

UNDERSTANDING collar joints

When specified, they should be filled 100% solid with high-slump grout to provide the wall system with composite action and a water barrier

By Walter Laska

Collar joints are one of the most misunderstood components in a masonry wall. Architects typically specify collar joints to act as a water barrier; in contrast, engineers specify them exclusively for structural purposes. But can a collar joint successfully perform either function?

The ACI 530/ASCE 5/TMS 102 Building Code Requirements for Masonry Structures (MSJC Code) defines a collar joint as the vertical longitudinal space between wythes of masonry or between an outer masonry wythe and another backup system. Often this space is specified to be filled solid with mortar or grout, but sometimes collar-joint treatment is left unspecified.

A common detail for masonry walls containing a collar joint is indicated in Figure 1. This wall system consists of a 4-inch nominal outer wythe of masonry and either a 4- or an 8-inch nominal inner wythe of masonry. The overall wall thickness is 8 or 12 inches, and the remaining space is a $\frac{3}{4}$ -inch-wide collar joint ($3\frac{5}{8}$ inches + $3\frac{5}{8}$ inches + $\frac{3}{4}$ inch = 8 inches; $3\frac{5}{8}$ inches + $7\frac{7}{8}$ inches + $\frac{3}{4}$ inch = 12 inches).

Collar joint function

Architects commonly design a wall system with the collar joint to be filled solid with mortar or grout. In this system, the collar joint might be intended to act as a

barrier to stop the inward migration of wind-driven rain.

Structural engineers specify solidly filled collar joints to create a composite masonry structure. In theory, the solid collar joint bonds the two wythes together and helps generate composite action by transferring stress between the two wythes. In effect,

the combined wythes act together as a single member. Composite masonry design is common for 8-inch-wide walls.

Composite masonry walls and barrier walls work conceptually. However, these wall systems rarely perform and are rarely constructed as intended. This is particularly true for mortar-filled

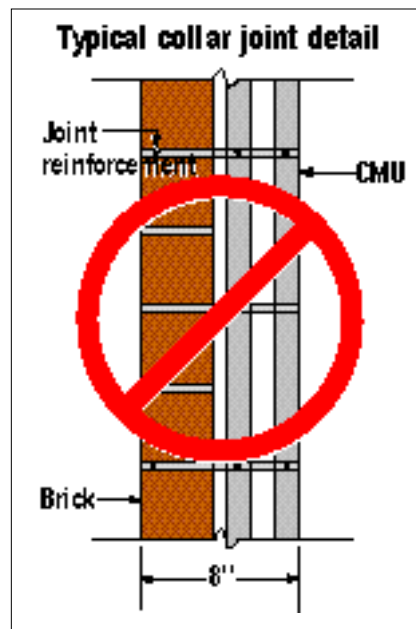


Figure 1. Representing a typical collar joint detail, this wall system consists of a 4-inch nominal outer wythe of brick, a 4-inch nominal inner wythe of concrete masonry and an implied $\frac{3}{4}$ -inch collar joint. However, it would be better for the collar joint to be $1\frac{1}{2}$ to 2 inches wide, so it could be filled solid more easily. In addition, the designer should provide more information on the drawing than is shown here.

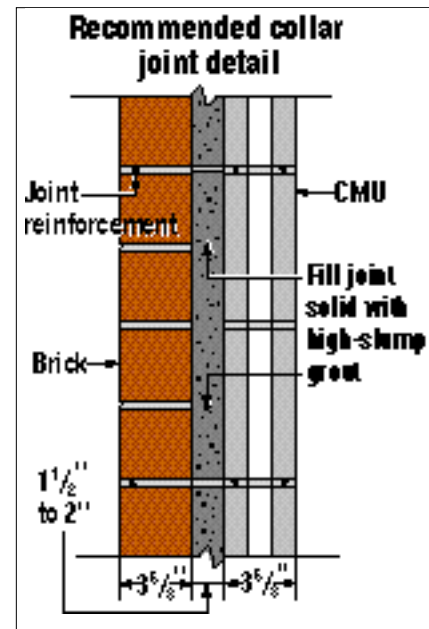


Figure 2. Representing the preferable way to detail collar joints, this wall system consists of a 4-inch nominal outer wythe of brick, a 4-inch nominal inner wythe of concrete masonry and a $1\frac{1}{2}$ - to 2-inch collar joint. This collar joint is wide enough to be grouted solid with high-slump grout, so it can perform as intended. The actual dimensions of the wall system's components should be called out on the drawing as shown.

collar joints.

Collar joints: the reality

Cracks and voids in collar joints filled with mortar are common and can be expected for a number of reasons (see Photo 1). Separation cracks sometimes develop between the interface of the masonry units and the collar joint. This can be due to the different absorption rates of each masonry wythe and the fact that mortar-filled collar joints aren't compacted. (In contrast, compaction occurs in head and bed joints as a result of tooling.)

In addition, thermal movement (expansion and contraction) can cause the outer wythe of masonry to separate from the collar joint. Moreover, given the absorptiveness of both wythes, mortar used in a collar joint doesn't contain enough water to fully hydrate the cement; consequently, shrinkage cracks occur, and low strength develops.

Voids in a mortar-filled collar joint inevitably occur. This is particularly true for a $\frac{3}{4}$ -inch-wide joint, which can be reduced to $\frac{1}{2}$ inch when allowable construction tolerances are considered. Because mortar isn't fluid, a $\frac{3}{4}$ -inch-wide joint is simply too difficult to fill completely with mortar.

The MSJC Code does not allow collar joints to be slushed (filled by pushing mortar into the space with a trowel). Therefore, the method by which a mason can fill a collar joint with mortar is limited. A mason can either butter the back of the brick before laying the unit or parge the concrete masonry backup shortly before laying the outer wythe of brick. But neither method is foolproof, and the possibility of collar-joint voids still exists.

Grouting a $\frac{3}{4}$ -inch-wide space may prove more successful than trying to fill the space with mortar. However, mortar extrusions and mortar droppings, which are difficult to remove from a narrow space, can cause grout to "hang up," leaving voids in the collar joint.

Research has indicated that walls with collar joints leak, even



Photo 1. When a collar joint is filled with mortar, voids and cracks are the inevitable result.

when the walls are constructed with average to good workmanship (Reference). Voids and cracks in the collar joint create pockets where water can collect; this water bridges to the interior of the building or contributes to the deterioration of masonry on the building exterior.

The worst-case scenario can occur when a wall is designed with a collar joint that was not specified to be filled solid or left void. What results is a space that is half-filled with mortar extrusions (see Photo 2). This creates



Photo 2. When a wall is designed with a collar joint that was not specified to be filled solid, what results is a space filled with mortar extrusions.

an environment that is ideal for the collection and transportation of penetrating water.

What are the remedies?

The only way to be assured that collar joints are filled 100% solid is to grout them. The MSJC Code allows the grout space in a composite wall to be a minimum of 1 inch. However, to create a functional barrier wall, this space should be sufficiently wide— $1\frac{1}{2}$ to 2 inches—so that the mason can keep it clear of all mortar obstructions (see Figure 2). Filling the space with high-slump grout and consolidating that grout will produce a 100% solid collar joint that provides the wall system with composite action and a water barrier.

However, walls built with solidly grouted $1\frac{1}{2}$ - to 2-inch collar joints sometimes are not practical and can be cost-prohibitive. So the best option might be to eliminate the collar joint altogether and design and construct a drainage wall system. (For information on cavity wall design, see "Wall Cavities: Design vs. Construction," August 1997, pages 445-446.)

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Reference

Clayford T. Grimm, "Water Permeance of Masonry Walls: A Review of the Literature," ASTM STP 778, 1982, American Society for Testing and Materials, 100 Barr Harbor Dr., West Conshohocken, PA 19428.

PUBLICATION #M970559
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