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Masonry and Movement

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Movement Control

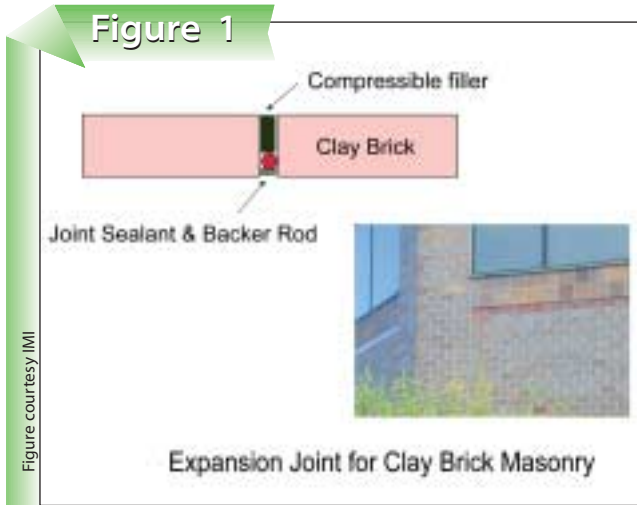
Issues in Masonry

Photo courtesy Sound School. Photo © Alicia Cook.

by Richard Filloramo and David Sovinski

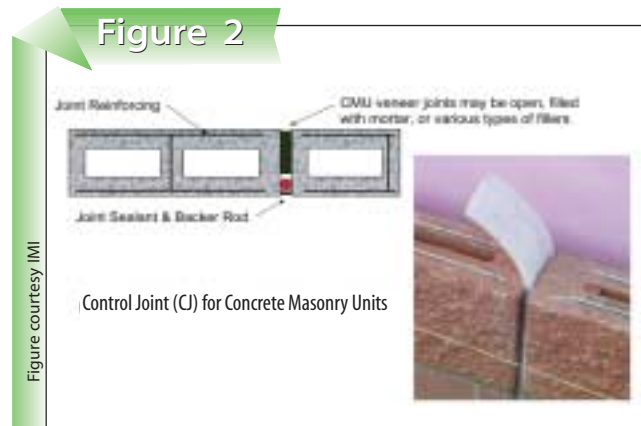
Although opinions and regional construction practices change, one thing is constant—buildings and their elements will move. Thermal and moisture changes cause movement, as do structural forces, including building settlement and creep. While the topic of movement control can spark nearly endless debate, this article offers strategies for accommodating masonry movement, while maintaining aesthetic and structural integrity.

The information compiled in this article represent the consensus thinking generated at the first Masonry Movement Joint Summit, held earlier this year in Annapolis, Maryland. Hosted by the International Masonry Institute (IMI), the summit brought together the key masonry organizations to review current industry literature and issues, and produced design and construction recommendations for improving masonry buildings.



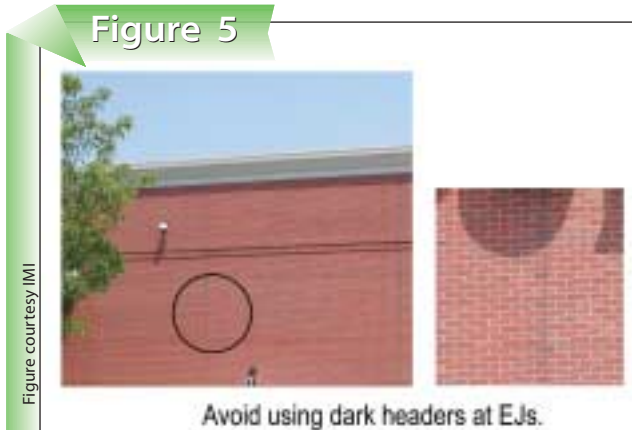
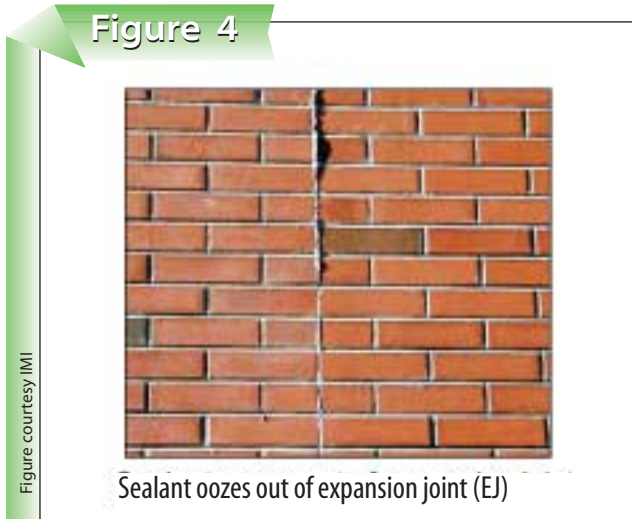
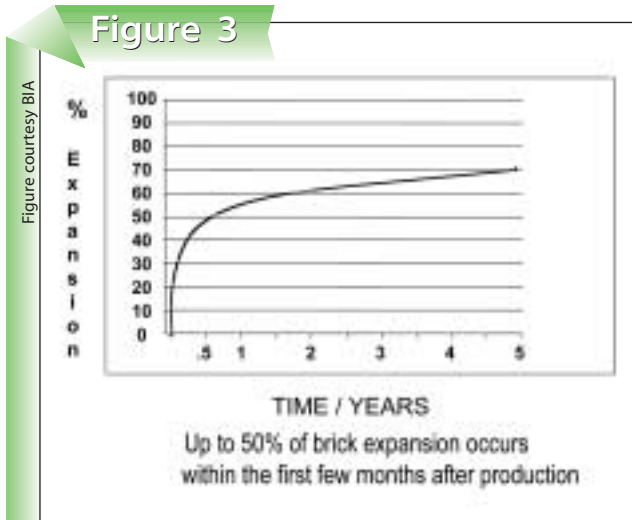
Recognizing the joints

It is important to address the confusion between expansion joints and control joints in masonry construction—simply put, not all movement joints are control joints. An expansion joint (EJ) is used to accommodate the expansion of clay masonry (*i.e.* brick) and prevent cracking. The joint accommodates movement due to the dimensional changes

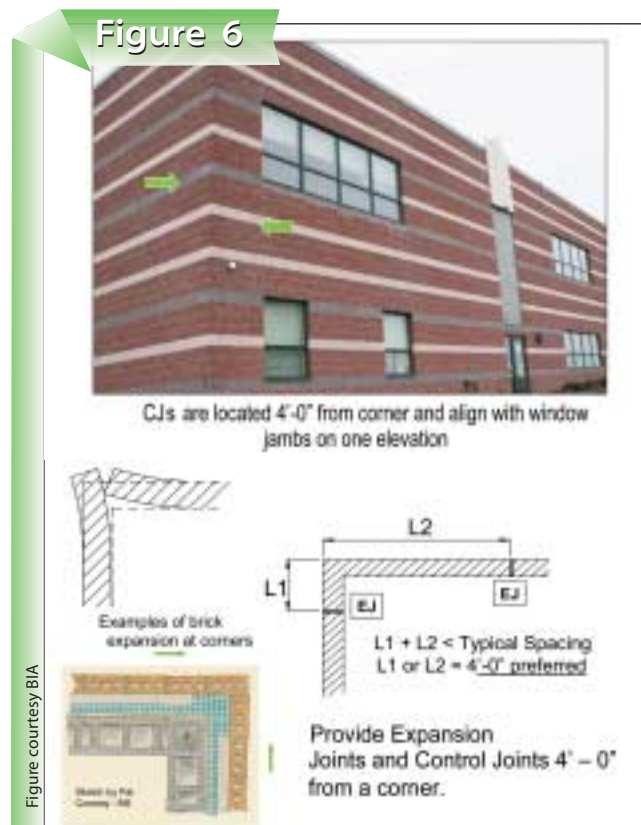


resulting from brick's moisture expansion and thermal conditions. Expansion joints may be horizontal or vertical and must be formed of highly compressible material (Figure 1). Expansion joints are also used with stone and calcium silicate materials.

A control joint (CJ) is used to separate segments of concrete masonry to prevent cracking. The joint creates a plane of weakness that, in conjunction with joint reinforcement, 'controls' the location of the crack caused by dimensional changes resulting from shrinkage and thermal



movements. A control joint is usually vertical and may be filled with rigid or compressible material. Concrete masonry unit (CMU) veneers consisting of 101.6-mm (4-in.) wide units often use compressible products that can match the brick veneer above (Figure 2, page 25).



The important point to remember is to not label a brick expansion joint as a 'control joint.' A contractor will refer to the specification and may end up placing a hard, non-flexible rubber or mortar in the joint, causing cracking and spalling of the brick veneer. (Architects may use the abbreviation 'BEJ' for brick expansion joints to avoid confusion with building expansion joints.)

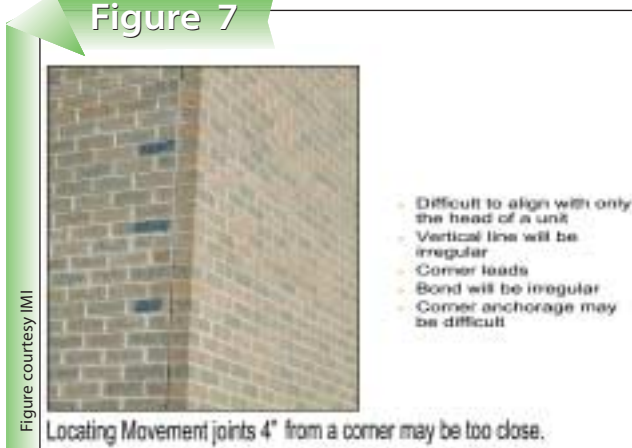
Planning for brick hot out of the kiln

As a result of frantic construction schedules (which often cost owners more money than they save), many projects are always in a rush for brick. This means less time for the initial expansion before installation. Brick significantly expands from moisture gain in the first few months after production, before leveling out (Figure 3). It is best to plan for this change and decrease the distance between expansion joints. While the Brick Industry Association's (BIA's) general rule for 7.6-m (25-ft) spacing is usually adequate, some recent projects have proven this to be not the case. Figure 4 illustrates the sealant oozing out of a closed EJ spaced at 7.6 m (25 ft). If a rush schedule is anticipated, it may be best to decrease spacing to 6.1 m (20 ft).

Expansion joints and brick heads

The distance between expansion joints should always be a 'modular' determined by the brick length. For example,

Figure 7



expansion joints at 7.6 m (25 ft) would lay out to 37 full brick and a half-unit ($25 \times 12/8 = 37.5$). A spacing of 7.7 m (25.3 ft) would lay out to 38 full brick and the next course would have a half-unit at each end. Generally, the units opposite each other at the expansion joint are the same size (Figure 4, page 26).

Some brick, particularly red-based units that are burned and flashed, have a certain percentage of dark

Figure 8



heads. It is essential to randomly place only a few of these dark heads on each side of an expansion joint to avoid forming a pattern, as shown in Figure 5 (page 26). In brick masonry construction, it is standard practice to split the brick in half and use the heads of brick for half-units. Aesthetically, this accentuates the expansion joint and forms a disturbing repetitious vertical pattern up the wall elevation. (This situation can also develop at corners and jambs.)

To avoid this situation, the architect should always ask the brick sales representative whether the manufacturing method will yield a high percentage of dark heads. The specification can call for a maximum percentage, and the manufacturer will have to cull out the excess. However, this should not be required or performed on-site. If there are insufficient red brick head units, brick would have to be cut on the job-site and the face of the unit used, possibly incurring additional cost.

Movement joints at corners

BIA recommends expansion joints be located within 3 m (10 ft) of a corner, and the total distance not exceed 7.6 m (25 ft) or the maximum distance used on the project. Some experts feel expansion (and control) joints should be located within 1.2 m (4 ft) of a corner to reduce cracking from opposing expanding forces, as shown in Figure 6 (page 26). Windows, doors, and other openings often dictate the location of EJs and are frequently the deciding factors for placing these joints at corners.

However, expansion and control joints should not be located 101.6 mm (4 in.), or 'one-unit-width' in from a corner, for the following reasons:

- it is impossible to make any unit adjustment when working with the above distance, as there are no head joints;
- the resulting vertical line at the control or expansion joint may waver due to normal unit variations and tolerances (Figure 7);

- the bond will be irregular, as units will not match on opposite sides of the joint;
- corner anchorage of the veneer can be difficult with steel columns in corners; and
- it makes it difficult for the mason to build a corner.

For these reasons, it is best to locate control and expansion joints 0.6 to 1.2 m (2 to 4 ft) in from a corner. If 203-mm (8-in.) long brick or other masonry units were used, a 0.6-m (2-ft) dimension would lay out to three brick and two joints. Once again, depending on the type of brick, it could be best to increase the distance from the corner to 0.8 m (2.7 ft) or more. If 406.4-mm (16-in.) long CMU units are used, 1.2 m (4 ft) is suitable, as it lays out to three units.

Control joints at low CMU veneer walls

Many designers use CMU decorative block at the base of a building, for banding within brick veneers, or below brick, other masonry units, or windows. These walls are usually 0.6 to 1.2 m (2 to 4 ft) high. It is important to install a bond breaker or joint reinforcing between brick and block for expansion and contraction variations. The details are available from any of the major masonry organizations—IMI, BIA, or the National Concrete Masonry Association (NCMA). The focus of this section is the CJ spacing at these low CMU walls.

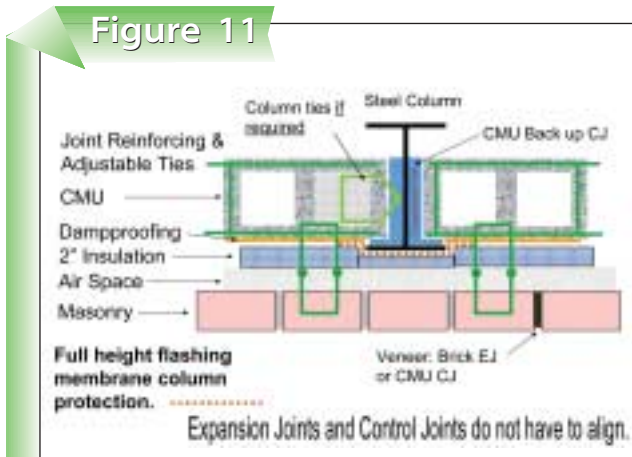
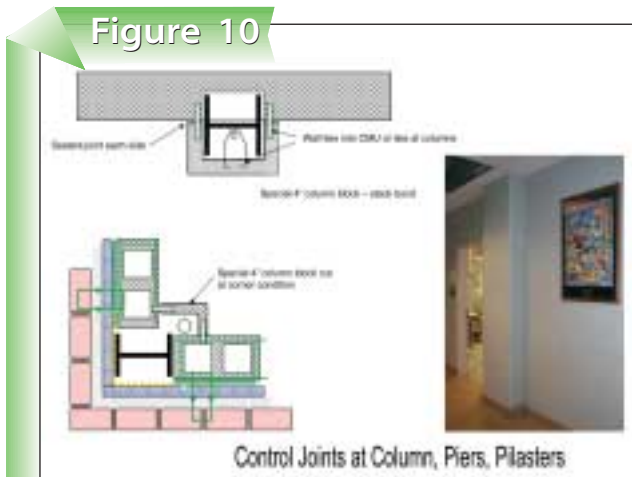
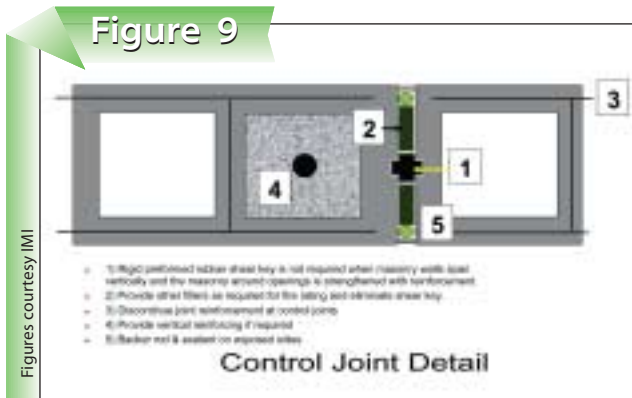
The *NCMA Tek Manual* recommends CMU veneer CJs and joints in banding not exceed 6.1 m (20 ft), and if geographical experience indicates, the spacing should be shortened to 4.9 m (16 ft). The length-to-height ratio (L/H) should not exceed 1.5. There are other factors to consider, such as window openings and joint reinforcing spacing. However, if the 1.5 L/H ratio is used, this would mean a 1.2-m (4-ft) high CMU veneer wall would require control joints at 1.8 m (6 ft) on center (oc). Aesthetically, this is undesirable. Recent studies and examinations of buildings with low CMU veneer walls have shown slight cracking when the CJ spacing was greater than 6.1 m (20 ft).

When low CMU veneers or bands are used, it is best to split this distance in half, and specify and install as much joint reinforcing as possible. For example, many typical designs use CMU to a height of 1.2 m (4 ft), and then use a cast stone water table with brick above. The EJ in the brick is set at 6.1 m (20 ft) and then aligned in the CMU veneer below. It is recommended to add a control joint at 3 m (10 ft) in the CMU veneer (Figure 8). When placing a CJ in the concrete masonry veneer midway between the brick expansion joints, it is important to insert a bond breaker between the CMU and brick veneer. Control joints are often naturally formed by doors or windows, making the number of joints less noticeable.

In very low CMU veneers (*i.e.* 0.6 m [2 ft]), it is essential to have joint reinforcing every course. This can be accomplished by adding single #9 (or ‘nine-gage’) wire at anchor courses, or by using special ties that combine joint reinforcing and anchors. It is occasionally necessary to have flashing at the first course with joint reinforcing. In this case, a termination bar could be used to secure the flashing to the outside face of the CMU backup.

Economics in CJ filler details

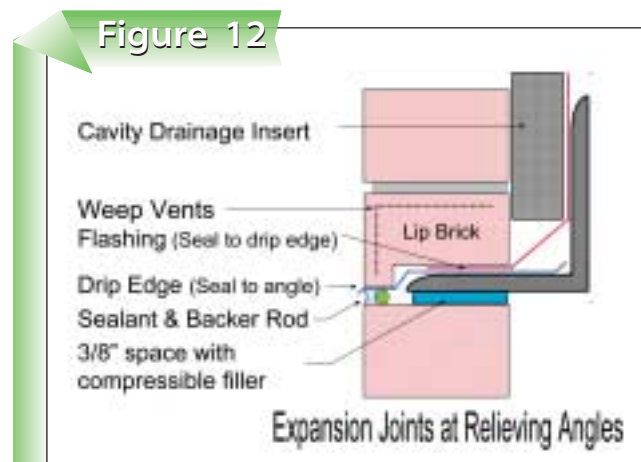
Preformed rubber gaskets that fit into a sash block have been used for more than 30 years as CJ fillers (Figure 9, page 30). The specially formed control joint filler acts as a shear key to transfer out-of-plane loads. This type of detail is applicable when walls are spanning horizontally between columns or other masonry walls. It is also used for unreinforced masonry, where control joints are placed through openings, resulting in no lateral support above or below the opening. However, most masonry partitions span vertically between the floor and slab above, as this distance is usually smaller and more consistent than horizontal supporting elements. If walls span vertically, the rubber shear key CJ filler is not



required. Ceramic fiber, mineral wool, or other less expensive fillers can be used, depending on the required fire rating. There is also a labor-saving factor since handling of sash block and filler is not required. The CJ is filled with sealant on both sides; anchors at the top of the wall should be within 203.2 mm (8 in.) of each end of the joint.

Column covers, piers, and pilasters

It is essential to provide control joints at all CMU column covers, piers, and pilasters. These elements usually form a



continuous vertical break in the wall and transition from one size unit to another. Figure 10 illustrates a CMU column cover using a specially made unit. The block can be anchored to the adjacent block with ties or can be tied to the steel column.

The important point here is to provide a sealant joint at both ends of the CMU column cover, pilaster, or pier. If the unit is bonded into a structural pier or pilaster, then the joint should be raked back and filled with backer rod and sealant. Both investigations and experiences have shown these types of wall configurations will crack, and it is best to use control joints on both sides of the element as noted.

Movement joint alignment

In masonry veneer and CMU backup drainage walls, the veneer joints do not have to align with the CMU backup control joints, as shown in Figure 11. The control joints for CMU backup usually are formed at columns when the structure is steel-framed, occurring every 6.1 to 7.6 m (20 to 25 ft). The brick or masonry veneer expansion joints may be located anywhere that best suits the veneer layout with consideration to windows, doors, and other openings. In load-bearing CMU structures, the backup could align by coincidence but, once again, this is unnecessary.

Expansion joints at relieving angles

Multi-story buildings requiring relieving angles need special attention at these locations. The most important, yet often overlooked, item is the space below the relieving angle. Although BIA recommends a minimum of 6.4 mm (0.25 in.), many industry summit participants noted 9.5 to 12.7 mm (0.375 to 0.5 in.) can be even better.

Architects like to minimize this space to keep the overall sealant joint as small as possible. In reality, job-site conditions require as much tolerance as possible, and 6.4 mm (0.25 in.) on a construction site is minute. Adjustable angles help construction, and material variations



Photos courtesy URS Corp. Photos © Paul Pizzo.



Located in New Haven, Connecticut, the Sound School Regional Vocational Aquaculture Center provides practical education in marine and agricultural science and technology. As illustrated by Figure 6, the project features control joints located 1.2 m (4 ft) from the corner, aligning with window jambs on one elevation.

can close that gap. Although more difficult to detail and install, lip brick can minimize the exposed sealant joint at relieving angles (Figure 12, page 30).

Roles and responsibilities

The architect is responsible for locating all nonstructural movement joints on a project, while the engineer is responsible for structural movement joints (in coordination with the architect). The Masonry Standards Joint Committee's (MSJC's) *Building Code Requirements for Masonry Structures*, Section 1.2—Contract Documents and Calculations (Subsection 1.22), states:

Show all code-required drawing items on the project drawings, including: (h) provisions for dimensional changes resulting from elastic deformation, creep, shrinkage, temperature and moisture.¹

This is the technical definition for expansion and contraction (control) joints. It is important to note the code requires both EJs and CJs be shown on the drawings.

In other words, it is neither sufficient nor code-compliant to simply have a note on the drawings or in the specifications that states "locate control joints at 20 ft maximum." On projects with many CMU interior partitions, it is especially important to locate control joints on the drawings. Architects often run out of drawing time and CJs are not shown; in these cases, the design team must work with IMI or other industry organizations and the mason contractor to locate the control joints before beginning work.

Mason contractors should not submit movement joint layouts, shop drawings, or otherwise assume any responsibility. Coordination and assistance is acceptable, but location of control joints is an architectural/engineering design responsibility.

'Moving' forward

There are many excellent publications written about design and construction of masonry movement joints. The Brick Industry Association is just completing updates to its Technical Notes 18 and 18A on brick expansion joints, while



The information in this article comes from a recent Movement Joint Summit held at the International Masonry Institute's (IMI's) James Brice House headquarters in Annapolis, Maryland. Participants included representatives from the Brick Industry Association (BIA), the National Concrete Masonry Association (NCMA), the Portland Cement Association (PCA), the International Union of Bricklayers and Allied Craftworkers (BAC), and the architecture/engineering community.

NCMA has information on control joints for concrete masonry units in Series 10 of its *Tek Manual for Concrete Masonry Construction*. The International Masonry Institute, Portland Cement Association (PCA), The Masonry Society (TMS), and various other organizations have books and publications with similar information.

The best approach is to analyze, plan, and design for any building movement by implementing the above recommendations to improve building performance and

aesthetics. After all, if the design team does not provide for movement, nature will. ♥

Notes

¹ The MSJC code comprises American Concrete Institute (ACI) 530-02/American Society of Civil Engineers (ASCE) 5-02/The Masonry Society (TMS) 402-02. Also see ACI 530.1-02/ASCE 6-02/TMS 602-02, *Specifications for Masonry Structures (and commentaries)*.

Additional Information

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B2010—Exterior Wall Exterior Skin
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 Movement joints
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Abstract

While masonry materials and systems appear static, they undergo volume changes and movement. Both thermal and moisture changes and structural forces (e.g. building

settlement and creep) lead to movement. This article discusses strategies for accommodating this inevitably, while maintaining aesthetic and structural integrity.