Accommodating Vertical Expansion

Unsupported brick veneer and concrete masonry walls can be designed and constructed in excess of 50 ft. in height. This type of design is not uncommon in mid-rise and high rise bearing wall systems.

A system of this type does not require shelf angles at every floor or every other floor. Shelf angles are not required to support the brick above for building 5 stories to 10 stories high.

The elimination of shelf angles in this type of bearing wall design will allow for cost savings, but more importantly, it will eliminate the difficulty of shelf angle design and construction. Designers need to consider special provisions to accommodate for vertical expansion and other potential movements in this bearing wall system.

Differential Movement

A typical brick veneer and concrete masonry wall is subjected to two types of movements. The outer wythe of brick will expand upward due to thermal changes and moisture gains and the concrete masonry will have a tendency to move downward due to initial shrinkage from drying and compressive loads.

Differential movement is greatest at the top of the wall where the masonry is unrestrained. The differential movement between the two wythes of masonry can be in excess of 1 inch (photo #1).

While there are no current calculations for determining the downward movement of the concrete masonry, there is a formula developed by the Brick Industry Association to determine the upward expansion of the brickwork. The total unrestrained vertical expansion of the outer wythe of brick can be estimated by the following formula:

M = [0.0005 + (0.000004 (□T))[L

Where:

M = Total expansion of the exterior wythe of brick

L = Length of the wall in inches

□T = Minimum mean wall temperature subtracted from the maximum mean wall temperature in degrees Fahrenheit.

0.0005 = Design value of the coefficient of moisture expansion, inches/inch

0.000004 = The coefficient of thermal expansion, inches/inch

Assume a southern exposure, somewhere in the Midwestern United States, and a temperature range of 135 degrees.

M = [0.0005 + 0.000004 (120)] (50 feet x 12 inches)

M = [0.0005 + 0.000054 (600 inches)

M = (0.00098) (600)

M = 0.588 or approximately ½ inch

Compensating for Vertical Movement

Designers should concentrate on accommodating differential movement in three areas of the wall - at the top, at wall ties between masonry wythes, and at wall openings. Details should be developed for these locations to prevent potential cracking and displacement of the brickwork.

Cap Details

A good detail should be developed for the top of the wall because this is where most of the movement will occur. It's a common masonry practice to provide a coping of a similar material, such as limestone or precast concrete, at the top of the wall. However, where differential vertical movement is likely, specifying a metal cap is beneficial. Providing a detail that allows the two wythes of masonry to move independently, with a metal cap to provide this flexibility.

Wall Ties

Another consideration is the type of wall tie used to connect the two wythes of masonry together. Differential movements between the two wythes will be transferred into the ties that connect them. Differential movements as great as 1 inch or more are possible at the roof level, so it's important to specify ties that can accommodate this movement.

The cross wires of standard joint reinforcement will deform and bend when subjected to differential movement. This deformation can break the galvanized coating on the cross wire, subjecting the joint reinforcement to rusting. Furthermore, bending or crimping the cross wire can reduce its ductility, affecting its structural capacity.

For such applications, specify adjustable ties that will accommodate the differential movement of wythes without compromising structural integrity.

The difference movement of dissimilar materials needn't cause performance problems in masonry buildings, as long as designers anticipate its occurrence and provide details to accommodate it.

Wall Openings

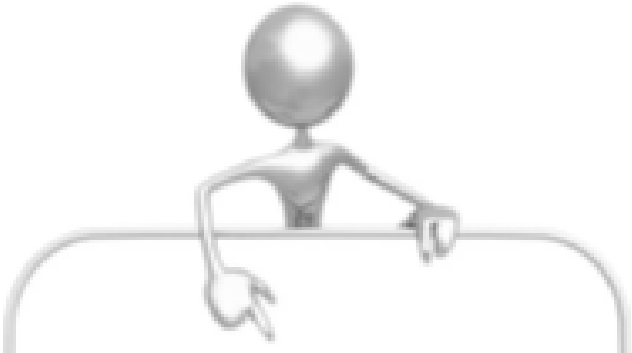
The third consideration is how to accommodate movement at wall openings. Window frames should be attached to the concrete masonry backup, not to both wythes. Otherwise, differential movements can cause the frame to distort.

Brick that is directly adjacent to window jambs should be allowed to expand without obstruction. However, this expansion can create a bonding problem for sealant in the building joint between the window jamb and the brick. Although most sealants perform well when subjected to tensile or compressive forces, vertical movement of the brick can stress the sealant in shear. Most sealants can resist only ¼ inch movement before the bond with the brick is broken. Because movement at window openings on upper floors can easily exceed ¼ inch, resealing these joints annually might be required. However, providing special slippage joints between the window jamb and brick is another alternative (Figure 4).

Window alignment and configuration also affect the amount of movement to be expected. Walls with few windows will experience more vertical movement at the top of the wall. Walls with windows aligned vertically should be designed to accommodate movement of the masonry between the vertical bands of windows. On the other hand, walls with numerous openings or those with horizontal window bands generally experience much less vertical movement.

The difference movement of dissimilar materials needn't cause performance problems in masonry buildings, as long as designers anticipate its occurrence and provide details to accommodate it.

See attached pages for referenced drawings.



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This masonry education course was developed by Walter A. Laska, Masonry Technologies

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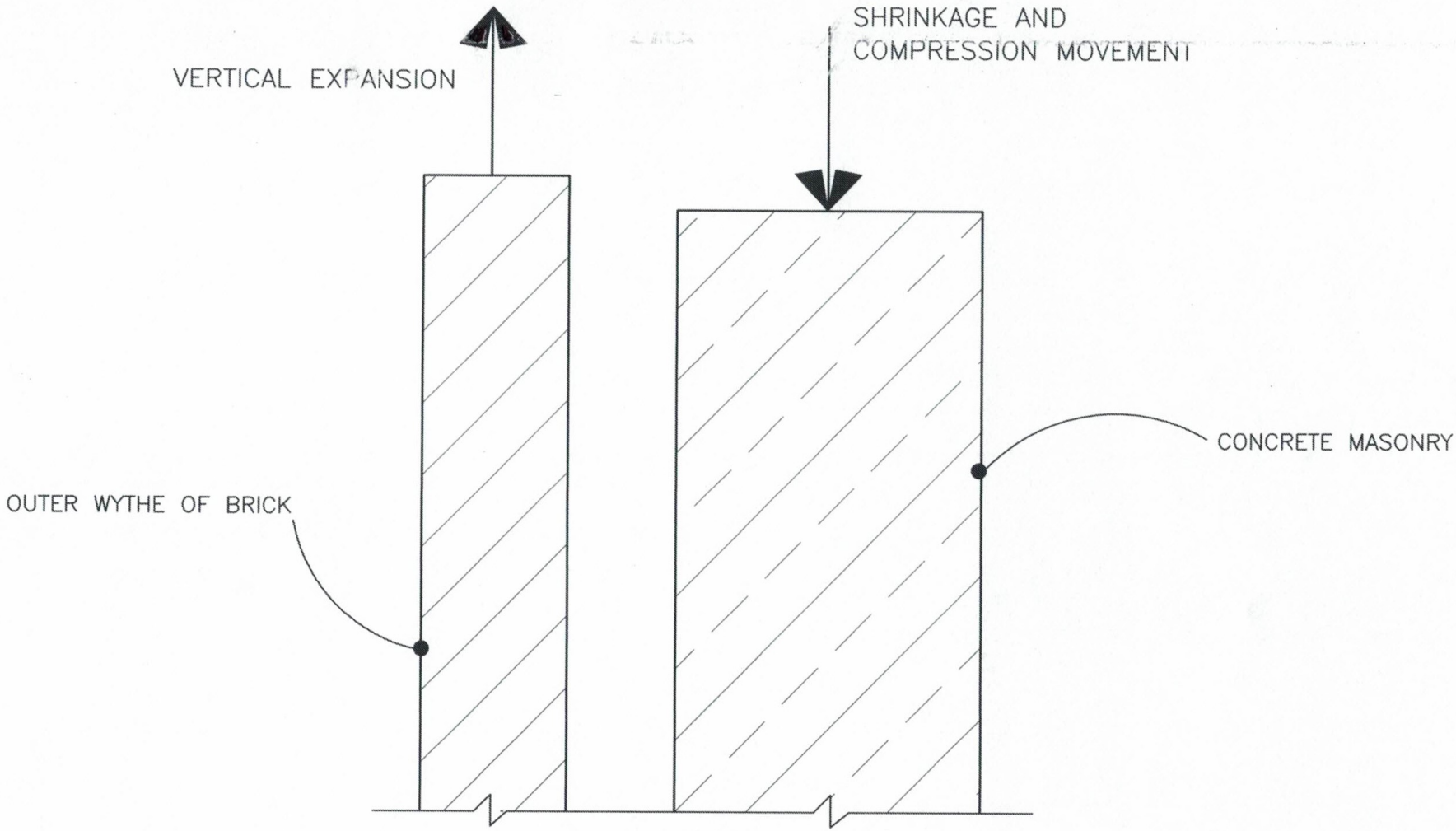

VERTICAL EXPANSION
SHRINKAGE AND
COMPRESSION MOVEMENT
CONCRETE MASONRY
OUTER WYTHE OF BRICK

FIGURE 1.

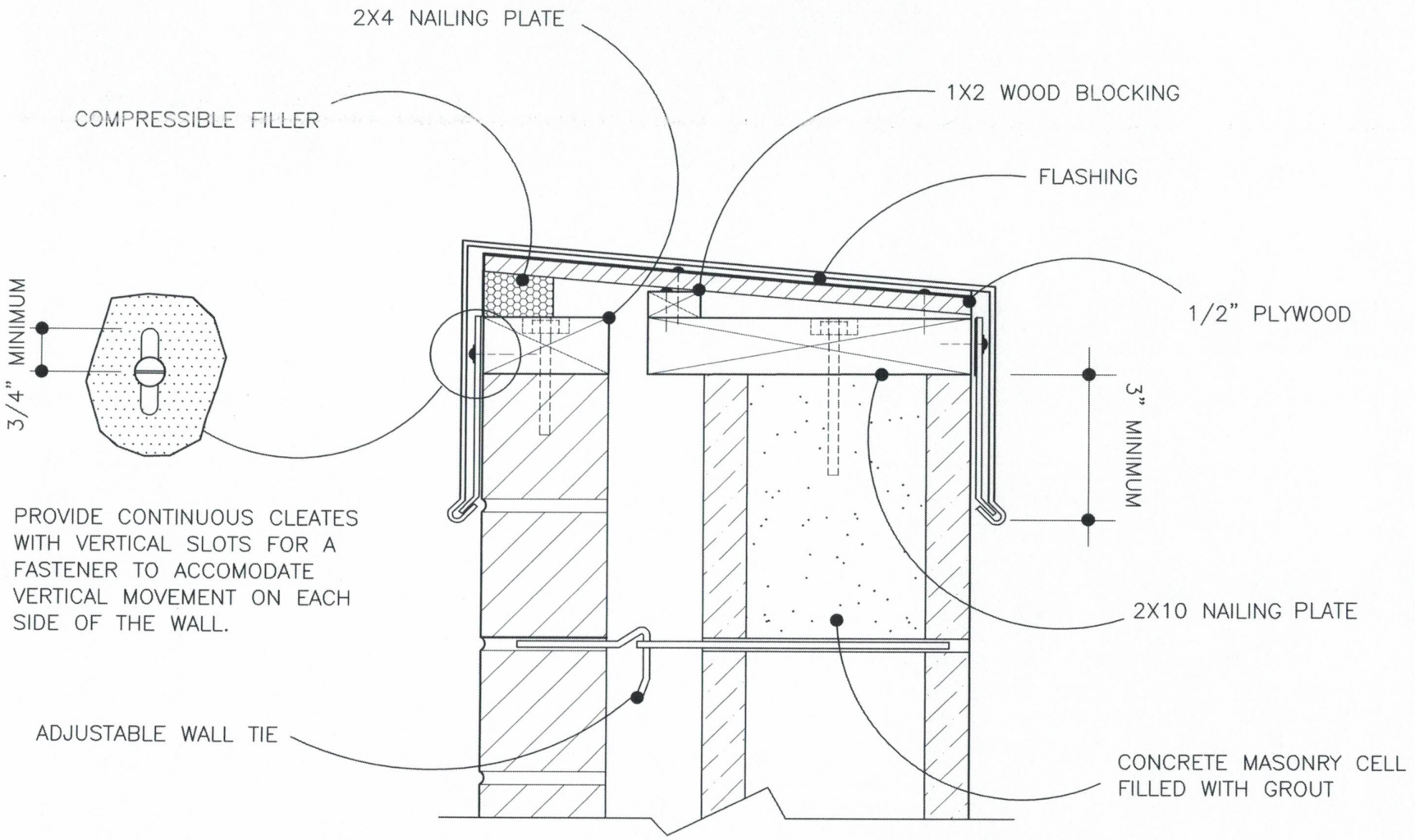
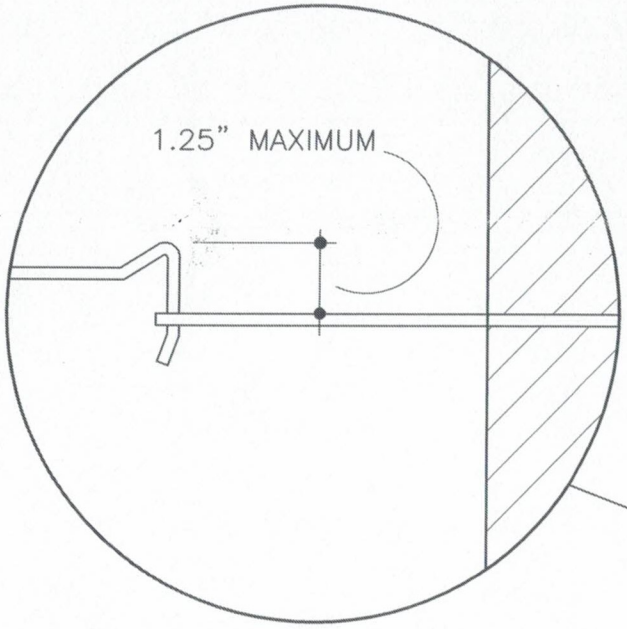
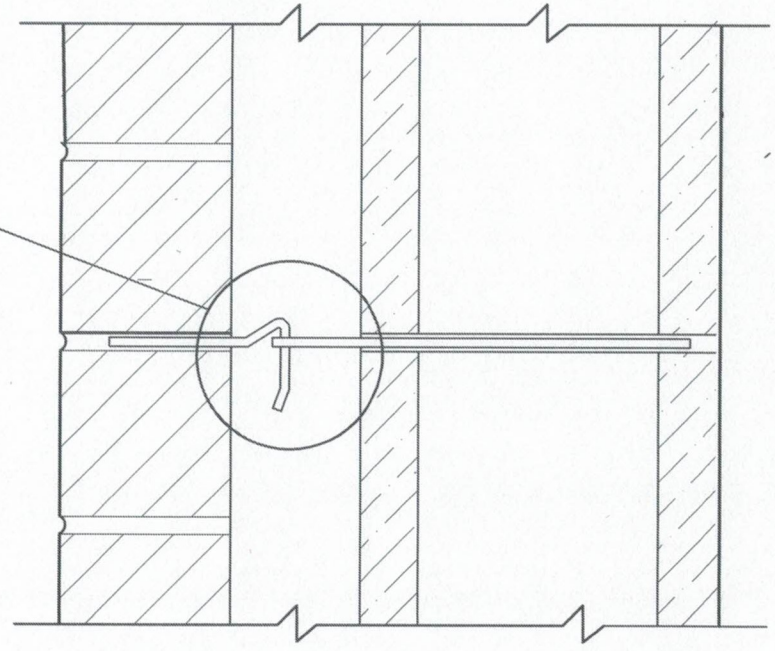

2X4 NAILING PLATE
COMPRESSIBLE FILLER
1X2 WOOD BLOCKING
FLASHING
1/2" PLYWOOD
3/4" MINIMUM
3" MINIMUM
PROVIDE CONTINUOUS CLEATES WITH VERTICAL SLOTS FOR A FASTENER TO ACCOMODATE VERTICAL MOVEMENT ON EACH SIDE OF THE WALL.
2X10 NAILING PLATE
ADJUSTABLE WALL TIE
CONCRETE MASONRY CELL FILLED WITH GROUT

FIGURE 2.



MAXIMUM ALLOWABLE VERTICAL MOVEMENT



TWO PEICE ADJUSTABLE WALL TIE

FIGURE 3.

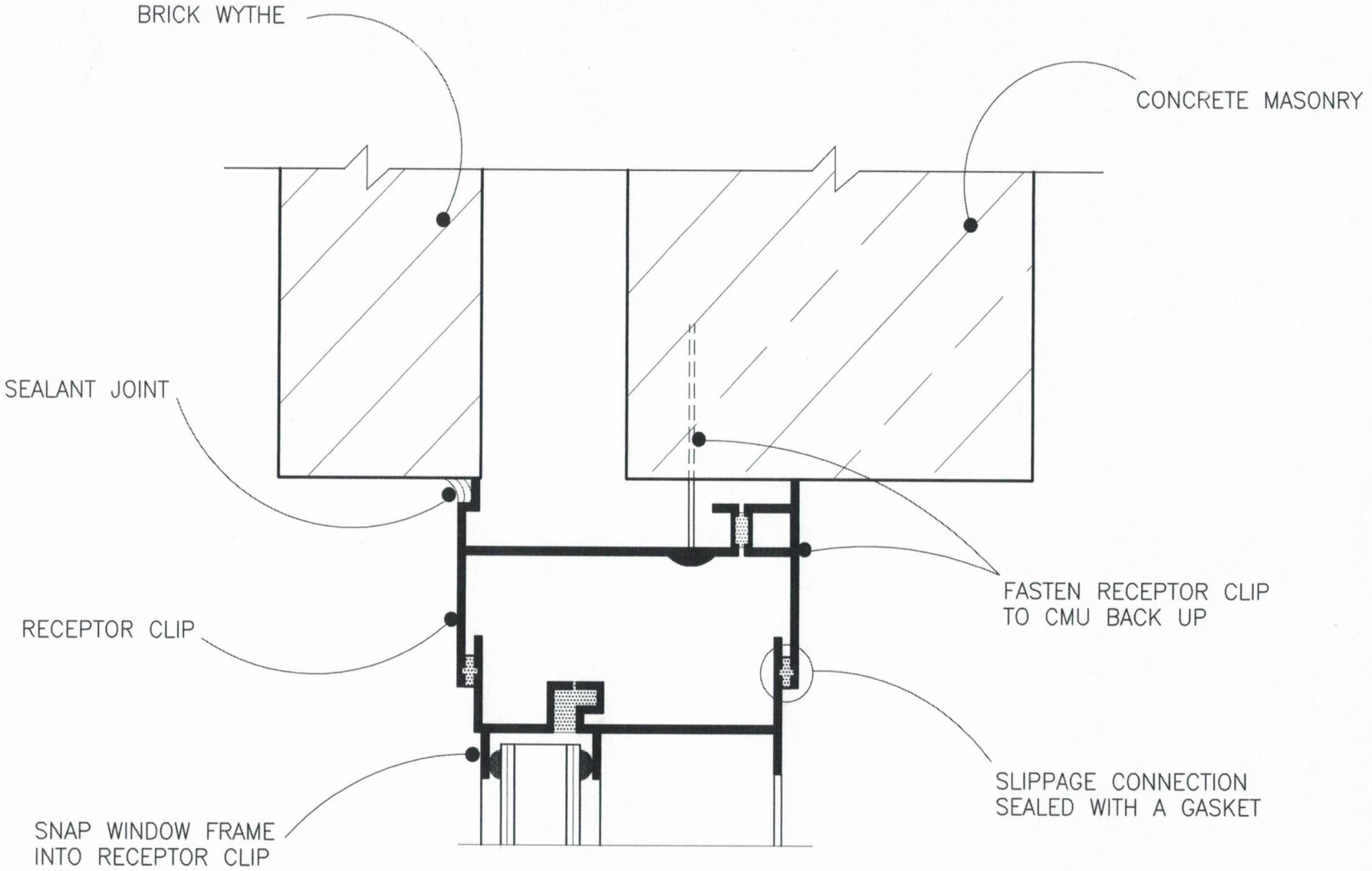

BRICK WYTHE
CONCRETE MASONRY
SEALANT JOINT
FASTEN RECEPTOR CLIP
TO CMU BACK UP
RECEPTOR CLIP
SLIPPAGE CONNECTION
SEALED WITH A GASKET
SNAP WINDOW FRAME
INTO RECEPTOR CLIP

FIGURE 4.