Repointing Masonry: Problems with Hard Mortar

In this dramatic example of the effects of hard repointing mortar on a Brooklyn church, the much softer, porous stone has spalled and eroded, leaving the impermeable mortar in place.

All too often, hard mortar is used to repoint historic houses of worship with no awareness or consideration of its damaging long-term effects.

Many religious properties constructed of stone or brick have been repointed with a mixture of mortar that is inappropriate to the building -- typically a hard mortar. Before undertaking a repointing project or signing a contract, it is important to determine and specify the type of mortar (known as the mortar mix) that will be used. While this may appear rather basic, mortar strength ranges from soft to hard, depending on the ratios of lime, sand, and cement in the mix. And all too often, individuals unknowingly use excessively hard mortars that cause the surrounding masonry to crack and deteriorate on historic buildings. Since religious properties built before the 1920s were typically constructed using softer, lime-rich mortars, it is crucial to specify them for repointing. A high-lime content is essential for softness, porosity, plasticity, and avoidance of shrinkage. Pre-mixed bags of mortar with a high cement content stocked by building supply companies are fine for modern bricks and cement block, but they can be disastrous for historic masonry, causing irreversible damage. The question of whether to replace the inappropriate mortar with a suitably flexible, porous mortar or leave it in place requires careful deliberation and professional advice.

Mortar and Historic Masonry

Mortar is the expendable component of masonry walls and consists of a mixture of lime, cement, and sand that is formulated in specific ratios. Due to the effects of weathering and erosion, it is must be replaced every 50 to 100 years, and sometimes sooner in selected locations. Using the type of mortar that is appropriate to the building is not only an aesthetic decision but a technical one as well. Accelerated deterioration of both mortar and masonry can occur if mortar is too rigid and impermeable to moisture -- a common occurrence when no one involved in a repointingproject has the expertise to specify an appropriate mortar.

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Ideally, mortar should be specially formulated for each job. Lime, cement, and sand ratios should result in a mortar softer and more porous than the surrounding masonry. For example, a suitable mix for many 19th-century brick rowhouses recommended by the New York City Landmarks Preservation Commission consists of 1 part white Portland cement, 2 1/2 parts hydrated lime, and 5 to 6 parts sand, in some cases with dry pigments added for color. Sand should be of a color, texture, and particle size to match the original mortar in appearance.

Mortar must be more flexible and weaker than the surrounding masonry so that it can absorb stresses from thermal movement. "It is a common error to assume that hardness or high strength is a measure of durability," notes Robert C. Mack, AIA in Preservation Briefs 2: Repointing Mortar Joints in Historic Brick Buildings. In fact, a hard, dense mortar can accelerate deterioration of the masonry. It tends to shrink when drying, causing hairline cracks between it and the masonry where moisture can penetrate. The mortar also tends to crack and break, trapping additional moisture which will expand on freezing and dislodge the mortar. And instead of mortar being flexible enough to "give" during movement caused by freeze/thaw cycles, the masonry itself may crack.

Mortar should also be slightly more porous than the surrounding masonry so that the joints provide areas where the wall can "breathe" and moisture can evaporate. If moisture cannot escape through mortar joints, it will attempt to migrate through the masonry and will freeze and expand within the masonry units, causing the surface to spall and crumble.

Hard Mortar: Options to Consider

If the masonry of your building is slowly deteriorating and the surrounding mortar is in good condition, you may want to investigate if the mortar is excessively hard or "cement-rich." This form of masonry deterioration (and possibly of the mortar as well) calls for a conditions survey by a preservation architect or architectural conservator to analyze symptoms and identify causes. If mortar is suspected of being incompatible with the masonry, laboratory testing of the mortar and the masonry should be carried out (see the box on "Mortar Analysis").

"Clearly, one should consider removing mortar if it is deemed responsible for or contributing to the deterioration of what is often more fragile surrounding masonry," advises architectural conservator Dawn Melbourne of Integrated Conservation Resources, New York, NY. "This happens most often with repair mortars which are too high in strength or have a water vapor transmission rate lower than that of the surrounding masonry." Even if symptoms are not visible now, "incompatible mortar may do damage down the road."

However, removing hard mortar can cause more damage to the surrounding masonry than leaving it in, particularly with "softer"

stones such as sandstone and marble. Each situation should be assessed independently based on a field investigation and laboratory analysis. If removal is being considered, a conservator should oversee mock-ups by an experienced masonry restoration contractor to test the effectiveness of the removal procedures being considered.

Removal Techniques

The use of hand tools only -- hammers and chisels -- to break up and rake out the mortar is a conservative approach intended to avoid damage to masonry. However, in practice it is slow and tiring, and consequently costs six to ten times more than mortar removal facilitated by power tools, according to contractor Ken Follett, Vice President of Apple Restoration, Brooklyn, NY.

It is common practice to speed up the process by using a thin round diamond-tipped blade on a small electric grinder to cut through the center of the mortar joint, says Tim Henry of Henry Restoration, Neconset, NY. "You try the grinder and hope that the mortar breaks," adds Mr. Follett. Blade diameters ranging from four to eight inches can be chosen to fit the length and depth of the joint. (Often a hard repointing mortar extends to a depth of only 1/2 inch over an historic mortar.) However, a major drawback is that masonry is easily nicked by the blade if the operator's aim strays off course momentarily. Minimizing damage depends on the level of skill and fatigue of the operator. Henry Restoration tries to keep the best grinder operators busy cutting joints, and the best pointers busy repointing.

Small pneumatic carving tools designed as finishing instruments for stone sculptors have also been successfully used for precise mortar removal. Blades can be made to any length or width to fit within the narrowest mortar joints. However, if misdirected "they can destroy the edges of soft brick and stone," warns restoration contractor Larry Burda of Burda Construction, Brooklyn, NY. "They should be used only by stone carvers experienced in handling these tools," Tim Henry adds. Work tends to be about three times faster than hand raking, according to Philip C. Marshall in Technical Note 8: The Use of Pneumatic Tools in Repointing Historic Masonry.

Conclusion

Before undertaking any repointing job, be sure to develop specifications that can be given to a contractor describing removal techniques for deteriorated mortar, joint preparation, an appropriate mortar mix, and joint depth and profile. This type of basic information is available in numerous publications and from the Landmarks Conservancy (See Resources). And make sure to ask your contractor specific questions about the mortar mix since it is essential to avoid the application of incompatible mortars. If you suspect that mortar in a building is too hard for the masonry, consult with a preservation architect or architectural conservator for evaluation, testing, and recommendations. Contractors for this type of delicate masonry restoration should be pre-qualified, with evidence of competency demonstrated by the individual masons who will be performing the work. "Poorly trained workers are more likely to injure both the building and themselves," warns Mr. Follett. Have your architect or conservator monitor ongoing work.

See Resources.

Acknowledgments: Dawn Melbourne and Glenn Boornazian, Integrated Conservation Resources, Inc., New York, NY; New York City Landmarks Preservation Commission, Rowhouse Manual; Philip C. Marshall, Technical Notes 8: The Use of Pneumatic Tools in Repointing Historic Masonry, APT Communique Vol. XV (1).

Mortar Analysis

A mortar analysis is a chemical test undertaken by an architectural conservator that provides the actual ratio of sand, lime, and other materials in the mortar mix. The architectural conservator should take several samples of mortar from representative locations in the house of worship, distinguishing between the original mortar and any subsequent repointing that will also require analysis. The condition of the masonry and characteristics of the mortar joints should also be documented. Through microscopic observation and chemical analysis, interpreted in the context of conditions observed on site, the conservator can recommend an appropriate repointing mortar mix and profile to match the physical and aesthetic characteristics of the historic mortar in strength, color, texture, and profile. A variety of other tests on the mortar and masonry can be performed to answer specific questions. Water vapor transmission rates and compressive strength are useful in evaluating whether an existing mortar is too hard for the masonry. Costs for a basic mortar analysis and new mortar design start at about $500 and increase depending on the complexity of evaluation required. See Resources for more information on repointing masonry.