of the exterior wall. (see figure 6)

Figure 6



The most obvious conclusion is that there is a leak, a source of liquid water coming down and in from a higher point, and in most cases, that is exactly what is happening. But there may be a number of other scenarios that could explain water and water patterns at a high point of an exterior wall detail.

One of them is that H₂O in vapor form will move upward with warm air to a higher point of a construction detail and come in contact with air or a surface that is cool enough to be a dew point and condense into water droplets and liquid water and wet a construction detail. (see figure 7)

This can happen on exterior surfaces of a construction detail or on the interior surfaces of a construction detail (inside a wall). (see figure 8) The other part of the answer has to do with why a high point of a wall would be cool enough to be a dew point when hot air rises and the top of the wall and ceilings should be warmer. This phenomenon is usually the result of a thermo bridge from the cold exterior of an exterior building envelope to a warm interior of an exterior building envelope with enough intensity to overcome the ability of the interior ambient air temperature to warm the construction detail. (see figure 7 and figure 8)

Figure 7

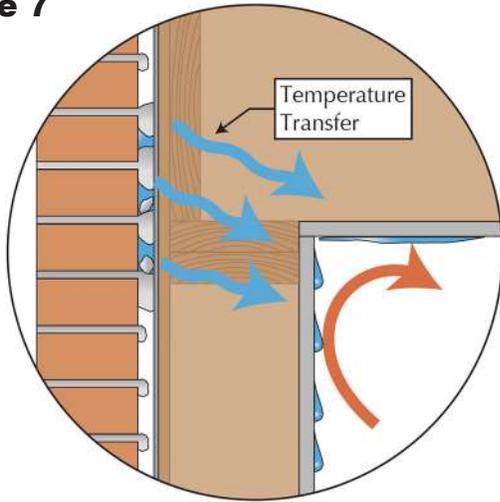
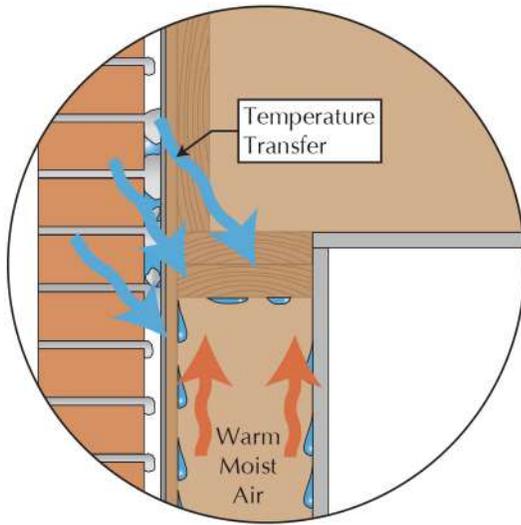


Figure 8

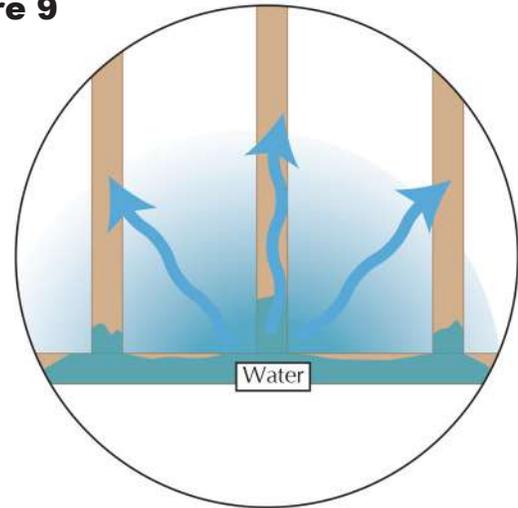


The ingredients required to allow this to happen are an opening to allow a sufficient amount of cool air to pass into or through the construction detail at this point or a material that can transfer this difference in temperature, “good conductors” such as steel, glass, solid concrete, or water (water transmits temperature 25 times better than open air). Wet construction materials are good conductors of temperature and poor insulators. The best insulations that are wet are very poor insulators.

So when a wet pattern in a high point of a construction detail is contributing to condensation, there very well may be an associated water source or wet material that has promoted cold temperature transfer (a water source that causes a temperature transfer and a dew point and a condensation wetting pattern but is not actually leaking or absorbing into a construction detail to wet it). (See figure 7 and figure 8)

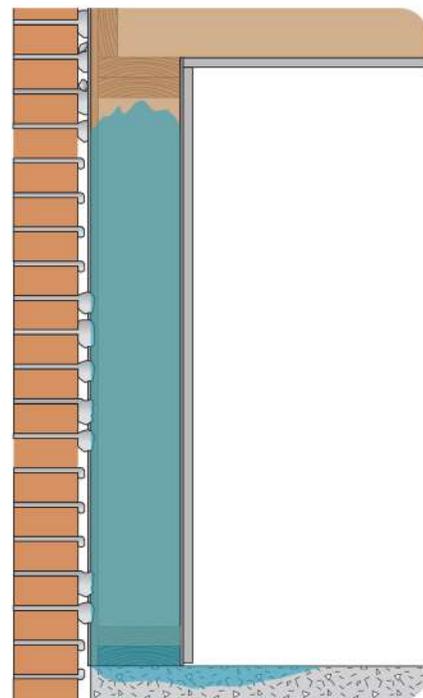
Another mechanism that transports moisture in liquid form into and through construction details is absorption. The general rule/law of physics says moisture will usually move from a high concentration of water into and through materials to a lesser concentration of water (drier materials) in an attempt to equalize the concentration of water. The distances that this moisture can travel into and through construction materials is truly surprising! (see figure 9)

Figure 9



If certain conditions exist, continuous source of liquid moisture, absence of driving mechanism and construction materials that funnel and or encapsulate (two or more) vapor retarders in the same exterior building envelope; the travel distance can be great. (see figure 10)

Figure 10



These distances will be expanded proportionally with the volume of the liquid moisture source. A large volume of liquid water has greater weight (pull of gravity) propelling the liquid moisture into and through construction materials.

It should be apparent that designing an exterior building envelope moisture management system brings a number of factors into consideration.

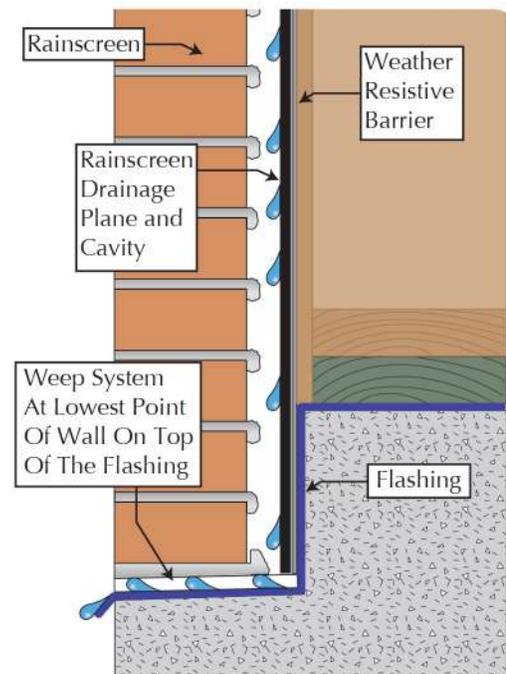
- The potential amounts of moisture to be managed
- How often the construction detail is exposed to this amount of moisture
- The duration of the exposure
- The physical form of the moisture (liquid, solid, gas)

The first, and most important, moisture management design requirement for your building's details is "Do not let them get wet!" They get wet quickly but they dry out slowly. The second moisture management requirement is "Get the moisture away from, off of and out of your construction detail as quickly as possible." It's about "Time." The amount of time moisture is in, on or near your construction detail is really what you are managing.

Drainage is "the movement of moisture from one point where it is not desired to a preferred location." In most cases this is from a high point in a construction detail or surface on a construction detail to a lower point out of, or off of that construction detail. In the interior of a wall of an exterior building envelope, this is a code compliant requirement. Section 1403.2, Weather Protection, of the 2012 IBC states, "Exterior walls shall provide the building with a weather-resistant exterior wall envelope. The exterior wall envelope shall include flashing, as described in Section 1405.4. The exterior wall envelope shall be designed and constructed in such a manner as to prevent the accumulation of water within the wall assembly by providing a water-resistive barrier behind the exterior veneer, as described in Section 1404.2, and a means for draining water that enters the assembly to the exterior. Protection against condensation in the exterior wall assembly shall be provided in accordance with Section 1405.3."

The moisture that may enter the exterior building envelope must be provided with a designed passageway to move it from a high point of entry to a lower point and allow it to exit the exterior building envelope to the exterior of the building. The technology that allows liquid moisture to move downward in the interior of an exterior building envelope is a core, cavity or a rainscreen drainage plane material. The technology that stops the downward movement of liquid moisture is a waterproof flashing material. The technology that gives liquid moisture a reason to go in one direction or another is slope-to-drain/elevation variation – "high to low." The technology that creates the opening from the interior of the wall to the exterior of the veneer/rainscreen material (brick, stone, stucco, etc.) is the weep. (See figure 11)

Figure 11



All of these four components are absolutely critical for an exterior building moisture management system to work. Weeps do not work until the liquid moisture gets to them. If the moisture that is attempting to move downward in a core, cavity or rainscreen is obstructed or slowed, it may just absorb into adjoining construction material and/or deeper into the exterior building envelope. If and when the liquid moisture gets to a flashing/water stop, if there isn't any slope-to-drain to the exterior of the exterior building envelope, it may just accumulate and absorb into the adjoining construction material or find its way deeper into the exterior building envelope (continued on next page)

through a void in imperfect flashing or out through veneer material through an undesigned pathway. If the weep holes are not at the lowest point of the core, cavity or rainscreen drainage plane, liquid water may accumulate and find its way deeper into the exterior building envelope or through veneer materials through an undesigned pathway.

All of these consequences of an improperly designed moisture management system are potentially very serious and may result in exterior building envelope component failure or total system failure, up to and including structural failure. An exterior building envelope moisture management system's reliance on all components of the system to function in concert with each other cannot be stressed enough!

The last and lowest (but certainly not "lowliest") components are in many cases the least understood and prioritized – these are the weeps and weep screeds. (See figure 12 and figure 13)

Figure 12

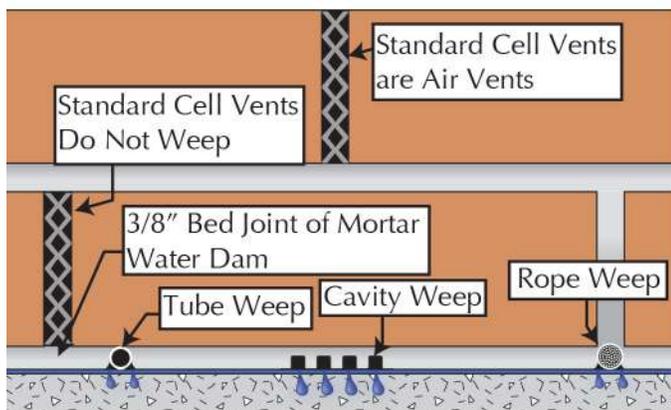
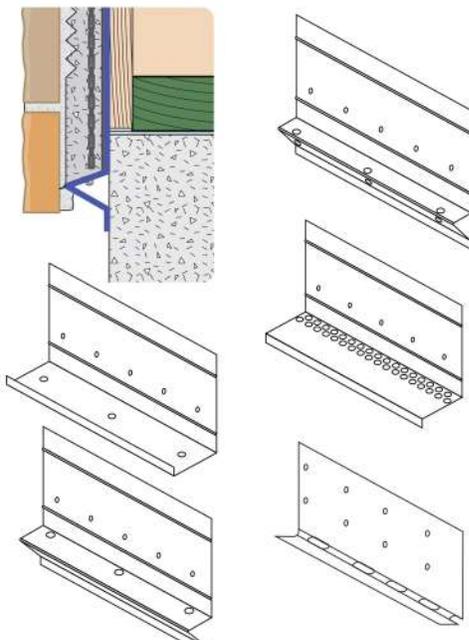


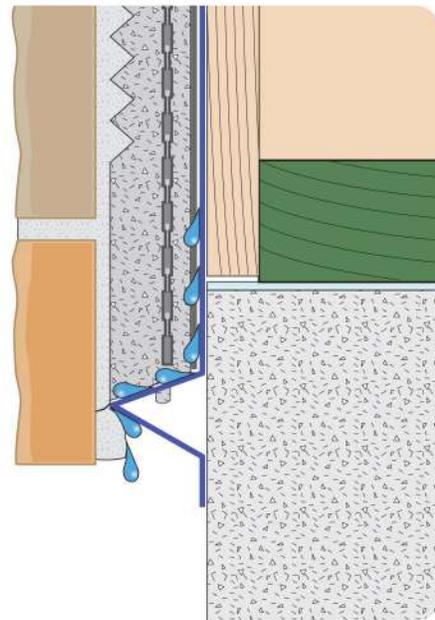
Figure 13



In the case of weeps, materials used, the number used and their location is completely without reason. Materials that are often used are thought to wick water out of a core or cavity. Here is some really good advice – Do not get into a wicking contest with masonry materials! A weep of any kind, good or bad, every 48 inches is of little value. A weep of any kind that is not at the lowest point of a core or cavity which is at the top surface of the flashing or water stop, is of little value. A weep that creates a hole in a veneer from the interior of the core or cavity to the exterior of the veneer is just another hole in the veneer that may let liquid moisture into the wall as well as let it out of the wall if there is no slope-to-drain that keeps it out and drains it out of the wall.

Weep screeds have very similar moisture management responsibilities, but in many cases they do not function appropriately. The notion that a shrinkage crack between the metal and cementitious material (scratch coat, brown coat and bedding and grouting mortar) is a dependable moisture management detail is ludicrous. (see figure 14)

Figure 14

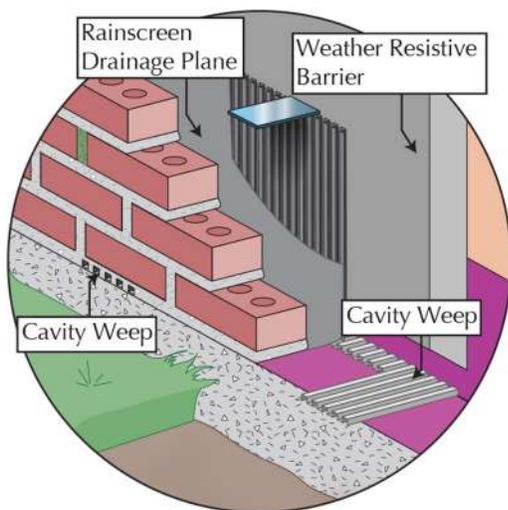


But for many popular/commonly installed weep screeds, that's exactly what the literature says. An example taken from a manufacturer's weep screed literature states, "The 'V' stop is punched with holes primarily intended as keying mechanisms. These also offer minor moisture weeping capabilities. As stucco cures it shrinks slightly away from the 'V' stop allowing moisture to flow down the building paper and exit down the sloped surface."

A weep and weep screed must have compatible moisture moving capacity with the core, cavity or rainscreen drainage plane above. If not, the slowing of moisture movement will cause an accumulative effect with all the negative consequences.

What makes a good weep? There are specific criteria to follow when choosing weep technology. Masonry Design and Detailing (Bell, 1987) defines weep holes as “Openings placed in mortar joints of facing material at the level of the flashing to permit the escape of moisture.” The voids/tunnels and channels that a weep creates through the bed joint of mortar, scratch coat, adhering mortar, etc. must be at the lowest point of a core, cavity or rainscreen drainage plane – where the water is – and must be no further than 12 inches apart. (see figure 15)

Figure 15

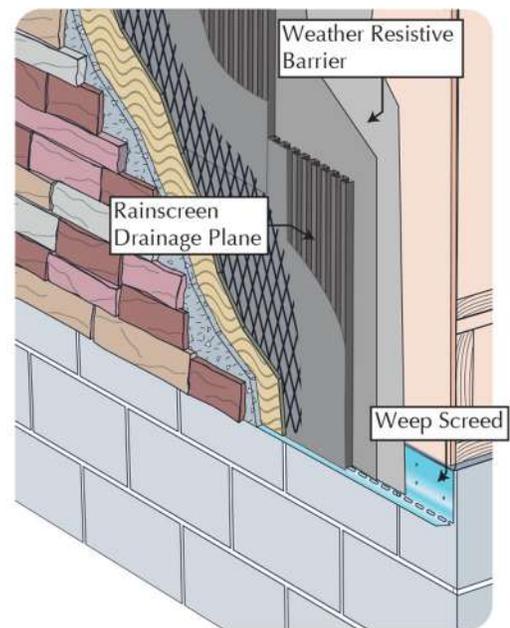


There is no need to consider modular configuration of masonry units because the voids/tunnels and channels are in the bottom side of the bed joint of mortar and do not affect layout or coursing.

What makes a good weep screed? There are specific criteria to follow when choosing weep technology. According to wiseGeek.com, “A weep screed is a type of building material used along the base of an exterior stucco wall. The screed serves as a vent so that the moisture can escape the stucco wall finish just above the foundation.” It is a device used to terminate the bottom of a cementitious-based thin veneer rainscreen. This device should allow liquid moisture that drains down the back side of a thin veneer rainscreen and on the surface of the weather resistant barrier in the rainscreen drainage plane to freely exit the thin veneer 1.5” to 2” below the bottom of the framed wall system and the top of the stem wall.

Section 2512.1.2, Weep Screeds, of the 2012 International Building Code states, “A minimum 0.019-inch (0.5 mm) (No. 26 galvanized sheet gage), corrosion-resistant weep screed or plastic weep screed, with a minimum vertical attachment flange of 3.5 inches (89 mm) shall be provided at or below the foundation plate line on exterior stud walls in accordance with ASTM C 926. The weep screed shall be placed a minimum of 4 inches (102 mm) above the earth or 2 inches (51 mm) above paved areas and shall be of a type that will allow trapped water to drain to the exterior of the building. The weather-resistant barrier shall lap the attachment flange. The exterior lath shall cover and terminate on the attachment flange of the weep screed.” (see figure 16)

Figure 16



It is critical that the drainage holes/weep holes be numerous and not more than 1 inch (or so) apart and located at the bottom of the weep screed and against the 3.5” back flange to allow for direct contact with the bottom of the rainscreen drainage plane. (see figure 17, figure 17A, and figure 17B) This is critical for two reasons: First, the liquid moisture that drains down the rainscreen drainage plane will have an immediate exit point. Second, the cementitious materials used to create the thin veneer will not have access to block them. (see figure 18, figure 18A, and figure--18B)

Figure 17

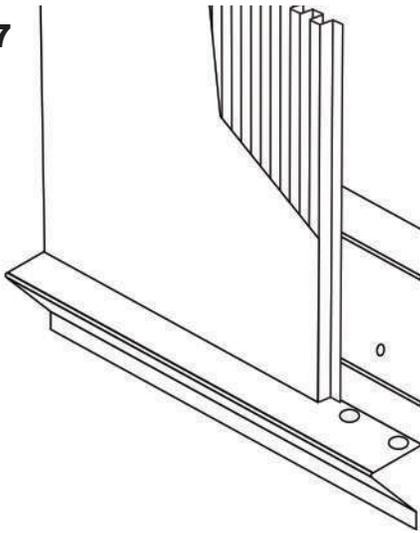


Figure 17A

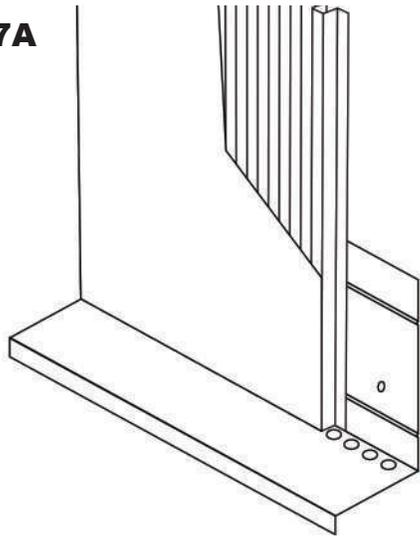


Figure 17B

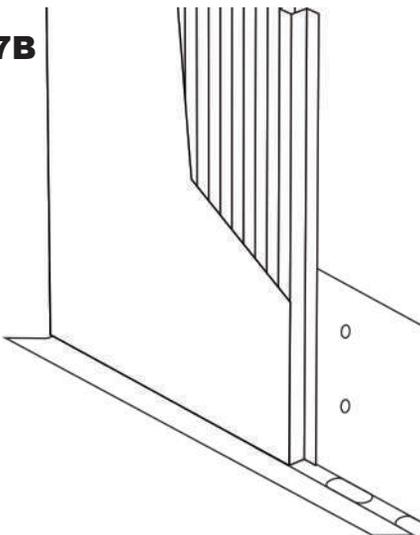


Figure 18

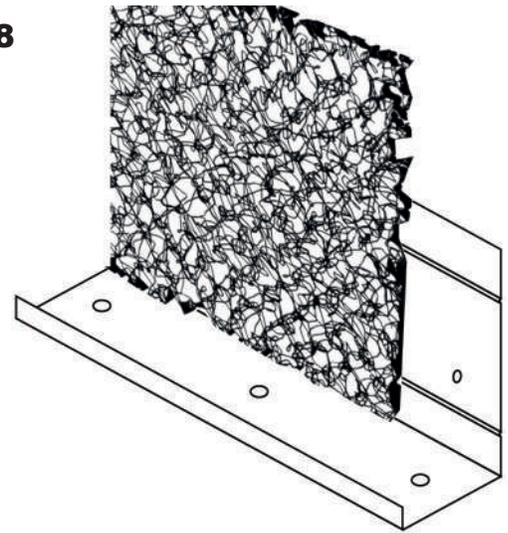


Figure 18A

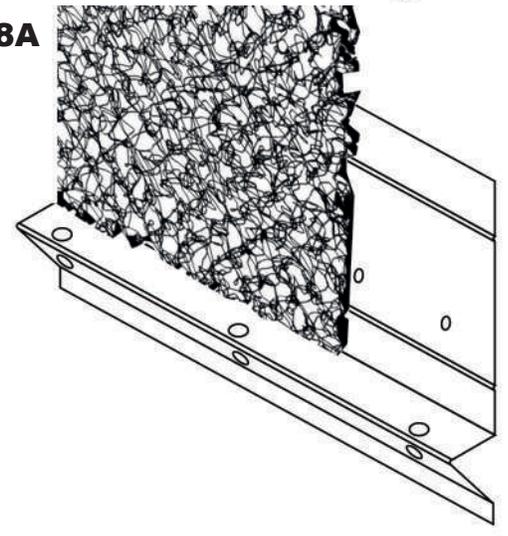
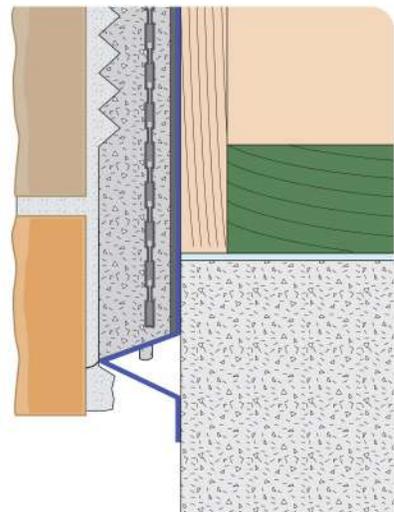


Figure 18B



Conclusion

There is little doubt that moisture will enter the building envelope and that it needs to be drained. This has become more and more the accepted practice, and in many cases, code mandated. Unfortunately, the liquid moisture gets drained to the bottom of the wall with little thought given as to how it will get out. This article has presented pragmatic solutions to getting the moisture out at the bottom. It is up to the reader to make prudent choices in the materials and methods they choose to employ.