

# TROWEL TIPS

*an aid to the masonry industry*

## Workmanship Part II, Imparting Quality to Masonry

The first of this two part series on workmanship (*Trowel Tips: Workmanship Part I, Preparing for Quality*, IS245) focused on the preparation, teamwork, and support that must be provided so that a mason can construct quality masonry structures. This document examines important aspects of hands-on mason skills that are employed in the actual onsite fabrication of masonry. Both are necessary to realize the goal of completing masonry construction that attains the level of strength, durability, and aesthetic appeal expected of masonry. Certain basic skills are required in addition to effective interaction between the mason constructing the masonry, other members of the masonry contractor's support crew, and the project construction team.

### Construction

**Mortar Consistency.** The need for the combination of skill and teamwork is perhaps best illustrated by examining the onsite establishment of the working consistency of freshly mixed mortar. Mortar should be mixed with the maximum amount of water that is consistent with satisfactory workability. The mason can best evaluate the optimum consistency of the freshly mixed mortar as he uses the mortar to place units under prevailing environmental conditions. Certainly, a proper evaluation of the mortar consistency by the mason requires a general knowledge of masonry materials, experience with the specific masonry materials, and an understanding of how prevailing environmental conditions affect masonry construction. However, unless that evaluation is effectively conveyed to the individual mixing the mortar and appropriate adjustments made to the mortar mix, the mason's evaluation is pointless. Knowledge, skill, communication, and teamwork are required to establish and maintain optimum consistency of freshly mixed mortar.

**Retempering.** Fresh mortar should be prepared at the rate used, so that its workability will remain about the same throughout the day. Mortar that has been mixed but not used immediately tends to dry out and stiffen. Loss of water by absorption and evaporation on a dry day can be reduced by wetting the mortarboard and covering the mortar in the mortar box, wheelbarrow, or tub.

Mortar that has stiffened due to evaporation should be retempered to restore workability by adding water and

thoroughly remixing (Fig. 1). Although small additions of water may slightly reduce the compressive strength of the mortar, the result is acceptable. Masonry built using plastic mortar has a better bond than masonry built using dry, stiff mortar. Bond, more than strength, affects the performance of a masonry wall.

Mortar that has stiffened because of hydration should be discarded. Since it is difficult to determine by sight or feel whether mortar stiffening is due to evaporation or to setting of the cement, the most practical method of determining the suitability of mortar is on the basis of time elapsed after mixing. Mortar should be used within 2-1/2 hours after mixing.

Retemper colored mortar cautiously to avoid color changes. Water content and stiffness of mortar during tooling affect color (see section on tooling mortar joints).

**Filling mortar joints.** Two types of mortar bedding are used in masonry construction: face-shell mortar bedding and full mortar

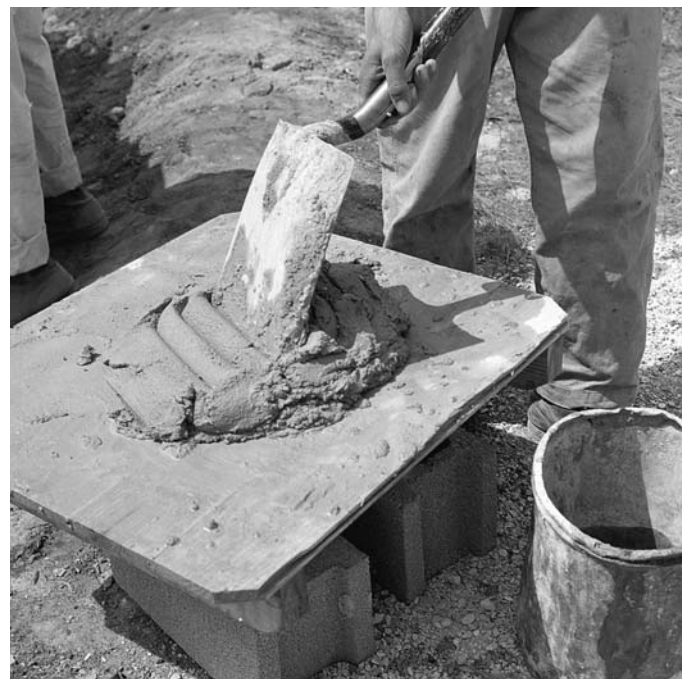
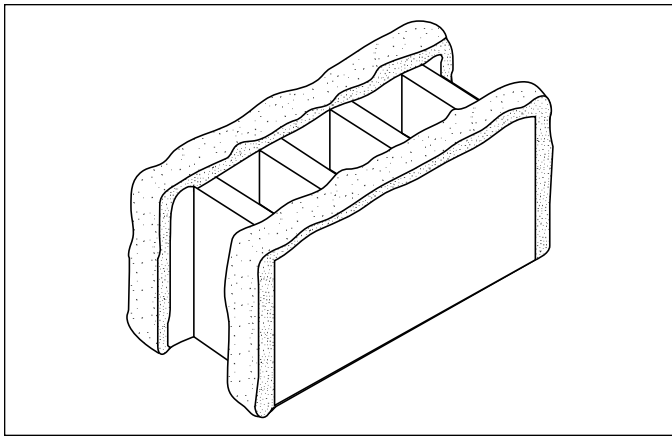
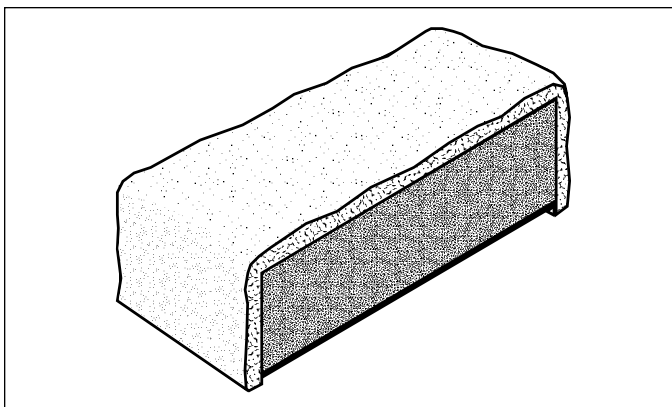


Fig. 1. Retempering restores workability.



**Fig. 2a. Face shell bedding is typically used in concrete block construction.**



**Fig. 2b. Full mortar bedding is used in concrete brick and clay brick construction.**

bedding (Fig. 2). Face shell bedding is generally used in concrete block or hollow clay masonry construction. Full mortar bedding is used for laying the first or starting course of block on a footing or foundation wall as well as for laying solid concrete brick, clay brick, or solid concrete block. It is also commonly used to construct concrete masonry columns, piers, and pilasters that will carry heavy loads. Where some vertical cores are to be grouted, such as in reinforced masonry, the webs around each grouted core are fully mortared.

Hollow concrete block should be laid with the thicker part of the face shell up. This provides a larger mortar-bedding area and makes the block easier to handle. Mortar is applied to the face-shell bedding surface of the previous course of units. For head joints, mortar is applied only to the face-shell ends of the block. Some masons butter (mortar) the vertical ends of the block previously placed; others set the block on one end and butter the other end before laying the block. Different techniques are acceptable provided the mason makes certain that face-shell head and bed joint surfaces are fully mortared. Buttering both the block already laid and the block to be laid provides well-filled head joints and improved bond (Fig. 3).



**Fig. 3. A well-filled head joint results from mortaring both block.**

Regardless of the method used to apply mortar to the vertical edges, each unit is brought over its intended final position and pushed downward into the mortar bed and sideways against the previously laid unit. Once laid and positioned, the unit should not be disturbed. Movement will break the bond between mortar and unit. That bond is never fully re-established unless the unit is removed and re-laid in fresh mortar.

For concrete brick as well as clay brick, mortar should be spread to a uniform thickness covering the full width of the bedding surface of the preceding course of masonry. The mortar bed should be furrowed only slightly, if at all. Many project specifications prohibit furrowing of bed joints.

Special care should be taken in filling the head joints. If head joints are not completely filled with mortar, resulting voids and channels may permit excessive moisture to penetrate that wythe of masonry. Mortar should be troweled on the end of the brick to be placed so that when the brick is pressed into place, the



**Fig. 4. Mortar extrudes from the joints of a unit being placed, indicating full mortar joints.**



**Fig. 5. (a) The mason checks corners for alignment,**



**(b) for being level,**



**(c) and for being plumb.**

mortar will ooze out at the top and around the sides of the head joint, indicating the joint is completely filled (Fig. 4). Dabs of mortar spotted on both corners of the brick do not completely fill the head joints, and "slushing" (attempting to fill the joints from above after the brick is placed) cannot be relied on to adequately fill head joints.

As each unit is laid, excess mortar extruding from the joints is cut off with the trowel and applied to the head joints of the unit just laid or returned to the mortarboard for reuse. If there has been any delay long enough for the extruded mortar to stiffen before it is cut off, it should be reworked on the mortarboard before reuse. Mortar droppings picked up from the scaffold or from the floor should not be reused.

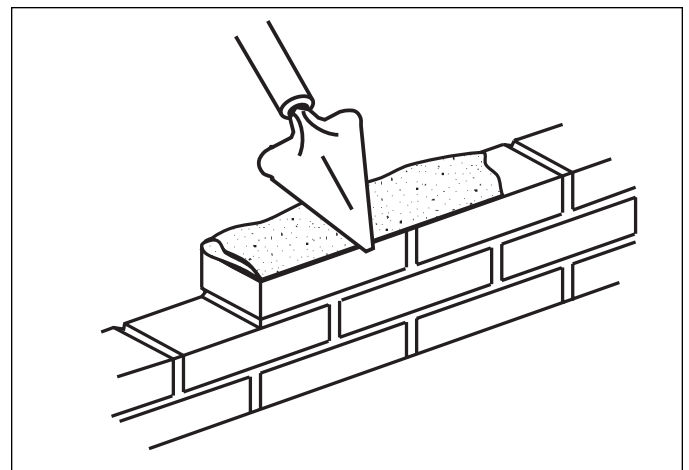
Mortar should not be spread too far ahead of the actual laying of units or it will tend to stiffen and lose its plasticity, thereby resulting in poor bond. In hot, dry weather it may be necessary to spread only enough mortar for a few units before they are laid.

**Laying up a wall.** On jobs where more than one mason is working, the foundation, footing, or shelf angles supporting the masonry must be level so that each mason can start his section of wall on a common plane and the bed joints will be uniformly straight when the sections are connected. If the support for the masonry is significantly out of level, the entire first course should be laid – establishing a level plane for subsequent courses. A line may be used to help align the units correctly. Before the corners are established, masons often lay out the masonry units for the first course without mortar to check the wall layout. The corner unit should be laid first and carefully positioned. After three or four units have been laid, the mason's level is used as a straightedge to assure correct alignment of the units. These units are then carefully checked with the level, brought to proper grade, and made plumb. It is especially important that units in the first course be properly aligned, leveled, and plumbed, since this course sets the pattern for succeeding courses.

Corner construction normally precedes laying of units between the corners. As each course is laid at a corner, it is checked with a level for alignment, for being level, and for being plumb (Fig. 5). A story pole may be used to check vertical spacing of courses.

After the corners at each end of a wall have been laid up, a mason's line (string line) is stretched tightly from corner to corner for each course, and the top outside edge of each unit is laid to this line. Different devices (line pins, line twigs, corner blocks, and line stretchers) can be used to fasten the line and eliminate sag. Careful application of these techniques will ensure true, straight walls.

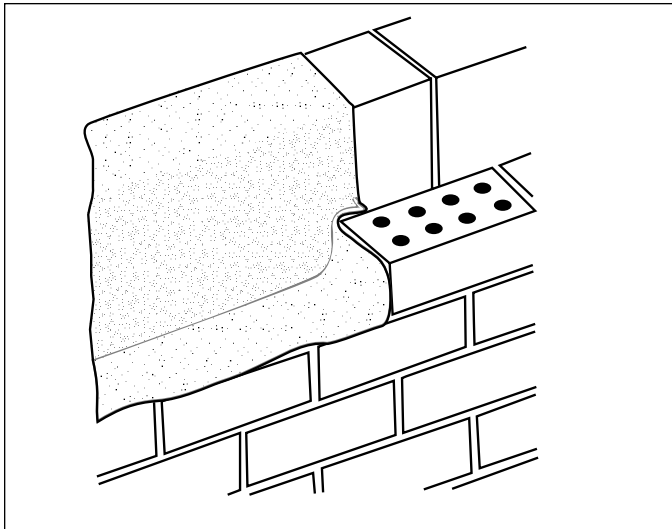
**Keeping cavities clean.** A drainage wall will not fulfill its intended purpose if construction practices permit mortar droppings in the drainage air-space (drainage cavity). The presence of mortar droppings on the flashing prevents exodus of water. Mortar extruded from bed joints will easily bridge cavities of 1 in. (25 mm) or less. Mortar bridges across the drainage cavity can conduct water to the interior, resulting in moisture problems, including deterioration of interior finishes. One solution is to assure that mortar spread as a bed joint is beveled or sloped away from the drainage cavity (Fig. 6). This practice requires very little effort and is a very effective means of keeping mortar out of the drainage cavity. For cavity walls having a minimum 2-in. (50-mm) air-space between wythes, another solution is to catch mortar droppings on a board laid across a tier of ties. The narrow board



**Fig. 6. Beveling the inside bed joint helps keep mortar out of a wall cavity.**

has strings attached at either end. When masonry reaches the next level for ties, the board is raised, cleaned, and repositioned.

**Installing flashing and weepholes.** Flashings are used to control water that may penetrate the outer wythe of masonry by providing direct drainage through weepholes to the exterior of the building. Flashing materials are generally formed from sheet metals, bituminous membranes, vinyls, or combinations. To function properly, it is important that the flashing extend to the outer face of the masonry, preferably slightly beyond the face, forming a drip. Care must be taken to avoid tearing or puncturing flashing during installation. All seams must be lapped at least 6 in. (150 mm) and sealed. The inside upper edge of the flashing must be installed so that water does not get behind the flashing. End dams must be installed wherever flashings terminate (Fig. 7).



**Fig. 7. End dams must be formed wherever flashings terminate in a wall.**

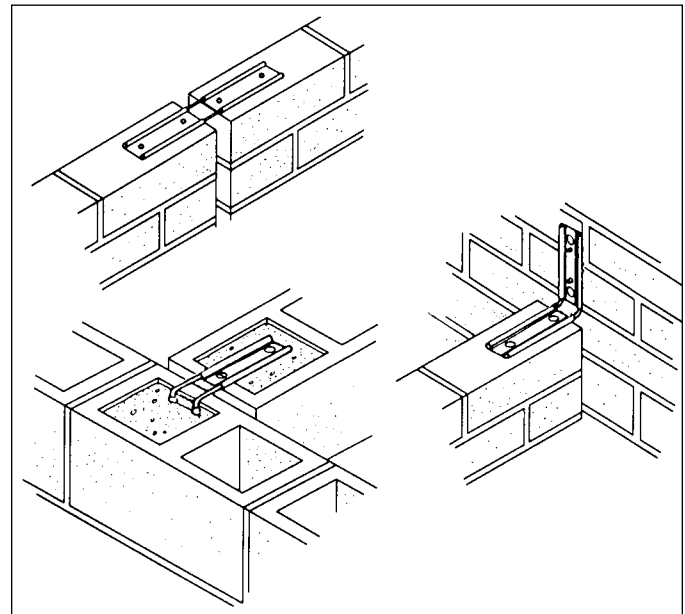
Weepholes are located over the flashing at the bottom of drainage walls. They can be formed by leaving an open head joint, or by installing a weephole vent or cotton sashcord in a mortared head joint. The weephole must provide an unobstructed pathway to the exterior for the drainage of water collected by the flashing.

**Ties and anchors.** Wall ties are used to connect two masonry wythes so that they act together to resist applied loads. Ties are also used to connect a masonry veneer to a structural back-up wall. Anchors are used to connect masonry walls to intersecting walls or other structural members. Several varieties of ties and anchors are used in masonry construction. The selection depends on the requirements of the specific application and is part of the design process. The project drawings and specifications should identify the type, size, and location of these connectors.

Proper installation of connectors is critical to the performance of the masonry. Wall ties should be installed such that the embedded end extends at least 1/2 in. (12 mm) into the outer face shell bedding of masonry constructed using hollow units and at least 1-1/2 in. (38 mm) into the mortar bed of masonry constructed using solid units. Bending wall ties from the

manufactured shape changes their ability to transfer loads. Many building codes prohibit bending of ties unless approved by the architect or engineer. Courses should be horizontal (level) and where two wythes are to be connected, joints in each wythe should be at the same elevation. This is especially important if more than one type (size) of unit is being used. In this case, the (vertical) spacing should be such that ties can be placed across joints in each wythe. If possible, ties that allow for small vertical adjustments should be used.

Anchors are often designed to transfer loads in one direction but allow movement in another. For example, joint stabilizing anchors resist lateral loads but allow shrinkage and expansion through the connector (Fig. 8). The mason must understand the purpose of these accessories so that he can properly install them to function as intended.



**Fig. 8. Joint stabilizing anchors connect intersecting walls and allow shrinkage or expansion through the joint.**

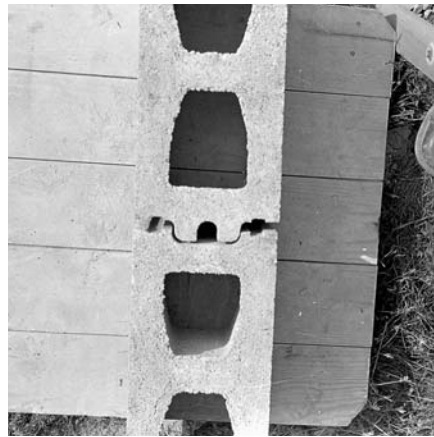
**Movement joints.** Clay masonry units expand slightly as they are exposed to moisture. Concrete masonry units shrink as they cure and dry. Movement joints are used to accommodate dimensional changes in masonry elements resulting from moisture and temperature changes. Determination of the required type and location of movement joints is part of the design process, and that information should be contained in the project drawings and details.

Control joints are used in concrete masonry construction to control possible cracking resulting from shrinkage. Control joints consist of a continuous, vertical weakened section built into the wall. In addition to accommodating longitudinal movement resulting from shrinkage, a control joint must usually provide lateral stability to the wall. Special units, accessories, or fabrication procedures may be used to accomplish this. Perhaps the most common examples are the Michigan type of control joint, the use of tongue-and-groove units, and the use of a premolded rubber insert (Fig. 9). Regardless of the type of control joint, it must be installed such that it permits ready longitudinal

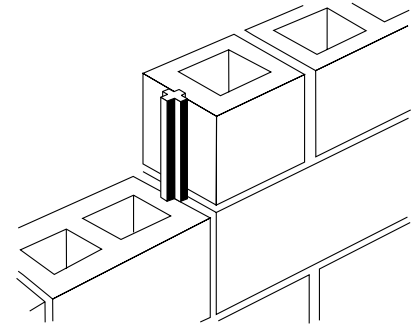




**Fig. 9. Examples of control joints:**  
**(a) Michigan type of control joint,**



**(b) use of tongue-and-groove units,**



**and (c) use of premolded joint insert with a sash block.**

movement away from the joint. For example, horizontal joint reinforcement must be terminated at the control joint for the joint to function properly.

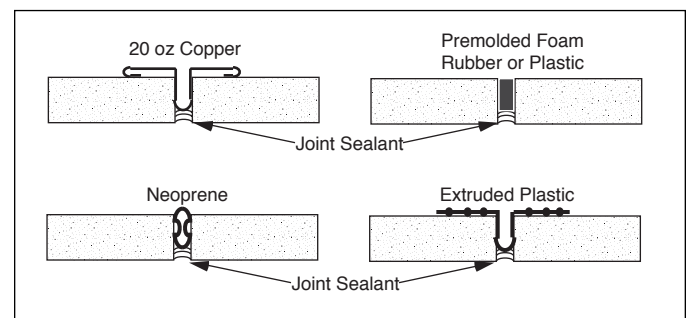
Expansion joints are used in clay masonry construction to provide a continuous void space in the wall plane that will accommodate movement resulting from expansion of the masonry. It is important that this joint be free of any non-compressible material such as mortar, grout, or wood. A variety of compressible expansion joint fillers are used to help assure that the expansion joint is not filled with mortar or other non-compressible materials (Fig. 10). The mason must properly install these materials and assure that the expansion joint can function as intended.

**Tooling mortar joints.** Tooling compacts the mortar to a dense, neat surface with good durability (Fig. 11). Tooling to a concave or a V shape provides optimum resistance to water penetration. This is especially important in cold and wet environments. These shapes are recommended because they do not allow water to rest on the joint, and they result in the mortar being pressed toward both the lower and the upper masonry unit. This reduces weathering and helps ensure maximum bond between the mortar and the masonry units. However, architects may specify other joint shapes for aesthetic reasons. Proper timing of joint finishing—tooling and compacting—provides the best assurance for good bond.

Timing is also important to achieve a uniform appearance in the finished mortar joint surface. The mortar should be allowed to stiffen until it is hard enough that a thumbprint just barely shows. Tooling too soon will bring more paste to the surface, resulting in a lighter appearance. Mortar smears are more likely to occur when tooling joints early. In addition, the high water content and fines contained in this surface layer of paste may result in visible shrinkage cracks. Tooling mortar joints after they have hardened too much results in an uneven dark appearance, sometimes termed "tool burning." Tooling at the proper time optimizes appearance and performance. The initial rate of absorption of units, ambient temperature, humidity, wind, and whether or not the area is exposed to direct sunlight all affect the rate at which

mortar stiffens in the wall. Therefore, a mason must evaluate whether or not a joint is ready to tool by observation and touch rather than by setting a specific elapsed time from placement until tooling.

**Cleaning.** Clean masonry walls are not simply the product of a cleaning procedure performed after the masonry is constructed. An accomplished mason will construct masonry walls having a minimum of mortar droppings or smears on the face of masonry units. An informed mason contractor will assure that steps are taken throughout the construction process to minimize the clean-



**Fig. 10. Compressible expansion joint fillers are used to assure that the expansion joint is not filled with mortar.**



**Fig. 11. Proper tooling yields a dense, weather-resistant mortar joint surface and a neat, uniform appearance.**

up required upon completion. The principle that "less is better" applies to final cleaning requirements for masonry. For a more complete discussion of this topic, see PCA publication IS244, *Trowel Tips: Cleaning Masonry*.

## Summary

When taken as a measure of the quality built into masonry, workmanship includes the topics discussed in this two-part series as well as additional measures, such as covering walls at the end of each day of construction, adequately bracing walls, and following proper hot and cold weather construction procedures. More detailed discussion of these topics can be found in the documents listed as related publications. This information is intended to increase awareness of the importance of good workmanship, contribute to the basic knowledge about the construction practices that are a part of good workmanship, and enhance appreciation of the skills required to achieve good workmanship.

## Related Publications

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Masonry Cement Mortars, IS181

Trowel Tips: Efflorescence, IS239

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Trowel Tips: Field Testing Mortar, IS242

Trowel Tips: Hot-Weather Masonry Construction, IS243

Trowel Tips: Cleaning Masonry, IS244

Trowel Tips: Workmanship Part I, Preparing for Quality, IS245

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