Brick Veneer & Steel Studs: Performance Questions

Some researchers question the durability of this popular building system, particularly in damp climates

by Jim Cowie
and Mike Wilson

Steel-stud walls with brick veneer became popular for light-commercial construction in the 1960s because the system offered a less expensive alternative to all-masonry cavity walls. However, over the years we have seen this system experience a number of problems. While some of these may be blamed on poor design or improper installation, there is increasing evidence that the errors lie with the system itself.

Our company, a structural engineering firm with offices in Canada, has investigated and documented failures of brick-veneer/steel-stud walls since 1976. In the process, we've done extensive testing of the system in both the laboratory and the field.

Although failures are often attributed to shoddy workmanship, we've found that no matter how carefully brick-veneer/steel-stud walls are built, they're exceedingly fragile. Even minor design and construction errors can cause extensive structural damage with this system, while the same errors in a conventional all-masonry cavity wall (brick veneer, masonry backup) will have little effect on its structural soundness.

While problems with the system are widespread in both Canada and the United States, failures are more common in coastal areas where high humidity and salt speed up corrosion of the studs and fasteners. Yet there have been plenty of failures in places like Kansas and Wisconsin where dryer climactic conditions prevail.

Building with Brick Veneer and Steel Studs

The system consists of 20- to 22-gauge, C-channel steel studs sheathed on the outside with exterior-grade gypsum board, plywood, or fiberglass insulation sheathing. The exterior-grade gypsum board and the plywood are usually covered with #15 asphalt building felt or a permeable house wrap (Figure 1).

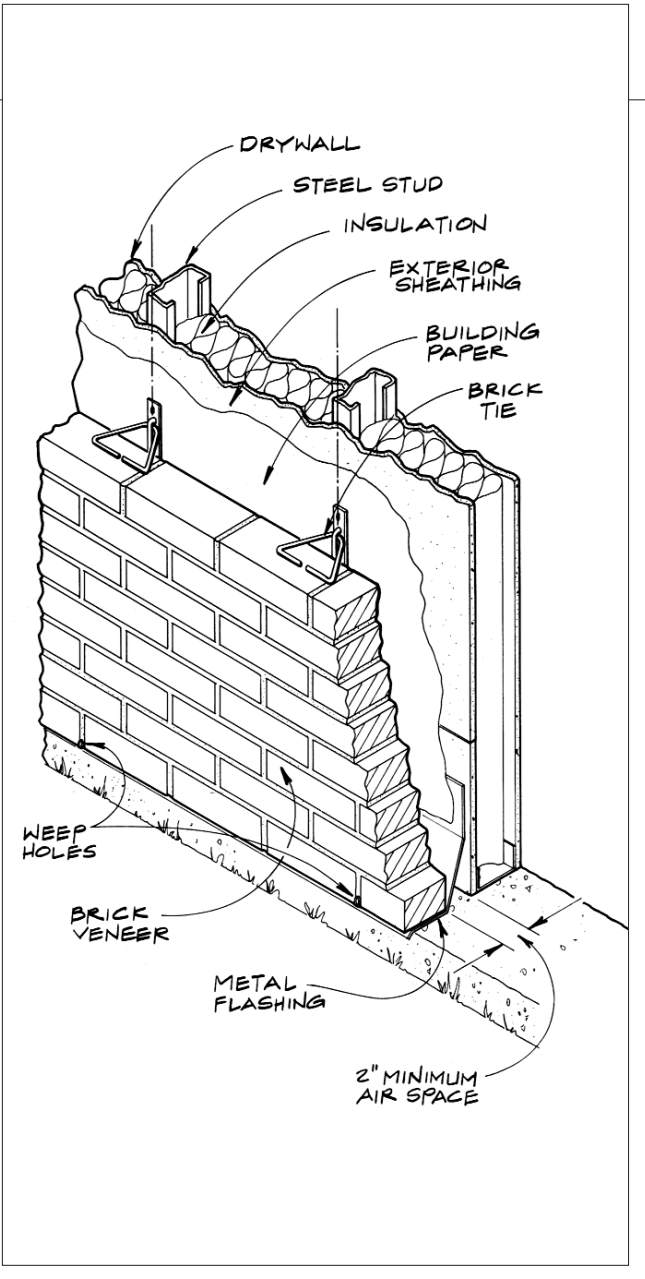


Figure 1. *For the brick-veneer/steel-stud system to perform properly, special attention must be given to flashing shelves and openings. A minimum of 2 inches must be maintained between the brick and the stud wall. Bricklayers must be careful not to allow mortar droppings to clog the cavity.*

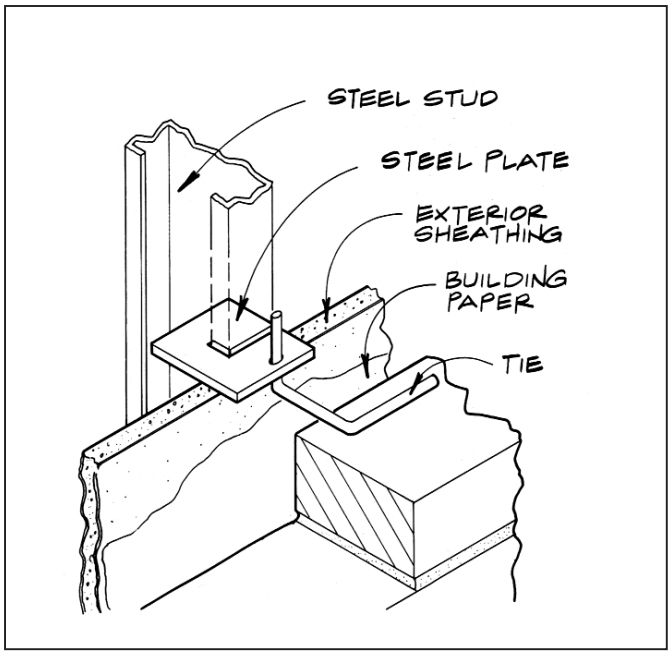
The brick veneer is connected to the studs with brick ties leaving, ideally, 2 inches of unobstructed air space between the sheathing and the brick. Until recently, the recommended cavity was only 1 inch. But tests, as well as real life examples, have shown that a cavity that narrow is prone to clogging from mortar droppings, leaving no escape route for rainwater that penetrates the veneer.

Since the brick-veneer/steel-stud wall has a cavity, some rainwater is expected to penetrate the brickwork. This should trickle down the back face of the veneer and drain from weepholes located at the base of the cavity. Flashing should be installed at each shelf angle to direct water out of the weepholes. Flashing must also be installed around windows and other openings where water is bound to enter.

Basic Flaws

A brick-veneer/steel-stud wall may fail within months or it may take years. But problems still fall into the same general areas: cracking, vulnerability to moisture, and inadequate fasteners. These are all interrelated. For instance, problems with cracking will inevitably lead to excessive moisture penetration, which will then result in rusted fasteners.

Cracking. Brick veneer is stiff and brittle while the steel-stud backup is somewhat flexible. With the 4-inch-deep, 20-gauge studs spaced at 24 inches on-center, the brick veneer is about six times stiffer than the backup wall. As a result, the veneer carries about 75% of the lateral wind load. Without sufficient support from the backup wall and without strong, stiff ties to hold the brick in place, the veneer is liable to crack, especially around windows and other openings. This not only disfigures the building, but it increases the amount of wind-driven rain entering the air cavity, leading to moisture problems.



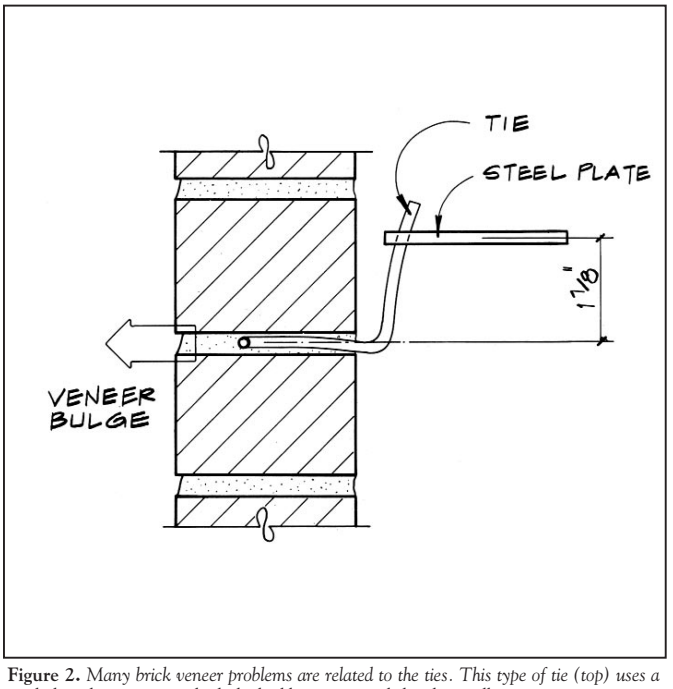


Figure 2. *Many brick veneer problems are related to the ties. This type of tie (top) uses a steel plate that penetrates both the building paper and sheathing, allowing moisture to enter. The placement of the plate is critical. If it is placed near the top of the wire tie (above) it offers little support to the brick veneer, allowing it to bulge and lean.*

Based on our studies, increasing the stiffness of the backup wall to prevent the brickwork from cracking would mean placing the studs at approximately 2 inches on-center, certainly not economical or practical.

Vulnerability to moisture. The intrusion of moisture, from rainwater leakage and condensation, leads to rusted studs, tracks, brick ties, and screws, contributing to structural failure. Moisture intrusion also causes deteriorated sheathing, saturated insulation, and the failure of interior finishes. Moisture also encourages mold and fungi growth.

Windows, doors, and other openings are probably the chief sources of water infiltration. Unless these are painstakingly flashed and caulked, moisture problems are inevitable.

While the exterior sheathing is typically wrapped in asphalt building felt or permeable house wrap, these provide little protection when they are punched full of holes. Yet in order to attach the ties to the studs, these barriers, as well as the exterior sheathing, must be punctured.

Using ties that incorporate steel plates (Figure 2), which require slicing the building wrap as well as the exterior sheathing, is particularly disastrous. It is next to impossible to adequately seal these slices. As a result, the ties create a bridge between the veneer and the studs, providing leakage paths for water penetration into the interior construction. In the process the gypsum board on the exterior and interior of the studs gets mushy and the fasteners lose their holding power. The insulation is likely to get wet, providing little protection.

Steel plates were the source of problems at one apartment building in Newfoundland, Canada. Although the structure was only a year old, the brick veneer had to be completely removed and replaced. The cavity side of the steel studs was sheathed with 1-inch-thick fiberglass board. The brickwork was connected with wire wall ties attached to horizontal steel plates that clipped to the steel studs. These projected through the joints of the fiberglass sheathing (set vertically at 24 inches on-center), allowing large amounts of water to infiltrate at these points.

To compound problems, the ties were incorrectly installed with variances of as much as 1 7/8 inches in vertical distance from the bed joint to the horizontal steel plate. The angled wire gave little or no support to the brick veneer, allowing it to bulge and lean.

Air pressure inside the cavity also affects the amount of rainwater entering the system. If the cavity is tightly sealed and properly divided into compartments with flashings and corner blocking, air pressure inside will approximate that of the outside air. In this case, water penetration would be minimal, regardless of whether the veneer is cracked.

In theory the brick-veneer/steel-stud wall system can approximate these ideal conditions. But in practice, there's no such thing as an airtight cavity. With all the punctures from the ties, windows, laundry vents, pipes, and other openings, cavity pressure cannot equal outside air pressure. As a result, water is actually sucked in.

Inadequate fasteners. There are no commercially available brick ties that satisfy the necessary criteria of stiffness, strength, and corrosion resistance for the life of a building. Ties depend upon anchorage to the studs by self-tapping screws which, with the moisture problems inherent with the system, are likely to rust.

While screws are electroplated with zinc or cadmium, during installation the protective coating is often abraded, leaving the threads of the screws with no resistance to corrosion. In addition, self-tapping screws are often improperly installed since the studs are concealed by the exterior sheathing. We've often found screws either completely missing the studs or only marginally engaged.

A History of Failures

It's difficult to determine the number of walls that have failed, since owners, designers, and contractors are understandably reluctant to have their buildings identified as having problems. Though many lawsuits have involved brick-veneer/steel-stud walls, most have been settled out of court. Silence on the matter is often a condition of settlement.

The most reliable estimates come from insurance companies that have handled claims relating to the wall systems. Encon Insurance Managers, a Canadian carrier, reports that of its 250 open claim files involving exterior wall problems, more than 100 are related to brick-veneer/steel-stud walls.

Last fall, Encon published a loss control bulletin directed at the architects and engineers it insures. The bulletin concludes: "Design professionals should be extremely cautious when using [brick-veneer/steel-stud] systems…Our experience with claims arising out of the failure of such wall systems indicates that remedial costs are exorbitant as very often an entire wall must be removed and reconstructed."

One 12-story apartment building in Nova Scotia, the first major brick-veneer/steel-stud wall failure docu-

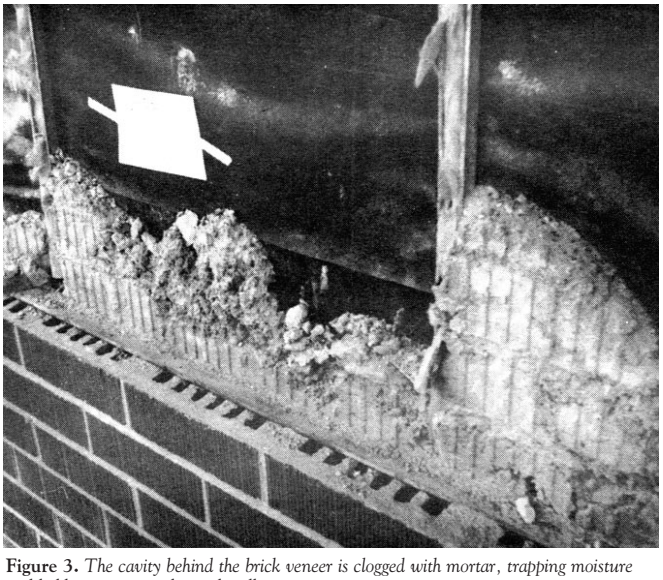


Figure 3. *The cavity behind the brick veneer is clogged with mortar, trapping moisture and holding it against the stud wall.*

mented in Canada, was only three years old when rainwater leakage problems necessitated replacement of the brick and the windows. In the process of repairing the building, we found many instances of poor workmanship. For example:

- The wall cavity was bridged with mortar droppings, clogging the weepholes and allowing rainwater to come in contact with the backup wall (see Figure 3, previous page).
- No movement joints were installed below the shelf angles, forcing the veneer to bulge and crack.
- Flashings were either improperly installed or missing altogether.
- The brick ties that were used lacked adequate strength, stiffness, and corrosion resistance. Many were severely rusted (see Figure 4).

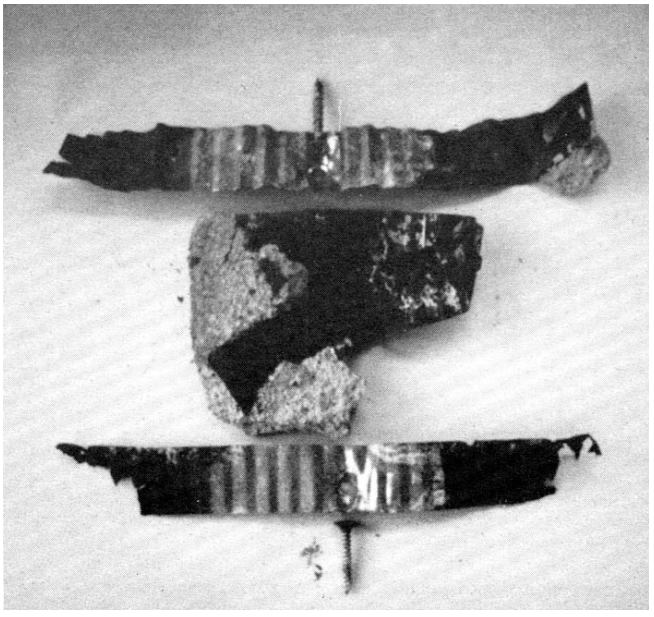


Figure 4. *These severely rusted ties provided little support to the brick veneer. Better corrosion resistance is required.*

Using industry design, material, and construction standards, such as the Brick Institute of America's (11490 Commerce Park Drive, Reston, VA 22091; 703/620-0010) *Technical Notes 28B* (Second Revision, 1987) may help avoid some of these problems. But even if these criteria are carefully followed, you can still expect problems from inadequate and corroded ties.

In restoring the apartment building in Nova Scotia, we found that the costs of reconstruction, including engineering design and inspection, were much higher than the original work. The owners were forewarned that if they chose to restore the brick-veneer/steel-stud walls, the building would still be prone to failure due to the problems of moisture, rust, cracking, and so on. Yet changing to an all-masonry backup wall would have meant evacuating all the residents so the walls could be torn down and rebuilt.

In this case, the owners decided to stick with the original design but are carefully monitoring the building for problems.

The windows, brickwork, existing shelf angles, flashings, brick ties, building paper, and all damaged steel studs and gypsum board sheathing were removed and replaced with new construction. Stiffer, custom-designed brick ties were locally fabricated for use in the restoration. To prevent clogging the flow of water to the weepholes, a net cavity width of not less than 2 inches was maintained. Most importantly, we provided continuous on-site inspection, insuring good workmanship.

Improvements Needed

Much of the research over the past ten years, especially in Canada, has shown that this wall system is vulnerable to moisture problems and is not structurally reliable. As a result, many buildings are in varying degrees of failure; and more that are destined for failure are under construction.

It's difficult to turn around and admit that a building system is flawed. Changing the system to make it reliable would increase costs and would mean some changes in components. For instance, an effective brick tie would have to be brought to market.

Yet not facing up to the problems will ultimately help neither contractors nor building owners. Those who will really benefit are the investigators, expert witnesses, and members of the legal profession. ■

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