RESTORING & REPOINTING BRICK MASONRY

Bad repairs can ruin a wall. Always test first to determine the right materials and techniques.

by Philip Marshall & Michael Watson

Many specialized masonry-cleaning and restoration firms have developed in response to the growing building rehab market. Some companies serve as subcontractors on large projects. In other cases, general contractors may employ a team of masons as part of their full-time work force.

In this article we assume high quality workmanship is desired whether it is on a historic restoration project or a building rehab. Existing masonry and the conditions that contribute to its deterioration are much the same on a 1930 apartment building as on a 1730 building that might have served as General Washington's headquarters.

According to the National Park Service, $10.4 billion of Economic Recovery Act-certified rehabilitation was completed from 1982 to 1987. Most of these buildings were masonry structures: mills, office buildings, housing complexes—all listed on the National Register.

To gain the tax credits so coveted by owners and developers, all this restoration was undertaken according to the Secretary of the Interior's *Standards for Rehabilitation* and approved by the Park Service.

Many projects are denied the credits, however, due to poor or inappropriate work—specifically masonry work. This means: Do *not* sandblast masonry, replace water-struck brick with extruded wire-cut units, or repoint with portland mortar and expect to get approval of your work from the National Park Service.

Why Repoint?

There are several possible reasons why any particular building needs to be repointed. These are listed with the most common reason first, the rarest last. If buildings were built and maintained better the sequence would be reversed:

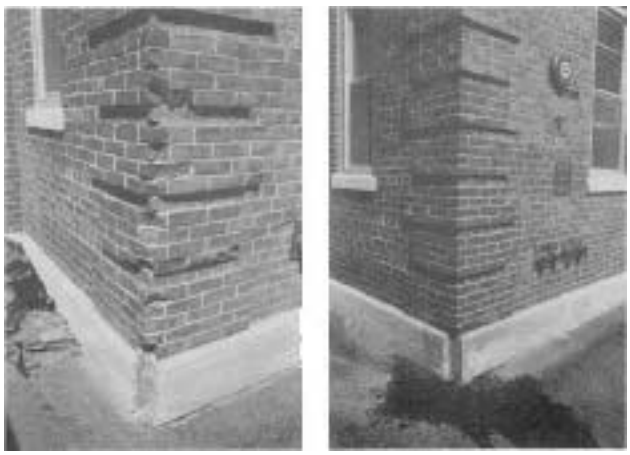
Poor workmanship—past or current. Past work may not only be visually inappropriate, it can actually speed up the deterioration of the brickwork. For example, sandblasting can cause the masonry to crumble. The use of portland-rich mortar can lead to spalling brick and visually unacceptable patches. These problems are very costly to repair.

Work rejected by an owner or architect may also need to be done over—at substantial cost to the contractor or mason. Masonry work may be rejected because it is just plain bad work, but often it stems from inadequate specifications: the scope of work does not provide an adequate standard of reference for the job.

Structural deficiencies. Structural problems may be caused by faulty construction (possibly altered during renovations), deteriorated structural members, or hydrostatic pressure. Whatever the case, a builder must determine if there is active movement. This will require evaluation—possibly by an engineer—to determine the cause, present activity, and corrective treatment needed. This may require substantial work before starting the masonry restoration.

Water damage. Change in grade, splashback, deteriorated flashing, missing gutters, colorless coatings, and sandblasted brick can all cause or contribute to water-related damage. Well maintained masonry itself will seldom fail prematurely. If there is spalling, efflorescence, or mildew, suspect water as the culprit. Eliminate the source of damage before undertaking any masonry restoration.

To fix water-related damage may require a lot of related work: regrading, roofing, flashing, cornice repair, and new downspouts. Even if all of this is beyond the scope of your work, be cer-



Before **After**

This corner detail, called a quoin, required many new bricks as well as repairs to the concrete sill. The finished job (right) demonstrates exact matching of all damaged areas. The "before" photograph (left) can be a valuable estimating tool.

It makes no sense to bid a repointing job until the type and condition of mortar is known. Test patches yield this information along with data on how best to strip and clean. The brick under this deteriorated paint turned out to be in excellent condition.

Details for Good Joints

Old mortar should be removed to a minimum depth of 2½ times the width of the joint—about 1 inch deep for most brick joints—to ensure an adequate bond (Figure 1). Any loose or disintegrated mortar beyond this depth should also be removed. Joints should be cleaned with care since damage to the bricks can affect not only the appearance, but can also lead to accelerated weather damage.

Where existing mortar has been removed to a depth greater than 1 inch, these deeper areas should be filled first, compacting the new mortar in several ¼-inch-thick layers to reduce overall shrinkage. It is important to allow each layer time to harden before applying the next layer, since most of the shrinkage occurs while the mortar hardens.

The rate of hardening can be controlled by dampening the brick and old mortar before filling the joint, but avoid free water or excessive wetting. Too much water will delay the tooling or cause excessive shrinkage; too little water will reduce bond strength.

When the final layer of mortar is thumb-print hard, the joint should be tooled to match the historic joint. Proper timing of the tooling is important for uniform color and appearance. If tooled too soft, the color will be lighter than expected, and hairline cracks may occur. If tooled too hard, there may be dark streaks called "tool burning," and good closure of the mortar against the brick will not be achieved.

If the old bricks have worn, rounded edges, it is usually best to recess the final mortar slightly from the face of the bricks. This will help avoid a joint wider than the actual joint width, which would change the character of the original brickwork. It will also avoid the creation of a large, thin feathered edge that is easily damaged (Figure 2).

If the repointing work is done carefully, the only cleaning required will be a small amount of mortar brushed from the edge of the joint with a stiff bristle brush following tooling. This is done after the mortar has dried, but before it is fully hardened (1 to 2 hours). Mortar that has hardened can usually be removed with a wooden paddle or, if necessary, a chisel. Further cleaning is best accomplished with plain water and bristle brushes.

New construction "bloom" or efflorescence occasionally appears within the first few months after repointing and usually disappears through the normal weathering process. If the the efflorescence is not removed by natural processes, the safest way to remove it is by dry brushing with stiff natural or nylon-bristle brushes and water. Muriatic acid is generally ineffective and should be avoided. It in fact can deposit additional salts which can lead to additional efflorescence. —

Adapted from Preservation Brief 2: Repointing Mortar Joints in Historic Buildings, *published by the National Park Service, Preservation Assistance Division.*

Incorrect

Mortar not cleaned out to a uniform depth.

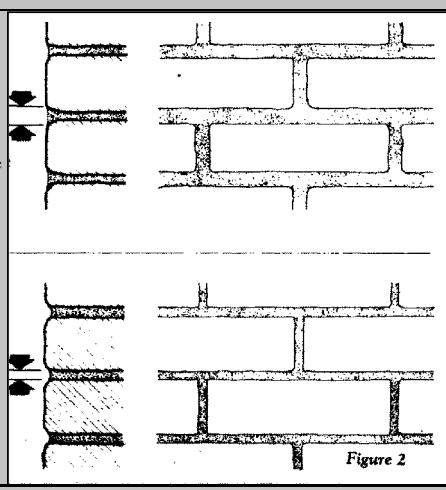
Edges of brick damaged by tool or grinder. Creates wider joint.

Correct

Mortar cleaned out to a uniform depth — about 1" deep.

Undamaged edges of brick.

Figure 1

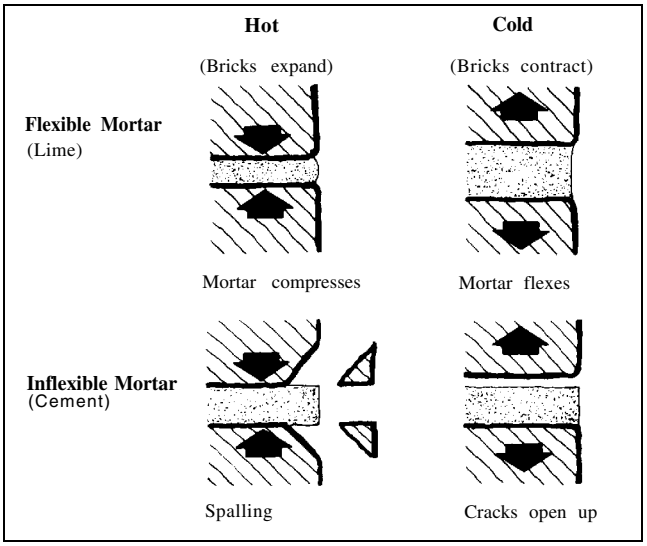


Joints filled too full.

Wide feather edge susceptible to spalling.

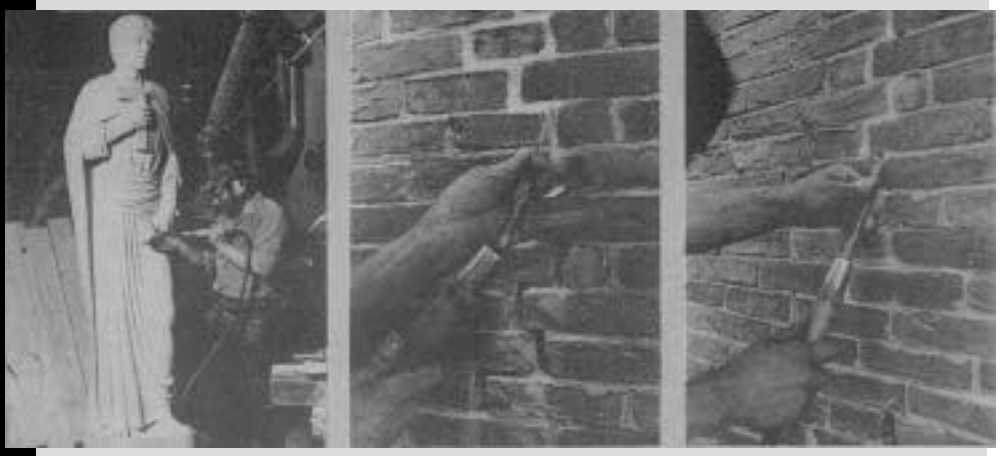
Joints slightly recessed.

Figure 2



This brick suffered the double whammy of sandblasting, and repointing with hard portland-cement mortar. The results (left): deteriorating brick and protruding mortar joints. The diagram (right) shows the effects of temperature change on lime mortar and cement mortar in old masonry.

Joint Preparation: A Job for Pneumatics



The Trow & Holden pneumatic chisel was developed fur sculpture (left), but can also remove old mortar quickly and with little fatigue to the worker. The worker maintains precise control by manipulating the loose-fitting chisel (center), and controlling the pneumatic back-pressure with his other hand. Vertical joints are easily cleaned (right), without harming adjacent brick—a real problem with grinding equipment.

Proper joint preparation is at least as important as the actual repointing work. Joint preparation consists of carefully removing deteriorated or inappropriate mortar from between the masonry or stone units. Deteriorated mortar, by nature, is not difficult to remove: The challenge is to remove it *carefully* to a sufficient depth. Inappropriate mortar, on the other hand, is typically hard portland-rich mortar, which can cause irreversible damage to the surrounding masonry.

Keep two things in mind: (1)all materials eventually fail and (2)historic mortar does not keep bricks together, it keeps them apart. With historic masonry, soft lime-rich mortar acts as a sacrificial material protecting surrounding brick. The point to repointing is to replace this material in-kind without changing its purpose. It is inexcusable for masons to sacrifice the bricks—rather than mortar—by using the wrong materials and techniques.

There are two prevalent methods of raking out mortar joints: the hand method and the use of electric grinders. You would do well to consider a third option: We've had great success with certain pneumatic carving tools described below.

Hand Tools

Many contractors consider the use of hand tools—a mason's hammer and chisel— as the best way to remove mortar. If you are among those, you'll have plenty of time to consider other options while using this slow, imprecise method. Laborious hand tooling is not simply a matter of time and expense but—more importantly—of worker fatigue. A weary body and mind is prone to mistakes, here in the form of irreversible damage.

Electric Grinders

At this point electric grinders might seem a viable option. Perhaps they are, but only on moderately wide horizontal joints uninterrupted by decorative elements such as brick window lintels or decorative terra cotta. And only if you have the skill to match the power of this tool.

Rotary electric grinders are frequently dangerous to both the building and the builder. Work cannot be properly viewed under the clouds of dust and fast-moving debris generated by a blade spinning at speeds as high as 6,000 rpm.

A major limitation of electric grinders is that they tend to overcut into neighboring courses when used on vertical mortar joints. Also the depth of removal is limited by the working radius of the blade. A 4-inch blade offers only 1½ inches maximum raking depth. Yes, grinders have their place, but it is usually as second or third fiddle to other methods, and always in conjunction with these preferred methods.

Pneumatic Tools

The use of pneumatic tools has had a tremendous impact on the restoration of historic masonry. Why? Exactly because of the precise manner and controlled impact of these air-powered instruments. They remove mortar by causing it to crumble and fall. First let's distinguish those tools that are just "full of hot air" from the precision instruments that can be employed for masonry restoration.

When most people think about pneumatic chiseling tools, they envision the implements used to remove mufflers from cars, or to scale steel, or worse yet, to drill post holes into sidewalks for "No Parking" signs.

We wish to separate the pneumatic tools described above, which are totally unacceptable for any restoration work, from the tool described below.

Trow and Holden "Barre" Pneumatic Carving Tool

You might think there is a choice of proprietary pneumatic tools on the market. Not so. While there is a wide range of tools and the opportunity to have any tools custom-made, they are all made by one company, the Trow and Holden Company, a firm that has specialized in tools for the stone industry since 1890. The company is located in Barre, Vt., the center of the world's largest granite quarry and this country's finest stone sculptors.

The Trow and Holden pneumatic carving tool was designed as a precision sculpting instrument and has been used by the arts and industry since 1890. It made its debut to the public at the World's Columbian Exposition of 1893 in Chicago; it carved Daniel Chester French's *Lincoln Memorial* in 1922. Today it details limestone figures at the Cathedral of St. John the Divine in New York, and it carves granite angels in Vermont. It is also employed by restoration masons for removing mortar on properties listed in the National Register.

The reasoning behind its application to restoration work is simple; if the tool is precise enough to sculpt the face of Abraham Lincoln, why shouldn't it be able to rake out loose mortar from masonry?

The difference between the "muffler remover" and the "countenance carver" tool is this. The Trow and Holden tool has neither a retainer nor a throttle. This is somewhat at odds with conventional tool design but does provide for some unique control characteristics not available with other pneumatic tools.

The Trow and Holden tool has a chisel with a round shank, handheld in place in the carving tool with no retainer. A round shank permits the chisel blade to be oriented independent of the tool, an essential feature that is impossible with square-shank tools. The absence of a retainer, or any mechanical connection, enables the mason to defeat the power of the tool immediately by pulling the chisel away from the piston, without any other action. Precision is effected by the tool design which enables one hand to operate the tool while the other control the chisel. The elimination of retainer and throttle hardware has resulted in a surprisingly light tool. Remember, this tool was developed as a finishing instrument to sculpt stone for hours at a time without fatigue to the artist.

The chisel blades arc tempered and available with carbide tips. They can be custom-made to any length or width. Even very thin "butter" joints can be cleaned, and a joint whose width is the distance between the lines on this page can be easily raked out. As with other raking tools, the width of the chisel should not exceed three-quarters of the width of the mortar joint.

This pneumatic tool is available in a range of sizes from those suitable for fine stone sculpting (or removing mortar) to those suited to heavier and more demanding jobs such as roughing-out blocks of masonry (or removing failed units). All tools require a compressor with only 8 cfm at 110 psi for full power.

Once mortar joints have been carefully raked out, any remaining debris can be easily cleaned with a regulated, light application of compressed air.

The Trow and Holden pneumatic carving tool is about three times faster than hand raking in removing loose mortar, hard mortar, and damaged bricks. Keep in mind, the object of masonry restoration is to restore only that material that actually requires work, with as little "intervention" as possible.

As with any instrument it takes time and practice to master the correct use of this tool and its potential. For product and technical information contact: Trow and Holden Company, Inc., 45 South Main Street, Barre, Vt., 05641; 800/451-4349 (out of state), or 802/476-7221. *—MW and PM*

tain to inform the owner/architect of these essentials. Otherwise your best work—backed by a guarantee—may prematurely fail through no fault of its own.

Deteriorated masonry. This means the normal, anticipated erosion of mortar that is to be expected after about a hundred years. Under these conditions, work is typically limited in scope and should not require 100 percent repointing. In fact, the rule is to only repoint where required.

Putting Masonry to the Test

Too often, contractors are expected to bid on masonry repairs based on poorly developed specifications, no test patches, and materials defined by phrases like "or equal." In these instances, the burden falls on the contractor to do the impossible, for example, to "match existing" mortar that is obscured from vision.

The only way to develop meaningful specs is to test first. Initial testing should be done during a preliminary evaluation of existing conditions. The results should be incorporated into the specifications for the scope of work, materials, and methods. These specs must be available to the contractor at the time of the walk-through prior to bidding the project.

After the initial scope of work is established, it may need to be updated as more information becomes available during the course of the project. For example, the degree of repointing needed on painted or badly stained masonry cannot be determined until the entire building is stripped or cleaned. The contractor should make allowances in the contract for the additional work anticipated and allow time in the schedule to complete the work.

Testing includes test patches on the building, mock-up panels, and work samples. By testing we mean *non-destructive* testing. There have been more than one case when poorly executed test patches posed more problems than the surrounding work. For example, paint removed by sandblasting, or original mortar profiles removed with electric grinders are likely to do more damage in one hour than a building has sustained in 100 years.

Specs for Lime Specks

Repair work may require several ranges of brick from various manufacturers (if existing bricks are no longer made); mortar ingredients from different lime/cement companies; a range of sand aggregate for color and texture; and two or three mortar colorings to properly "age" the new to look old. Also, the use of properly slaked quicklime is worth considering on brick structures built before 1850 where the mortar contains lime specks.

For matching mortar, dozens of samples may be needed to match the structural properties and texture of the original joints. Ingredients will include various aggregates, mortar dyes, cement, and lime. Do not use ready-mixed mortar, latex additives, or antifreezing agents. Each sample should be carefully labeled, accurately proportioned by volume (coffee cans work well), and documented. These must be allowed to naturally dry before a perfect match for color and texture can be achieved.

A single building can have substantial differences in mortar from elevation to elevation. Over a dozen different mortar mixes may be required on one side of a two-story house. We know of one project, however, where the test results for two mortar samples served as the basis for restoring mortar on a 200,000-square-foot mill constructed over a period of 50 years.

Raking Out Mortar

There are several techniques for raking out mortar and removing masonry units. What is excellent for one job, however, can be disastrous for another. The methods include:

- Hand (hammer and chisel)
- Mechanical/electrical (tuckpoint grinders)
- Mechanical/pneumatic (small grinders, reciprocating hammers)

In many cases a combination of techniques is useful. For example, most historic masonry with soft lime mortar will require a combination of hand and mechanical/pneumatic techniques. On newer structures—with hard portland mortar—grinders are predominantly employed with the fine work done using pneumatics.

Proper selection and testing of tools will also help you match the original mortar-joint condition and depth of joint. The right tool can also make a major difference in efficiency (see "Joint Preparation" previous page).

Repointing Techniques

Aside from matching the color, texture, and physical properties of the mortar, the (1)application, (2)tooling, and (3)cleaning must be done correctly to match the original work. This will often involve a study of the joint profile to determine the original—and present—tooling. If the original tool is no longer manufactured, this might require making a special tool.

The time allowed between tuckpointing and tooling (dwell time) is critical. This will affect how deep the tool penetrates, and the mortar's viscosity and density. It also affects the texturing techniques used at the end (for example, brushing, burlapping, water/air spray).

Final cleaning must be done carefully and, again, after testing. Various materials react differently with a common chemical. Improper cleaning can lead to problems such as efflorescence, erosion, and burning of the mortar joint.

Range of Masonry Restoration

The range of masonry restoration is broken down into three basic groups: localized, complete, and construction. After determining the proper methods and materials to use by testing, we can now fit the job into one of these categories.

Localized. By localized we mean there are clearly defined areas of deterioration, surrounded by sound masonry. This may require replacement of individual masonry units, tuckpointing, and perhaps cleaning of atmospheric stains. Seldom does this group require the integration of other trades.

Complete. Complete masonry restoration means just that. In many cases after paint or heavy atmospheric stains are removed, the scope of work will change with the revelation of what lies beneath. There may be widespread damage and structural movement. Other trades are included. Typically, stone foundations, sills, lintels, thresholds, brick walls, arches, parapets, and chimneys are involved.

Construction. This is the recreation of missing or severely damaged elements of a building, or an addition to an existing structure. Where building elements are recreated it's important to photographically document any remaining parts of the original structure. These often must be taken down because of structural damage. Here, questions of compatibility can only be answered by looking at photographs.

In fact, you should use photography to document all masonry repair work—before, during, and after. This will help with pricing and scheduling, it serves as a job record, and it helps in presenting past work to prospective clients.

New Materials

The need to match the original materials exactly is the single most overlooked element of masonry restoration. With the range of materials available today—cement, lime, aggregate, dyes, brick, and stone—you can meet almost any job requirements. These elements, in the hands of a skilled individual, can produce work virtually impossible to tell from the original. ■

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To repair this brick-veneer facade, author Michael Watson had to remove and replace a number of damaged bricks before repointing.

Any structural cracks must be analyzed and repaired, if needed, prior to repoinring. Such cracks are common near windows and arches.