Brick Veneer That Works

Strategies for avoiding failure

BY HARRISON MCCAMPBELL

As a forensic architect, I see a lot of building failures due to poorly installed brick veneer. While brick is an extremely durable and water-tolerant cladding material, it cannot overcome poor workmanship and poor detailing. It certainly is not water*proof*, and care must be taken to protect the structure behind the veneer. Unfortunately, I don't see this care on the projects I visit. (Of course, I wouldn't be on a project if something wasn't wrong.) Again and again I see the same mistakes made, many of which lead to very expensive callbacks.

In this article, I'll share what I've learned in my forensic work, beginning with some of what doesn't work. Seeing the results of doing things the wrong way helps to explain why the details I advocate as best practice are worth doing in the first place, even if they seem a bit excessive at first.

HOW BRICK VENEER CAN FAIL

Rarely does the brick installation itself fail. Laying up a flat wall with straight, even courses and raking the mortar joints is often done well. The challenge is making sure that the brick is supported properly, that it's securely tied to the structural wall, and that the proper moisture-control measures have been taken to ensure that moisture won't affect the wood framing behind the brick veneer.

Photos: Harrison McCampbell


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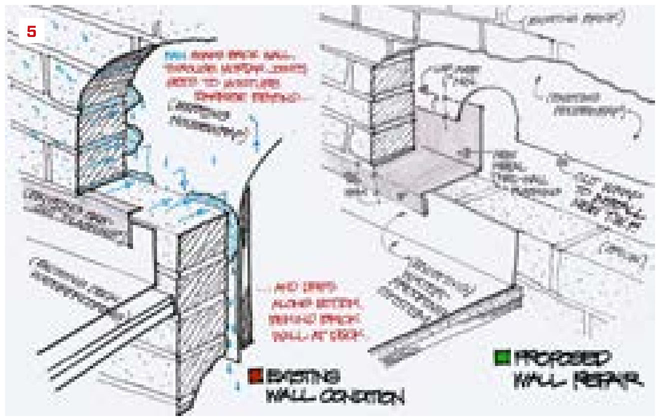

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Modern brick fired at high temperatures can be fairly water-resistant. Older bricks are typically more porous and will absorb a surprising amount of water. But regardless of the type of brick, water will find its way through the cladding.

For starters, there are all the common leak spots, such as roof and wall penetrations and (of course) windows. In addition, mortar joints in a brick wall tend to leak. Mixing mortar introduces tiny air bubbles. Once troweled on, the water in the mix evaporates, leaving even more holes, as well as lots of hairline cracks between the mortar and the brick. Wind-driven rain will soak the wall, and as the moisture moves from wet to dry and warmer to cooler, the back of the brick will eventually get wet—you can count on it.

THROUGH-WALL FLASHING FAILURES

On a surprising number of the brick projects I am called in to investigate, the failure stems from a lack of proper through-wall flashings.

A classic example of a detail that often fails is counterflashing installed where a sloped shingle roof abuts a brick wall **(1)**. The metal is usually 4 or 5 inches high and follows the slope of the roof. The flashing shown here has simply been let into a saw kerf in the brick and held in place with caulk or the occasional nail wedged between the metal and the brick. Inevitably, the flashing falls out of the wall, and then it offers no help whatsoever.

Similar meager attempts were made to flash a chimney **(2)**, a headwall **(3)**, and a gable-end parapet wall **(4)**. All used saw-cut flashings that provided little protection from water flowing down the roof and zero protection from rain soaking the wall above the flashing.

Any water that gets behind the brick will be headed right down into the framing and the interior finishes, as I've illustrated above for one wall repair **(5)**. A proper through-wall flashing (shown as the "proposed wall repair") must run from under the weather-resistive barrier on the structural wall and extend all the way through the brick to the exterior; anything short of meeting the front face of the brick is much less effective at getting the water out.

WEEP HOLES

Through-wall flashing works in concert with weep holes to gather the water that leaks past the brick face and give it a path

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to drain safely away. According to the Brick Industry Association (BIA), weep holes should be placed every 24 inches on-center (or every 16 inches when cotton rope is used as a wick).

I would rather see a wall with good through-wall flashing and too few or even no weep holes than a wall with weep holes and no or poorly installed through-wall flashings. Even if there are no weep holes, when there is a proper through-wall flashing that terminates on the face of the wall, the collected water will eventually evaporate or escape through the tiny cracks in the mortar before it can damage the framing. But without through-wall flashing, weep holes won't do much of anything.

STEPPED PAN FLASHING

Admittedly, installing through-wall flashing correctly, particularly on a sloped roof-to-wall intersection, involves a detailed process and requires close coordination between the roofer and the mason. As painstaking as this can be, it's the only way to prevent water from seeping into the living space below.

Stepped pans. Executing a true through-wall counterflashing along the rake of a sloped roof requires installing a series of stepped pans. On the job shown above, the masons began by building up the brick in stair-step fashion **(6)**. The rise and run of these stair steps will vary with the pitch of the roof, but each step will be the same because the slope stays the same and the brick coursing is the same.

Next, the masons laid in copper pans **(7)**. A key feature of these pans is the soldered end-dams that direct water onto the front edge of the pan **(8)**. This edge laps over the front of the brick about ½ inch, providing a lip to which the counterflashing will be attached.

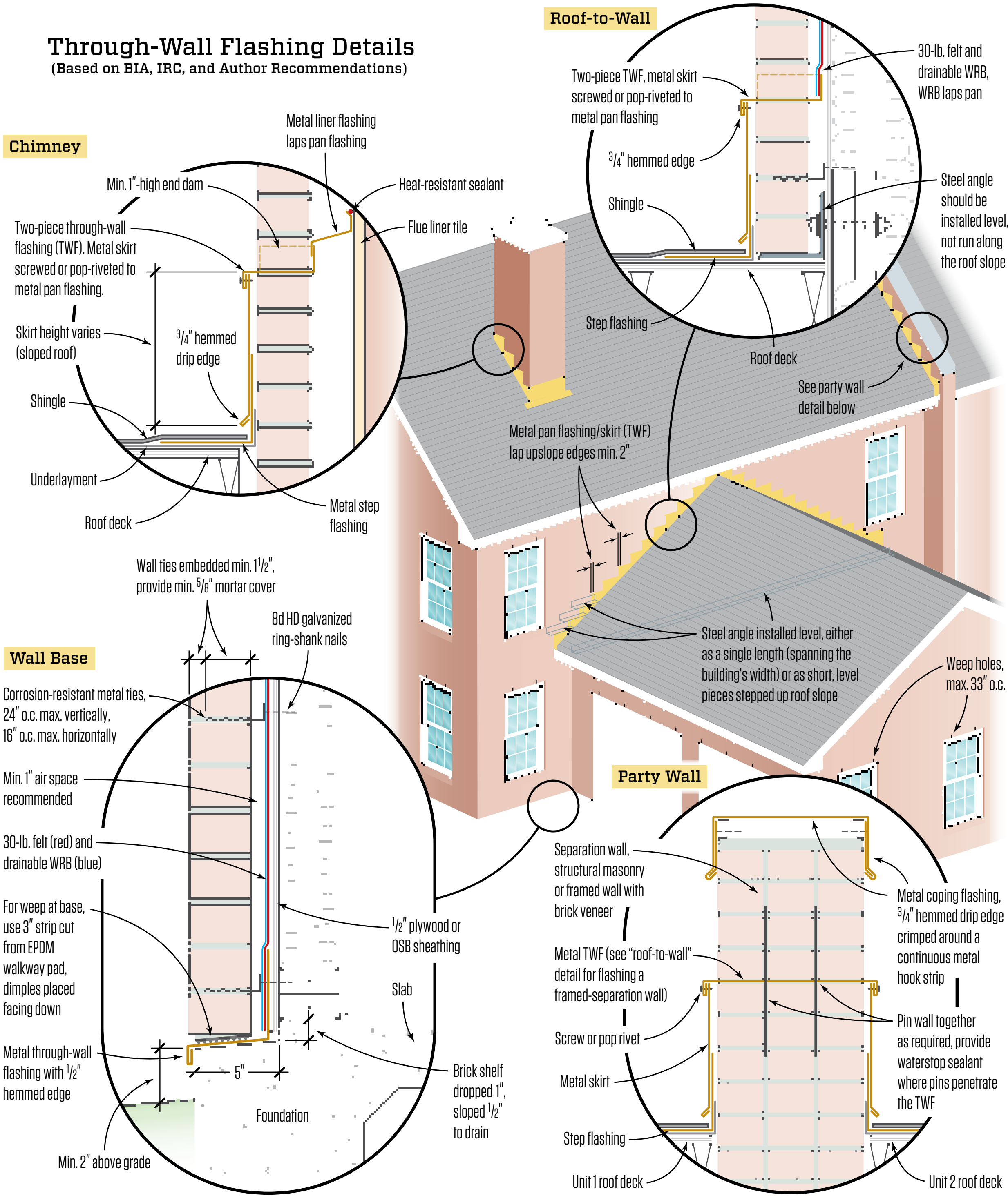
On this particular job, we had been called in because of the severe cracking of the brick across the entire gable-end wall **(9)**. All of the unpainted brick shown was removed. We discovered that only three brick ties had been installed high up on the wall near the gable vent. There were no brick ties whatsoever across the entire area below it. It was lucky that this wall had not come down entirely.

When we replaced the brick, we included the stepped pan flashings where the sloped roof joined the gable-end wall (at left behind the railing in photo 9 above; the railing was removed for the demolition phase).

When everything had been cleaned up from laying the new brick, copper skirts were slid up under the front edge of each pan and pop-riveted or screwed in place **(10)**. These copper skirts

Through-Wall Flashing Details

(Based on BIA, IRC, and Author Recommendations)



serve as a counterflashing to the stepped L-flashings that the roofers wove in with the new roof shingles.

TWO-LAYER WRB

While the lack of brick ties caused the initial failure on the gable end, when we took the brick down, we discovered a number of other flaws. The most glaring was a combination of excessive mortar squeeze-out on the back surface of the brick, along with a very cheap and poorly installed weather-resistive barrier.

A single layer of housewrap provides almost no barrier to water when mortar comes in direct contact with it. Water that leaks behind the brick wicks along the excess mortar to the face of the WRB and then seeps right through, wetting the wood sheathing.

Cavity or not. Currently, building codes require a minimum 1-inch air space between the brick and the structural wall. (This requirement could be challenged when you're using some of the newer self-adhesive or liquid-applied WRBs in tandem with a drainable insulation, such as mineral wool. See "Challenging Tradition," pages 41 and 42.)

In theory, this space provides a drainage path and enough space to keep mortar, and any water it holds, safely away from the WRB that guards the wall sheathing.

In practice, however, that gap is not enough to always keep mortar at bay. On a recent job, one mason proved this point **(11)**. Right around the corner on the same building, a different mason did a much better job of keeping the cavity clear **(12)**. This variation in workmanship is inevitable and is why I insist on a double-layer WRB.

Asphalt felt plus a drainable wrap. In my opinion, brick—like stucco—should be installed over two moisture barriers, as shown in the detail illustrations on the facing page. I like to see a layer of #30 asphalt-impregnated organic felt covered with a "drainable" housewrap, such as Tyvek StuccoWrap or CommercialWrap D. Both of these wraps are "crinkled" to create a textured surface, which forms channels that help drain water down the face of the WRB.

There are several other textured building wraps on the market. Steer clear of woven building wraps. These abrade easily and the holes between the woven filaments don't do much to keep water out. I recommend choosing a commercial-grade WRB, which will be a little more resistant to abrasion and UV exposure. Durability is key in any working environment where masonry is being used.

The more durable building wrap will protect the asphalt felt from the sun during construction. It acts as a first line of defense against any moisture that leaks past the brick. The felt is there as protection against any moisture that seeps through the building wrap, as it will at every transfer point where mortar slops against the WRB.

WINDOW AND DOOR FLASHING

Ideally, window and door head flashing would be fabricated out of metal and formed with end dams, similar to the stepped pans for roof-to-wall intersections. Membrane flashings that extend to the exterior will eventually weather and deteriorate. But even if a membrane flashing is used and it extends well past the side of the window, it can work.

In the example shown on page 39 **(13)**, you can see the rusted angle going across the top of the window. The membrane over it extends beyond the sides of the rough opening and comes out the exterior face of the brick. Provided the membrane laps under the WRB, this is a serviceable attempt to keep water off the head of the window. The problem, of course, is that it looks bad.

A good alternative to membrane flashing is a thin copper sheet laminated to waterproof Kraft paper. Two sources are York Manufacturing (yorkmfg.com) and MasterCraft Metals (mastercraft metals.net). Because the copper is thin, it's not too noticeable on the face of the brick. It doesn't shrink, and it withstands the compression of the masonry and resists the acids and alkalis in mortar. This material can be turned up to make little pigs' ears at the corners to form end dams, and the Kraft paper will protect the copper from galvanic reaction with the lintel. If you're using a bare-copper pan flashing at the head, you will need to apply a strip of peel-and-stick over the steel before setting the copper pan.

The steel angle is for structural support only; it should not be used for flashing. Some contractors will lap the WRB over the top leg and rely on the angle alone to divert water to the exterior. More often, though, the steel is installed on top of the housewrap **(14)**. (Note the brick ties, as well, in this photo. They were affixed to the sheathing but were never bent over and embedded into the mortar.)

Window sills should always be sloped at least 15 degrees, per BIA standards, and should overhang the face brick by at least 1½ inches. Too often, I see flat brick sills that barely poke past the facade, providing very little positive drainage of all the water that sheets off the face of a window.

Through-wall flashing should also be placed under the sloped course of brick immediately below the window. This is meant to catch any water that makes its way into the wall cavity through or around the window.

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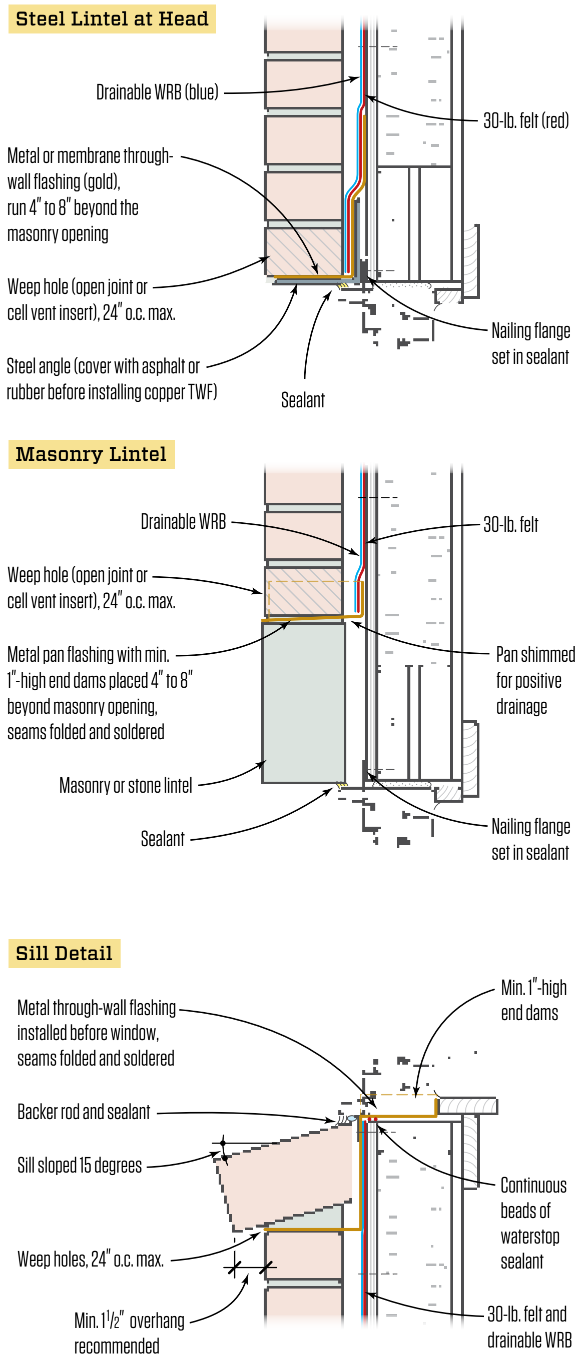
Window Flashing Details

(Based on BIA, IRC, and Author Recommendations)



CHALLENGING TRADITION:
NEW MATERIALS MAY LEAD TO A CODE CHANGE

Bulk water management is one of the main functions of a wall assembly. When rain hits the side of a building, the wall needs to direct the water down and out, away from the structure. The wall also needs to be able to dry if it does get wet.

That's all very simple in theory, but it can get complicated in practice—especially with brick walls. Brick is porous and holds water. Some of the water that hits a brick wall soaks in, and in the case of a single-wythe brick veneer, some of it even soaks through to the back of the brick. Water doesn't hurt brick, but it could damage whatever lies behind the brick.

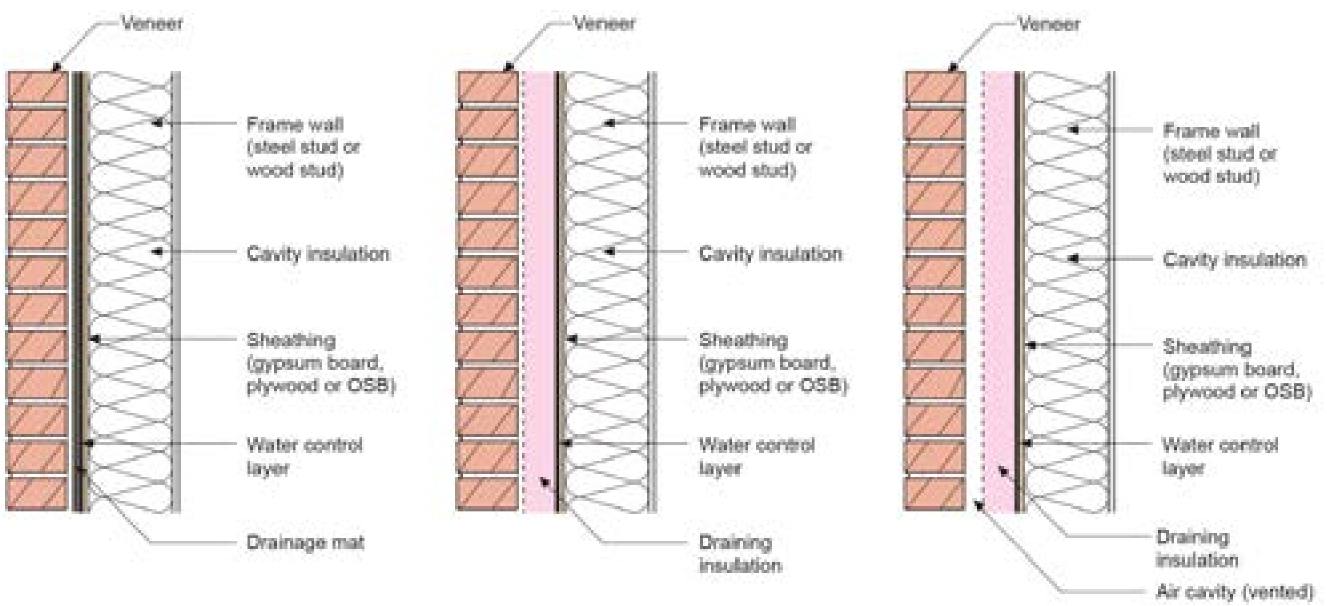
The masonry trade has traditionally detailed brick to handle soaking rains with a generous air space behind the brick and flashing. The air space not only allows water to flow down the back face of the brick, but—provided it has air inlets top and bottom—also allows air to flow in and help dry the brick. The flashings collect any water that leaks behind the brick and direct it out weep holes and onto the face of the wall.

Some building scientists, however, are increasingly taking another approach. Instead of focusing on the masonry, they focus on waterproofing the structural wall that sits behind the brick. If you create an effective water-control layer on the structural wall—which is possible with today's self-adhesive and liquid-applied WRBs—you may not need through-wall flashing. And if you use a drainable filter fabric or drainable insulation material—materials that will allow the wall system to drain, even if some mortar falls down behind the brick—on the face of the backing wall, you may not need the air space either.

Building-science expert Joe Lstiburek lays out the justification for this view in a recent paper titled "Vitruvius Does Veneers."Lstiburek points to the "Ten Books of Architecture,"written in about the year 15 A.D. by Roman architect Marcus Vitruvius Pollio: "... if a wall is in a state of dampness all over, construct a second thin wall a little way from it on the inside, at a distance suited to circumstances, and in the space between these two walls run a channel ... with vents to the open air. ... when the wall is brought up to the top, leave air holes there. For if the moisture has no means of getting out by vents at the bottom and at the top, it will not fail to spread all over the new wall."

Vitruvius went on to specify brick ties: "In the course of time, the mortar has lost its strength ... and so the monuments are tumbling down and going to pieces ... He who wishes to avoid such a disaster should leave a cavity behind the facings, and on the inside build walls two feet thick, made of red dimension stone or burnt brick or lava in courses, and then bind them to the fronts by means of iron clamps and lead."

There you have it: 2,000-year-old instructions for ventilated cavity walls with a structural backing wall, brick veneer, and masonry wall ties. As for the air space between the walls, Lstiburek observes, Vitruvius left wiggle room with his phrase "a distance suited to circumstances." According to Lstiburek, the strict 1-inch air-gap requirement in today's building code doesn't always suit today's circumstances. On the contrary, he argues, a practical approach is to modify the air gap depending on the main wall



Building Science Corporation

When using an advanced water-control layer, such as a self-adhesive or liquid-applied membrane, and a drainage mat or a draining insulation, such as mineral wool, no air cavity is needed. However, in IECC Climate Zone 5 and higher, and in areas with annual rainfall over 20 inches, a minimum 3/8-inch air cavity with vent openings top and bottom (far right) should be maintained.

characteristics and the climate.

Lstiburek also takes issue with the traditional practice of through-wall flashing at window heads and windowsills. If a flanged window taped to housewrap is sufficient for wood or vinyl siding, he argues, there's no reason it can't work as well behind brick veneer.

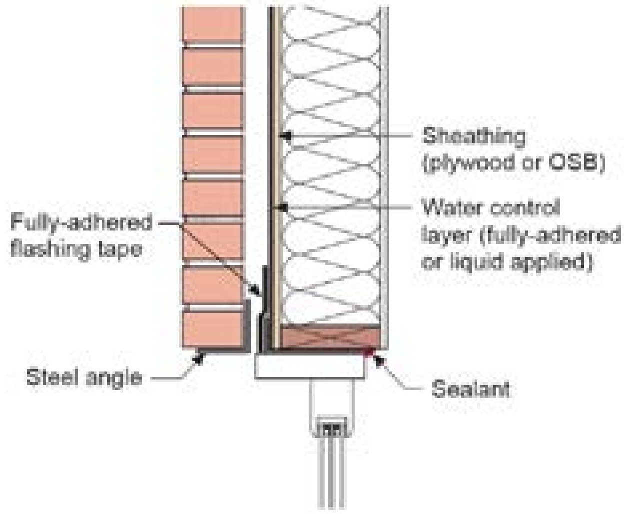
Masonry wall systems have evolved rapidly since the middle of the last century. Early on, Lstiburek observes, designers embraced a two-layer concept: pairs of single-wythe brick walls tied with 2-inch to 3-inch ties (based on the strength limits of the ties). Next, designers beefed up the inner masonry walls, evolving the classic concrete block masonry wall with brick cladding—again, with an air space of 2 to 3 inches.

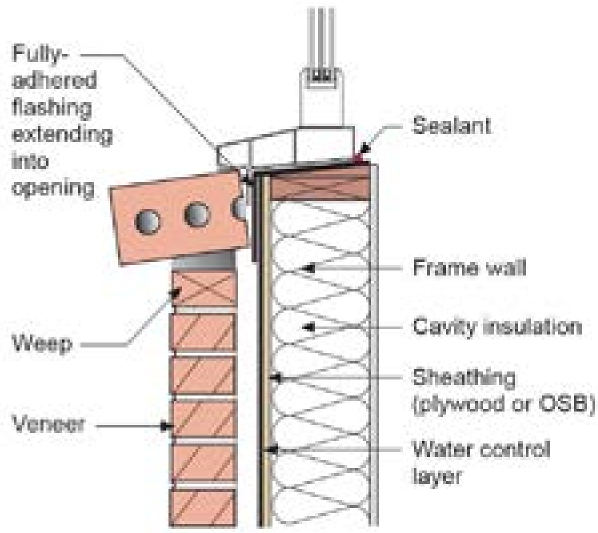
Those traditional walls had no waterproofing over the masonry backing wall, notes Lstiburek. They needed a hefty air space so that masons could keep the gap free of mortar droppings—otherwise, mortar would keep the space from draining, and water trapped inside the wall could pool against the masonry, creating hydrostatic pressure that led to trouble.

But these days, Lstiburek says, masonry backing walls are routinely waterproofed, as are light-gauge steel or wood-framed walls behind brick veneer. Builders now also use drainage mats, too, which drain walls, relieve hydrostatic pressure, and create a capillary break, despite any mortar droppings. Even better, Lstiburek notes, we now have materials such as mineral wool that can insulate between the brick and the house wall while still allowing drainage. If you're building a system with a waterproofed main wall and a drainage mat or drainable insulation layer, argues Lstiburek, you don't need any additional air gap at all—at least not for drainage or drying.

Code challenge. In an email, Lstiburek told *JLC*, "A code change proposal is coming." Lstiburek and his organization, Building Science Corporation, have been successful at spurring code revisions in the past—most notably in the case of interior-wall vapor barriers, where Lstiburek was instrumental in the effort to repeal requirements for poly under drywall in most climates. Lstiburek said his suggestion to omit the air space behind the brick—provided the wall has waterproofing and a drainage mat or drainable insulation, and the plans have been stamped by an architect or engineer—has been accepted many times on a case-by-case basis by code authorities.

But Lstiburek offers a couple of cautions. In climates with freeze/thaw conditions, he says, the air space helps dry the back of the brick veneer. This space should be kept as protection against frost damage. Lstiburek says experience teaches that a gap of ⅜ inch should be plenty for those purposes. Lstiburek also notes that the gap allows masons to meet visual construction tolerances. If the backing wall isn't perfectly regular and flat, the gap allows masons to maintain a flat face on the side people can see. The larger the building and the masonry wall area, the more room masons are likely to need. So even if building science doesn't justify requiring the gap, the gap will remain an option that many builders will continue to choose for practical reasons. *—Ted Cushman*





Self-adhesive and liquid-applied water-control membranes will reportedly protect the structural wall well enough that head and sill flashings can drain into the cavity instead of coming through the brick to the exterior face.

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