INTRODUCTION

This Arriscraft•NOTE discusses the properties and performance of the various types of manufactured masonry units, and the industry recommended best practices for construction and detailing when combining with clay brick. Material types discussed in this paper include Calcium Silicate Masonry Units (CSMU), Concrete Masonry Units (CMU), and Cast Stone Units.

Product Standards for Manufactured Masonry Units

Calcium Silicate Masonry Units are formed in much the same way as sedimentary stone. Calcium Silicate Masonry Units are manufactured by mixing lime with an inherently strong, silica-based sand, and pressing under high pressure. The 'green' units are then subjected to high-pressure steam in an autoclave to produce a unit with a uniformly fine-grained texture. A calcium silicate hydrate binder is formed when the elements in the raw materials chemically react in the autoclave resulting in a durable, strong and intimately bonded unit. This process distinguishes Calcium Silicate Masonry Units from cement-based concrete masonry units.

ASTM C73 – Standard Specification for Calcium Silicate Brick (Sand-Lime Brick) is the standard that applies to Calcium Silicate Masonry Units. The material is classified as either Severe or Moderate Weathering based upon its properties of compressive strength and absorption.

ASTM C90 – Standard Specification for Loadbearing Concrete Masonry Units is the standard that applies to cement-based concrete masonry units. Specified physical properties include compressive strength, absorption, density and linear drying shrinkage. Units are classified as lightweight, medium-weight or normal-weight.

ASTM C1364 – Standard Specification for Architectural Cast Stone is the standard that applies to cast stone masonry units. Physical properties requirements include a minimum compressive strength and a maximum absorption, freeze/thaw requirements (air content range, cumulative percent mass loss), and linear drying shrinkage.

In assessing masonry materials for use in a masonry veneer wall system it is important that the particular material meets the criteria under the ASTM material specification that was developed for that particular material. When the material meets these ASTM specification requirements, it is expected that that product will perform as required assuming the wall system is correctly detailed.

Accommodating Differential Movement

When combining different masonry materials within a wall system it is important to understand how the materials' movement properties may impact design.

Clay brick units expand irreversibly over time upon exposure to water or humid air. A brick unit is smallest in size when it cools after coming from the kiln. Most of the expansion takes place quickly over the first few weeks, but expansion will continue at a much lower rate for several years. In addition to this net expansion, clay brick, like other masonry materials, will experience cyclical expansion and contraction with variations in temperature. The Brick Industry Association (BIA) Technical Note #18 – Volume Changes – Analysis and Effects of Movement discusses these movements and their coefficients in greater detail and Technical Note #18A – Accommodating Expansion of Brickwork discusses the design and detailing considerations to accommodate these movements.

Due to the high-temperature and pressure autoclaving process for Calcium Silicate Masonry Units there is no significant net movement of calcium silicate units. Similar to other masonry materials they will undergo cyclical thermal movement. As a result, considerations for placement and construction of movement joints in calcium silicate masonry veneer wall systems are similar to those of clay brick. Movement joints are recommended at 20 – 25 foot intervals along continuous lengths of wall and where stress concentrations occur (building corners, openings, etc.). With Calcium Silicate Masonry Units, there is no material-specific need for the incorporation of horizontal joint reinforcement. Design considerations such as installation in stack bond pattern or seismic requirements may still necessitate the use of joint reinforcement. Refer to arriscraft•NOTE (Vol. I, No. 1), Movement Joints for Unit Masonry Veneer, for further discussion on the construction and placement of movement joints in calcium silicate masonry veneer walls.

Concrete masonry walls undergo a net shrinkage over time and industry guidelines cite the need to consider the incorporation of horizontal joint reinforcement at periodic intervals up the height of the wall and more frequent vertical control joints. The National Concrete Masonry Association (NCMA)'s technical note series includes TEK 10-4 Crack Control for Concrete Brick and Other Concrete Masonry Veneers. This technical note recommends spacing for control joints in cement-based unit masonry veneer to be the more frequent of: the panel length-to-height ratio of 1-1/2, or 20 feet. Control joints must also be considered where stress concentrations occur (building corners, openings, etc.). In addition, horizontal joint reinforcement is recommended to be spaced vertically at a maximum of 16" on center. Further information on control joint construction and placement in concrete masonry walls can be found in TEK 10-4 and TEK 10-1A Crack Control in Concrete Masonry Walls.

The Cast Stone Institute (CSI) Technical Bulletin #52 – Allowing for Movement of Masonry Materials is the industry reference for accommodation of movement for Cast Stone Units. CSI recommends a

maximum spacing for control joints in Cast Stone masonry walls be the more frequent of the panel length-to-height ratio of 1-1/2, or 25 feet. Refrain from installing units until they have been cured to CSI specifications.

Effect of Absorption on Installation

The absorption properties of a masonry unit can have an impact on its installation. The moderate absorption levels found in Calcium Silicate Masonry Units are achieved without the use of admixtures and the product will naturally wick the moisture from the plastic mortar to achieve a good extent of bond and allow for initial mortar set in a reasonable time frame. The height of calcium silicate that can be installed in a day is not limited due to an extended setting time. Where water repellent admixtures are utilized to achieve lower absorptions, this can have the effect of limiting installation height. In some conditions, the low absorption units may also have a tendency to "float" in the mortar making it more difficult to lay in a line.

In addition to the movement joint and isolation requirements, with cast stone masonry it is recommended to drench unit faces fully before setting. This is to ensure good bonding with the mortar joints. Once set, it is recommended that the mortar joints be raked out to a minimum depth of 3/4" and repointed for units larger than conventional unit masonry sizes.

Other Considerations for Comparison

Whereas site cutting and finishing of Calcium Silicate Masonry Units is generally possible, the same may not be true of Cast Stone units, which may require custom manufacturing of ends and shapes. The CSI recommends that Cast Stone units be saturated prior to installation and be laid with a full mortar joint which should then be raked back and re-pointed. These aspects of design and construction should be incorporated in consultation with the technical services department of the particular cast stone manufacturer that you are dealing with.

Combining Masonry Materials with Clay Brick

When Calcium Silicate masonry and clay brick units are combined within a masonry veneer wall assembly, expansion joint placement considerations are the same for both materials and the joints should therefore carry through all masonry types up the height of the wall. There is no material-specific need for horizontal joint reinforcement and empirical evidence suggests that a bond break between the two materials is not necessary when Calcium Silicate Masonry Units are used as a band in clay brick walls.

Additional detailing considerations may apply when concrete masonry units are placed in a wall adjacent to clay brick. Industry guidelines from both the BIA (Technical Note #18A) and NCMA (TEK 10-1A) call for the isolation of dissimilar materials with the use of a bond breaker. A bond breaker can be one of several material types, and commonly through-wall flashing extending between courses of masonry will suffice for this purpose. Building paper placed between courses could also work effectively. Bond breakers should be provided to allow for independent movement while still providing gravity support.

When clay brick is used as an accent band in a concrete masonry or Cast Stone wall (or vice-versa) industry organizations recommend - either slip planes between the band and the surrounding wall, horizontal reinforcement, more frequent control joints or a combination thereof be used to control cracking. If a bond break is to be used with cast stone it should be placed either directly above or below the banding course; using a bond break both above and below the banding course is not recommended unless proper mortar embedment of the anchors in the veneer can be achieved. It is particularly important that the band, as well as the wall panel above and below the band be supported by wall ties. Wall ties should be installed within 12 inches of the top and bottom of the band to help ensure the surrounding masonry is adequately supported.

Summary

This Arriscraft•NOTE describes the properties of common masonry veneer materials and the movement control considerations relative to each other. The combination of different kinds of masonry veneer materials used with clay brick in walls is also discussed, along with additional detailing considerations that may apply in such situations.

Calcium Silicate Masonry Units and clay brick have proven very compatible in a wall system. No additional movement control requirements are needed when combining the two materials. Cement-based masonry units such as concrete block or cast stone may require the use of more frequent movement joint placement as well as horizontal joint reinforcement and/or bond breaks between materials.

The information and suggestions contained herein are based upon the available data and information published by the listed references and the experience of Arriscraft architectural and engineering staff. More detailed information may be found by referring to any of the related references listed below.

The information contained herein must be used in conjunction with good technical judgment and a competent understanding of masonry construction. Final decisions on the use of the information contained in this Arriscraft•NOTE are not within the purview of Arriscraft and must rest with the project designer or owner, or both. It remains the sole responsibility of the designer to properly design the project, ensure all architectural and engineering principles are properly applied throughout,

and ensure that any suggestions made by Arriscraft are appropriate in the instance and are properly incorporated through the project.

Related References

1. Brick Industry Association, Technical Notes on Brick construction 18, Volume Changes – Analysis and Effects of Movement, October 2006.
2. Brick Industry Association, Technical Notes on Brick Construction 18A, Accommodating Expansion of Brickwork, November 2006.
3. National Concrete Masonry Association, NCMA-TEK 5-2A, Clay and Concrete Masonry Banding Details, 2003.
4. National Concrete Masonry Association, NCMA-TEK 10-1A, Crack Control in Concrete Masonry Walls, 2005.
5. National Concrete Masonry Association, NCMA-TEK 10-4, Crack Control for Concrete Brick and Other Concrete Masonry Veneers, 2001.
6. Cast Stone Institute, Technical Bulletin #44, Pointing of Joints, Revised October 6, 2011.
7. Cast Stone Institute, Technical Bulletin #52, Allowing for Movement of Masonry Materials, Revised October 6, 2011.

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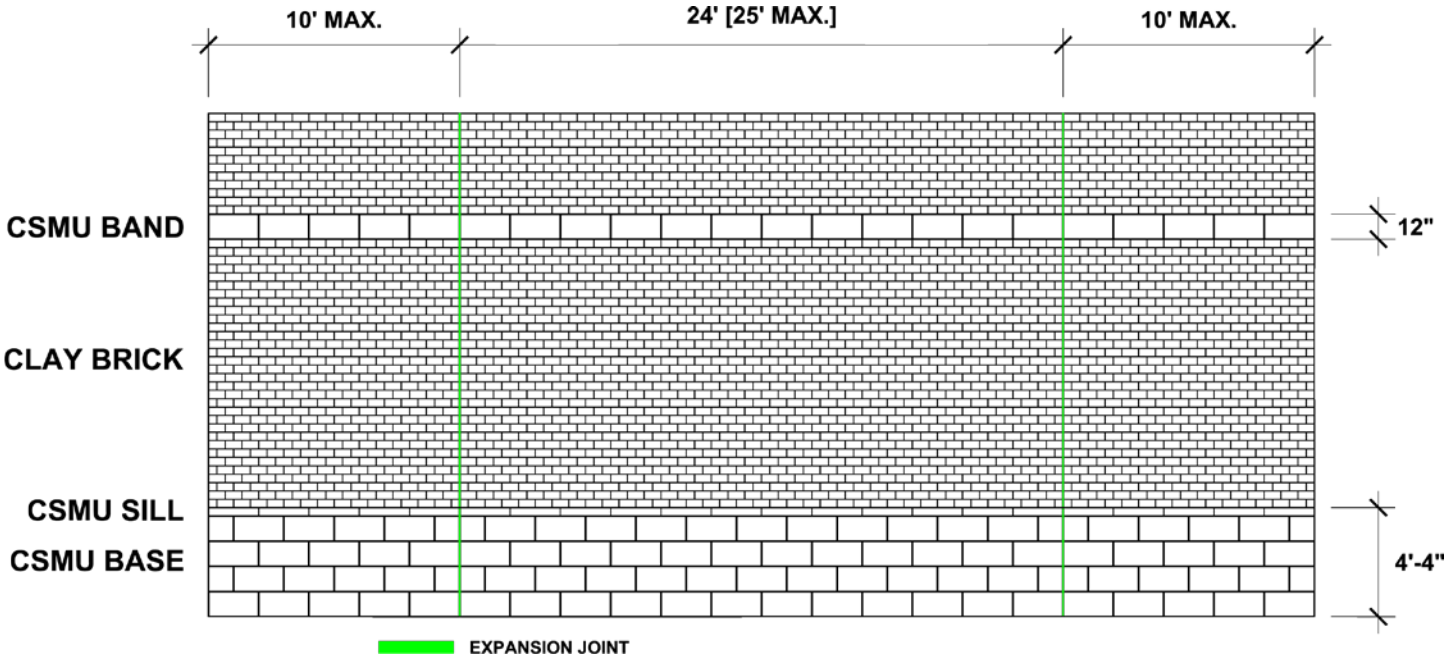
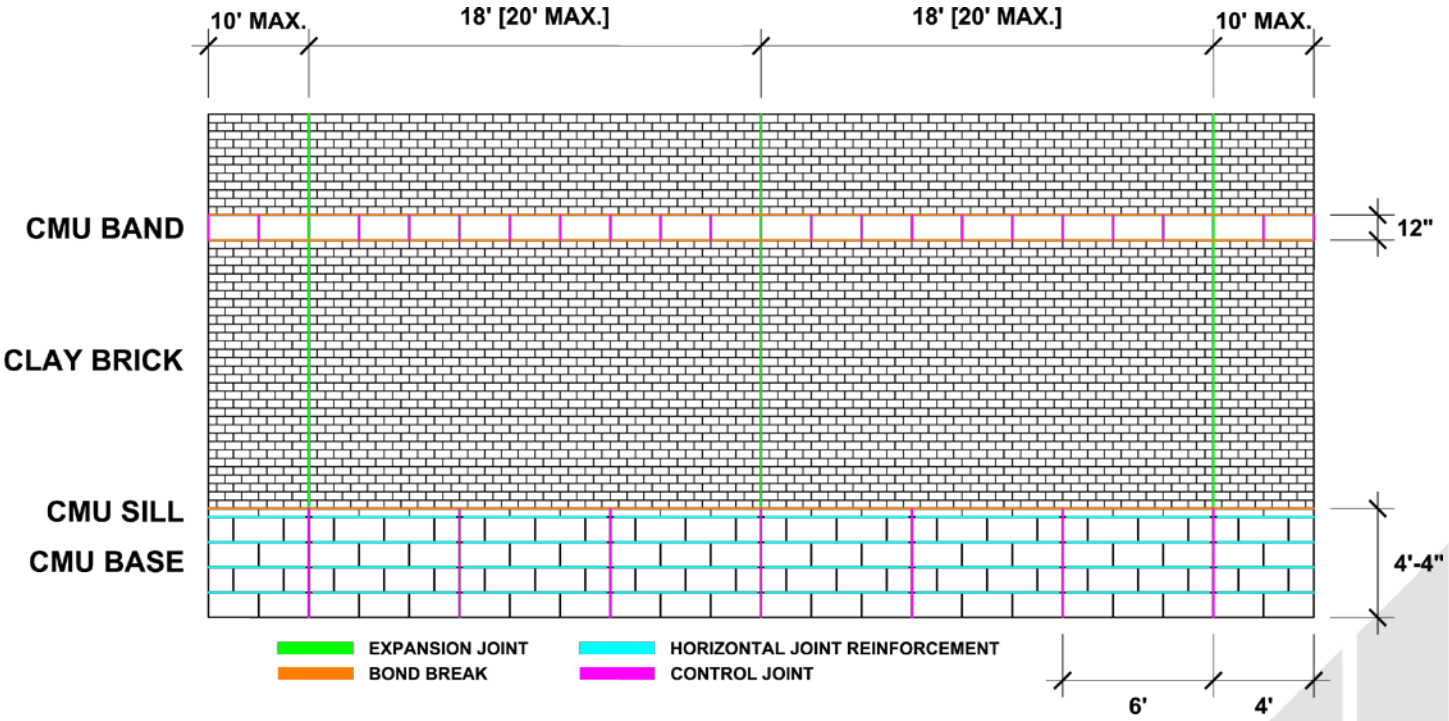
Calcium Silicate Masonry Units and Clay Brick



Combining Concrete Masonry Units and Clay Brick



Note that the horizontal joint reinforcement in the beds of the concrete masonry units should not bridge the control joints.

Combining Cast Stone and Clay Brick