Restoring mortar joints in historic buildings

Compatible mortar and painstaking craftsmanship are the keys to successful repairs

By Kenneth A. Hooker

In a properly designed and constructed masonry wall, mortar joints can last 50 years or more without maintenance. Eventually, though, natural weathering by wind and rain will cause the mortar to erode. Inferior original materials or workmanship, design flaws, or traumatic damage to the building can hasten mortar deterioration.

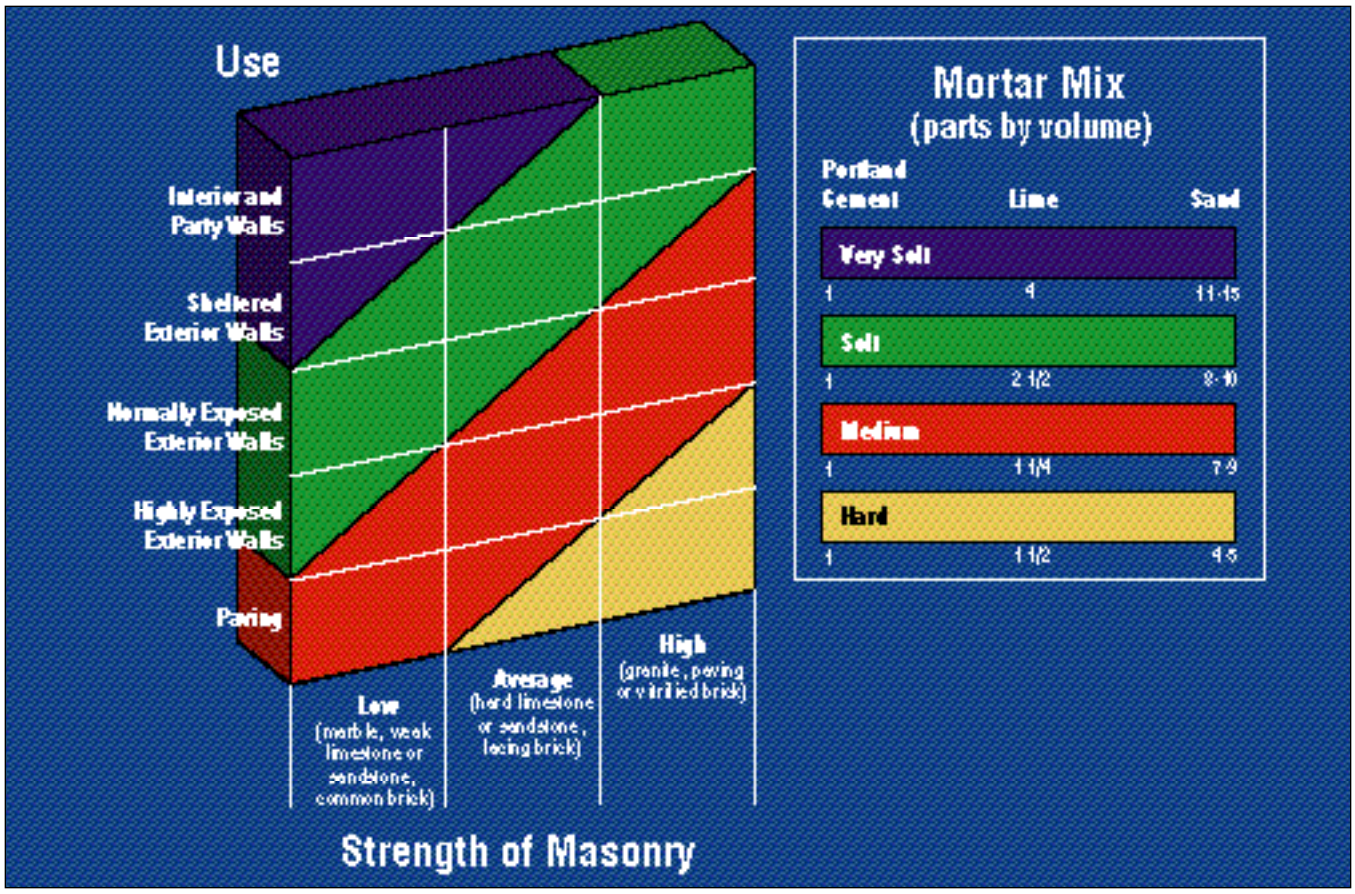
Masonry with seriously deteriorated mortar can be repaired by *repointing;* that is, removing the damaged mortar back to a uniform depth and refilling the joints with new material.

Properly done, repointing is painstaking and expensive work, which should be performed only by skilled craftsmen. A poor repointing job can be not only ineffective, but actually harmful to the masonry. When the building being repaired is very old or historically significant, the challenge is that much greater. The original materials often differ substantially from those used today, so choosing a compatible pointing mortar can be complicated. Also, the risk of damaging historic masonry while removing old mortar is considerable.

When to repoint

Repointing should be considered whenever existing mortar joints are eroded ⅛ inch or more

This table indicates the proportion of various mortar ingredients based on the role and location of the masonry and the strength of the stone or brick. Source: Ref. 1.



from the face of the masonry, visibly cracked, or separated from the masonry units. But mortar that can be chipped away easily or penetrated with a screwdriver is not necessarily unsound: The lime-based mortar used in many older buildings often may be quite soft, yet still intact and effective.

Mortar deterioration can be caused or aggravated by other problems, particularly those that allow water to enter the wall, and these must be corrected before repointing is done. If water is coming in at the roofline, for example, repointing alone will not be successful.

It is seldom necessary to repoint all the joints in a building. Some areas may be less exposed to weathering, while others may have had earlier repairs that still are in good condition. To avoid needless effort and control costs, it's best to repoint only those areas where the mortar actually has deteriorated.

On the other hand, avoid making spot repairs; it's too difficult to make them blend visually with the rest of the wall. Furthermore, some defects may not be readily apparent.

Mortar compatibility

When repointing historic masonry, trying to match the original mortar is important. For one thing, some of the old mortar may be visible after the repairs. For another, the aim of restoration should be to return the building to its original appearance.

In most cases, though, exactly duplicating the original mix isn't necessary. What you want is a mortar that's functionally compatible with the units and the original mortar, and as close a visual match as possible in color, texture, and detailing. Achieving this compatibility depends on both the mortar's composition and how it is handled.

Mortar composition

All mortars consist of water, aggregate, and a binder (usually cement or lime). Mortar admixtures, a rather recent development, generally are not used in repointing historic buildings.

Binders. Although clay sometimes was used as a binder in the early colonial period, lime was the sole binder in most mortar produced before the introduction of portland cement in the 1870s. Some natural cement (hydraulic lime) mortars also were used, beginning in the 1840s. Repointing mortar for old masonry may use lime alone or lime combined with a small amount of white or gray portland cement to speed setting and improve durability.

Pointing mortar should have less compressive strength than the units and be similar in strength to the original mortar. Soft, lime-rich mortars better accommodate dimensional changes in the masonry due to temperature and moisture. Mortar that's too strong (or hard) can cause spalling as the units expand or cracking at the mortar and unit interface as units contract.

Masonry cement mortars usually are too hard to be used with the soft brick or weak stone in old, historic buildings. If the units are dense, hard brick or stone, masonry cement mortars mixed with more than the usual amount of sand may be acceptable.

The table on the first page can serve as a guide to appropriate mix designs.

Aggregates. Aggregate makes up the largest portion of mortar and is the most important element in matching color and texture. In the past, mortar sand generally was obtained from local natural deposits rather than manufactured. Because it was not screened and graded as most mortar sand is today, sand in historic mortars includes a wider range of grain sizes and colors. Therefore, matching an original mortar often requires mixing sand from various sources.

Other aggregates such as clay particles or crushed shells sometimes were added to sand in historic mortars. Though these other materials make up only a small portion of the mortar mix, they may be important in matching color and texture.

Pigments. Generally it's best to try to match color by finding the correct combination of binder and aggregates. However, some 19th-century mortars were colored with red, black, or brown pigments. Any pigments added to mortar

Basic Analysis of Historic Mortar

1. With a chisel, remove three or four unweathered samples of the mortar to be matched from several locations on the building. Because the masonry may have been repointed several times, it takes several samples to obtain a composite mortar sample from which test specimens can be taken. Avoid obviously recent samples. Set the largest specimen aside for later comparison with the repointing mortar.

2. Break apart the remaining specimens from the composite sample, powdering them with a wooden mallet until the mortar is separated into its constituent parts. There should be a good handful of the material.

3. To establish what the binder is, stir part of the sample into diluted hydrochloric acid. If there is a vigorous chemical reaction (bubbling) and most of the binder disappears leaving clean aggregate, then the binder was lime. Cement will leave a murky liquid and take several days to dissolve.

4. To establish what the aggregate is, some must be separated. Take the aggregate left in the previous step, rinse it in water, and dry it. Or take more of the ground-up sample and carefully blow away the powdery binder (this won't work if the binder is too strongly adhered to the aggregate). Examine the aggregate with a low-power magnifying glass. Note and record the range of color as well as the varying sizes of the individual grains of sand or shell. Also note the presence of other materials.

—Adapted from *Masonry: How to Care for Old and Historic Brick and Stone* [Ref 1.]

should be made up of metallic oxides and should be limited to a maximum of 10% of the volume or 6% of the weight of the binder.

Sampling and matching

A simple test (see box on previous page) can be used to develop basic information about the original mortar. When necessary, chemical or petrographic analysis
can determine its composition more precisely (see "Mortars Don't Keep Secrets," *Masonry Construction*, June 1990).

Once you've determined the original mortar ingredients and properties, you can produce some samples of repointing mortar to find the best match. Take a sample of the original mortar and snap it in two to expose its unweathered interior and compare it to cured test samples of the new mix. Or wet the original sample and compare it to a newly mixed test sample. If they match wet, both should dry to the same color.

Joint preparation

Before repointing, remove any loose, crumbling mortar and rake the joints back to a uniform depth 2 to 2½ times the joint width. Joints may be raked back further if necessary to reach mortar sound enough to serve as a base for the repair.

In ordinary work, power grinders or pneumatic chipping hammers sometimes are used to remove the old mortar. However, using power tools carries a serious risk of damaging the units and is strongly discouraged in restoring historic buildings. Instead, mortar should be removed using a hammer and chisel with a blade about half the width of the joint.

For extremely strong brick or a strong stone such as granite, a power grinder may be acceptable to rake back bed joints, but never try to grind out head joints in brickwork. Many late-19th-century buildings have walls of very strong brick, but with mortar joints only ⅛-inch wide. Extreme care is needed to rake back these joints without damaging the brick. One authority says that if power tools are needed to remove the old mortar, it probably should be left in place (Ref. 1).

A new power tool called a pin grinder is designed to ease mortar removal while minimizing the risk of damaging the units. A narrow (¼- or ⅜-inch) pin coated with a diamond abrasive fits like a drill bit into the grinder. As it rotates, the pin grinds out the old mortar.

Filling joints

After removing the old mortar, clear the bedding surface of dust and debris, then spray it with water. The area to be repointed should be moist but surface dry when the new mortar is placed.

Mix the mortar to a drier, stiffer consistency than would be used for laying brick. Place the pointing mortar in layers about ⅓ inch deep, using a narrow pointing trowel. Pack each layer in firmly, then allow it to reach thumbprint hardness before placing the next layer. The final layer should bring the mortar flush with the face of the masonry. When it reaches thumbprint hardness, tool the joint to provide a smooth, dense face. Even when matching an untooled joint, it's better to tool the joint first, then let it weather or treat the surface so it matches.

Shaping the joint

The finished joint profile affects both the joint's durability and the visual match between the repointed joints and the original mortar. From the standpoint of durability and weather-resistance, concave, vee, or grapevine joints are best; joint profiles that project from the face of the masonry or leave horizontal ledges where water can collect are worst.

If the original mortar joints were tooled in shapes that don't shed water properly, it may be advisable to finish the repointed joints in a way that resembles the original but is more weather-resistant.

Aging joints

Because the pointing mortar is matched to an unweathered sample of the original mortar, the newly repointed areas will look somewhat different from the original joints. This difference should decrease with normal weathering and aging of the new mortar. Staining the new mortar to match the old sometimes is attempted, but the effect can be short-lived, as the old and new mortars weather differently.

Tooling also can affect the match, as a newly tooled joint has a film of lime or cement that makes it look smoother than a weathered one. Normal weathering should remove the film and reduce the discrepancy within a few months. However, to accelerate the process, try stippling or gently rubbing the joint with a damp, soft-bristled brush or a piece of burlap after tooling.

With appropriate materials and careful workmanship, repointing can restore the beauty of historic masonry and extend its useful life for decades.

References

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