practical solutions

Portland Cement Cast Stone Veneers

An Overview of Practical Detailing Issues

By Dave MacGregor, P.E. and Edward Schwieter, P.E.

Our firm has investigated and analyzed a number of projects that have developed cracks in Portland cement-based cast stone veneers.

The most common problems have been vertical cracks through head joints and cast stone units, connected by cracks through bed joints. A properly constructed exterior wall can tolerate cracking in the veneer and moisture penetration into the airspace, so cracking is primarily an aesthetic issue.

Basically, the cracking that we have seen is the result of natural shrinkage in Portland cement-based concrete masonry units, which is made more severe by the natural expansion of adjacent clay masonry bonded to the cast stone. Cracking is often more severe on the south and west building faces due to unequal heat gain between darker clay brick and lighter cast stone. Minor shrinkage and thermal cracks are not unusual in concrete masonry veneers and should be expected by the design team, supplier, and mason, but are often an unacceptable surprise to the Owner.

Wainscots

Cast stone is often used as wainscots because it can tolerate contact with ground surfaces and is a visual counterpoint to brick veneer. Cracking occurs when the cast stone is restrained from movement as it dries and shrinks. Possible sources of restraint and differential movement are at the bottom of the wainscot from concrete foundations (which may have been placed months before the cast stone was installed and already experienced much of its shrinkage), openings in the wainscot, and expansion in the brick veneer bearing on the top of the wainscot. Wainscot cracking typically occurred for two reasons:

- Control joint spacing divided by wainscot height ratios (panel aspect ratios) significantly larger than the NCMA-recommended 1.5 are particularly likely in structures with short wainscots where the control joints are based on the maximum spacing allowed for brick veneer (where the aspect ratio can exceed 4)
- Changes in height and/or the projection of windows down into the wainscot.

This building has a wainscot of six courses of 8 x 24-inch cast stone, 8-inch high accent bands at the top of the wainscot and near the top of the wall, and a 12-inch high accent band above the windows. A control joint was installed below the window after cracks appeared at a number of windows. It should be noted that nearly all of the head joints in the accent band over the window have hairline cracks, but they were not noticed by the Owner.

It is important to space vertical control joints in cast stone wainscots at distances no greater than 1.5 times the wainscot height (not the combined wainscot and brick veneer height), at window corners projecting into the wainscot, and at changes in the wainscot height. We have found that cracks in wainscots are noticeable because they tend to be fairly wide due to stress accumulation and because they are at the base of the building where they are easily seen. It is not necessary to extend closely spaced wainscot control joints into brick veneer, but all brick veneer control joints should be extended into the cast stone.

Accent Bands

Accent bands within brick veneer are prone to cracking because they have expansive brick both above and below, creating significant tension forces in the cast stone. Fairly narrow cracks tend to occur in nearly all mortar head joints due to the uniform application of tension from brick expansion and the relatively low tension capacity of the head joint. We have noticed that when the accent band consists of more than one course, a crack in a head joint will frequently continue through the body of the unit above or below. We generally recommend a single course accent band or stack bond if more than one course is desired. It is interesting to note that where the cast stone band is a story or more above the adjacent ground, clients typically have not noticed head joint cracking and have only occasionally complained about through-unit cracking. Cast stone accent bands at parapets and head, sill and jamb accents at isolated openings have similar issues. Shrinkage and thermal cracks tend to form in head joints because of low mortar tension capacity. Since the shear capacity of the bed joint is greater than the tension capacity of the cast stone unit, the crack will tend to extend through the cast stone unit above and below unless the horizontal distance between the head joints is small relative to the height of the cast stone course. We typically recommend raking and caulking accent band bed joints to encourage cracks in the mortar joints rather than through the cast stone units.

The National Concrete Masonry Association (NCMA) has a number of TEK Guides that address these issues: TEK 5-2A *Clay and Concrete Masonry Banding Details* and TEK

10-4 *Crack Control for Concrete Brick and Other Concrete Masonry Veneers* are most relevant. Suggestions include placing a horizontal slip joint between the brick and cast stone veneer and placing steel wire joint reinforcing in the mortar joints. Slip joints may have limited effectiveness due to the friction force from the weight of the brick veneer above the cast stone and may require additional wall ties to maintain veneer stability.

We created a finite element model of an actual wall in which the stress concentrations correlated very well with observed cracking in the field. We found that the suggested vertical control joint spacing reduced wainscot net tension significantly, but did not affect net tension in cast stone accent bands within brick veneer walls. We also found that joint reinforcing did not substantially reduce net tension in either the wainscot or accent bands. However, field testing may show that steel wire joint reinforcing is effective.

Work closely with the Project Architect to review wall elevations and specify vertical control joints in accordance with NCMA recommendations, perhaps with additional joints in wainscots. Close consultation provides an opportunity to educate the architect about the different vertical joint requirements in brick veneer and concrete unit veneer walls, and suggest that the Owner be informed of the potential for cracking.▪

Edward W. Schwieter, P.E., is Vice President and Senior Principal with Steven Schaefer Associates, Inc. Mr. Schwieter is registered in fourteen states and has a total of twenty-two years of practical engineering experience. Dave C. MacGregor, P.E. joined Steven Schaefer Associates, Inc. in 1998 as a Project Engineer and has fifteen years experience.

Comments and recommendations contained in this article do not apply to simulated limestone products not made from Portland cement, which have different practical concerns.

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