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Standard Guide for Repointing (Tuckpointing) Historic Masonry[1]

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ε[1] NOTE—Section 2.2 was editorially corrected in November 2013.

1. Scope

1.1 This guide applies only to existing historic masonry construction. For purposes of this guide historic masonry is intended to refer to buildings that have significant historic, architectural, cultural or social meaning and are constructed of masonry materials. Similar techniques and evaluation should be employed for non-historic masonry, but are not addressed in this guide.

1.2 This guide outlines procedures for repointing historic masonry and is intended to provide guidelines for the user to establish project-specific requirements for repointing of historic masonry.

1.3 This guide only pertains to masonry units: brick, terra cotta, stone, cast stone, and concrete brick laid in mortar, and may or may not be appropriate for other masonry units.

1.4 This guide addresses repointing (tuckpointing) as defined in 3.1.3.

1.5 When considering repointing, especially on masonry of artistic, architectural, cultural, or historical significance, guidance from a specialist experienced in historic masonry and repointing should be sought.

1.6 This guide does not address pointing styles or profiles used on masonry or the methods of producing them.

1.7 Additional repairs that may impact the structural integrity of the masonry may necessitate that a structural stability analysis be completed prior to the execution of any work.

1.8 Following this guide may involve hazardous materials, operations, and equipment. *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory requirements prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C67 Test Methods for Sampling and Testing Brick and Structural Clay Tile

C140 Test Methods for Sampling and Testing Concrete Masonry Units and Related Units

C170 Test Method for Compressive Strength of Dimension Stone

C780 Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry

C1324 Test Method for Examination and Analysis of Hardened Masonry Mortar

E1857 Guide for Selection of Cleaning Techniques for Masonry, Concrete, and Stucco Surfaces

C270 Specification for Mortar for Unit Masonry

C1072 Test Methods for Measurement of Masonry Flexural Bond Strength

E631 Terminology of Building Constructions

2.2 *Other Referenced Documents:*

ACI 530.1/ASCE 6/TMS 602 Specifications for Masonry Structures[3]

BIA Technical Note 7F Moisture Resistance of Brick Masonry Maintenance, reissued October 1998[4]

BIA Technical Note 1 All-Weather Construction, revised March 1992[4]

Secretary of the Interior's Standards for the Treatment of Historic Properties, revised 1995[5]

London, M., *Masonry: How to Care for Old and Historic Brick and Stone*, The Preservation Press, Washington, DC, 1988

[1] This guide is under the jurisdiction of ASTM Committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06.24 on Building Preservation and Rehabilitation Technology.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, MI 48333-9094, http://www.concrete.org.

[4] Available from the Brick Industry Association (BIA), 1850 Centennial Park Drive, Suite 301, Reston, VA 20191, http://www.bia.org.

[5] Available from U.S. Department of the Interior, National Park Service, Preservation Assistance Division, 1849 C Street, N.W., Washington DC 20240, http://www.doi.gov.

McKee, H. J., "Introduction to Early American Masonry: Stone, Brick, Mortar, and Plaster," The National Trust, Washington, DC, 1973.
"Preparation and Use of Lime Mortars: An Introduction to the Principles of Using Lime Mortars," Historic Scotland, Edinburgh, Scotland, 1998
Oats, J. A. H., *Lime and Limestone—Chemistry and Technology, Production and Uses*, Wiley-VCH, New York, 1998
Mack, R. C., and Speweik, J. P., Preservation Brief #2, "Repointing Mortar Joints in Historic Masonry Buildings," National Park Service, U.S. Department of the Interior, Washington, DC, 1998
Weaver, M., *Conserving Buildings: A Guide to Techniques and Materials*, John Wiley & Sons, Inc., New York, NY, 1993
IS 240 "Trowel Tips: Tuckpointing," Portland Cement Association, Skokie, IL, 1992

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *in-situ mortar*—mortar existing in the masonry construction which includes the original setting or pointing mortar, or both and subsequently installed setting or repointing mortar.

3.1.2 *masonry*—for this guide, masonry is defined as brick, terra cotta, stone, cast stone and concrete brick which is set in mortar.

3.1.3 *mortar removal techniques:*

3.1.3.1 *chiseling*—use of a hammer and chisel to remove mortar.

3.1.3.2 *power chiseling*—hand-held short stroke pneumatic carving tool with a round shank chisel blade with no retainer to remove mortar.

3.1.3.3 *power router*—hand-held motor driven device using a diamond embedded router bit or other suitable abrasive bit to removal mortar.

3.1.3.4 *raking*—use of a hand tool to remove mortar.

3.1.3.5 *sawing/grinding*—use of a diamond-tipped, silicon carbide-tipped, or other suitable abrasive blade to remove mortar.

3.1.4 *original mortar*—mortar used in the original construction of the masonry wall which may be only the original setting mortar or may also include original pointing mortar.

3.1.5 *original pointing mortar*—the mortar placed into a joint (exposed outer edge) from which fresh setting mortar was raked out during original construction of the masonry wall.

3.1.6 *point*—placing mortar into a properly prepared joint.

3.1.7 *repointing*—the process of removal of defective mortar from between masonry units and placement of fresh mortar.

3.1.8 *repointing mortar*—the new mortar to be selected by the user of this guide.

3.1.9 *specialist*—architect, conservator, engineer or other professional with appropriate applicable experience, hereinafter referred to as the specialist.

3.1.10 *tuckpointing*—for purposes of this guide, synonymous with repointing.

4. Significance and Use

4.1 Repointing masonry improves weather resistance, reduces water penetration, maintains structural and visual integrity, and prolongs the life of the building by allowing a mortar joint to shed water and avoid the accumulation and penetration of rainwater between mortar and masonry units.

4.2 This guide provides for the selection of the most effective methods appropriate for repointing masonry based upon the following parameters:

4.2.1 Determination of joints to be repointed.

4.2.2 Evaluation of in-situ masonry.

4.2.3 Evaluation of techniques for removal of mortar.

4.2.4 Determination of appropriate repointing mortar.

4.2.5 Selection of repointing mortar.

4.2.6 Establishing the method of execution of the work.

4.2.7 Visual inspection of the work.

5. Determination of Joints to be Repointed

5.1 In many cases, not all joints in the masonry need to be repointed. It may be prudent to repoint only portions of the masonry or not to repoint at all (see Secretary of the Interior's Standards).

5.2 Closely examine mortar joints to determine which joints require repointing. Defective joints require repointing. Defective joints include joints that are cracked, deteriorated, eroded, contain voids, or are poorly bonded to masonry units. Cleaning of selected areas of the masonry to help identify areas needing repointing should only be done when necessary for evaluation (see Guide E1857 and Secretary of the Interior's Standards).

5.3 If the masonry was previously repointed with a mortar which has a higher compressive strength than the adjoining masonry, the previously installed repointing mortar should be removed and the joints should be repointed.

5.4 Visually inappropriate, previously installed repointing mortar should be replaced. If color, texture, and joint profiles do not match the existing historic mortar joints, the joints should be removed and repointed.

5.5 In some cases, sealants or other inappropriate materials may have been used in joints of masonry units. These materials should be removed and the joints repointed.

6. Evaluation of In-Situ Masonry

6.1 If shoring of the masonry is required, the necessary materials and methods should be identified.

6.2 *Evaluate In-Situ Mortar:*

6.2.1 In-situ mortar may include previously installed repointing mortar, and each masonry structure may be comprised of different mortars of varying ages and materials. Identification of the original mortar is an integral part of the process of selecting an appropriate repointing mortar.

6.2.2 The color and texture of the in-situ mortar to be matched should be evaluated by visual and laboratory means. Original color can be reasonably determined by visual examination of a freshly broken surface of a mortar sample.

6.3 *Evaluate Masonry Materials*—The physical properties of masonry units should be assessed to ensure compatibility with the repointing mortar.

6.3.1 When required, the physical properties of the masonry should be tested in accordance with Test Methods C67, C140, and C170, respectively.

6.3.2 For some repointing projects, sampling and testing of masonry units and materials is not permitted or necessary. In such cases, a qualitative assessment of the physical properties of materials can suffice. Such qualitative assessment should include identification of the type of masonry materials and a visual inspection of the condition of the materials. Literature from the appropriate period can be reviewed for an indication of properties of the materials. When available, the original material specifications and relevant maintenance and repair work for the building should be reviewed.

7. Evaluation of Techniques for Removal of Mortar

7.1 In determining the method of mortar removal, a standard should be established for joint preparation that limits the damage to masonry units and provides a proper substrate for bonding of new mortar. Prior to beginning the work, potential techniques for mortar removal should be evaluated.

7.2 Mortar removal procedures should attempt to remove all mortar from joints to the specified depth and to provide a substrate to which the repair mortar can properly adhere.

7.3 Mortar can be removed using various procedures. Techniques including raking, chiseling, routing, and grinding, are listed and described in Section 3. Combinations of these techniques can also be used.

7.4 On historic masonry, it is recommended that the most effective and least damaging technique be used as the method of mortar removal.

NOTE 1—Hand raking alone as a technique should only be used if it can be determined that hand raking can be performed without causing damage to masonry. If hand raking is determined to damage the masonry units, other techniques of mortar removal shall be considered.

7.5 Although some damage may be inevitable, careful joint preparation can help limit damage to masonry units.

7.6 It is the responsibility of the user of this guide to evaluate the advantages and disadvantages of the various removal techniques as they relate to type and condition of the masonry to be repointed.

7.7 The use of power tools is not recommended for joints of less than 3 mm, where the geometry of the joint limits access, or where the masonry units are weak or friable.

7.8 Evaluate the method of mortar removal with regard to the structural and visual integrity of the masonry.

7.9 Technicians should be evaluated with regard to their ability to remove in-situ mortar without damage to the masonry units. A demonstration of their ability should be conducted and approved on a test area representative of the work to be performed.

8. Use of Mortar Samples and Test Areas

8.1 Samples of the proposed repointing mortar should be prepared for comparison with the original mortar for color, texture, and finish prior to the repointing work. Samples should be compared after the mortar has sufficiently hardened for handling and has attained its final color.

8.2 Samples of the proposed repointing mortar should be prepared prior to the repointing work to determine mortar properties. Mortar properties should be evaluated in accordance with the sampling and testing procedures in Test Method C780.

8.3 Test areas should be used to evaluate mortar removal techniques, mortar formulation, pointing techniques, final cleaning and appearance. Test areas should be approved prior to proceeding with the work. Test areas should have the following characteristics:

8.3.1 Test areas should include materials and conditions representative of surfaces to be repointed.

8.3.2 Test areas should permit evaluation of the effects of the repointing work on materials, surfaces, and surroundings.

8.3.3 Test areas should permit visual inspection and comparison to adjacent masonry surfaces that have not been repointed. Inspection should be performed under similar lighting and exposure conditions.

9. Selection of Repointing Mortar

9.1 The repointing mortar should be selected based on the purpose of repointing and with consideration given to its historic proportions and compatibility with masonry materials. Formulation of the repointing mortar should not be based on an inappropriate, previously installed pointing mortar.

9.2 The selected repointing mortar should match the original mortar (if originally used) or exposed mortar unless it is determined that either is inappropriate for use.

9.3 The selected repointing mortar should be the appropriate color and texture as determined by the user of this guide and exhibit the durability and performance desired. See 8.1.

9.4 The visual matching of in-situ mortar with the repointing mortar may be desired but can be difficult to achieve. An acceptable match can require analysis of the in-situ mortar materials, trial mix proportions using new mortar materials, and variations in placement and tooling of the repointing mortar. If it is desired to match the appearance of the repointing mortar to the in-situ mortar, the unsoiled color, determined by examining the interior surface of the mortar, should be matched. Proposed repointing mortars should be installed and evaluated in test areas, refer to Section 8.

9.5 The composition of the repointing mortar should be designed and assessed to ensure compatibility of the physical properties with the in-situ mortar and masonry units. Mortar composition may be evaluated in accordance with Test Method C1324.

NOTE 2—Substantial disparity between the compressive strengths or other physical properties of the in-situ mortar and the repointing mortar, or the repointing mortar and the masonry units can lead to spalling or other distress of the masonry units. A common approach to ensure compatibility of physical properties is to evaluate the composition of the in-situ mortar and approximate the compressive strength of the mortar before selecting the repointing mortar. The repointing mortar should have a similar or lower compressive strength and greater water vapor permeability than the masonry units.

9.6 Mortar materials should be chosen in accordance with the applicable ASTM material specifications. Appropriate pigments and additives may be permitted if analysis of original mortar and evaluation of the project repointing mortar requirements indicate that inclusion of such materials is applicable.

9.7 In regions subject to freeze-thaw cycling, resistance to freeze-thaw damage is an important consideration. The mortar should have the capacity to transmit more water vapor than the masonry unit.

10. Procedure

10.1 *Preparation:*

10.1.1 If cleaning of the masonry surface is deemed necessary, establish cleaning techniques in accordance with Guide E1857. See 5.2.

10.1.2 The structural, architectural, and material properties of the masonry should be considered prior to commencing a repointing project.

10.1.3 Prepare mortar samples and test areas for color matching and physical property testing.

10.1.4 If required, implement protection practices for weather conditions in accordance with the cold and hot weather construction requirements, as stipulated in ACI 530.1/ASCE 6/TMS 602 and BIA Technical Note 1 and BIA Technical Note 7F.

10.2 *Mortar Removal and Preparation of Joints:*

10.2.1 Remove in-situ mortar from mortar joints. See Section 7.

10.2.2 The mortar should be removed to a depth of between 2 and 2-½ times the width of the joint with a minimum depth of ¾ in. This requirement for the depth of mortar removal provides adequate embedment of the repointing mortar. All unsound mortar should be removed. See 7.3 for removal techniques.

10.2.3 Brush, vacuum, or flush joints with water to remove all materials deleterious to the repointing procedure. In flushing, use water judiciously as too much can result in the development of efflorescence. All joints should be inspected before repointing to ensure that they are free of materials deleterious to the repointing.

10.2.4 Moisten joints with water prior to repointing to reduce water absorption from the repointing mortar before it is properly set; this improves cure and bond strength. No standing water should be visible in the joint.

10.3 *Preparation of Mortar:*

10.3.1 Mix dry mortar materials first. Add enough water to dry materials such that the mortar can be pressed into a ball by hand.

10.3.2 Establish a period of prehydration of the repointing mortar. Prehydrate the mortar by mixing the dry materials with just enough water to allow the mortar to be formed into a ball by hand. The prehydrated mortar should then be allowed to stand for not less than one hour, nor more than one and one half hour (BIA Technical Note 7F). Prehydration helps to reduce shrinkage cracks in the mortar joints. Adjust prehydration time as necessary depending on weather conditions.

10.3.3 After the prehydration period, mix mortar materials with only enough water to be workable.

10.3.4 Use mortar within two hours of final mixing.

10.3.5 Adding additional water to the mortar to maintain workability, known as retempering, can be performed during the two-hour period. Retempering of pigmented mortar may change the color of the mortar.

10.4 *Placement of Repointing Mortar:*

10.4.1 Manually insert repointing mortar into open joints. Fill the joints in three successive layers.

10.4.2 Joints with significant voids should have mortar placed into the void to partially fill the joint and be allowed to set. Subsequently, the joint should be pointed to the specified depth with at least two more layers of mortar.

10.4.3 Compact each layer by striking with a compaction tool prior to placement of the next layer of mortar.

10.4.4 Apply successive lifts and tool mortar joints when the repointing has achieved initial set.

10.4.5 Selection of joint profile should be made with consideration of the original profile, the amount and visual appearance of the existing mortar to remain, and the performance of the mortar joint as a function of its profile.

NOTE 3—Compression of the mortar during tooling makes concave, vee, and grapevine joints more weather-tight than rakes, flush, extruded, weathered, beaded, or struck joints.

10.5 *Curing and Protection:*

10.5.1 Cure new pointing lime-putty and non-lime-putty mortar in accordance with accepted procedures. Curing techniques are not covered in this guide.

10.5.2 Clean any excess mortar from the face of masonry with water or the least aggressive effective technique. The cleaning technique used should not have adverse effects on the surfaces, substrates, related components, and adjacent surfaces. Cleaning should be performed when the mortar has reached initial set, but can still be removed. The timing of the cleaning should be assessed during the preparation of the test areas.

10.6 Protect the work from weather and construction activities during and after the work until the mortar has cured. Curing time will vary depending on weather conditions.

11. Visual Inspection of the Work

11.1 Visual inspection of repointing procedures and materials should be required at regular intervals during the execution of the work. Visual inspection of completed areas and comparison to approved samples and test areas should be made under similar lighting and exposure conditions. If cleaning the masonry after repointing is required, such cleaning should be conducted prior to a final visual evaluation of the work. Overall consistency of color, joint configuration, and general appearance should be evaluated by visual inspection.

12. Keywords

12.1 historic masonry; mortar; pointing; repointing; tuckpointing