MASONRY INSIGHTS

written in conjunction with International Masonry Institute

Why Are Masonry Control Joint Locations Significant?

Crack Control

When designing concrete masonry walls, one aspect that needs to be considered is the location of control joints. Control joints are continuous vertical mortar joints where a bond breaker is placed between the mortar and the units on one side as shown in Figure 1. Masonry walls, like concrete walls, will shrink after placement due to moisture content and temperature. Control joints provide a plane of weakness where shrinkage cracks can form in a controlled manner. The number and location of control joints can have a considerable effect on the capacity of the walls.

Since the purpose of a control joint is to provide a bond break (as shown in Figure 1) that will permit longitudinal movement and relieve horizontal tensile stresses, horizontal reinforcing is generally not continuous through a control joint. Therefore it makes sense for the structural engineer to locate the joints so that they will have as little impact as possible on wall capacity, within prescribed spacing recommendations. The National Concrete Masonry Association (NCMA TEK 10-2C) recommends that control joints be spaced at 25 feet or 1.5 times the height of the wall, whichever is less. It also recommends that joints be located at areas of stress concentrations, such as changes in wall height or thickness or near wall openings or corners. Paying attention to these requirements, and adding some

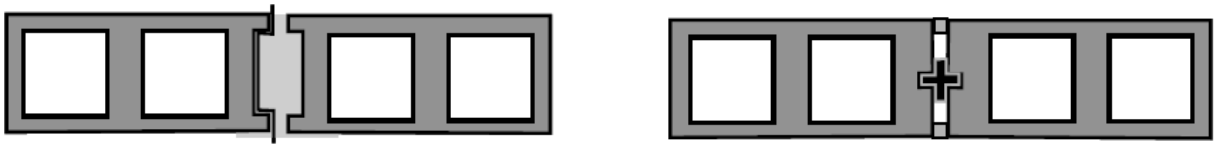

Figure 1: Shrinkage Control Joints (From Klingner 2010)

reinforcing, can result in the need for fewer construction joints.

One of the likely spots for stress concentrations, and an increased potential for cracking, is at wall openings. Therefore, in this situation, reinforcement needs to be added to prevent the cracks or control joints need to be added at wall openings. With many masonry walls having at least minimal reinforcement added, and openings essentially surrounded by reinforcing—that is, jamb reinforcing on

each side, lintel reinforcing, and sill reinforcing (if applicable)—the wall around the opening can be considered sufficiently strengthened to avoid stress concentrations, and control joints can and should be placed away from the opening to meet the minimum spacing listed above. Control joints should be spaced a minimum of two feet away from the vertical edge of openings to allow for this reinforcing. This procedure will also allow the designer to take into account the full length of the wall when checking capacity. If, for example, a wall is 20 feet long and has a six foot wide opening centered within it, reinforcing around the opening will allow the wall to be designed as a 20 foot long perforated shear wall as opposed to two separate eight foot long walls. This design can be performed in software packages such as RISA 3D and RAM Elements.

For unreinforced walls without sufficient reinforcement at openings, smaller openings should have a control joint at one side, while larger openings should have a joint on each side; see Figure 2 for joint arrangement and locations in masonry walls.

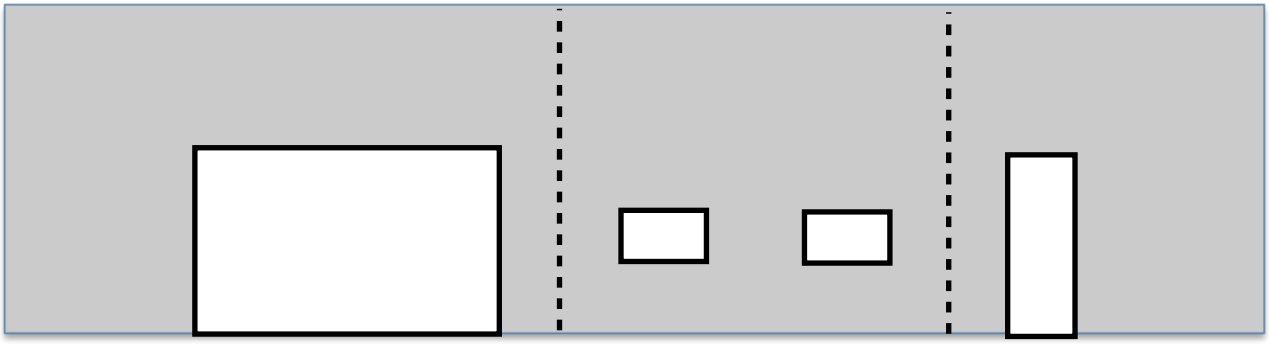

Figure 2a : Arrangement of Control Joints away from Openings in Reinforced walls

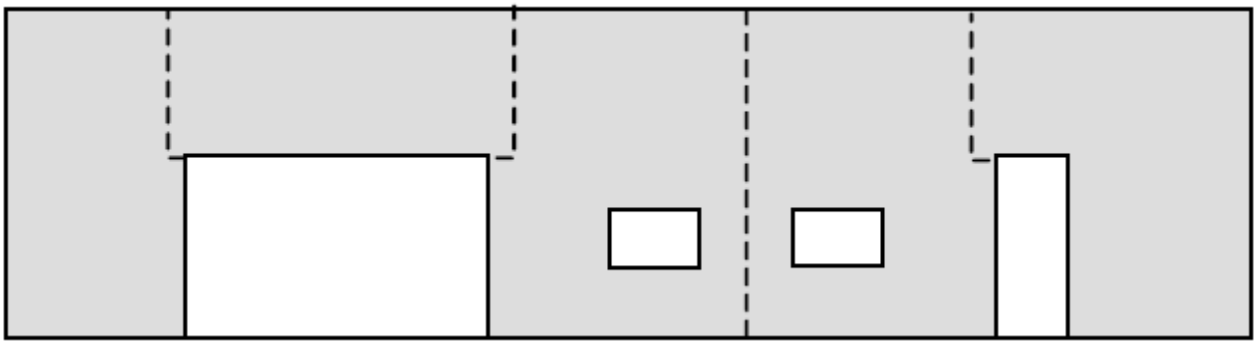

Figure 2b : Arrangement of Control Joints in Unreinforced Walls (From Klingner 2010)

Also, note that the joints are "doglegged" above the opening so that the lintel can be supported by the masonry on both sides of the opening, and also to restrain the lintel against uplift by vertical reinforcement at the edges of the opening. The control joints above the windows and doors are normally offset from the jambs so that the lintels produced by these joints can have 8 in. of bearing at each end.

The control joints below the windows are normally even with the window jambs because there is no need for an offset.

Lateral Capacity

It is also important to consider control joints during design of the lateral force resisting system. A 48 foot long wall, for example, could have three joints spaced at 12 feet (Figure 3a) or two joints spaced at 16 feet (Figure 3b). If the wall is eight inch CMU and 20 feet tall with an f'm of 2000 psi, the option with four 12 foot walls has a shear capacity of 4*50 = 200 kips total, while the option with the three 16 foot walls has a capacity of 3*93 = 279 kips. This represents a 39% increase in strength just from spacing the control joints farther apart. In this case, it is advantageous to space control joints as far as possible in order to have longer wall panels.

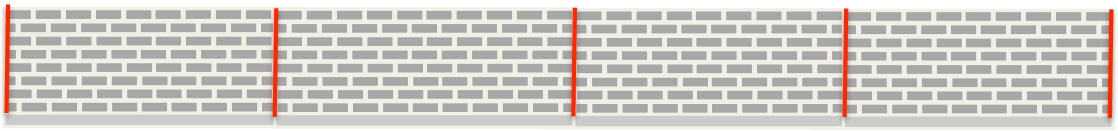

Figure 3a : More CJs result in shorter walls with less in-plane shear capacity than the elevation below

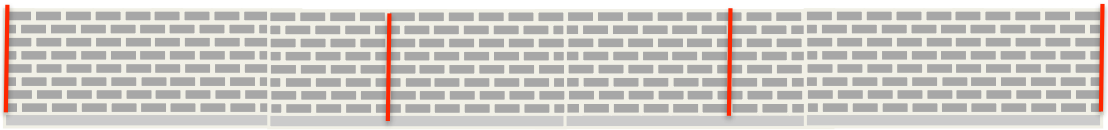

Figure 3b : Less CJs result in longer walls with increased in-plane shear capacity

By not having control joints in stair and elevator core walls, the designer benefits from the stiffness of a box shape rather than just a few individual short walls. When horizontal reinforcing is not continuous through control joints, wall panels will act separately for in-plane shears. As an example, a masonry core eight feet long on each side and composed of eight inch blocks, when analyzed as a box, has a moment of inertia nearly three times greater than if it were analyzed as just the individual walls.

NCMA also has recommendations on increasing horizontal reinforcement to allow for control joints to be removed altogether in boxed wall groups, or in long continuous walls, by providing sufficient horizontal reinforcing in the wall. See attached NCMA TEK 10-3 for reference.

Lastly, it is critical for control joints in load-resisting concrete masonry walls to be shown on the structural drawings, and for movement joints in non-load bearing walls to be shown on architectural drawings per the TMS Code. This is to avoid the potential for the contractor to arbitrarily locate them in the field during construction. This way the designer can locate them to provide greater structural stiffness and capacity, which can ultimately save money on the project.

Movement Joints in Cavity Walls

Another consideration is that movement joints in veneers will often be at different locations than the structural backup walls; see Figure 4 below. For example, it is good practice to place movement (expansion) joints in the unreinforced masonry brick veneer at the edge of the opening, while movement (control) joints in the reinforced structural concrete masonry backup wall should be away from the openings (as shown in Figure 2a above).

Movements joints per TMS 402-16, Section 12.1.6.3, design and detail the veneer to accommodate differential movement. TMS 602-16 Mandatory Requirements Checklist – "Notes to Architect/Engineer", Part 3, 3.3 D.6, page S-73. "Indicate type and location of movement joints on the project drawings."

Movement joints for veneer can be indicated on plans or wall elevation architectural drawings, and control joints for structural walls can be located on structural plan drawings.

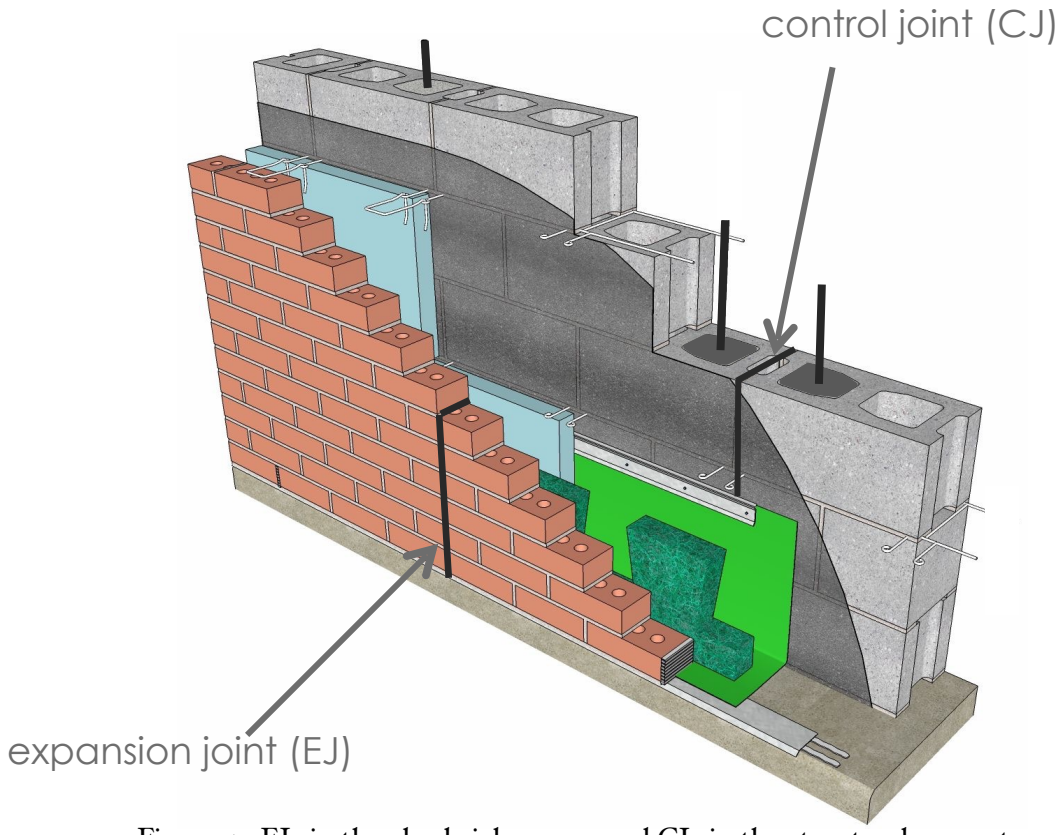

Figure 4 : EJs in the clay brick veneer and CJs in the structural concrete masonry

