

## Technical Notes 30 - Bonds and Patterns in Brickwork [March 1999]

### BOND

The word bond, when used in reference to masonry, may have three meanings:

**Structural Bond:** The method by which individual masonry units are interlocked or tied together to cause the entire assembly to act as a single structural unit.

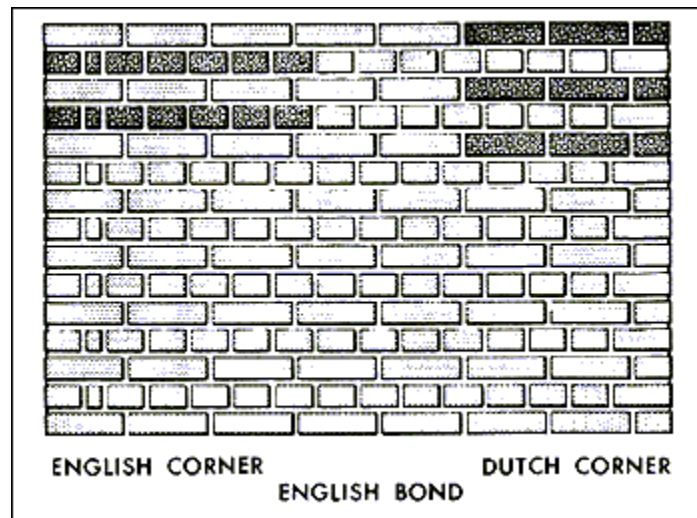
**Pattern Bond:** The pattern formed by the masonry units and the mortar joints on the face of a wall. The pattern may result from the type of structural bond used or may be purely a decorative one unrelated to the structural bonding.

**Mortar Bond:** The adhesion of mortar to the masonry units or to reinforcing steel.

### STRUCTURAL BONDS

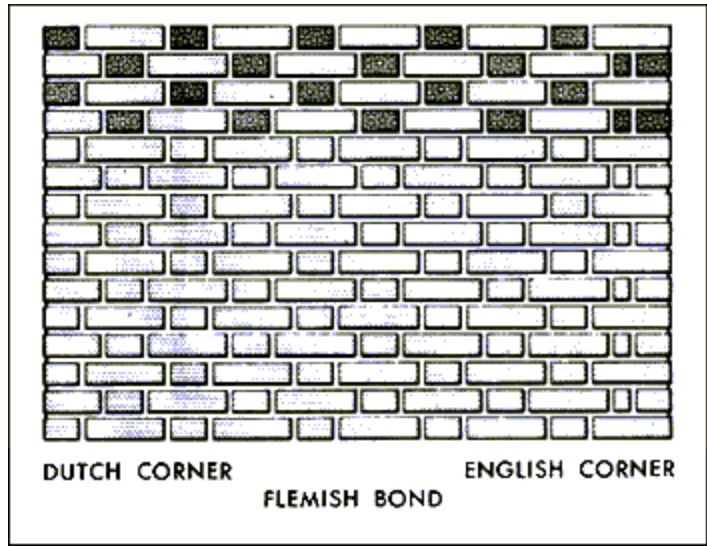
Structural bonding of masonry walls may be accomplished in three ways: (1) by the overlapping (interlocking) of the masonry units, (2) by the use of metal ties embedded in connecting joints, and (3) by the adhesion of grout to adjacent wythes of masonry.

The overlapped bond is based on variations of two traditional methods of bonding. The first is known as English bond and consists of alternating courses of headers and stretchers (Fig. 1). The second is Flemish bond and consists of alternating headers and stretchers in every course, so arranged that the headers and stretchers in every other course appear in vertical lines (Fig. 1).



English and Flemish Bonds

FIG. 1a



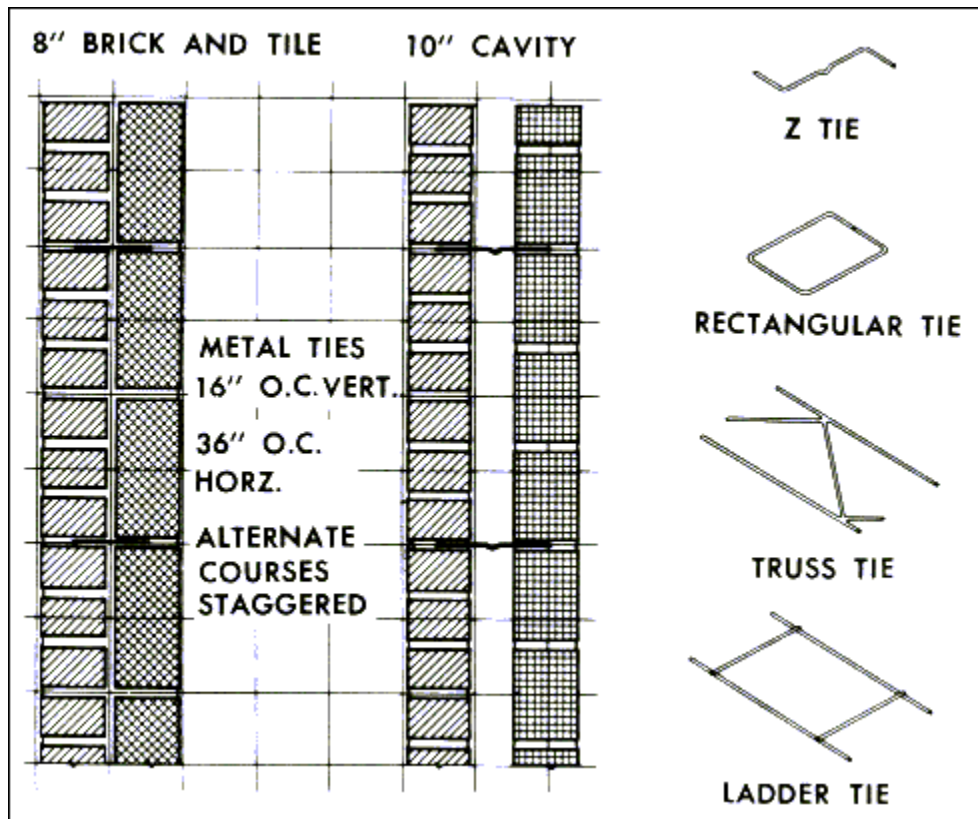
English and Flemish Bonds

FIG. 1b

The stretchers, laid with the length of the wall, develop longitudinal bonding strength; while the headers, laid across the width of the wall, bond the wall transversely.

Modern building codes require that masonry-bonded brick walls be bonded so that not less than 4 per cent of the wall surface is composed of headers, with the distance between adjacent headers not exceeding 24 inches, vertically or horizontally.

Structural bonding of masonry walls with metal ties is used in both solid wall and cavity wall construction (Fig. 2).



Metal-Tied Masonry Walls

FIG. 2

Most building codes permit the use of rigid steel bonding ties in solid walls.

At least one metal tie should be used for each 4 1/2 sq ft of wall surface. Ties in alternate courses should be staggered. The distance between adjacent ties should not exceed 24 in. vertically nor 36 in. horizontally. Additional bonding ties, spaced not more than 3 ft apart around the perimeter and within 12 in. of the opening, should be provided at all openings.

If ties less than 3/16 in. in diameter are used, tie spacing should be reduced so that the tie area per square foot of wall is not less than specified above.

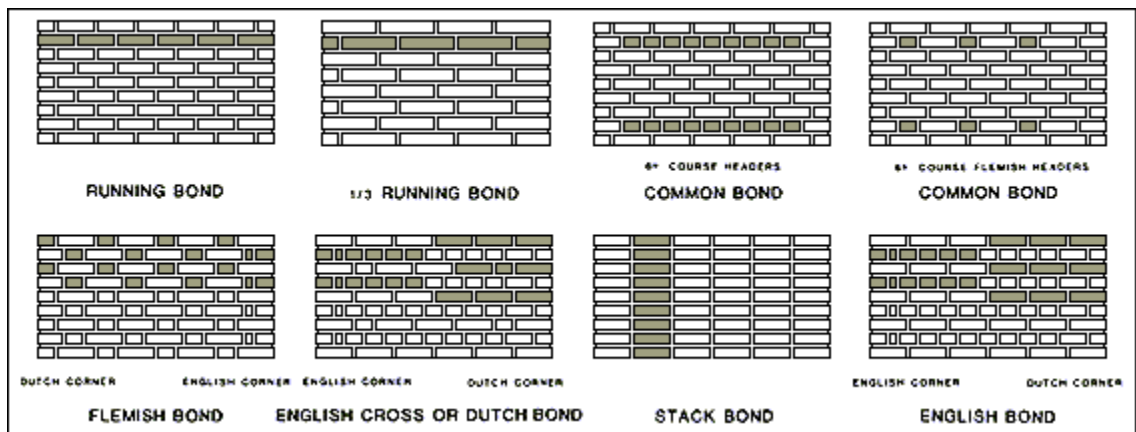
Structural bonding of solid and reinforced brick masonry walls is sometimes accomplished by grout which is poured into the cavity or collar joint between wythes of masonry.

The method of bonding will depend on the use requirements, wall type and other factors, However, the metal tie method is generally recommended for exterior walls. Some of the advantages of this method are greater resistance to rain penetration and ease of construction. Metal ties also allow slight differential movements of the facing and backing which may relieve stresses and prevent cracking.

### PATTERN BONDS

Frequently, structural bonds, such as English or Flemish, or variations of these, may be used to create patterns in the face of the wall. However, in the strict sense of the term, pattern refers to the change or varied arrangement of the brick texture or color used in the face. Therefore, it may be possible to secure many patterns using the same structural bond. Patterns also may be produced by the method of handling the mortar joint or by projecting or recessing certain brick from the plane of the wall, thus creating a distinctive wall texture that is not solely dependent upon the texture of the individual brick.

There are five basic structural bonds commonly used today which create typical patterns. These are: Running bond, common or American bond, Flemish bond, English bond and block or stack bond, as illustrated in Fig. 3. Through the use of these bonds and variations of the color and texture of the brick, and of the joint types and color, an almost unlimited number of patterns can be developed.



Traditional Pattern Bonds

FIG. 3

**Running bond.** The simplest of the basic pattern bonds, the running bond, consists of all stretchers. Since there are no headers in this bond, metal ties are usually used. Running bond is used largely in cavity wall construction and veneered walls of brick, and often in facing tile walls where the bonding may be accomplished by extra width stretcher tile.

**Common or American Bond.** Common or American bond is a variation of running bond with a course of full length headers at regular intervals. These headers provide structural bonding, as well as pattern. Header courses usually appear at every fifth, sixth or seventh course.

In laying out any bond pattern, it is important that the corners be started correctly. For common bond, a three-quarter brick should start each way from the corner at the header course.

Common bond may be varied by using a Flemish header course.

**Flemish Bond.** Each course of brick consists of alternate stretchers and headers, with the headers in alternate courses centered over the stretchers in the intervening courses. Where the headers are not used for the structural bonding, they may be obtained by using half brick called "clipped" or "snap" headers.

Flemish bond may be varied by increasing the number of stretchers between headers in each course. If there are three stretchers alternating with a header, it is known as "garden wall" bond. If there are two stretchers between headers, it is designated as "double stretcher garden wall" bond. Garden wall bond may also be laid with four or even five stretchers between the headers.

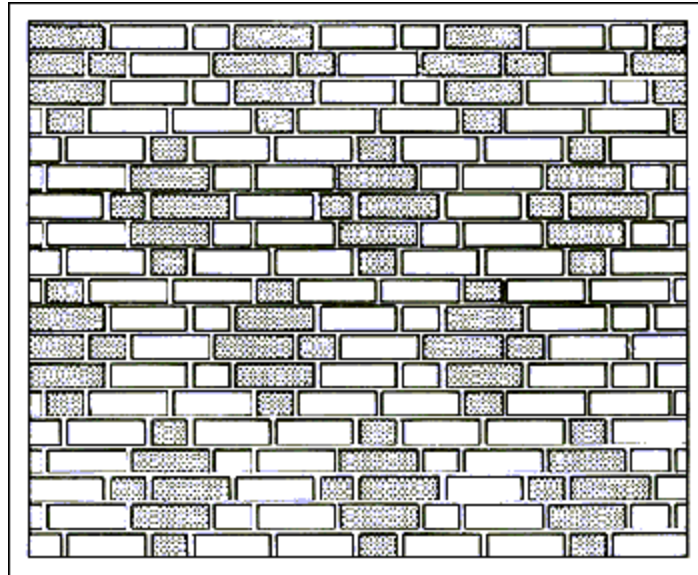
**English Bond.** English bond is composed of alternate courses of headers and stretchers. The headers are centered on the stretchers and joints between stretchers in all courses are aligned vertically. Snap headers are used in courses which are not structural bonding courses.

**English Cross or Dutch Bond.** English cross or Dutch bond is a variation of English bond which differs only in that vertical joints between the stretchers in alternate courses do not align vertically. These joints center on the stretchers themselves in the courses above and below.

There are two methods used in starting the corners in Flemish and English bonds. Figure 3 shows the so-called "Dutch corner" in which a three-quarter brick closure is used, and the English corner in which a 2-in. or quarter brick closure, called a "queen closure", is used. The 2-in. closure should always be placed 4 in. in from the corner, never at the corner.

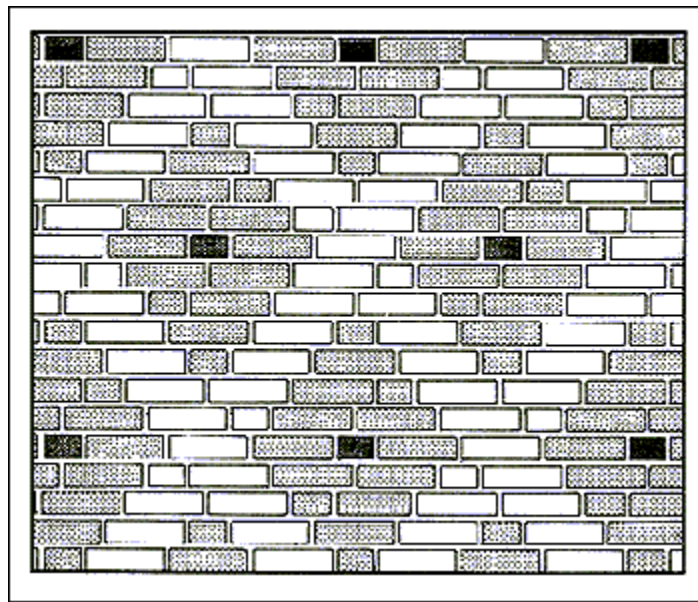
**Block or Stack Bond.** Block or stack bond is purely a pattern bond. There is no overlapping of units since all vertical joints are aligned. Usually this pattern is bonded to the backing with rigid steel ties, but when 8 - in. bonder units are available, they may be used. In large wall areas and in load bearing construction, it is advisable to reinforce the wall with steel reinforcement placed in the horizontal mortar joints. In stack bond it is imperative that prematched or dimensionally accurate masonry units be used if the vertical alignment of the head joints is to be maintained.

Figures 4 and 5 illustrate patterns that may be obtained by varying brick color. Figure 4 is a double stretcher garden wall bond with the pattern units in diagonal lines. Figure 5 shows a garden wall bond with the pattern units set in dovetail fashion.



**Double Stretcher Garden Wall Bond with Units in Diagonal Lines**

**FIG. 4**



**Garden Wall Bond with Units in Dovetail Fashion**

**FIG. 5**

**Wall Texture.** Recently many contemporary modifications of the traditional bonds have been used by projecting and recessing units, also by omitting units to form perforated walls or screens. Figure 6 illustrates contemporary uses of masonry which imaginatively extend the traditional patterns.



**Contemporary Bonds**

**FIG. 6**

### **MORTAR JOINTS**

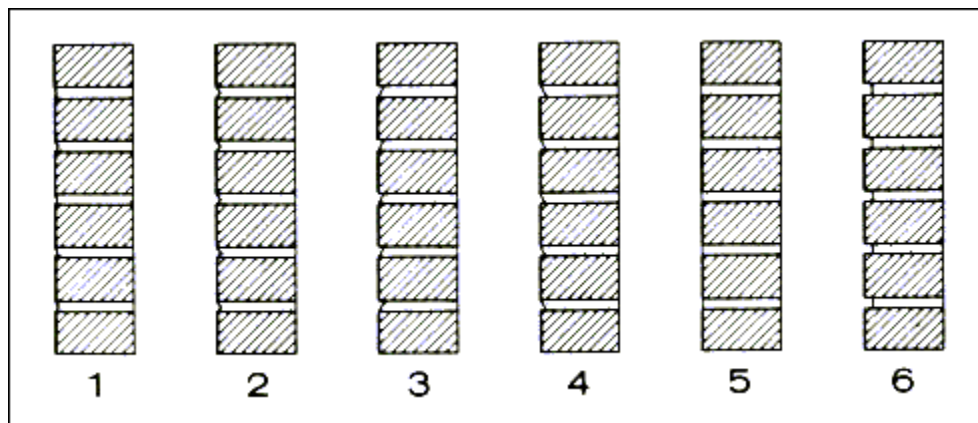
As previously indicated, the treatment of mortar joints in the face of the wall affects the pattern and wall texture.

The mortar serves four functions:

1. It bonds the units together and seals the spaces between.
2. It compensates for dimensional variations in the units.
3. It bonds to and, therefore, causes reinforcing steel to act as an integral part of the wall.
4. It provides a decorative effect on the wall surface by creating shadow or color lines.

Mortar joint finishes fall into two classes: troweled and tooled joints. In the troweled joint, the excess mortar is simply cut off (struck) with a trowel and finished with the trowel. For the tooled joint, a special tool, other than the trowel, is used to compress and shape the mortar in the joint.

Figure 7 shows a cross section of typical mortar joints used in good brickwork.



**Mortar Joints**

**FIG. 7**

**Concave Joint ( 1 ) and V-Shaped Joint ( 2 )** . These joints are normally kept quite small and are formed by the use of a steel jointing tool. These joints are very effective in resisting rain penetration and are recommended for use in areas subjected to heavy rains and high winds.

**Weathered Joint (3)**. This joint requires care as it must be worked from below. However, it is the best of the troweled joints as it is compacted and sheds water readily.

**Struck Joint (4)**. This is a common joint in ordinary brickwork. As American mechanics often work from the inside of the wall, this is an easy joint to strike with a trowel. Some compaction occurs, but the small ledge does not shed water readily, resulting in a less watertight joint than joints (1), (2) or (3).

**Rough Cut or Flush Joint (5)**. This is the simplest joint for the mason, since it is made by holding the edge of the trowel flat against the brick and cutting in any direction. This produces an uncompacted joint with a small hairline crack where the mortar is pulled away from the brick by the cutting action. This joint is not always watertight.

**Raked Joint (6)**. Made by removing the surface of the mortar, while it is still soft. While the joint may be compacted, it is difficult to make weather-tight and is not recommended where heavy rain, high wind or freezing is likely to occur. This joint produces marked shadows and tends to darken the overall appearance of the wall.

Colored mortars may be successfully used to enhance the patterns in masonry. Two methods are commonly used: (1) the entire mortar joint may be colored or (2) where a tooled joint is used, tuck pointing is the best method. In this technique, the entire wall is completed with a 1-in. deep raked joint and the colored mortar is carefully filled in later.