



Brick Expansion Joints and Wall Openings

design element minimizes movement cracking

BY J GREGG BORCHELT, PE

Most designers are aware that vertical expansion joints are required in brickwork. Brick Industry Association Technical Notes 18 and 18A, *Volume Changes — Analysis and Effect and Accommodating Expansion of Brickwork*, respectively, discuss the reasons for expansion joints and give information on sizing and locating them. Industry recommendations for walls without openings are relatively straight forward: a vertical $\frac{1}{2}$ " wide expansion joint is needed at approximately 25' oc. Placing door or window openings in the wall complicates matters.

As a quick review, remember that long-term moisture expansion of the brick and thermal movement of the brick wythe result in an increase of size of approximately 1" for each 100' of wall length. This movement is outward from the centerline of the wall section. Vertical expansion joints, including the sealant with which they are closed, must accommodate this movement. A $\frac{1}{2}$ " wide expansion joint closed with a sealant capable of 50% movement results in functioning expansion joints at 25' oc.

The presence of openings in the wall changes the manner in which the movement takes place. Each wall section with a different horizontal length expands outward from its centerline. Thus, wall components are moving different distances and perhaps in opposite directions. That movement causes stress concentrations and cracks unless vertical expansion joints are positioned properly. Typically, the expansion joint locations are more frequent than 25' oc in walls with frequent punched window openings.

In Figure 1, wall segments 1 and 6, below and above the windows, move horizontally from their center. That movement carries along segments 2 through 5. Each of these elements also expands from its own centerline. Thus, a shear force develops between segments 1 and 2, 1 and 3, 1 and 4, and 1 and 5 and between segments 6 and 2, 6 and 3, 6 and 4, and 6 and 5. These shear forces are highest where the movements in different directions meet.

Items that influence the expansion joint location and spacing

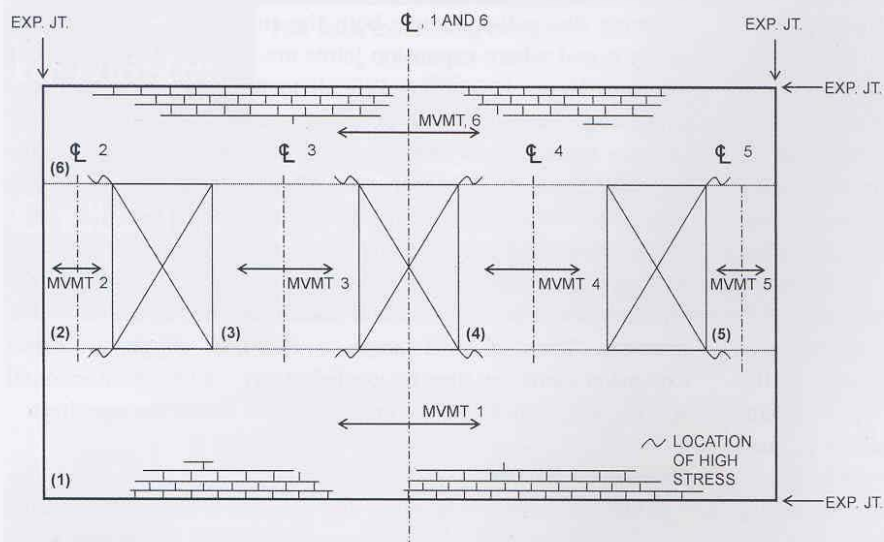


Figure 1. Wall segment movement



Learning Objectives

After reading this article, you should:

1. Recognize that building elevations with large or frequent openings need special consideration for placement of vertical expansion joints in brick veneer.
2. Identify that how the brickwork above openings is supported influences expansion joint placement.
3. Learn rules of thumb for location of expansion joints to reduce potential for cracking of brickwork.

See insert for test and answer form.

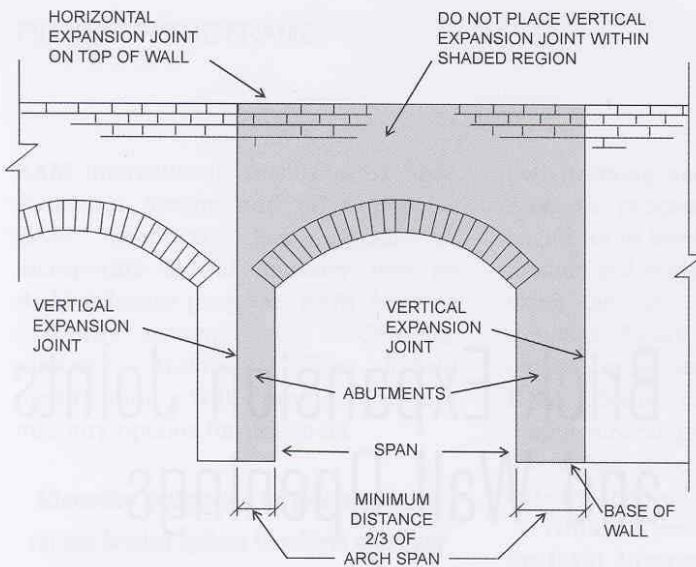


Figure 2. Expansion joints near an arch

include how the masonry above the opening is supported, the opening width and horizontal distance between openings.

Support of masonry above openings

There are several means of carrying masonry above openings. The four means of supporting masonry above openings are: an arch, a reinforced brick beam, a loose steel lintel and a shelf angle. The first three are supported by the masonry at the jambs; a shelf angle is attached to a structural frame. For each of these, expansion joint location will influence how much load the structural element carrying the masonry above the opening must support.

ARCH A structural brick arch needs a sufficient length of horizontal masonry to resist its thrust. An expansion joint near either jamb prevents this from occurring. Thus, for an arched opening, expansion joints must be located away from the opening beneath the arch. A horizontal distance of two-thirds of the arch span from the vertical edge of the opening to the expansion joint should suffice for a segmental arch. Similarly, any expansion joint above the arch will prevent arching action from occurring. So, none can be placed there. See Figure 2.

If a steel angle supports a non-structural arch, treat it as a loose lintel for expansion joint locations. If an expansion joint is desired above the arch, locate it only above the crown of the arch.

REINFORCED BRICK BEAM A reinforced brick beam needs sufficient bearing area at the jambs to transfer its vertical reaction to the masonry below. Further, attempting to accommodate horizontal movement of the beam on its bearing is difficult. There is a mortar joint at this junction and the coefficient of friction is relatively high. If there is an expansion joint at either jamb, arching cannot take place in the masonry above the opening. As a result, the beam must be designed to carry the weight of the rectangular section of brickwork above the opening. So, let's not put a vertical expansion joint at the jamb of an opening spanned by a reinforced brick beam. Placing it at the end of the beam bearing is possible, but at least 3' from the vertical edge of the opening is recommended.

LOOSE LINTEL Loose lintels, single structural steel angles placed in the brick wythe, offer more options for expansion joint locations. Since the coefficient of friction of the angle on the

brickwork or of the brickwork on the lintel is lower than that of a mortared joint and bond is broken by the presence of the angle, it is possible to place the expansion joint at the jamb of the opening. However, doing so requires that the lintel be designed to carry the entire weight of the rectangular section of brickwork above the opening. In most cases this is the logical loading condition. Even if the expansion joint is moved to the end of bearing of the lintel, the brickwork above will not be able to develop arching action and the lintel still has to be designed for the full area above the lintel. Placing the expansion joint past the end of the lintel by at least 3' from the vertical edge of the opening is recommended in order to get arching action above the opening. Then the lintel can be designed for a 45° triangular area of masonry above the opening. However the vertical expansion joint should then continue through the brickwork adjacent to the opening. Which location is preferred? That is a matter of aesthetic preference. Engineers do not go there.

SHELF ANGLE A shelf angle is supported by the building frame or structure. It may be continuous around the perimeter of the building or over just one or a series of openings. The masonry above the shelf angle is, therefore, supported by structure at the height of the shelf angle. The brickwork horizontally adjacent to the opening is supported by the foundation or structure at a lower level. For continuous shelf angles, the vertical expansion joints can be placed at any desired location. For shelf angles over a single or series of openings, the vertical expansion joint must be placed at the ends of the shelf angle. That is, since the support conditions are different, these two sections of brickwork must be separated by a vertical expansion joint. This is a steadfast rule.

Expansion joints at or near jambs are more difficult to detail properly when reinforced brick beams or loose lintels are used. With expansion joints at the jambs, be sure to detail the bearing ends so horizontal movement can occur. Refer to Technical Note 18A.

Opening and pier size

Opening size will influence both the support of the brickwork above it and where expansion joints are located. As the opening becomes larger, it is more difficult to limit the deflection of a single angle loose lintel. For openings greater than 8', it is prudent to have a reinforced brick beam or a shelf angle support the masonry above it rather than a loose lintel. Then expansion joints may be placed at virtually any horizontal spacing less than 25'.

Openings with narrow piers between them may not provide a long enough section of masonry to resist the weight of the masonry above or the horizontal shear from the expansion of that masonry. Thus, a shelf angle is the best support. Vertical expansion joints can then be located at any convenient horizontal spacing less than 25' in the brick spandrel above the openings.

Rules of thumb

- One can never cover all of the possible situations that brick masonry affords the designer. However, there are some common sense rules that should make it easier to properly

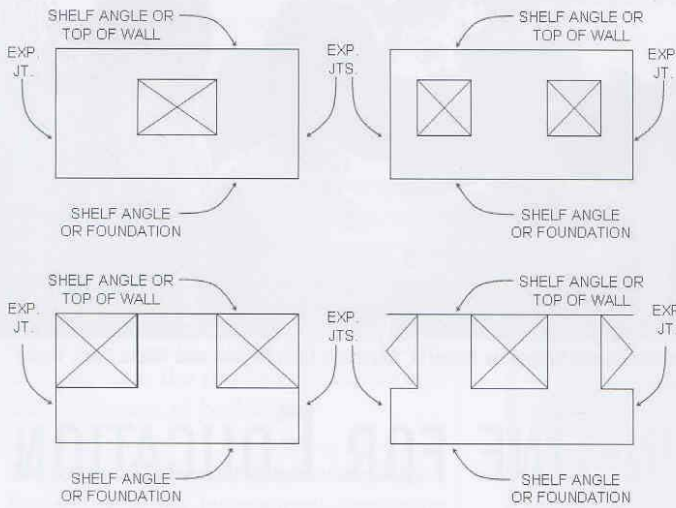


Figure 3. Symmetrical sections

locate expansion joints in walls with openings.

- Walls with openings must have more frequent vertical expansion joints than do solid walls. Consider a maximum spacing of 20' oc. As opening frequency increases, expansion joint spacing decreases.
- Divide the wall into symmetrical sections. The sections do not have to be rectangular, just the same on either side of the vertical centerline. Use expansion joints to create symmetrical sections of brickwork. If you cannot maintain symmetry, reduce the horizontal spacing of the expansion joints. See Figure 3.

- Have at least 3' of brickwork on each side of expansion joints between openings. This provides enough brickwork to resist the horizontal stress at the top and bottom of the openings and sufficient area to carry the weight of the brickwork above.
- If the openings have piers between them that are less than 2' wide, use a shelf angle above rather than a series or a single loose lintel.
- One final point: if the color of the sealant used in a vertical expansion joint matches that of the brick, the appearance of the joint is minimized.

Remember that expansion joints minimize cracks from occurring. So you want to include a sufficient number. Sure, too many could be included, but most designers will not let this happen. Expansion joints can be a design feature of the project so the building looks great and functions properly. ☺

J Gregg Borchelt, PE, FASTM, FCSI, vice president, Engineering and Research Division, Brick Industry Association (BIA), is responsible for technical information and publications on the use of brick. He represents the brick industry on many design and construction industry committees. Borchelt holds a degree in civil engineering from Purdue University. borchelt@bia.org, 703-674-1547



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