Cavity Wall *Construction*

Take a historical journey of this building design concept's application in the commercial market from the 1930s to today.

Cavity walls designed and specified for the commercial market in the last 43+ years of my experience in the architectural profession are one of the most misunderstood areas of the design profession. In particular, flashings and weeps are the least understood component by engineers and architects alike in that they believe these systems are so minor to the entire project that no time is really spent on them.

For many years, composite or cavity wall construction consisted of a back-up wall, which was generally masonry with a brick or stone veneer built concurrently (back-up and veneer staged at the same time). The cavity in composite wall construction was filled with mortar or concrete material, usually the same mortar used for the brick, stone, and masonry. There was no differentiation for the mortar used since it was mixed onsite with cement, lime, and aggregate in proportions determined by the mason based on his experience. Reinforcing bars were placed in the cavity at regular intervals just prior to filling the cavity with mortar. Water penetration through the walls ranged from slight to rather profuse.

The introduction of true cavity walls sought to modify the construction to alleviate water penetration and certain other shortcomings. This change was accomplished by placing the reinforcing in the cores of the block rather than in the cavity, which eliminated the requirement to fill the cavity. Using an air space between the masonry back-up wall and the veneer created a pathway for the movement of water in the cavity.

The air space seems to have been "designed" as 1 inch, where in truth it was the space required by the mason to get the brick in place with his fingers holding it. The back-up masonry wall was coated with an asphaltic material called dampproofing to allow water that reaches the air space from the exterior to ride down the cavity and exit the wall at pre-determined places. The exit areas were located where the through-wall flashings were placed. These flashings were placed at the foundation perimeter just above grade, at the floor lines in multiple floor construction, at heads and sills of windows and doors, and at copings of low-slope roofs.

Flashing details and locations were suggested by technical documents available from several sources, such as the BIA's (Brick Institute of America, now known as Brick Industry Association) *Technical Notes* and Ramsey Sleeper's *Graphic Standards*.

Flashing materials were generally copper or lead, with the former being more prevalent, probably for cost reasons. Copper flashing was generally laminated with asphalt and fiberglass on each side, which allowed the copper thickness to be reduced with no lowering in quality or performance. Laminated copper was patented in 1935 and is still used today by most manufacturers.

The flashing was built into the back-up masonry as the wall was constructed by tucking it into the bed joint one block course above the exterior veneer supporting lintel. Additionally, since water was now allowed in the cavity and would collect at horizontal flashings, there had to be a way to move the moisture to the exterior.

Movement was accomplished by placing a length of cotton rope about 16-inches long in the cavity on top of the flashing material and turning it out from the cavity to the veneer face. These "weep wicks" were generally placed at 4-foot centers.

Masonry reinforcing was placed in the bed joints 2-foot on-center vertically, or every third masonry course. Reinforcing consisted of two pencil rods running along the bed joints continuously, with cross rods in either a truss or ladder pattern.

Different approaches

Times change, philosophies change or are modified, and the manner in which walls are built change. No longer are back-up masonry walls and the veneer built at the same time. The back-up wall is constructed first and some time later (as much as several months) the veneer is staged and built. Many areas of the country have two separate crews building the walls: one laying the block and one laying the veneer. This procedure is used because there may be two pay classes and different expertises required or an express

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Hurricanes such as Ivan in 2004 have been a major factor behind the toughening of wind requirements for veneer construction.

need to close in the project for interior work to begin.

The intent is to get the building closed in as early as possible, allowing the interior work to start. Weather is a convincing factor for staging two separate sequences for exterior walls. Additionally, the use of steel stud/sheathing is quite commonplace so some masonry crews only lay veneer materials today. The advent of using steel stud and a sheathing material in lieu of the masonry back-up was an evolution from the residential market, which used wood studs and sheathing with a veneer. The veneer was connected to the wood studs with corrugated metal ties (metal studs require the use of adjustable ties in accordance with BIA *Technical Note 7*, August 2005).

Flashing and weep requirements were the same as with the masonry back-up. Instead of using dampproofing, 15-lb asphalt impregnated felt was applied shingle-fashion over the sheathing and fastened to the studs. Additionally, the felt was lapped over the through-wall flashing.

This practice of using the metal studs and sheathing as the back-up quickly became the standard in multi-floor commercial construction because block was too heavy, costly, labor intensive, and time consuming. Today, masonry back-up walls are generally reserved for schools and some other commercial building types.

Changes in venting the cavity also have occurred in the last 20 years. Moving from the cotton rope wick, designers used open head joints, weep tubes, and plastic head joint ventilators with mesh to prohibit insects from entering the cavity. Cotton rope wicks are seldom used today in commercial construction.

Additionally, there has been a concern in the last 10 years that mortar is dumped into the cavity by the masons in such quantity that it blocks venting water from finding its way to the exterior. This possibility has been at the forefront in the advertising campaign of companies that manufacture mortar deflection devices.

Even though there are temporary mortar dams available from masonry anchor and reinforcement companies, architects and engineers have been convinced that masons are so sloppy that mortar deflection devices are required. Specifiers have graduated from using nothing for mortar deflection to putting pea gravel at horizontal flashings, and being required to use these manufactured devices as the ultimate answer for exiting water from the cavity.

Flashing materials

Through the 1960s, laminated copper fabric was specified for through-wall flashings, either as pure copper or copper/lead coated. New materials entered the market that were more cost effective, including PVC, EPDM, vinyl, butyl rubber, and peel-and-stick.

Polyvinylchloride (PVC) is a plastic material that is brittle unless plasticizers are added to the mix for pliability and forming. PVC is not capable of withstanding UV very well, and when exposed to weather, the plasticizers leach out and the product again becomes brittle and cracks.

Most PVCs used in through-wall flashing today are not prime material, but combined with reground and reprocessed PVC for cost savings. Its hard to determine what you are getting when PVC is used.

A 40-mil product was often specified as an alternative to laminated copper, but it was not uncommon to find it was actually 20 mil or less. Most installed product today is in the 20-mil range.

History has shown that PVC is not a permanent flashing material. If building a temporary structure with a 5- to 10-year lifetime, PVC can last in the cavity environment before deteriorating and becoming useless. When using PVC, detail an edge material made of copper, stainless steel, or some other metal that does not rust since the flashing is required to exit the veneer to direct cavity moisture/water to the exterior (refer to BIA *Technical Note 7*, August 2005, "Extension Through Wall"). It states: "When possible, flashing should extend beyond the face of the wall to form a drip as shown in Fig. 7. If using a flashing that deteriorates with UV exposure, a metal or stainless steel drip edge can accomplish this purpose. It is imperative that flashing be extended at least to the face of the brickwork."

The best solution is to use a PVC-coated metal where the flexible sheet can be bonded to the metal. Remember that this is not the same PVC type or formulation used in some low-slope roofing membranes, nor is it as expensive.

In our specification consulting business, we have required only laminated copper core materials for the last 10 years or so since we are expecting lifetime performance. Copper flashing has graduated from laminating fiberglass to copper with asphalt to a new technology using a non-asphalt adhesive to adhere the fiberglass fabric to each copper face. The newest generation provides a copper core with fiberglass fabric laminated to one copper face and a non-woven wicking fabric laminated to the opposing face with a non-asphalt adhesive.

Since there are inherent problems with using certain specified sealants with asphalt products – silicone in particular – we feel that the new breed of non-asphalt laminates enhances the flashings' performance. Now we can bed the flashing on the lintels with a silicone bead, thereby sealing the flashing at a critical point and not allowing water to migrate under the lintel and traverse down the wall to the next level. Asphalt bleed is not a concern.

Building a masonry back-up wall in the fall, installing the flashing material in the block bed joints, and then closing the exterior of the building construction down for the winter is not an uncommon construction practice. Leaving a flexible sheet material such as PVC or EPDM exposed to weather and wind generally causes a lot of repair and replacement when the exterior veneer is started again in favorable weather. That cost is most likely included in the bid, however hidden.

The new kid on the block, relatively speaking, is the peel-and-stick flashing. This membrane is similar to below grade waterproofing material in that a rubberized asphalt material, generally 32-mil thick, is sandwiched between a polyethylene sheet and a release paper that is detached as the membrane is surface applied to the back-up wall.

The problem with this flashing type, however well received in the industry, is that the design professional is depending on the 6 or 8 mil of polyethylene to hold the rubberized asphalt in place. After all, asphalt is a liquid and gravity prevails.

Several caveats are presented in the manufacturers' literature. One requires that the membrane have a solid backing and cannot bridge gaps. Another is that the material is not UV resistant and requires a stainless steel drip edge when exiting the wall. Items not explained include the formulation of rubberized asphalt and the actual polyethylene carrier sheet properties.

Rubberized asphalt formulations vary among manufacturers, as do the type of polyethylene. Polyethylene deteriorates in a short time frame (typically 10 to 15 years) and the rubberized asphalt migrates or oozes over time.

Remember that asphalt is a liquid. Even in roofing, it is desirable to have a coating of gravel protecting the asphalt. Wall face temperatures on a southerly exposure can be very high, which allows the asphalt to become more fluid and search for gravity.

What is the flashing protecting your wall? Maybe it is 6 to 8 mil of polyethylene and 32 to 34 mil of rubberized asphalt. I have seen asphalt ooze in buildings at the flashing line if peel-and-stick membranes are chosen. This flashing material is intended to be surface applied to either masonry or steel stud/sheathing back-up and requires a termination bar for successfully adhering to the back-up substrate, as well as a metal edge strip where the flashing exits the wall.

End dams are required and must be made of another material compatible with the peel and stick membrane since the peel and stick materials cannot span more than ?-inch supported and certainly cannot span the cavity.

Mortar deflection devices

These products are placed in the cavity during veneer construction and bring up another interesting point. They are generally about 10-inches high and a through-wall flashing is required to terminate above them on the back-up wall. Therefore, the flashing height must be set above the highest point of any mortar droppings, which is now over 10 inches.

Veneer wall reinforcing typically used to be 2-foot on-center for masonry back-up and the flashing was tucked in the masonry joint 8-inches above the lintel. Add the 10 inches for the deflection device and the additional height for suspected mortar droppings and we are now up to the second bed joint of the block if the flashing is intended to be built into the bed joint.

We have added 8 inches to the flashing height times the number of horizontal feet, or 2/3 sq ft of additional material per lineal foot of flashing. This amount represents a hidden cost added to the project. Hopefully, the reinforcing can be above the flashing by one block course in this scenario.

Flashing/drainage material are set in the mortar joint.

Today's market

In the past, there were several codes to comply with, including SBCCI, BOCA, Florida Building Code, National Building Code, various state-sponsored and enforced codes, and the ICBO. Most states have fully adopted the ICBO, International Building Code (IBC), some with state specific criteria.

With the adoption of the IBC, criteria further restrict construction through additional requirements for seismic, wind, or a combination of both. Seismic considerations have been toughened and areas that never had to contend with these factors are now required to have controls.

Seismic controls are in effect for most building veneers. More stringent requirements are designed through structural engineering calculations for "pinning" the veneer on the building. This fact may not seem relevant, but these requirements now require closer spacing of wall ties, depending on the zone the project is located. Old methods are gone and old spacing is gone. It is time to rethink veneer construction.

Wind pressures are a real factor for veneer construction. A building in Savannah came under the new code and it had to take into account both seismic and wind loads.

Stud wall construction that had a spacing of 16-inches on-center was still allowed, but instead of placing the wall ties vertically every 2 feet, they had to be placed every 5th brick course, or about 13½ inches. Masonry back-up areas had reinforcing at every other block course, with adjustable ties to accommodate the 13½-inch spacing. Add to that the flashing details, mortar deflection device heights, and the new IBC requirement and BIA requirement (*Technical Note 7*, August 2005, Fig. 5) for a 2-inch cavity space rather than the historical 1-inch cavity and the pending changes begin to stack up.

A solution

Still use time-tested dampproofing on masonry back-up, or 15-lb felt on steel stud/sheathing back-up. Avoid the mortar deflection device and save the additional 10+ inches of vertical height. Use material that combines the copper flashing with the laminated non-woven wicking fabric. The system is surface applied so the mason is the one installing the material at the same time he is building up the veneer. This approach eliminates the need to repair flashing that has been exposed to the weather for long periods of time.

Masons can field form end dams in less that one minute by using copper fabric. Attach the system with a termination bar and bed the flashing in the sealant bead. The wicking fabric eliminates the mortar deflection device and saves flashing height/cost and the increased code required wall tie criteria is more easily accommodated.

This system, using a combination flashing /drainage, has a cost factor that allows a design professional to move from PVC (or peel-and-stick), a mortar deflection device, and stainless steel to the permanence of copper for less initial material cost. Additional savings are realized in system installation since there is only one piece to place rather than several.

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Quality built buildings, such as this dormitory at the University of New Hampshire, often use cavity wall construction.