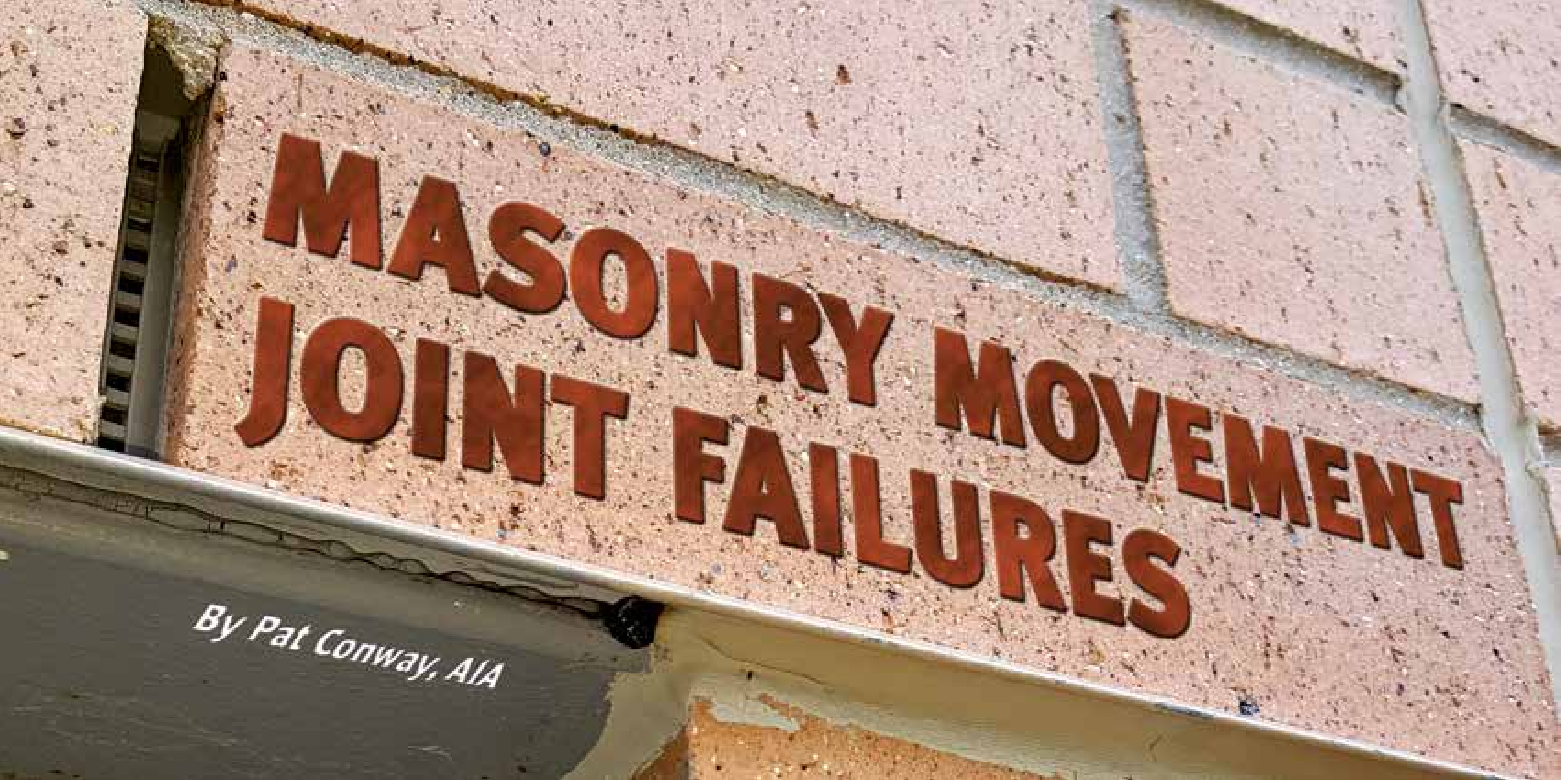

Masonry Movement Joint Failures

By Pat Conway, AIA

Masonry movement joints are one of the most misunderstood and underappreciated technical issues in the masonry industry. The lack of properly located, detailed, specified, and installed masonry movement joints can result in "masonry failures." However, most masonry deficiencies due to movement issues are not performance issues with masonry units or systems, but rather can be attributed to "design failures."

WHO IS RESPONSIBLE?

According to the national masonry model code mandatory requirements checklist for designers, in the specification section, TMS 602, of "Building Code Requirements and Specification for Masonry Structures," (TMS 402/ACI 530/ASCE 5 and TMS 602/ACI 530.1/ASCE 6), Page S-31, Part 3.3 F.7, designers are required to "indicate type and location of movement joints on the project drawings." Furthermore, TMS 402, Section 6.1.6.3, states it is the responsibility of the building designer to "design and detail the veneer to accommodate differential movement."

CONTROL JOINTS VS. EXPANSION JOINTS

There are many types of masonry movement joints and movement control strategies, but the two most common are control joints in the concrete masonry unit (CMU) walls and expansion joints in clay brick veneers. In the past, when CMU and brick walls were constructed as bonded composite walls, control joints and expansion joints needed to be coordinated and aligned through both the block and the brick.

In modern masonry cavity walls, these two different masonry wythes are connected with flexible connections so control joints in the CMU backup wall can be located independently of the expansion joints in the brick veneer. It is recommended that structural engineers locate control joints in structural masonry walls for structural reasons, while the architects are free to locate movement joints in the veneer to address both functional and aesthetic priorities.

COMMON MISTAKES

When masonry structural walls, partitions, or veneers crack due to a scarcity of masonry movement joints or their improper placement, this is a design failure. When

Figure 1 – Control joints properly located between openings.

masonry cracks occur due to poor workmanship, then the failure can be attributed to the mason—but this is not as common.

The main errors designers make when locating masonry movement joints are:

1. Relying on generic specification language to locate movement joints instead of showing them on the building plans and elevations
2. Locating control joints at the ends of masonry lintels in vertically reinforced masonry walls
3. Not understanding movement control strategies for CMU veneers
4. Not understanding industry recommendations for locating veneer movement joints in relation to outside corners
5. Not locating movement joints at inside corners
6. Not understanding the use of isolation joints
7. Not understanding how veneer lintel type influences placement of vertical movement joints at or near window openings
8. Not detailing proper expansion joint width in clay brick veneers
9. Not having movement joints between different veneer material types
10. Not having movement joints at window and door frames

MOVEMENT JOINT MISTAKES

Following are some examples of common mistakes building designers make when developing movement control strategies for masonry walls.

Failure #1: Specifications Approach to Locating Movement Joints

"Locating" masonry movement joints with generic specification language does not give masons enough information to make decisions about where to locate movement joints. For example, common specification language typically does not address different industry guidelines for movement joints to be spaced closer in clay brick veneer with multiple openings as opposed to walls without any openings. In addition, a general specifications approach to movement control may erroneously negate the structural capacity of masonry if a mason unknowingly segments a CMU shear wall. Therefore, it makes sense for the structural engineer to locate movement joints in structural masonry walls and the architect to locate movement joints strategically in the veneer for both functional and aesthetic reasons.

Failure #2: Vertical Control Joints at Ends of Masonry Lintels

When masonry lintels are used to span openings in vertically reinforced masonry walls, vertical control joints should not be located at the end of the masonry lintel when vertical reinforcement is located at jambs of openings. In this scenario, the vertical reinforcement at opening jambs is bonded integrally with the horizontal reinforcement bar and grout of the masonry lintel; therefore, a control joint in this location cannot move properly. In vertically reinforced masonry walls with masonry lintels, vertical control joints should be located between openings, or at least 24 inches away from the opening, not to exceed 25 feet on-center (*Figure 1*).

Failure #3: Not Understanding Concrete Masonry Veneers

When masonry veneer is comprised of

Figure 2 – Control joints in this 4-in. CMU veneer were placed 24 ft. off center to accommodate the clay brick expansion above. CMU control joints, however, should have been placed no more than 12 ft. off center, with horizontal joint reinforcement in the CMU spaced appropriately.

CMUs, there are special movement control guidelines to be considered as outlined in the National Concrete Masonry Association (NCMA) TEK 10-4 (2001), "Crack Control for Concrete Brick and Other Concrete Masonry Veneers." These guidelines can be very different than movement control strategies for clay brick veneers in some environments (*Figure 2*). For example, CMU veneers are required to have horizontal joint reinforcement that is not required in clay brick veneers in certain seismic design categories and in those with non-stack bond jointing patterns. Also, vertical movement joints in CMU veneers are typically spaced closer than those in clay brick veneers—especially wall panels less than 14 ft. tall. These additional and extra veneer movement control components should be considered when evaluating the real cost and performance of a clay versus concrete brick veneer.

Failure #4: Movement Joints at Outside Corners

Vertical masonry movement joints should be located on both sides of outside wall corners so that the distance between them does not exceed the appropriate spacing between movement joints for that specific project (*Figure 3A*). Also, when locating a movement joint near a door or window that is near to the corner, the movement joint should be located on the corner side of the opening (*Figure 3B*).

Figure 3A – This veneer expansion joint should have been located on the corner side of the opening. The next closest veneer movement joint to the left of the one shown is 18 ft. around the corner. This makes the expansion joints 42 ft. apart, which is too far, resulting in a crack at the corner of the veneer.

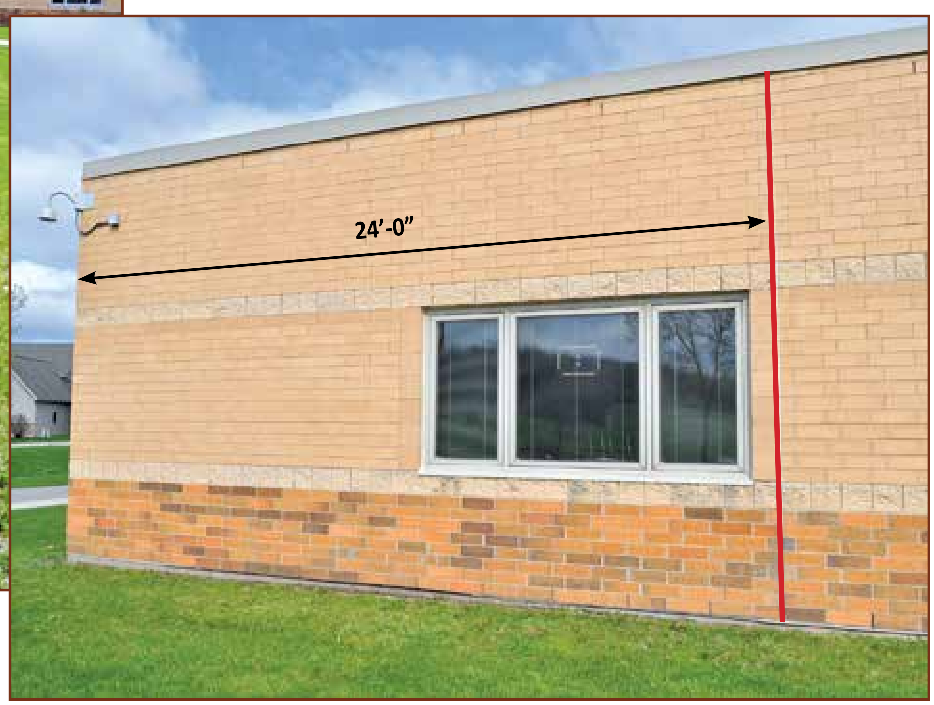

Figure 3B – Crack developed at the corner because veneer movement joints were spaced too far away from the corner on both sides.

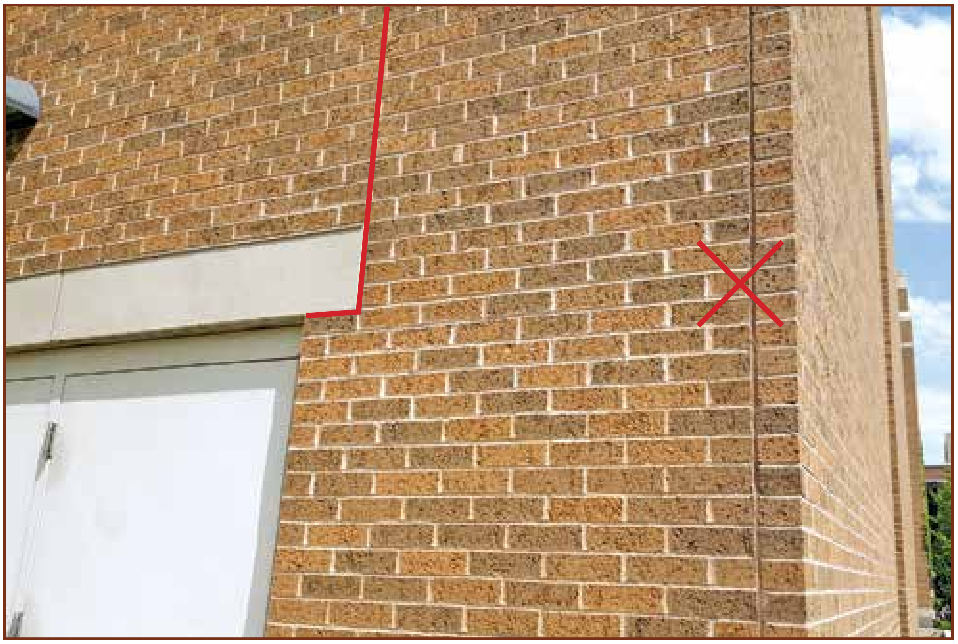

Figure 4 – A veneer movement joint placed 4 in. from the corner will make masonry look panelized. A more functional and aesthetically pleasing solution would be to locate the movement joint at the end of the window lintel, omit the corner movement joint, and then locate a movement joint further away from the corner, not to exceed 20 ft.

Movement joints do not need to be located at the outside corner of masonry walls. In fact, doing so will make the masonry wall look panelized; that will impact the aesthetics of the building (*Figure 4*).

Failure #5: Not Locating Movement Joint at Inside Corners

Unless there are special circumstances, a good general rule-of-thumb is to put vertical movement joints at the inside corner of masonry walls (*Figure 5*). This is a good place to start when locating movement joints on either building plans or elevations. Then, the distance between them can be calculated and decisions can be made to segment the remaining wall length.

Failure #6: Isolation joints

An isolation joint is a movement joint in masonry walls that separates portions of walls that have different heights, volume, loads, and bearing conditions (*Figure 6*). It is necessary to install these types of move-

Figure 5 – Corner movement joint with sealant color selected to make it less noticeable.

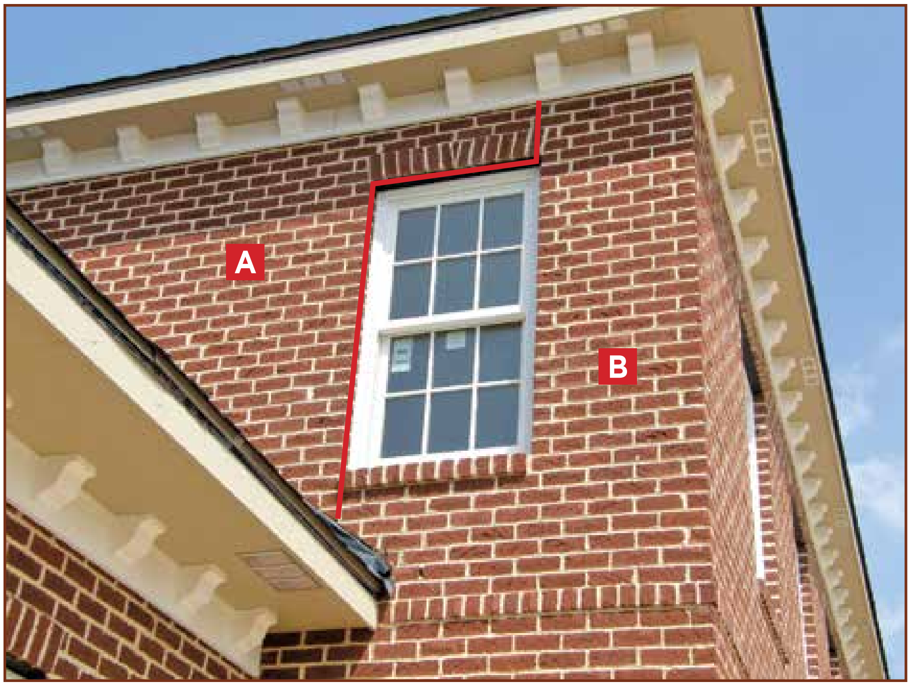

Figure 6 – The red line denotes location of a crack due to lack of isolation joint between elevation segments A and B, which have different bearing conditions. Segment A bears on steel, and segment B bears on the foundation below.

ment joints to allow differential movement of adjacent wall or veneer panels.

Failure #7: Veneer Lintels

There are two types of masonry lintels: loose and fixed. Fixed lintels are those that are connected to the lintel in the backup wall, as is typical for larger spans. When masonry veneer is supported with fixed lintels, a portion of the veneer will bear on the structural steel, and the nearby portion of wall will bear on the foundation or some other bearing point. Therefore, when portions of the veneer have different bearing points, they are often separated with a vertical

Figure 7 – Vertical movement joint properly located at the end of the beam bottom plate that supports the clay brick veneer at the door opening. Sealant properly installed under drip edge to prevent wind-driven rain penetration.

movement joint (*Figure 7*). There can be exceptions to this recommendation when there are stacked openings with fixed lintels in multistory elevations.

Figure 8 – Approximately 80% of all CMU units are cracked in the accent bands on this large hospital project because of differential movement of the shrinking CMU band bonded to large expanses of clay brick veneer.

Failure #8: Expansion Joint Width

Expansion joints are movement joints that pass through materials that have properties of expansion, such as clay brick. With expansive clay bricks on both sides of an expansion joint, these joints should be installed a minimum of ½ inch wide to let them reduce down to ⅜ inch to match a typical mortar joint's width. In conditions where oversized or dark-colored clay brick is specified, in certain climate zones, when vertical movement joints are spaced farther apart than industry recommendations, or when the brick is less than one year old, expansion joints may need to be installed even wider than ½ inch.

Failure #9: Movement Joints at Different Materials

When bands of differentially moving materials are used in the same veneer wall

Figure 9 – This sealant joint prematurely failed because there was no room to install a backer rod for a properly formed sealant joint. Designers should draw and dimension a gap on all four sides of windows.

plane, provisions should be made to accommodate the differential movement with bond breaks, back rod, and sealant (*Figure 8*). With single-course bands of masonry, care should be taken to attach masonry bands to the building either by connecting the band to the support wall with veneer connectors in the head joints of the band, or only breaking the bond at the top joint of the band. Another strategy for this condition is to achieve the banding aesthetic with similarly moving masonry materials of different size, color, or texture so that there is no differential movement to address.

Failure #10: Gaps at Windows and Doors

Designers should illustrate and create dimension gaps at the interface of masonry veneers with window and doorframes. Without this dimensioned gap, masons may build too tightly up against frames, resulting in inadequate space to install appropriate backer rod and sealant joint for a properly proportioned sealant joint (*Figure 9*).

CONCLUSION

Most cracks in masonry walls are not "masonry failures," but rather a failure of the building designer to adequately specify, detail, and locate masonry movement joints in the construction documents. The code clearly states that it is the responsibility of the designer—not the mason—to locate movement joints. Masons do not have enough information about building loads, environmental conditions, product specifications, and aesthetic intent of the designer to locate movement joints.

Pat Conway

Pat Conway is a registered architect in Wisconsin and a member of the American Institute of Architects. He is codirector of the International Masonry Institute's (IMI's) national masonry technical team, IMI's Director of Architectural Education, a faculty member of IMI's Contractor College, and a provider of Craftworker upgrade courses. Conway is a frequent lecturer and author on numerous masonry subjects.