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USMMA Historic District Property Maintenance and Repair Manual

Volume 4 – Brick Elements

Sunny E. Adams and Adam D. Smith

June 2018

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Cover Photo: Staining on brick should be removed with gentlest cleaning method per guidelines (ERDC-CERL, 2015).

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Volume 4 – Brick Elements

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Abstract

The U.S. Merchant Marine Academy is located in Kings Point, New York. The Academy is listed on the National Register of Historic Places (#14000538). The historic district contains contributing mansions constructed during the Gold Coast Era and the Academy buildings constructed in 1942 to 1969. All buildings require regular planned maintenance and repair. The most notable cause of historic building element failure and/or decay is not because the historic building is old, but rather it is caused by an incorrect or inappropriate repair and/or basic neglect of the historic building fabric. This document is a maintenance manual compiled with as-is conditions of building materials at the Academy. The *Secretary of the Interior's Standards for the Treatment of Historic Properties on Preservation, Rehabilitation, and Repair* are discussed per material. This 8-volume report includes an overview volume plus volumes on each of the following elements: concrete, wood, brick, metal, roofing, stucco, and mechanical systems. All mentioned repair procedures are from the U.S. General Services Administration (GSA): Historic Preservation Technical Procedures and/or the National Park Service's series of Preservation Briefs. This report satisfies Section 110 of the National Historic Preservation Act (NHPA) of 1966, as amended.

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Preface

This study was conducted for the U.S. Department of Transportation Maritime Administration (MARAD) under Project Number 450153, “Historic Preservation Plan for U.S. Merchant Marine Academy.” The technical monitor was Barbara Voulgaris, Federal Preservation Officer, U.S. Department of Transportation, MARAD.

The work was performed by the Land and Heritage Conservation Branch (CNC) of the Installations Division (CN), U.S. Army Engineer Research and Development Center – Construction Engineering Research Laboratory (ERDC-CERL). At the time of publication, Dr. Michael Hargrave was Chief, CEERD-CNC; and Ms. Michelle Hanson was Chief, CEERD-CN. The Deputy Director of ERDC-CERL was Dr. Kirankumar Topudurti, and the Director was Dr. Lance D. Hansen.

COL Bryan S. Green was the Commander of ERDC, and Dr. David W. Pittman was the Director.

Foreword

ERDC-CERL's effort to put together a guide to proper maintenance and repair of the historic elements at the U.S. Merchant Marine Academy has been divided into multiple volumes for ease of use by installation personnel.

This is Volume 4 of 8, and it covers guidance for proper maintenance and repair of historic brick elements at USMMA.

Please see Volume 1 for an overview of the project and the USMMA's historic context, an explanation of the Secretary of the Interior's Standards and their application, and overviews and lists of immediate concerns for the USMMA's historic exteriors and interiors.

ADAM D. SMITH
Project Manager

1 Brick Elements

NOTE: Maintenance manuals such as those produced as part of this report are a general guide for the historic materials used throughout the USMMA. Do not assume that because a particular building or a particular material on a building is not mentioned in these manuals that the material in need of maintenance or repair does not need to follow the Standards.

1.1 Brick walls

1.1.1 Deterioration problems with historic brick

Cracking is a term describing narrow fissures from 1/16 to 1/2 in. wide in a block of masonry. Cracking may result from a variety of conditions such as structural settlement of a building or too hard a repointing mortar, or it may be an inherent characteristic of the masonry itself (e.g., unfired brick). Small cracks within a single block of masonry may not be serious, but longer and wider cracks extending over a larger area may be indicative of structural problems and should be monitored (Grimmer 1984, 6).

Crazing is the formation of a pattern of tiny cracks or crackles in a glaze. Unless the cracks visibly extend into the porous tile body beneath the glaze, crazing should not be regarded as highly serious material failure. It does; however, tend to increase the water absorption capability of the glazed unit. To date, no completely effective treatment has been developed for this condition (Grimmer 1984, 7).

Efflorescence is a whitish haze of soluble salts on masonry generally caused by excessive “pulling” of soluble salts into the masonry and out through the surface. In addition, carbonates from lime mortar and airborne or water-deposited pollutants from the atmosphere may cause sulfates to be deposited on the surface of the masonry. Efflorescence itself may be more unsightly than harmful, but its presence on an older or historic masonry building often serves as a warning by indicating that water has found a point of entry into the structure (Grimmer 1984, 11).

Erosion is the wearing away of the surface, edge, corners, or carved details of masonry slowly and usually by the natural action of wind or windblown particles and water (Grimmer 1984, 12).

Flaking is an early stage of peeling, exfoliation, delamination, or spalling and is best explained as the detachment of small, flat thin pieces of the outer layers of masonry from a larger piece. Flaking is usually caused by capillary moisture or freeze-thaw cycles that occur within the masonry (Grimmer 1984, 14).

Pitting is the development or existence of small cavities in a masonry surface which may be caused by the differential removal of individual components of the masonry and may be the result of natural weathering or erosion of an inherently porous type of masonry. To date, no completely effective treatment has been developed for this condition (Grimmer 1984, 17).

1.1.2 Immediate concerns for brick walls

Historic brick masonry is a durable product whose primary source of deterioration is exposure to moisture and water. Historic bricks are generally softer than their modern counterparts, and the original mortars used with them were more flexible than those used currently. Original mortars had a high lime content which allowed the mortar to absorb cyclical movement of the structure, in particular at the critical movement times of freeze-thaw.

The three most common causes for deterioration of historic brick masonry are (1) prolonged exposure to water, usually due to improper roof drainage; (2) spalling, due to the use of excessively hard repointing mortars; and (3) exposure to moisture and salts at grade. Signs of deterioration include: (a) rust staining from concealed fasteners, (b) white surface staining or buildup due to the mitigation of salts, (c) cracking and spalling of brick due to water or excessively hard mortar installed during previous repointing efforts, (d) pitting of the softer rubbed bricks, and (e) crazing of the glazed brick headers.

Overall care should be taken to protect the original brick and mortar. Where brick masonry is extremely deteriorated, replacement in-kind must

occur. Care must be used to select sound and matching bricks for all repairs. Specialty brick is available from a variety of sources, and efforts to identify matching brick units should be required.

The brick and mortar are evaluated by observing the following conditions and taking the following steps based on the observations:

- Brick and mortar is structurally and architecturally intact (Figure 7).
- Poor patch work over parts of the brick and mortar will need to be replaced (Figure 1).
- Maintenance of the brick and mortar is needed for it to continue to function as designed.
- Cracks need to be evaluated and assessed to determine the cause and severity of major cracks.
- Major cracks need to be repaired to prevent moisture penetration.
- Cracks need to be monitored on a regular basis.
- Inappropriate brick replacement (not in-kind to the original) needs to be addressed (Figure 1).
- Replacement bricks and mortar should be used if original bricks are too deteriorated or damaged; replacement should match the original in size, color, texture, and profile (Figure 1).
- Repairs performed as necessary with materials that are like in appearance and mechanical properties.
- Incorrect mortar or epoxy fill has been used, creating inappropriate repair (Figure 1).
- Walls show efflorescence, a white powdery substance, leaching onto the surface of the brick walls (Figure 1–Figure 3).

- Efflorescence present on brick walls should be removed with the gentlest cleaning method per guidelines (Figure 1–Figure 3).
- All gutters, downspouts, and other water run-off systems should be checked to appear in good repair and clear of debris (Figure 3, Figure 4, and Figure 6).
- Vegetation such as trees and shrubbery should be kept trimmed so that it is not touching brick walls (see Figure 3).
- Stains and surface dirt of several types were identified on brick surfaces, so cleaning should be performed using the gentlest methods outlined in the guidelines (Figure 4, Figure 5, and Figure 6)
- Biological growth needs to be removed from brick wall surfaces (Figure 6).
- Painted brick needs to be cleaned according to the guidelines without damaging the painted brick (Figure 8).
- Repainted brick needs to match the original in color and luster.
- Any brick maintenance is to be executed by a qualified professional.

Figure 1. Inappropriate replacement bricks on the Mariners' Chapel are outlined in red (ERDC-CERL, 2015).

Figure 2. Efflorescence and surface dirt should be removed with gentlest cleaning method per guidelines (ERDC-CERL, 2015).

Figure 3. Efflorescence and surface dirt should be removed with gentlest cleaning method per guidelines [note here on the Mariners' Chapel the efflorescence is more than likely due to the gap in the downspout that is highlighted here with red] (ERDC-CERL, 2015).

Figure 4. Staining should be removed with gentlest cleaning method per guidelines (ERDC-CERL, 2015).

Figure 5. Staining on brick should be removed with gentlest cleaning method per guidelines [note here on the Mariners' Chapel the staining is due to the failure of the coating on the metal railing and a failure in the mortar/grout of the stone cap] (ERDC-CERL, 2015).

Figure 6. Biological growth should be removed with gentlest cleaning method per guidelines, and downspouts should be installed and functioning properly (ERDC-CERL, 2015).

Figure 7. Example of a brick element where the foundation is failing, but it can be remediated by mudjacking the entry's walls into alignment; this remediation should be a permanent fix [unless the failure was caused by water or animals] (ERDC-CERL, 2015).

Figure 8. Painted brick should be monitored for cracking, peeling, and bubbling (ERDC-CERL, 2015).

1.1.3 Guidelines, briefs, bulletins, and sources for brick walls

In addition to the information contained in this manual, the authors have compiled the following federal resource publications (reproduced here for convenience, with links for online access given in References) to inform managers about standards, guidelines, and procedures for understanding architecture, and caring for, preserving, and rehabilitating historic buildings with emphasis on historic brick (see subsections 1.1.3.1–1.1.3.13).

1.1.3.1 Guidelines for evaluating the condition of brick masonry and mortar (GSA 2016a)

U.S. General Services Administration

Guidelines for Evaluating the Condition of Brick Masonry and Mortar

Procedure code:
421109G

Source:
NPS Southeast Regional Office

Division:
Masonry

Section:
Brick Unit Masonry

Last Modified:
08/17/2016

Guidelines for Evaluating the Condition of Brick Masonry and Mortar

CAUTION: This method of condition assessment is destructive and should only be used to test areas believed to be deteriorated. This test should be performed only by an experienced mason.

This method of evaluation was developed by restoration architect Max Ferro and masonry conservator Tom Russack and appeared in the January/February 1987 issue of the Old House Journal.

Materials

- Mason's hammer
- Cold chisel (1/2 to 1-1/2 inches)
- Sturdy slotted screwdriver

The deterioration of brick and mortar are evaluated by rating each on a scale from 0 to 10 based on their level hardness or softness. A rating of 0 indicates severe brick and/or mortar deterioration. A brief description of each rating follows.

Assessment of Brick

- A rating of '4' or below indicates brick in an unsalvageable condition.
- A rating between '5' and '7' indicates that some remedial measures may need to be taken.
- A rating of '10' indicates that the brick units are in good, sound condition.

Rating	Description
0	Bricks are totally disintegrated.
1	Evidence of spalling at least 1/4" to 3" deep.

2	Slight erosion at corners of brick; slight powdering of surface when rubbed with hand or scraped with fingernail.
3	Spalling brick in layers when rubbed with hand; fragments do not powder.
4	Bricks can be broken by poking and jabbing with screwdriver; fragments are semi-hard and resemble compacted clay.
5	FIRST CLASS OF STABLE, STRUCTURALLY SOUND BRICK: Screwdriver can penetrate the brick by hand roughly 1/4" but brick does not crumble.
6	Screwdriver can penetrate the brick roughly 1/4", but ONLY with the assistance of a hammer; this may cause coarse jagged pieces to become dislodged.
7	Screwdriver is unable to penetrate the brick even with assistance from hammer but may make a slight impression in the surface. There may be a slight ring or bounce as the screwdriver hits the surface.
8	Chisel is necessary to crack the brick.
9	Chisel is unable to make an indentation or impression in the brick; brick shears cleanly; brick is strong with crisp edges and corners.
10	A NEW BRICK: Brick with crisp corners; chisel striking the surface produces a clear ringing sound.

Assessment of Mortar

- A rating between '0' and '4' indicates that repointing is necessary.
- A rating between '5' and '8' indicates mortar in satisfactory condition.
- A rating of '9' or '10', indicates that the mortar is too hard and should be replaced with a softer mortar.

Rating	Description
0	No evidence of mortar within at least 1-1/2" of the wall face.
1	Mortar crumbles when poked with finger or screwdriver; many surface irregularities are evident.
2	Mortar is easily removed with screwdriver, but FEW surface irregularities are evident in joint.
3	Mortar collapses and freely and cleanly breaks adhesion with brick when scored along centerline with screwdriver.
4	Slight spalling occurs at edges and corners of brick when mortar is scored and tapped with screwdriver..
5	Screwdriver is unable to dislodge the mortar; chisel can disengage and pop mortar free without damaging the brick
6	Edges and corners of brick are slightly marred when mortar is scored with a chisel.
7	Hammer AND chisel are necessary in order to disengage the mortar; there should be little damage to the brick.
8	Several blows with hammer and chisel are required to break the mortar into several large pieces; bricks will be noticeably marred.
9	MORTAR IS STRONGER THAN THE BRICKS: Successive blows with hammer and chisel crack brick.

1.1.3.2 Removing and replacing deteriorated brick masonry (GSA 2017)

Removing And Replacing Deteriorated Brick Masonry

Procedure code:

421102S

Source:

Hspg Prepared For Nps - Sero

Division:

Masonry

Section:

Brick Unit Masonry

Last Modified:

01/25/2017

PART 1---GENERAL

1.01 SUMMARY

A. This procedure includes guidance on removing and replacing deteriorated brick masonry. It should be used in conjunction with the procedure on repointing historic masonry. For guidance on repointing, see 04520-02-R "Repointing Masonry Using Lime Mortar".

B. See 01100-07-S for general project guidelines to be reviewed along with this procedure. These guidelines cover the following sections:

1. Safety Precautions
2. Historic Structures Precautions
3. Submittals
4. Quality Assurance
5. Delivery, Storage and Handling
6. Project/Site Conditions
7. Sequencing and Scheduling
8. General Protection (Surface and Surrounding)

These guidelines should be reviewed prior to performing this procedure and should be followed, when applicable, along with recommendations from the Regional Historic Preservation Officer (RHPO).

C. For general information on the characteristics, uses and problems associated with brick, see 04211-08-S.

1.02 PROJECT/SITE CONDITIONS

A. Environmental Requirements:

1. Do not proceed with brick replacement under adverse weather conditions, or when temperatures are below or above manufacturer's recommended limitations for installation; Proceed with the work only when forecasted weather conditions are favorable for proper cure.
2. Wet Weather: Do not apply or mix mortar on outside surfaces with standing water or outside during rain.
3. Cold Weather, winter construction is not allowed without consent of RHPO; Winter construction when surface temperature of masonry is below 40o F. or air temperature is predicted to be below 40o F. within 48 hours. See #6 below.
4. Hot Weather: The surface temperature of the work, not the ambient temperature, should not be higher than 100o F.; Mortar mixing should be done only in the shade; Cover mortar with water-misted burlap in hot weather to reduce evaporation; Pointing work should be done in the shade; Work around the building during the day so that the fresh work will be shielded from direct sunlight to reduce evaporation rate. High temperatures can cause flash setting of cements and rapid evaporation of water in the mix, leading to lack of development of final strength by the cement.
5. All materials must be kept above 40degrees F.
6. Special Precautions and Notes: Do not allow masonry to freeze until mortar is thoroughly dry and hardening almost complete (approx. three days time); The setting of lime mortar is very much slower than that of cement mortar because the curing requires the absorption of carbon dioxide to form hard lime carbonates; It is a very lengthy process, so do not expect it to become hard immediately, especially at the core of large masses of masonry.

PART 2---PRODUCTS

2.01 MATERIALS

A. Salvaged Brick: Approved by RHPO, sound, crack free, clean brick without face chips larger than 1/2 inch, salvaged from removal of removed face brick work of same type.

B. Replacement Brick: Approved by RHPO.

C. Brick slips: Approved by RHPO.

D. Mortar to match existing (see 04100-03-S "Preparing Lime Mortar for Repointing Masonry").

2.02 EQUIPMENT

A. Trowel

B. Joint tools

C. Chisel

D. Hawk

E. Hammer

F. Stiff bristle brushes

PART 3---EXECUTION

3.01 EXAMINATION

A. Deterioration of brick due to moisture is evident as spalling, erosion, cracking, peeling paint, and deteriorated mortar joints.

B. Some causes of brick deterioration include:

1. Rising damp,
2. the accumulation of dissolved acids carried by rainwater and condensation,
3. soluble salts crystallizing in the pores of the brick face,
4. alternate freezing and thawing, and e) the accumulation of dirt and air-borne particles on the exterior surface.

3.02 PREPARATION

A. Surface Preparation:

1. Wet brick having absorption rates greater than 0.025 oz. per sq. inch per minute.
  - On the flat side of a brick, deposit water on an area approximately the size of a 25 cent coin.
  - If the water disappears in less than 30 seconds, wet the bricks.
2. Absorptive brick should be thoroughly soaked in the pile each afternoon prior to the day they are to be used.
3. Cover the bricks with tarps or heavy paper to prevent evaporation.
4. Wet brick as necessary during the day; Sprinkle the brick pile with a hose for a period long enough for water to run down the side of the pile; Use wetting methods which ensure that each masonry unit is nearly saturated but surface dry when laid; (DO NOT wet stone masonry units).
5. Repair flashing if necessary.
6. Where fresh masonry joins existing work, clean the exposed surface of the set masonry by removing loose brick and mortar and wet lightly to obtain the best possible bond with the new work.

3.03 ERECTION, INSTALLATION, APPLICATION

A. Replacing Deteriorated Masonry with Brick slips: The use of brick slips should be limited to replacement of individual bricks or to small areas of brickwork.

NOTE: Brick slips are brick facings about 1 inch thick. They are used when damage to adjacent sound brickwork is likely to occur if full-size replacement is attempted.

1. Cut out the deteriorated masonry to a regular shape.
2. Clean the cavity of loose mortar and other debris by hand using a chisel and stiff bristle brushes.
3. Solidly set the slip in a bed of mortar.

B. Replacing Deteriorated Units with Full-Size Bricks:

1. Carefully remove deteriorated brick units by hand using a hammer and chisel.
2. Rebuild back-up and substrate as required to replace any unsound material that was removed.
3. Clean the cavity of loose mortar and other debris by hand using a chisel and stiff bristle brushes.
4. Lightly wet the exposed brick surfaces.
5. Lay brick units with completely filled bed and head joints; Butter ends with sufficient mortar to fill head joints and shove into place.

NOTE: Lay masonry plumb and true following the coursing and patterns of the adjacent existing sound construction; Level off work at required heights and form beds to build-in salvaged or moved materials.

6. If adjustments are required, remove units, clean off mortar and reset in fresh mortar.

7. Blend new work into existing work smoothly with no lines of demarcation and no change of pattern or coursing.
8. Rake all joints in replacement work to receive tuck pointing; Joints up to 3/8" in width shall be raked to a depth of 1/2"; Joints 3/8" in width shall be raked to a depth of 1".
9. Brush all excess mortar from the wall surface frequently during the work; Protect all existing surfaces from mortar dripping and splashing.

3.04 ADJUSTING/CLEANING

- A. Clean off adjacent surfaces which have been spattered during the course of the work. Rinse immediately with clean, clear water.
- B. Wipe all excess mortar as the work progresses. Dry brush at the end of each day's work.
- C. After mortar is thoroughly set and cured, remove loose mortar and dirt from new masonry surfaces.
- D. Wash down the masonry surface with clean, clear water.

1.1.3.3 Monitoring and evaluating cracks in masonry (GSA 2016b)

Monitoring And Evaluating Cracks In Masonry

Procedure code:

420002G

Source:

HSPG Prepared For NPS - Southeast Regional Office

Division:

Masonry

Section:

Unit Masonry

Last Modified:

08/04/2016

MONITORING AND EVALUATING CRACKS IN MASONRY

PART 1---GENERAL

1.01 SUMMARY

- A. This standard includes guidance on monitoring and evaluating cracks in masonry. Three different methods are described and include the following:
  - 1. Using tape and a pencil,
  - 2. Using glass and epoxy, and
  - 3. Using the Avongard Crack Monitor.
- B. Cracks in masonry are evidence that the building material has moved or is still moving, (active cracking).
- C. Some causes of cracking include: settlement or foundation erosion, decay of materials, "vandalism" by renovators, structural failure, change in materials or geometry, and moisture and temperature changes.
  - 1. In foundation piers and piles, general cracking is often due to settlement or rotation of the pier footing.
  - 2. Vertical cracking or bulging of a masonry foundation wall is often due to physical deterioration of the pier from exposure, poor construction or overstressing.
  - 3. Horizontal cracking or bowing of a masonry foundation wall may be caused by improper backfilling, or by swelling or freezing and heaving of water saturated soils adjacent to the wall.
  - 4. Differential settlement of a masonry foundation wall may be caused by many different things including soil consolidation, soil shrinkage, soil swelling, soil heaving, soil erosion or soil compaction.
  - 5. Differential settlement of a chimney is often caused by inadequate foundations which may cause the chimney to lean and crack.
- D. See "General Project Guidelines" for general project guidelines to be reviewed along with this procedure. These guidelines cover the following sections:
- E. Safety Precautions
  - 1. Historic Structures Precautions
  - 2. Submittals

3. Quality Assurance
4. Delivery, Storage and Handling
5. Project/Site Conditions
6. Sequencing and Scheduling
7. General Protection (Surface and Surrounding)

These guidelines should be reviewed prior to performing this procedure and should be followed, when applicable, along with recommendations from the Regional Historic Preservation Officer (RHPO).

PART 2---PRODUCTS

2.01 MANUFACTURERS

- A. Crack Monitor: Avongard,

2.02 EQUIPMENT

- A. A pencil, tape, ruler
- B. Small piece of window glass (single thickness) or glass slide
- C. Epoxy adhesive
- D. Crack monitor

PART 3---EXECUTION

3.01 EXAMINATION

- A. Examine the nature and severity of the crack:
  1. What direction are the cracks going and where are they the widest?
  2. Note sloped floors, bulging walls and doors that do not fit.
- B. Determine the probable cause:
  1. Foundation erosion.
  2. Decay and/or improper use of materials.
  3. Structural failure.
  4. Change in materials or geometry.
  5. Changes in moisture content.
  6. Thermal changes:
    - a. Horizontal or diagonal cracks near the ground at piers in long walls: due to horizontal shearing stresses between the upper wall and the wall where it enters the ground,
    - b. Vertical cracks near the ends of walls,
    - c. Vertical cracks near the top and ends of the facade,
    - d. Cracks around stone sills or lintels: due to expansion of the masonry against both ends of the tight fitting stone piece that cannot be compressed.

3.02 ERECTION, INSTALLATION, APPLICATION

- A. Monitoring Cracks Using Tape and Pencil:
  1. Place a piece of tape on each side of the crack.
  2. Draw one short line on each piece of tape at a convenient distance apart (2 inches) and parallel to the crack.
  3. If there is movement in the crack, the distance between the line on the tape will vary; If the crack is long, several monitors will be needed.
  4. Make a record chart of the distance between the marks of the tape at weekly intervals.
  5. Keep accurate records of these measurements and place them along with photographs in file.
  6. If significant widening occurs, report this with back-up data and copies of photographs to the RHPO for consideration.

B. Monitoring Cracks Using Glass and Epoxy:

1. Take a small piece of single strength window glass (a microscope slide is good) to bridge over the crack. Tiny glass rods are also made for this purpose.
2. Epoxy the ends of the glass to the masonry on either side of the crack; locate it in an inconspicuous place.
3. If the glass breaks, it is an indication that the walls are still moving and that the crack is widening.

C. Monitoring Cracks Using the Avongard Crack Monitor:

1. Position the monitor over the crack with the vertical "0" line on scale parallel with the crack to be measured.
2. Fix the monitor with screws or adhesive.
3. Cut the transparent tape holding the two plates of the scale on the monitor in a fixed position with a sharp knife; over time, the degree of movement on either side of the crack will be measured as the two plates slide independently of one another.

1.1.3.4 Patching cracks in brick masonry (GSA 2018a)

Patching Cracks in Brick Masonry

Procedure code:

421103S

Source:

National Capitol Region Specifications

Division:

Masonry

Section:

Brick Unit Masonry

Last Modified:

01/04/2018

PATCHING CRACKS IN BRICK MASONRY

PART 1---GENERAL

1.01 SUMMARY

A. This procedure includes guidance on repairing cracks or infilling small holes in brick masonry using a cementitious patching material.

B. See 01100-07-S for general project guidelines to be reviewed along with this procedure. These guidelines cover the following sections:

1. Safety Precautions
2. Historic Structures Precautions
3. Submittals
4. Quality Assurance
5. Delivery, Storage and Handling
6. Project/Site Conditions
7. Sequencing and Scheduling

8. General Protection (Surface and Surrounding)

These guidelines should be reviewed prior to performing this procedure and should be followed, when applicable, along with recommendations from the Regional Historic Preservation Officer (RHPO).

PART 2---PRODUCTS

2.01 MANUFACTURERS

A. Jahn Restoration Techniques and Research (Cathedral Stone Company)

B. Edison Chemical Systems, Inc.

2.02 MATERIALS

A. Cementitious patching material such as "M70 Stone Restoration Mortar" (Jahn Restoration), "Custom System 45" (Edison Chemical Systems), or approved equal.

B. Clean, soft cloths

C. Clean, potable water

2.03 EQUIPMENT

A. Stiff natural bristle brushes

B. Trowel

C. Chisel

D. Hammer

E. Putty knife

PART 3---EXECUTION

3.01 ERECTION, INSTALLATION, APPLICATION

A. Remove all loose materials from cracked brickwork.

B. Widen crack to 1/8" wide and grout crack and any voids with a cementitious grout that is color matched to clean brick. The grout should be compatible in texture and porosity to the adjacent masonry. Tape joint to provide a clean neat finished appearance.

C. Severely cracked brick associated with displaced masonry should be dismantled. Probe interior conditions and

repair following an engineer's evaluation. Rebuild brickwork to match existing bonding patterns and use salvaged brick where possible and new brick to match existing color, texture and porosity.

1.1.3.5 Repointing mortar joints in historic masonry buildings – Preservation Brief #2 (Mack and Speweik, October 1998)

Technical Preservation Services

National Park Service
U.S. Department of the Interior

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Some of the web versions of the Preservation Briefs differ somewhat from the printed versions. Many illustrations are new and in color; Captions are simplified and some complex charts are omitted. To order hard copies of the Briefs, see [Printed Publications](#)®.

PRESERVATION BRIEFS

2

Repointing Mortar Joints in Historic Masonry Buildings

Robert C. Mack, FAIA, and John P. Speweik

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Soft mortar for repointing. Photo: John P. Speweik.

Masonry—brick, stone, terra-cotta, and concrete block—is found on nearly every historic building. Structures with all-masonry exteriors come to mind immediately, but most other buildings at least have masonry foundations or chimneys. Although generally considered "permanent," masonry is subject to deterioration, especially at the mortar joints. Repointing, also known simply as "pointing" or—somewhat inaccurately—"tuck pointing"*, is the process of removing deteriorated mortar from the joints of a masonry wall and replacing it with new mortar. Properly done, repointing restores the visual and physical integrity of the masonry. Improperly done, repointing not only detracts from the appearance of the building, but may also cause physical damage to the masonry units themselves.

The purpose of this Brief is to provide general guidance on appropriate materials and methods for repointing historic masonry buildings and it is intended to benefit building owners, architects, and contractors. The Brief should serve as a guide to prepare specifications for repointing historic masonry buildings. It should also help develop sensitivity to the particular needs of historic masonry, and to assist historic building owners in working cooperatively with architects, architectural conservators and historic preservation consultants, and contractors. Although specifically intended for historic buildings, the guidance is appropriate for other masonry buildings as well. This publication updates *Preservation Briefs 2: Repointing Mortar Joints in Historic Brick Buildings* to include all types of historic unit masonry. The scope of the earlier Brief has also been expanded to acknowledge that the many buildings constructed in the first half of the 20th century are

now historic and eligible for listing in the National Register of Historic Places, and that they may have been originally constructed with portland cement mortar.

*Tuckpointing technically describes a primarily decorative application of a raised mortar joint or lime putty joint on top of flush mortar joints.

Historical Background

Mortar consisting primarily of lime and sand has been used as an integral part of masonry structures for thousands of years. Up until about the mid-19th century, lime or quicklime (sometimes called lump lime) was delivered to construction sites, where it had to be slaked, or combined with water. Mixing with water caused it to boil and resulted in a wet lime putty that was left to mature in a pit or wooden box for several weeks, up to a year. Traditional mortar was made from lime putty, or slaked lime, combined with local sand, generally in a ratio of 1 part lime putty to 3 parts sand by volume. Often other ingredients, such as crushed marine shells (another source of lime), brick dust, clay, natural cements, pigments, and even animal hair were also added to mortar, but the basic formulation for lime putty and sand mortar remained unchanged for centuries until the advent of portland cement or its forerunner, Roman cement, a natural, hydraulic cement.

Portland cement was patented in Great Britain in 1824. It was named after the stone from Portland in Dorset which it resembled when hard. This is a fast-curing, hydraulic cement which hardens under water. Portland cement was first manufactured in the United States in 1872, although it was imported before this date. But it was not in common use throughout the country until the early 20th century. Up until the turn of the century portland cement was considered primarily an additive, or "minor ingredient" to help accelerate mortar set time. By the 1930s, however, most masons used a mix of equal parts portland cement and lime putty. Thus, the mortar found in masonry structures built between 1873 and 1930 can range from pure lime and sand mixes to a wide variety of lime, portland cement, and sand combinations.

In the 1930s more new mortar products intended to hasten and simplify masons' work were introduced in the U.S. These included **masonry cement**, a premixed, bagged mortar which is a combination of portland cement and ground limestone, and **hydrated lime**, machine-slaked lime that eliminated the necessity of slaking quicklime into putty at the site.

Identifying the Problem Before Repointing

The decision to repoint is most often related to some obvious sign of deterioration, such as disintegrating mortar, cracks in mortar joints, loose bricks or stones, damp walls, or damaged plasterwork. It is, however, erroneous to assume that repointing alone will solve deficiencies that result from other problems. The root cause of the deterioration—leaking roofs or gutters, differential settlement of the building, capillary action causing rising damp, or extreme weather exposure—should always be dealt with prior to beginning work.

Without appropriate repairs to eliminate the source of the problem, mortar deterioration will continue and any repointing will have been a waste of time and money.

Use of Consultants

Because there are so many possible causes for deterioration in historic buildings, it may be desirable to retain a consultant, such as a historic architect or architectural conservator, to analyze the building. In addition to determining the most appropriate solutions to the problems, a consultant can prepare specifications which reflect the particular requirements of each job and can provide oversight of the work in progress. Referrals to preservation consultants frequently can be obtained from State Historic Preservation Offices, the American Institute for Conservation of Historic and Artistic Works (AIC), the Association for Preservation Technology (APT), and local chapters of the American Institute of Architects (AIA).

Masons practice using lime putty mortar to repair historic marble. Photo: NPS files.

Finding an Appropriate Mortar Match

Preliminary research is necessary to ensure that the proposed repointing work is both physically and visually appropriate to the building. Analysis of unweathered portions of the historic mortar to which the new mortar will be matched can suggest appropriate mixes for the repointing mortar so that it will not damage the building because it is excessively strong or vapor impermeable.

Examination and analysis of the masonry units—brick, stone or terra cotta—and the techniques used in the original construction will assist in maintaining the building's historic appearance. A simple, non-technical, evaluation of the masonry units and

mortar can provide information concerning the relative strength and permeability of each—critical factors in selecting the repointing mortar—while a visual analysis of the historic mortar can provide the information necessary for developing the new mortar mix and application techniques.

Although not crucial to a successful repointing project, for projects involving properties of special historic significance, a mortar analysis by a qualified laboratory can be useful by providing information on the original ingredients. However, there are limitations with such an analysis, and replacement mortar specifications should not be based solely on laboratory analysis. Analysis requires interpretation, and there are important factors which affect the condition and performance of the mortar that cannot be established through laboratory analysis. These may include: the original water content, rate of curing, weather conditions during original construction, the method of mixing and placing the mortar, and the cleanliness and condition of the sand. *The most useful information that can come out of laboratory analysis is the identification of sand by gradation and color.* This allows the color and the texture of the mortar to be matched with some accuracy because sand is the largest ingredient by volume.

This late 19th century granite has recently been repointed with the joint profile and mortar color carefully matched to the original. Photo: NPS files.

In creating a repointing mortar that is compatible with the masonry units, the objective is to achieve one that matches the historic mortar as closely as possible, so that the new material can coexist with the old in a sympathetic, supportive and, if necessary, sacrificial capacity. The exact physical and chemical properties of the historic mortar are not of major significance as long as the new mortar conforms to the following criteria:

- The new mortar must match the historic mortar in **color, texture and tooling**. (If a laboratory analysis is undertaken, it may be possible to match the binder components and their proportions with the historic mortar, if those materials are available.)
- The **sand must match the sand** in the historic mortar. (The color and texture of the new mortar will usually fall into place if the sand is matched successfully.)
- The new mortar must have **greater vapor permeability** and be **softer** (measured in compressive strength) than the masonry units.
- The new mortar must be **as vapor permeable** and **as soft or softer** (measured in compressive strength) than the historic mortar. (Softness or hardness is not necessarily an indication of permeability; old, hard lime mortars can still retain high permeability.)

Mortar Analysis

Methods for analyzing mortars can be divided into two broad categories: **wet chemical** and **instrumental**. Many laboratories that analyze historic mortars use a simple **wet-chemical** method called acid digestion, whereby a sample of the mortar is crushed and then mixed with a dilute acid. The acid dissolves all the carbonate-containing minerals not only in the binder, but also in the aggregate (such as oyster shells, coral sands, or other carbonate-based materials), as well as any other acid-soluble materials. The sand and fine-grained acid-insoluble material is left behind. There are several variations on the simple acid digestion test. One involves collecting the carbon dioxide gas given off as the carbonate is digested by the acid; based on the gas volume the carbonate content of the mortar can be accurately determined (Jedrzejewska, 1960). Simple acid digestion methods are rapid, inexpensive, and easy to perform, but the information they provide about the original composition of a mortar is limited to the color and texture of the sand. The gas collection method provides more information about the binder than a simple acid digestion test.

Instrumental analysis methods that have been used to evaluate mortars include polarized light or thin-section microscopy, scanning electron microscopy, atomic absorption spectroscopy, X-ray diffraction, and differential thermal analysis. All instrumental methods require not only expensive, specialized equipment, but also highly-trained experienced analysts. However, instrumental methods can provide much more information about a mortar. Thin-section microscopy is probably the most commonly used instrumental method. Examination of thin slices of a mortar in transmitted light is often used to supplement acid digestion methods, particularly to look for carbonate-based aggregate. For example, the new ASTM test method, ASTM C 1324-96 "Test Method for Examination and Analysis of Hardened Mortars" which was designed specifically for the analysis of modern lime-cement and masonry cement mortars, combines a complex series of wet chemical analyses with thin-section microscopy.

The drawback of most mortar analysis methods is that mortar samples of known composition have not been analyzed in order to evaluate the method. Historic mortars were not prepared to narrowly defined specifications from materials of

This mortar is the proper consistency for repointing historic brick. Photo: John P. Spewak.

uniform quality; they contain a wide array of locally derived materials combined at the discretion of the mason. While a particular method might be able to accurately determine the original proportions of a lime-cement-sand mortar prepared from modern materials, the usefulness of that method for evaluating historic mortars is questionable unless it has been tested against mortars prepared from materials more commonly used in the past.

Properties of Mortar

Mortars for repointing should be softer or more permeable than the masonry units and no harder or more impermeable than the historic mortar to prevent damage to the masonry units. It is a common error to assume that hardness or high strength is a measure of appropriateness, particularly for lime-based historic mortars. Stresses within a wall caused by expansion, contraction, moisture migration, or settlement must be accommodated in some manner; in a masonry wall, these stresses should be relieved by the mortar rather than by the masonry units. A mortar that is stronger in compressive strength than the masonry units will not "give," thus causing stresses to be relieved through the masonry units—resulting in permanent damage to the masonry, such as cracking and spalling, that cannot be repaired easily.

While stresses can also break the bond between the mortar and the masonry units, permitting water to penetrate the resulting hairline cracks, this is easier to correct in the joint through repointing than if the break occurs in the masonry units.

Permeability, or rate of vapor transmission, is also critical. High lime mortars are more permeable than denser cement mortars. Historically, mortar acted as a bedding material—not unlike an expansion joint—rather than a "glue" for the masonry units, and moisture was able to migrate through the mortar joints rather than the masonry units. When moisture evaporates from the masonry it deposits any soluble salts either on the surface as *efflorescence* or below the surface as *subflorescence*. While salts deposited on the surface of masonry units are usually relatively harmless, salt crystallization within a masonry unit creates pressure that can cause parts of the outer surface to spall off or delaminate. If the mortar does not permit moisture or moisture vapor to migrate out of the wall and evaporate, the result will be damage to the masonry units.

This early 19th century building is being repointed with lime mortar. Photo: Travis McDonald.

Components of Mortar

Sand

Sand is the largest component of mortar and the material that gives mortar its distinctive color, texture and cohesiveness. Sand must be free of impurities, such as salts or clay. The three key characteristics of sand are: particle shape, gradation and void ratios.

When viewed under a magnifying glass or low-power microscope, particles of sand generally have either rounded edges, such as found in beach and river sand, or sharp, angular edges, found in crushed or manufactured sand. For repointing mortar, rounded or natural sand is preferred for two reasons. It is usually similar to the sand in the historic mortar and provides a better visual match. It also has better working qualities or plasticity and can thus be forced into the joint more easily, forming a good contact with the remaining historic mortar and the surface of the adjacent masonry units. Although manufactured sand is frequently more readily available, it is usually possible to locate a supply of rounded sand.

The gradation of the sand (particle size distribution) plays a very important role in the durability and cohesive properties of a mortar. Mortar must have a certain percentage of large to small particle sizes in order to deliver the optimum performance. Acceptable guidelines on particle size distribution may be found in ASTM C 144 (American Society for Testing and Materials). However, in actuality, since neither historic nor modern sands are always in compliance with ASTM C 144, matching the same particle appearance and gradation usually requires sieving the sand.

A scoop of sand contains many small voids between the individual grains. A mortar that performs well fills all these small voids with binder (cement/lime combination or mix) in a balanced manner. Well-graded sand generally has a 30 per cent void ratio by volume. Thus, 30 per cent binder by volume generally should be used, unless the historic mortar had a different binder: aggregate ratio. This represents the 1:3 binder to sand ratios often seen in mortar specifications.

For repointing, sand generally should conform to ASTM C 144 to assure proper gradation and freedom from impurities; some variation may be necessary to match the original size and gradation. Sand color and texture also should match the original as closely as possible to provide the proper color match without other additives.

Lime

Mortar formulations prior to the late-19th century used lime as the primary binding material. Lime is derived from heating limestone at high temperatures which burns off the carbon dioxide, and turns the limestone into quicklime. There are three

types of limestone—calcium, magnesium, and dolomitic—differentiated by the different levels of magnesium carbonate they contain which impart specific qualities to mortar. Historically, calcium lime was used for mortar rather than the dolomitic lime (calcium magnesium carbonate) most often used today. But it is also important to keep in mind the fact that the historic limes, and other components of mortar, varied a great deal because they were natural, as opposed to modern lime which is manufactured and, therefore, standardized. Because some of the kinds of lime, as well as other components of mortar, that were used historically are no longer readily available, even when a conscious effort is made to replicate a "historic" mix, this may not be achievable due to the differences between modern and historic materials.

Lime, itself, when mixed with water into a paste is very plastic and creamy. It will remain workable and soft indefinitely, if stored in a sealed container. Lime (calcium hydroxide) hardens by carbonation absorbing carbon dioxide primarily from the air, converting itself to calcium carbonate. Once a lime and sand mortar is mixed and placed in a wall, it begins the process of carbonation. If lime mortar is left to dry too rapidly, carbonation of the mortar will be reduced, resulting in poor adhesion and poor durability. In addition, lime mortar is slightly water soluble and thus is able to re-seal any hairline cracks that may develop during the life of the mortar. Lime mortar is soft, porous, and changes little in volume during temperature fluctuations thus making it a good choice for historic buildings. *Because of these qualities, high calcium lime mortar may be considered for many repointing projects, not just those involving historic buildings.*

Caulking was inappropriately used here in place of mortar on the top of the wall. As a result, it has not been durable. Photo: NPS files.

For repointing, lime should conform to ASTM C 207, Type S, or Type SA, Hydrated Lime for Masonry Purposes. This machine-slaked lime is designed to assure high plasticity and water retention. The use of quicklime which must be slaked and soaked by hand may have advantages over hydrated lime in some restoration projects if time and money allow.

Lime Putty

Lime putty is slaked lime that has a putty or paste-like consistency. It should conform to ASTM C 5. Mortar can be mixed using lime putty according to ASTM C 270 property or proportion specification.

Portland Cement

More recent, 20th-century mortar has used portland cement as a primary binding material. A straight portland cement and sand mortar is extremely hard, resists the movement of water, shrinks upon setting, and undergoes relatively large thermal movements. When mixed with water, portland cement forms a harsh, stiff paste that is quite unworkable, becoming hard very quickly. (Unlike lime, portland cement will harden regardless of weather conditions and does not require wetting and drying cycles.) Some portland cement assists the workability and plasticity of the mortar without adversely affecting the finished project; it also provides early strength to the mortar and speeds setting. Thus, it may be appropriate to add some portland cement to an essentially lime-based mortar even when repointing relatively soft 18th or 19th century brick under some circumstances when a slightly harder mortar is required. The more portland cement that is added to a mortar formulation the harder it becomes—and the faster the initial set.

For repointing, portland cement should conform to ASTM C 150. White, non-staining portland cement may provide a better color match for some historic mortars than the more commonly available grey portland cement. But, it should not be assumed, however, that white portland cement is always appropriate for all historic buildings, since the original mortar may have been mixed with grey cement. The cement should not have more than 0.60 per cent alkali to help avoid efflorescence.

Masonry Cement

Masonry cement is a preblended mortar mix commonly found at hardware and home repair stores. It is designed to produce mortars with a compressive strength of 750 psi or higher when mixed with sand and water at the job site. It may contain hydrated lime, but it always contains a large amount of portland cement, as well as ground limestone and other workability agents, including air-entraining agents. Because masonry cements are not required to contain hydrated lime, and generally do not contain lime, they produce high strength mortars that can damage historic masonry. *For this reason, they generally are not recommended for use on historic masonry buildings.*

Lime Mortar (pre-blended)

Hydrated lime mortars, and pre-blended lime putty mortars with or without a matched sand are commercially available. Custom mortars are also available with color. In most instances, pre-blended lime mortars containing sand may not provide an exact match; however, if the project calls for total repointing, a pre-blended lime mortar may be worth considering as long as the mortar is compatible in strength with the masonry. If the project involves only selected, "spot" repointing, then it may be better to carry out a mortar analysis which can provide a custom pre-blended lime mortar with a matching sand.

In either case, if a preblended lime mortar is to be used, it should contain Type S or SA hydrated lime conforming to ASTM C 207.

Water

Water should be potable—clean and free from acids, alkalis, or other dissolved organic materials.

Other Components

Historic components

In addition to the color of the sand, the texture of the mortar is of critical importance in duplicating historic mortar. Most mortars dating from the mid-19th century on—with some exceptions—have a fairly homogeneous texture and color. Some earlier mortars are not as uniformly textured and may contain lumps of partially burned lime or "dirty lime", shell (which often provided a source of lime, particularly in coastal areas), natural cements, pieces of clay, lampblack or other pigments, or even animal hair. The visual characteristics of these mortars can be duplicated through the use of similar materials in the repointing mortar.

Replicating such unique or individual mortars will require writing new specifications for each project. If possible, suggested sources for special materials should be included. For example, crushed oyster shells can be obtained in a variety of sizes from poultry supply dealers.

Pigments

Some historic mortars, particularly in the late 19th century, were tinted to match or contrast with the brick or stone. Red pigments, sometimes in the form of brick dust, as well as brown, and black pigments were commonly used. Modern pigments are available which can be added to the mortar at the job site, but they should not exceed 10 per cent by weight of the portland cement in the mix, and carbon black should be limited to 2 per cent. Only synthetic mineral oxides, which are alkali-proof and sun-fast, should be used to prevent bleaching and fading.

Modern Components

Admixtures are used to create specific characteristics in mortar, and whether they should be used will depend upon the individual project. *Air entraining agents*, for example, help the mortar to resist freeze-thaw damage in northern climates. *Accelerators* are used to reduce mortar freezing prior to setting while *retarders* help to extend the mortar life in hot climates. Selection of admixtures should be made by the architect or architectural conservator as part of the specifications, not something routinely added by the masons.

Generally, modern chemical additives are unnecessary and may, in fact, have detrimental effects in historic masonry projects. The use of antifreeze compounds is not recommended. They are not very effective with high lime mortars and may introduce salts, which may cause efflorescence later. A better practice is to warm the sand and water, and to protect the completed work from freezing. No definitive study has determined whether air-entraining additives should be used to resist frost action and enhance plasticity, but in areas of extreme exposure requiring high-strength mortars with lower permeability, air-entrainment of 10-16 percent may be desirable (see formula for "severe weather exposure" in Mortar Type and Mix). Bonding agents are not a substitute for proper joint preparation, and they should generally be avoided. If the joint is properly prepared, there will be a good bond between the new mortar and the adjacent surfaces. In addition, a bonding agent is difficult to remove if smeared on a masonry surface.

Mortar Type and Mix

Mortars for repointing projects, especially those involving historic buildings, typically are custom mixed in order to ensure the proper physical and visual qualities. These materials can be combined in varying proportions to create a mortar with the desired performance and durability. The actual specification of a particular mortar type should take into consideration all of the factors affecting the life of the building including: current site conditions, present condition of the masonry, function of the new mortar, degree of weather exposure, and skill of the mason.

Thus, no two repointing projects are exactly the same. Modern materials specified for use in repointing mortar should conform to specifications of the American Society for Testing and Materials (ASTM) or comparable federal specifications, and the resulting mortar should conform to ASTM C 270, Mortar for Unit Masonry.

Specifying the proportions for the repointing mortar for a specific job is not as difficult as it might seem. Five mortar types, each with a corresponding recommended mix, have been established by ASTM to distinguish high strength mortar from soft flexible mortars. The ASTM designated them in decreasing order of approximate general strength as Type M (2,500 psi), Type S (1,800 psi), Type N (750 psi), Type O (350 psi) and Type K (75 psi). (The letters identifying the types are from the words MASON WORK using every other letter.) Type K has the highest lime content of the mixes that

Here, a hammer and chisel are being correctly used to prepare a joint for repointing. Photo: John P. Spew elk.

contain portland cement, although it is seldom used today, except for some historic preservation projects. The designation "L" in the accompanying chart identifies a straight lime and sand mix. Specifying the appropriate ASTM mortar by proportion of ingredients, will ensure the desired physical properties. Unless specified otherwise, measurements or proportions for mortar mixes are always given in the following order: cement-lime-sand. Thus, a Type K mix, for example, would be referred to as 1-3-10, or 1 part cement to 3 parts lime to 10 parts sand. Other requirements to create the desired visual qualities should be included in the specifications.

The strength of a mortar can vary. If mixed with higher amounts of portland cement, a harder mortar is obtained. The more lime that is added, the softer and more plastic the mortar becomes, increasing its workability. A mortar strong in compressive strength might be desirable for a hard stone (such as granite) pier holding up a bridge deck, whereas a softer, more permeable lime mortar would be preferable for a historic wall of soft brick. Masonry deterioration caused by salt deposition results when the mortar is less permeable than the masonry unit. A strong mortar is still more permeable than hard, dense stone. However, in a wall constructed of soft bricks where the masonry unit itself has a relatively high permeability or vapor transmission rate, a soft, high lime mortar is necessary to retain sufficient permeability.

Budgeting and Scheduling

Repointing is both expensive and time consuming due to the extent of handwork and special materials required. It is preferable to repoint only those areas that require work rather than an entire wall, as is often specified. But, if 25 to 50 per cent or more of a wall needs to be repointed, repointing the entire wall may be more cost effective than spot repointing.

Total repointing may also be more sensible when access is difficult, requiring the erection of expensive scaffolding (unless the majority of the mortar is sound and unlikely to require replacement in the foreseeable future). Each project requires judgement based on a variety of factors. Recognizing this at the outset will help to prevent many jobs from becoming prohibitively expensive.

In scheduling, seasonal aspects need to be considered first. Generally speaking, wall temperatures between 40 and 95 degrees F (8 and 38 degrees C) will prevent freezing or excessive evaporation of the water in the mortar. Ideally, repointing should be done in shade, away from strong sunlight in order to slow the drying process, especially during hot weather. If necessary, shade can be provided for large-scale projects with appropriate modifications to scaffolding.

The relationship of repointing to other work proposed on the building must also be recognized. For example, if paint removal or cleaning is anticipated, and if the mortar joints are basically sound and need only selective repointing, it is generally better to postpone repointing until after completion of these activities. However, if the mortar has eroded badly, allowing moisture to penetrate deeply into the wall, repointing should be accomplished before cleaning. Related work, such as structural or roof repairs, should be scheduled so that they do not interfere with repointing and so that all work can take maximum advantage of erected scaffolding.

A mechanical grinder improperly used to cut out the horizontal joint and incompatible repointing have seriously damaged the 19th century brick. Photo: NPS files.

Building managers also must recognize the difficulties that a repointing project can create. The process is time consuming, and scaffolding may need to remain in place for an extended period of time. The joint preparation process can be quite noisy and can generate large quantities of dust which must be controlled, especially at air intakes to protect human health, and also where it might damage operating machinery. Entrances may be blocked from time to time making access difficult for both building tenants and visitors. Clearly, building managers will need to coordinate the repointing work with other events at the site.

Contractor Selection

Contractor Selection The ideal way to select a contractor is to ask knowledgeable owners of recently repointed historic buildings for recommendations. Qualified contractors then can provide lists of other repointing projects for inspection. More commonly, however, the contractor for a repointing project is selected through a competitive bidding process over which the client or consultant has only limited control. In this situation it is important to ensure that the specifications stipulate that masons must have a minimum of five years' experience with repointing historic masonry buildings to be eligible to bid on the project. Contracts are awarded to the lowest responsible bidder, and bidders who have performed poorly on other projects usually can be eliminated from consideration on this basis, even if they have the lowest prices.

When repairing this stone wall, the mason matched the raised profile of the original tuckpointing. Photo: NPS files.

The contract documents should call for unit prices as well as a base bid. Unit pricing forces the contractor to determine in advance what the cost addition or reduction will be for work which varies from the scope of the base bid. If, for example, the contractor has fifty linear feet less of stone repointing than indicated on the contract documents but thirty linear feet more of brick repointing, it will be easy to determine the final price for the work. Note that each type of work—brick repointing, stone repointing, or similar items—will have its own unit price. The unit price also should reflect quantities; one linear foot of pointing in five different spots will be more expensive than five contiguous linear feet.

Execution of the Work

Test Panels

These panels are prepared by the contractor using the same techniques that will be used on the remainder of the project. Several panel locations—preferably not on the front or other highly visible location of the building—may be necessary to include all types of masonry, joint styles, mortar colors, and other problems likely to be encountered on the job.

Unskilled repointing has negatively impacted the character of this late-19th century building. Photo: NPS files.

If cleaning tests, for example, are also to be undertaken, they should be carried out in the same location. Usually a 3 foot by 3 foot area is sufficient for brickwork, while a somewhat larger area may be required for stonework. These panels establish an acceptable standard of work and serve as a benchmark for evaluating and accepting subsequent work on the building.

Joint Preparation

Old mortar should be removed to a minimum depth of 2 to 2-1/2 times the width of the joint to ensure an adequate bond and to prevent mortar "popouts." For most brick joints, this will require removal of the mortar to a depth of approximately 2 to 1 inch; for stone masonry with wide joints, mortar may need to be removed to a depth of several inches. Any loose or disintegrated mortar beyond this minimum depth also should be removed.

Although some damage may be inevitable, careful joint preparation can help limit damage to masonry units. The traditional manner of removing old mortar is through the use of hand chisels and mash hammers. Though labor-intensive, in most instances this method poses the least threat for damage to historic masonry units and produces the best final product.

The most common method of removing mortar, however, is through the use of power saws or grinders. The use of power tools by unskilled masons can be disastrous for historic masonry, particularly soft brick. Using power saws on walls with thin joints, such as most brick walls, almost always will result in damage to the masonry units by breaking the edges and by overcutting on the head, or vertical joints.

However, small pneumatically-powered chisels generally can be used safely and effectively to remove mortar on historic buildings as long as the masons maintain appropriate control over the equipment. Under certain circumstances, thin diamond-bladed grinders may be used to cut out *horizontal* joints only on hard portland cement mortar common to most early-20th century masonry buildings. Usually, automatic tools most successfully remove old mortar without damaging the masonry units when they are used in combination with hand tools in preparation for repointing. Where horizontal joints are uniform and fairly wide, it may be possible to use a power masonry saw to assist the removal of mortar, such as by cutting along the middle of the joint; final mortar removal from the sides of the joints still should be done with a hand chisel and hammer. Caulking cutters with diamond blades can sometimes be used successfully to cut out joints without damaging the masonry. Caulking cutters are slow; they do not rotate, but vibrate at very high speeds, thus minimizing the possibility of damage to masonry units. Although mechanical tools may be safely used in limited circumstances to cut out horizontal joints in preparation for repointing, they should never be used on vertical joints because of the danger of slipping and cutting into the brick above or below the vertical joint. Using power tools to remove mortar without damaging the surrounding masonry units also necessitates highly skilled masons experienced in working on historic masonry buildings. Contractors should demonstrate proficiency with power tools before their use is approved.

Using any of these power tools may also be more acceptable on hard stone, such as quartzite or granite, than on terra cotta with its glass-like glaze, or on soft brick or stone. The test panel should determine the acceptability of power tools. If power tools are to be permitted, the contractor should establish a quality control program to account for worker fatigue and similar variables.

Mortar should be removed cleanly from the masonry units, leaving square corners at the back of the cut. Before filling, the joints should be rinsed with a jet of water to remove all loose particles and dust. At the time of filling, the joints should be damp, but with no standing water present. For masonry walls—limestone, sandstone and common brick—that are extremely absorbent, it is recommended that a continual mist of water be applied for a few hours before repointing begins.

Mortar Preparation

Mortar components should be measured and mixed carefully to assure the uniformity of visual and physical characteristics. Dry ingredients are measured by volume and thoroughly mixed before the addition of any water. Sand must be added in a damp, loose condition to avoid over sanding. Repointing mortar is typically pre-hydrated by adding water so it will just hold together, thus allowing it to stand for a period of time before the final water is added. Half the water should be added, followed by mixing for approximately 5 minutes. The remaining water should then be added in small portions until a mortar of the desired consistency is reached. The total volume of water necessary may vary from batch to batch, depending on weather conditions. It is important to keep the water to a minimum for two reasons: first, a drier mortar is cleaner to work with, and it can be compacted tightly into the joints; second, with no excess water to evaporate, the mortar cures without shrinkage cracks. Mortar should be used within approximately 30 minutes of final mixing, and "retempering," or adding more water, should not be permitted.

Using Lime Putty to Make Mortar

Mortar made with lime putty and sand, sometimes referred to as roughage or course stuff, should be measured by volume, and may require slightly different proportions from those used with hydrated lime. No additional water is usually needed to achieve a workable consistency because enough water is already contained in the putty. Sand is proportioned first, followed by the lime putty, then mixed for five minutes or until all the sand is thoroughly coated with the lime putty. But mixing, in the familiar sense of turning over with a hoe, sometimes may not be sufficient if the best possible performance is to be obtained from a lime putty mortar. Although the old practice of chopping, beating and ramming the mortar has largely been forgotten, recent field work has confirmed that lime putty and sand rammed and beaten with a wooden mallet or ax handle, interspersed by chopping with a hoe, can significantly improve workability and performance. The intensity of this action increases the overall lime/sand contact and removes any surplus water by compacting the other ingredients. It may also be advantageous for larger projects to use a mortar pan mill for mixing. Mortar pan mills which have a long tradition in Europe produce a superior lime putty mortar not attainable with today's modern paddle and drum type mixers.

For larger repointing projects the lime putty and sand can be mixed together ahead of time and stored indefinitely, on or off site, which eliminates the need for piles of sand on the job site. This mixture, which resembles damp brown sugar, must be protected from the air in sealed containers with a wet piece of burlap over the top or sealed in a large plastic bag to prevent evaporation and premature carbonation. The lime putty and sand mixture can be recombined into a workable plastic state months later with no additional water.

If portland cement is specified in a lime putty and sand mortar—Type O (1:2:9) or Type K (1:3:11)—the portland cement should first be mixed into a slurry paste before adding it to the lime putty and sand. Not only will this ensure that the portland cement is evenly distributed throughout the mixture, but if dry portland cement is added to wet ingredients it tends to "ball up," jeopardizing dispersion. (Usually water must be added to the lime putty and sand anyway once the portland cement is introduced.) Any color pigments should be added at this stage and mixed for a full five minutes. The mortar should be used within 30 minutes to 1½ hours and it should not be retempered. Once portland cement has been added the mortar can no longer be stored.

Filling the Joint

Where existing mortar has been removed to a depth of greater than 1 inch, these deeper areas should be filled first, compacting the new mortar in several layers. The back of the entire joint should be filled successively by applying approximately 1/4 inch of mortar, packing it well into the back corners. This application may extend along the wall for several feet. As soon as the mortar has reached thumb-print hardness, another 1/4 inch layer of mortar—approximately the same thickness—may be applied. Several layers will be needed to fill the joint flush with the outer surface of the masonry. It is important to allow each layer time to harden before the next layer is applied; most of the mortar shrinkage occurs during the hardening process and layering thus minimizes overall shrinkage.

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 when too soft, the color will be lighter than expected, and hairline cracks may occur; if tooled when too hard, there may be dark streaks called "tool burning," and good closure of the mortar against the masonry units will not be achieved.

If the old bricks or stones have worn, rounded edges, it is best to recess the final mortar slightly from the face of the masonry. This treatment will help avoid a joint which is visually wider than the actual joint; it also will avoid creation of a large, thin featheredge which is easily damaged, thus admitting water. After tooling, excess mortar can be removed from the edge of the joint by brushing with a natural bristle or nylon brush. Metal bristle brushes should never be used on historic masonry.

Curing Conditions

The preliminary hardening of high-lime content mortars—those mortars that contain more lime by volume than portland cement, i.e., Type O (1:2:9), Type K (1:3:11), and straight lime/sand, Type "L" (0:1:3)—takes place fairly rapidly as water

in the mix is lost to the porous surface of the masonry and through evaporation. A high lime mortar (especially Type "L") left to dry out too rapidly can result in chalking, poor adhesion, and poor durability. Periodic wetting of the repointed area after the mortar joints are thumb-print hard and have been finish tooled may significantly accelerate the carbonation process. When feasible, misting using a hand sprayer with a fine nozzle can be simple to do for a day or two after repointing. Local conditions will dictate the frequency of wetting, but initially it may be as often as every hour and gradually reduced to every three or four hours. Walls should be covered with burlap for the first three days after repointing. (Plastic may be used, but it should be tented out and not placed directly against the wall.) This helps keep the walls damp and protects them from direct sunlight. Once carbonation of the lime has begun, it will continue for many years and the lime will gain strength as it reverts back to calcium carbonate within the wall.

Aging the Mortar

Even with the best efforts at matching the existing mortar color, texture, and materials, there will usually be a visible difference between the old and new work, partly because the new mortar has been matched to the unweathered portions of the historic mortar. Another reason for a slight mismatch may be that the sand is more exposed in old mortar due to the slight erosion of the lime or cement. Although spot repointing is generally preferable and some color difference should be acceptable, if the difference between old and new mortar is too extreme, it may be advisable in some instances to repoint an entire area of a wall, or an entire feature such as a bay, to minimize the difference between the old and the new mortar. If the mortars have been properly matched, usually the best way to deal with surface color differences is to let the mortars age naturally. Other treatments to overcome these differences, including cleaning the non-repointed areas or staining the new mortar, should be carefully tested prior to implementation.

This 18th century pediment and surrounding wall exhibit distinctively different mortar joints. Photo: NPS files.

Staining the new mortar to achieve a better color match is generally not recommended, but it may be appropriate in some instances. Although staining may provide an initial match, the old and new mortars may weather at different rates, leading to visual differences after a few seasons. In addition, the mixtures used to stain the mortar may be harmful to the masonry; for example, they may introduce salts into the masonry which can lead to efflorescence.

Cleaning the Repointed Masonry

If repointing work is carefully executed, there will be little need for cleaning other than to remove the small amount of mortar from the edge of the joint following tooling. This can be done with a stiff natural bristle or nylon brush after the mortar has dried, but before it is initially set (1-2 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 natural bristle or nylon brushes. If chemicals must be used, they should be selected with extreme caution. Improper cleaning can lead to deterioration of the masonry units, deterioration of the mortar, mortar smear, and efflorescence. New mortar joints are especially susceptible to damage because they do not become fully cured for several months. Chemical cleaners, particularly acids, should never be used on dry masonry. The masonry should always be completely soaked once with water before chemicals are applied. After cleaning, the walls should be flushed again with plain water to remove all traces of the chemicals.

Several precautions should be taken if a freshly repointed masonry wall is to be cleaned. First, the mortar should be fully hardened before cleaning. Thirty days is usually sufficient, depending on weather and exposure; as mentioned previously, the mortar will continue to cure even after it has hardened. Test panels should be prepared to evaluate the effects of different cleaning methods. Generally, on newly repointed masonry walls, only very low pressure (100 psi) water washing supplemented by stiff natural bristle or nylon brushes should be used, except on glazed or polished surfaces, where only soft cloths should be used.**

New construction "bloom" or efflorescence occasionally appears within the first few months of repointing and usually disappears through the normal process of weathering. If 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 followed by wet brushing. Hydrochloric (muriatic) acid, is generally ineffective, and it should not be used to remove efflorescence. It may liberate additional salts, which, in turn, can lead to more efflorescence.

Surface grouting is sometimes suggested as an alternative to repointing brick buildings, in particular. This process involves the application of a thin coat of cement-based grout to the mortar joints and the mortar/brick interface. To be effective, the grout must extend slightly onto the face of the masonry units, thus widening the joint visually. The change in the joint appearance can alter the historic character of the structure to an unacceptable degree. In addition, although

masking of the bricks is intended to keep the grout off the remainder of the face of the bricks, some level of residue, called "veiling," will inevitably remain. Surface grouting cannot substitute for the more extensive work of repointing, and it is not a recommended treatment for historic masonry.

**Additional information on masonry cleaning is presented in Preservation Briefs 1: Assessing Cleaning and Water-Repellent Treatments for Historic Masonry Buildings, Robert C. Mack, FAIA, and Anne E. Grimmer, Washington, D.C.: Technical Preservation Services, National Park Service, U.S. Department of the Interior, 2000; and Keeping it Clean: Removing Exterior Dirt, Paint, Stains & Graffiti from Historic Masonry Buildings, Anne E. Grimmer, Washington, D.C.: Technical Preservation Services, National Park Service, U.S. Department of the Interior, 1988.

Visually Examining the Mortar and the Masonry Units

A simple *in situ* comparison will help determine the hardness and condition of the mortar and the masonry units. Begin by scraping the mortar with a screwdriver, and gradually tapping harder with a cold chisel and mason's hammer. Masonry units can be tested in the same way beginning, even more gently, by scraping with a fingernail. This relative analysis which is derived from the 10-point hardness scale used to describe minerals, provides a good starting point for selection of an appropriate mortar. It is described more fully in "The Russack System for Brick & Mortar Description" referenced in

[Reading List](#) at the end of this Brief.

Mortar samples should be chosen carefully, and picked from a variety of locations on the building to find unweathered mortar, if possible. Portions of the building may have been repointed in the past while other areas may be subject to conditions causing unusual deterioration. There may be several colors of mortar dating from different construction periods or sand used from different sources during the initial construction. Any of these situations can give false readings to the visual or physical characteristics required for the new mortar. Variations should be noted which may require developing more than one mix.

1. Remove with a chisel and hammer three or four unweathered samples of the mortar to be matched from several locations on the building. (Set the largest sample aside--this will be used later for comparison with the repointing mortar). Removing a full representation of samples will allow selection of a "mean" or average mortar sample.
2. Mash the remaining samples with a wooden mallet, or hammer if necessary, until they are separated into their constituent parts. There should be a good handful of the material.
3. Examine the powdered portion—the lime and/or cement matrix of the mortar. Most particularly, note the color. There is a tendency to think of historic mortars as having white binders, but grey portland cement was available by the last quarter of the 19th century, and traditional limes were also sometimes grey. Thus, in some instances, the natural color of the historic binder may be grey, rather than white. The mortar may also have been tinted to create a colored mortar, and this color should be identified at this point.
4. Carefully blow away the powdery material (the lime and/or cement matrix which bound the mortar together).
5. With a low power (10 power) magnifying glass, examine the remaining sand and other materials such as lumps of lime or shell.
6. Note and record the wide range of color as well as the varying sizes of the individual grains of sand, impurities, or other materials.

Other Factors to Consider

Color

Regardless of the color of the binder or colored additives, the sand is the primary material that gives mortar its color. A surprising variety of colors of sand may be found in a single sample of historic mortar, and the different sizes of the grains of sand or other materials, such as incompletely ground lime or cement, play an important role in the texture of the repointing mortar. Therefore, when specifying sand for repointing mortar, it may be necessary to obtain sand from several sources and to combine or screen them in order to approximate the range of sand colors and grain sizes in the historic mortar sample.

Pointing Style

Close examination of the historic masonry wall and the techniques used in the original construction will assist in maintaining the visual qualities of the building. Pointing styles and the methods of producing them should be examined. It is important to look at both the horizontal and the vertical joints to determine the order in which they were tooled and whether they were the same style. Some late-19th and early-20th century buildings, for example, have horizontal joints that were raked back while the vertical joints were finished flush and stained to match the bricks, thus creating the illusion of horizontal

bands. Pointing styles may also differ from one facade to another; front walls often received greater attention to mortar detailing than side and rear walls. **Tuckpointing** is not true repointing but the application of a raised joint or lime putty joint on top of flush mortar joints. **Penciling** is a purely decorative, painted surface treatment over a mortar joint, often in a contrasting color.

Masonry Units

The masonry units should also be examined so that any replacement units will match the historic masonry. Within a wall there may be a wide range of colors, textures, and sizes, particularly with hand-made brick or rough-cut, locally-quarried stone. Replacement units should blend in with the full range of masonry units rather than a single brick or stone.

Matching Color and Texture of the Repointing Mortar

New mortar should match the unweathered interior portions of the historic mortar. The simplest way to check the match is to make a small sample of the proposed mix and allow it to cure at a temperature of approximately 70 degrees F for about a week, or it can be baked in an oven to speed up the curing; this sample is then broken open and the surface is compared with the surface of the largest "saved" sample of historic mortar.

If a proper color match cannot be achieved through the use of natural sand or colored aggregates like crushed marble or brick dust, it may be necessary to use a modern mortar pigment.

During the early stages of the project, it should be determined how closely the new mortar should match the historic mortar. Will "quite close" be sufficient, or is "exactly" expected? The specifications should state this clearly so that the contractor has a reasonable idea how much time and expense will be required to develop an acceptable match.

The same judgment will be necessary in matching replacement terra cotta, stone or brick. If there is a known source for replacements, this should be included in the specifications. If a source cannot be determined prior to the bidding process, the specifications should include an estimated price for the replacement materials with the final price based on the actual cost to the contractor.

Mortar Types (Measured by volume)

Designation	Cement	Hydrated Lime or Lime Putty	Sand
M	1	1/4	3 - 3 3/4
S	1	1/2	4-4 1/2
N	1	1	5-6
O	1	2	8-9
K	1	3	10-12
"L"	0	1	2 1/4-3

Suggested Mortar Types for Different Exposures

Masonry Material	Exposure		
	Sheltered	Moderate	Severe
Very durable: granite, hard-cored brick, etc.	O	N	S
Moderately durable: limestone, durable stone, molded brick	K	O	N
Minimally durable: soft hand-made brick	"L"	K	O

Summary and References

For the Owner/Administrator

The owner or administrator of a historic building should remember that repointing is likely to be a lengthy and expensive process. First, there must be adequate time for evaluation of the building and investigation into the cause of problems. Then, there will be time needed for preparation of the contract documents. The work itself is precise, time-consuming and noisy, and scaffolding may cover the face of the building for some time. Therefore, the owner must carefully plan the work

to avoid problems. Schedules for both repointing and other activities will thus require careful coordination to avoid unanticipated conflicts. The owner must avoid the tendency to rush the work or cut corners if the historic building is to retain its visual integrity and the job is to be durable.

For the Architect/Consultant

Because the primary role of the consultant is to ensure the life of the building, a knowledge of historic construction techniques and the special problems found in older buildings is essential. The consultant must assist the owner in planning for logistical problems relating to research and construction. It is the consultant's responsibility to determine the cause of the mortar deterioration and ensure that it is corrected before the masonry is repointed. The consultant must also be prepared to spend more time in project inspections than is customary in modern construction.

For the Masons

Successful repointing depends on the masons themselves. Experienced masons understand the special requirements for work on historic buildings and the added time and expense they require. The entire masonry crew must be willing and able to perform the work in conformance with the specifications, even when the specifications may not be in conformance with standard practice. At the same time, the masons should not hesitate to question the specifications if it appears that the work specified would damage the building.

Conclusion

A good repointing job is meant to last, at least 30 years, and preferably 50- 100 years. Shortcuts and poor craftsmanship result not only in diminishing the historic character of a building, but also in a job that looks bad, and will require future repointing sooner than if the work had been done correctly. The mortar joint in a historic masonry building has often been called a wall's "first line of defense." Good repointing practices guarantee the long life of the mortar joint, the wall, and the historic structure. Although careful maintenance will help preserve the freshly repointed mortar joints, it is important to remember that mortar joints are intended to be sacrificial and will probably require repointing some time in the future. Nevertheless, if the historic mortar joints proved durable for many years, then careful repointing should have an equally long life, ultimately contributing to the preservation of the entire building.

Useful Addresses

Brick Institute of America

11490 Commerce Park Drive
Reston, VA 22091

National Lime Association

200 N. Glebe Road, Suite 800
Arlington, VA 22203

Portland Cement Association

5420 Old Orchard Road
Skokie, IL 60077

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This publication has been prepared pursuant to the National Historic Preservation Act of 1966, as amended, which directs the Secretary of the Interior to develop and make available information concerning historic properties. Technical Preservation Services (TPS), National Park Service prepares standards, guidelines, and other educational materials on responsible historic preservation treatments for a broad public.

October 1998

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1.1.3.6 Preparing lime mortar for repointing masonry (GSA 2017b)

Preparing Lime Mortar For Repointing Masonry

Procedure code:

410003G

Source:

Hspg Prepared For Nps - Sero

Division:

Masonry

Section:

Mortar & Masonry Grout

Last Modified:

02/21/2017

PART 1---GENERAL

1.01 SUMMARY

- A. This standard includes guidance on preparing lime mortars for repointing masonry.
- B. Lime mortars are preferable to Portland cement mortars for repointing historic masonry:
  - I. Lime mortars are more permeable by water. Water passing through lime mortar will dissolve a small portion of the lime and then will deposit it in hairline cracks as the water evaporates.
  - II. Lime mortars expand slightly during setting, and resists shrinkage which causes cracking.
  - III. Lime mortars are more durable than generally recognized.
- a. See 01100-07-S for general project guidelines to be reviewed along with this procedure. These guidelines cover the following sections:
  - 1. Safety Precautions
  - 2. Historic Structures Precautions
  - 3. Submittals
  - 4. Quality Assurance
  - 5. Delivery, Storage and Handling
  - 6. Project/Site Conditions
  - 7. Sequencing and Scheduling
  - 8. General Protection (Surface and Surrounding)

These guidelines should be reviewed prior to performing this procedure and should be followed, when applicable, along with recommendations from the Regional Historic Preservation Officer (RHPO).

1.02 REFERENCES

- A. American Society for Testing and Materials (ASTM)
<http://www.astm.com/>

1.03 DELIVERY, STORAGE AND HANDLING

- A. Storage and Protection: Lime and cement must be protected from rainwater and ground moisture, as water vapor in the air can begin the setting process. Other materials also should be protected from contamination.

PART 2---PRODUCTS

2.01 MATERIALS

NOTE: The use of standard specifications for materials, such as those developed by the ASTM, provides an easily referenced level of quality.

- A. Lime: Should conform to ASTM C207, Type S, high plasticity, Hydrated Lime for Masonry Purposes.
  - 1. Lime which meets this standard will "work" well, resists drying during curing, and is sufficiently strong for the purpose of repointing.
  - 2. Lime expands as it hydrates, making high lime mortars more resistant to crack formation.
- B. Cement: Should conform to ASTM C150, Type I, White. It should not have more than 0.60% alkali nor more than 0.15% water soluble alkali. Use gray Portland cement ONLY if a dark mortar is to be matched.
  - 1. Cement meeting this standard should increase the workability of the mortar, accelerate the setting time and slightly increase the strength of the mortar.
  - 2. The low alkali content will prevent efflorescence.
- C. Sand: Free of impurities and conforming to ASTM C144.
  - 1. Sand color, size, and texture should match the original as closely as possible. Provide a sample of the sand for comparison to the original, and have it approved by the RHPO before beginning repointing work.
  - 2. When possible, use bar sand or beach sand rather than crushed sand for the repointing mortar.

NOTE: BAR SAND OR BEACH SAND SHOULD BE WASHED TO REMOVE THE SALTS BEFORE USING.

- a. Crushed sand has sharp edges, which makes it more "sticky" and difficult to work into the joints.
- b. Bar sand, on the other hand, has rounded edges and flows easily during the mortar application.
- c. The working characteristics of mortar made with crushed sand may be improved by adding a slight amount of Portland cement. The amount of cement should be determined by experimentation, but should not exceed 20% of the total lime/cement binder. 20% OR LESS OF CEMENT HAS MINIMAL EFFECT ON THE HARDNESS OF THE MORTAR. CEMENT CONTENT ABOVE 20% WILL MAKE THE MORTAR TOO HARD.
- D. Clean, potable water: If the water must be transported or stored in a container, the container must not impart any chemicals to the water.
- E. Stone dust finely ground from the same stone as that to be repointed.
- F. Additives: NO antifreeze compounds or other admixture shall be used.

NOTE: Do not use anti-freeze compounds. These compounds are designed for use with cement mortars, and their effectiveness with high lime mortars is questionable. Furthermore, the compounds contain salts which can lead to serious problems in the masonry at a later time.

NOTE: Air entraining agents are not recommended. These agents are designed for use with cement rather than lime, and they result in decreased bonding of the mortar and the masonry. Air entraining is not necessary with high lime mortars because of the natural ability of these mortars to flex with temperature changes.

2.02EQUIPMENT

A. Surface temperature thermometer - can be either mechanical (less expensive but must be calibrated often) or digital electronic

B. Wooden mortar boxes

C. Hoe

D. Mesh screen

E. Hawks: Plywood or steel hawk (mortar board)

2. 03 MIXES

A. Some factors to consider when mixing lime mortar include durability, color and texture, and workability.

1. Durability: Repointing mortar should be softer than the masonry units and the original mortar to reduce stresses at the edge of the masonry and, in the case of lime mortar, to reduce shrinkage which can cause cracks in the mortar.
  - a. If the new mortar is harder than the masonry or the original mortar, it can cause serious stresses within the wall during thermal expansion and contraction, which can lead to deterioration of the masonry units rather than the mortar.
  - b. If the mortar is softer, any deterioration which occurs will take place in the mortar, which is easier to replace than the units themselves.
2. The repointing mortar should allow the passage of water, both liquid and vapor. If the mortar does not allow water to pass freely through it, the water can become trapped inside the wall, freeze and cause serious deterioration to the masonry.
3. Color and texture: The repointing mortar should match the original mortar in color, texture and physical characteristics.
  - a. Obtaining an accurate color match is best achieved by selecting an appropriate sand.
    1. Use sand which is similar to the original in color and gradation. Sand from more than one source may be required.
    2. For repointing of natural stones, use finely ground stone "dust" in the mortar to match the joints as closely as possible to the stone.
  - b. If the original mortar was tinted, or if it is impossible to obtain a color match through the use of sand, it may be necessary to use a special mortar pigment.

CAUTION: Pigments may react with other ingredients in the mortar to form efflorescence. They may also weather at a different rate than natural coloring and cause a color variation in the mortar.

NOTE: IF PIGMENTS MUST BE USED, PURE MINERAL OXIDES SHOULD BE USED BECAUSE THEY DO NOT FADE OR LEACH OUT OF THE MORTAR. AMOUNT OF PIGMENT SHOULD NOT EXCEED 2% OF THE MORTAR MIX BY WEIGHT.

- c. Many mortars used before the twentieth century have small lumps of incompletely burned or ground lime, or other impurities. To match the original appearance of the masonry, these impurities must be included in the new repointing mortar. Use identical materials, such as ground oyster shells (obtained at feed stores) or lumps of lime, to duplicate original lumps.
5. Workability: The workability or plasticity of the mortar is a direct result of the selection of materials.

B. MORTAR MIX:

1. Have the existing mortar completely analyzed to insure that the repointing mortar will not be less permeable/harder than the masonry units or the original mortar. IT IS BETTER TO HAVE MORTAR THAT IS MORE PERMEABLE THAN LESS.
2. Measure all ingredients by cubic volume using a pre-established uniform measure, such as a small bucket, rather than a less uniform measure such as a shovel.
3. For historic masonry set in lime mortar, use the following mortar mix:

1 part portland cement
3 parts lime
8-12 parts sand (To match existing mortar as closely as possible.)

NOTE: The exact mix required will relate to the grain size and sharpness of the sand and will vary depending on the supply.

-OR-

For historic masonry set in standard mortar, use the following mortar mix (ASTM C270 Type "O") as a starting point:

1 part portland cement
2 parts lime or lime putty
6 to 9 parts sand and stone dust (To match existing mortar as closely as possible.)

-OR-

For Limestone (ASTM C270 Type "N"):

1 part portland cement
1 parts lime
4-6 parts aggregate
Enough water to form a workable consistency

-OR-

For Granite (ASTM C270 Type "S"):

2 parts portland cement
1 part lime
7-9 parts aggregate
Enough water to form a workable consistency

NOTE: For deteriorated granite or granite walls indicating movement, use astm c270 type "n" as listed above for limestone.

4. Mix a final "job-size" batch once the correct sand color, cement content, etc. have been determined through small tests to ensure the on-site mixing conditions will result in the same final product.

PART 3---EXECUTION

3.01 ERECTION, INSTALLATION, APPLICATION

A. Mix Hydrated Lime:

1. Add dry bagged hydrated lime to water. Stir and hoe the mass to form a thick cream.
2. Allow to stand at least 24 hours before use.

B. Prepare Roughage Premix (for later use):

1. Accurately proportion the sand and lime using measuring boxes constructed to contain the exact volume of each ingredient required to make on batch.
2. Mix sand and lime thoroughly for about ten minutes. Store in plastic-lined drums and seal until required.

NOTE: THIS COMPOUND MAY BE STORED INDEFINITELY IF KEPT SEALED FROM AIR AND KEPT FROM FREEZING.

3. When required for use, add and mix the correct portion of gauging cement as specified and use immediately. ACCURATE PORTIONING IS VERY IMPORTANT.

D. Add cements to lime and aggregate mixes immediately before the use of the mortar.

1. Perform all batching with wooden boxes or plastic pails of known volume to ensure standardization and conformity of measurement; SHOVEL MEASUREMENT OF MATERIALS IS NOT PERMITTED.
2. Use box sizes that are sufficient for producing a batch size equal to one mixer load.

NOTE: MIX DRY INGREDIENTS THOROUGHLY BEFORE ADDING ANY WATER (APPROXIMATELY FIVE MINUTES).

D. Add a small amount of water so that the mortar is just wet enough to hang on a trowel.

NOTE: EXCESS WATER WILL CAUSE SHRINKAGE AND TOO LITTLE WATER WILL RETARD CARBONATION. RECORD THE AMOUNT OF WATER ADDED SO THAT IT MAY BE USED AS A GUIDE FOR FUTURE BATCHES.

E. Mix mortars at least 10 minutes before using to improve workability and ensure thorough mixing.

NOTE: AUTOMATIC MIXERS SHOULD HAVE RUBBER BLADES. CLEAN MIXING BOARDS AND MIXING MACHINES THOROUGHLY AFTER EACH USE TO PREVENT HARDENED LUMPS OF MORTAR FROM CONTAMINATING THE NEXT BATCH OF MORTAR.

1. Repointing mortars may sit 1-2 hours after initial mixing and then may be remixed to a workable consistency. This is done to reduce shrinkage.
2. Test the mix by holding a trowel with mortar on it upside down and shaking it once.
  - a. If the mortar falls off without shaking, it has too much sand.
  - b. If more than one shake is required, the mortar is too sticky or "plastic" and the lime content must be decreased.

F. Coloring Mortars:

1. Take samples of freshly-broken mortar from the original masonry pointing. Note color of aggregate for color-matching. DO NOT TRY TO MATCH THE COLOR OF THE BINDER.
NOTE: USE UNWEATHERED, UNSOILED SAMPLES ONLY.
2. Prepare test patties of mortar approximating the inner color of the sample and set aside to dry for at least 72 hours. Drying time may be accelerated by placing the patty sample in an oven or over a hot-plate.
3. Break the sample test patties and compare the inner portions to the original.
4. See Section 2.03 above for additional information on coloring mortars.

- G. Use repointing mortar within approximately 1-2 hours of final mixing. Retemper the mortar as necessary to maintain workability.

NOTE: Re-tempering is permitted to maintain workability. Remixing is not permitted. Add water at the mortar-board using a spray bottle to replace only water lost through evaporation.

NOTE: use all mortar within two hours of gauging; throw out left over mortar; do not re-temper or remix mortars after this time has elapsed.

NOTE: this time limit may vary depending upon the outside temperature (longer on cooler days and shorter on warmer days).

- H. For guidance on repointing, see 04520-02-R.

1.1.3.7 Repointing masonry using lime mortar (GSA 2018b)

U.S. General Services Administration

Repointing Masonry Using Lime Mortar

Procedure code:

452002S

Source:

Custom House, Portland, OR, GSA Facilities Support Center

Division:

Masonry

Section:

Masonry Restoration

Last Modified:

01/04/2018

REPOINTING MASONRY USING LIME MORTAR

PART 1---GENERAL

1.01 SUMMARY

A. This procedure includes guidance on repointing stone masonry using lime mortar.

B. Repointing is the process of removing deteriorated mortar from a masonry joint and replacing old mortar with new, sound mortar.

C. This process is sometimes referred to as "tuck pointing", though "tuck pointing", is actually a decorative treatment rather than a method of repair. True tuck pointing is the process of adding a finish layer of mortar, occasionally tinted, to the outer portion of a newly laid joint.

D. Major reasons for mortar joint failures include:

1. Weathering action
2. Settling
3. Temperature cycles
4. Poor original design and materials
5. Lack of exterior maintenance

E. See 01100-07-S for general project guidelines to be reviewed along with this procedure. These guidelines cover the following sections:

1. Safety Precautions
2. Historic Structures Precautions
3. Submittals
4. Quality Assurance
5. Delivery, Storage and Handling
6. Project/Site Conditions
7. Sequencing and Scheduling
8. General Protection (Surface and Surrounding)

These guidelines should be reviewed prior to performing this procedure and should be followed, when applicable, along with recommendations from the Regional Historic Preservation Officer (RHPO).

F. For guidance on preparing lime mortar, see 04100-03-S.

1.02 SUBMITTALS

- A. Manufacturers' literature describing packaged items.
- B. Source and screen analysis of bulk aggregate.
- C. Mortar sample: Submit, for verification and approval, a sample of each type of mortar used, in form of 6" long by 1/2" wide sample strips of mortar set in aluminum or plastic channels.
  1. Provide record of mortar mix, composition and field procedures to be followed.

1.03 QUALITY ASSURANCE

- A. Mock-ups: Raking and Repointing Sample Work:

1. Test/Sample Area and RHPO Approval:

- a. Initially perform sample joint raking and repointing on each of a 100 sq. ft. test of stone, brick, and terra cotta areas as approved by RHPO.
    - b. Demonstrate proficiency with joint raking tools and ability to not damage masonry units with either hand or power tools.

c. Mix and cure test batch of repointing mortar and place in joints; repeat test mix until mortar color is approved. Test mortar should be matched, dried and approved before placing in joints.

d. Demonstrate workmanship of repointing procedures and joint finishing.

e. Gain written approval from RHPO for test area before proceeding with remaining work.

2. Joint Raking Method: Rake joints by hand ONLY using special joint cleaning chisels and hammer.

3. Repointing Method: Repoint joints by hand ONLY using approved pointing trowels. NO "BAGGING" OR CAULKING GUN POINTING METHODS APPROVED.

1.04 PROJECT/SITE CONDITIONS

A. Environmental Conditions: Perform repointing only when the temperature is between 40 degrees Fahrenheit and 80 degrees Fahrenheit. If the temperature is below 40 degrees, the mortar sets too slowly, and there is a good chance of freezing before it fully sets. If the temperature is above 80 degrees, the mortar will set too quickly, and there is a strong chance of excessive loss of water prior to adequate setting.

PART 2---PRODUCTS

2.01 MANUFACTURERS

A. Repointing Tools: Available from good hardware stores, building material suppliers or mail-order catalogues.

1. The Stanley Gold-blatt Tool Co.

2. Marshalltown Trowel Co.

2.02 MATERIALS

A. Lime mortar (See 04100-03-S for materials and procedures in preparing lime mortar)

B. Clean, potable water

2.03 EQUIPMENT

A. Trowels: range in length from 10-12 inches

B. Chisels:

1. Joint chisels or a standard mason's chisel with a 1-1/2 in. blade and a long narrow handle

2. Floor chisels

C. Hammers:

1. 5# stone dressing hammer

2. 2# striking hammer

3. "No-Bounce" hammer

4. Full size and one half size brick hammers

D. Joint Tools: (see 2.01 MANUFACTURERS above)

1. 3/8"-1/4" raised beaded tool

2. 3/8"-1/4" beaded striking tool

3. 1/2" raised beaded tool with offset handle

4. 1/2" flat joint iron

5. Pointing tool should be about 1/16" narrower than the joint being filled to achieve good compaction

E. Hawks: Plywood or steel hawk (mortar board)

F. Brushes:

1. Natural bristle brushes

2. Stiff bristle brushes (no wire)

G. Spray bottle

2.03 MIXES

A. See 04100-03-S for lime mortar mixes

PART 3---EXECUTION

3.01 EXAMINATION

A. Examine all existing exterior mortar joints. If the answer to any of the following questions is yes, then the building's joints are deteriorated and need repointing:

1. Are mortar joints eroded back more than 1/4" from the masonry face?

2. Are there cracks running vertically or horizontally through the mortar?

3. Are mortar bonds broken or pulled away from the masonry?

4. Has mortar fallen out of joints?

5. Is mortar excessively soft, powdery or crumbling?

6. Is pointing badly-stained?

B. Typical exterior damage due to mortar deterioration includes open joints, efflorescence, spalling and loosened masonry units.

C. Typical interior damage due to mortar deterioration includes failing plaster and stained wall paper.

D. A professional pointer experienced in old masonry is required for any of the following areas or conditions:

1. Chimneys need repointing

2. Window lintels must be rebuilt.

3. Masonry is loose or missing.

4. Work must be done from scaffolds or extension ladders.

5. The original mortar joints were "beaded"-tooled with a raised, round-profiled joint that projects out from the wall.

3.02 PREPARATION

A. Preparing the Joints:

1. Clean area of loose dirt and debris using a stiff bristle brush and remove all extraneous fastenings and devices.

2. Install necessary protection of adjacent building materials, property and persons from joint cleaning work and dirt.

3. Control dust and dirt from raking work; dampen area being worked; and use curtains to limit spread of dust from joint raking and cutting operations.

B. Joint Cutting and Raking:

1. Cut and rake old mortar from existing joints by hand using a hammer and chisel. NOTE: POWER CHISELS AND POWER SAWS SHOULD NOT BE USED.

2. Place the chisel in the center of the joint and pound it with a striking hammer or "No-Bounce" hammer until the mortar disintegrates.

3. Rake out the loose material to a depth of about 1 inch and never to a depth less than their width. Leave a clean, square face at the back of the joint to provide optimum contact with the new mortar.

CAUTION: AVOID OVERCUTTING ENDS OF VERTICAL JOINTS, WIDENING JOINTS OR CUTTING INTO

BEDDING FACES OF MASONRY UNITS.

4. While raking out joints, remove all metal fittings such as nails, brackets and clips on both horizontal and vertical surfaces.

5. Carefully clean out the prepared face with a soft or stiff bristle brush, or blow the joints clean with low-pressure compressed air (40-60 psi).

6. Thoroughly flush out joint with clean, clear water.

3.03 ERECTION, INSTALLATION, APPLICATION**A. Filling Joints:**

1. Dampen masonry surfaces and joints to control suction and evaporation before placing repointing mortars.

NOTE: THERE SHOULD BE NO FREE WATER PRESENT WHICH MAY CAUSE VOIDS IN THE MORTAR.

2. Using a pointing tool, push the mortar into the joint from a board and iron with the maximum possible pressure; The mortar should be applied in layers, each to a maximum thickness of 3/8".

NOTE: THE POINTING TOOL SHOULD BE ABOUT 1/16" NARROWER THAN THE JOINT BEING FILLED TO ACHIEVE GOOD COMPACTION. IN SOME CASES, THE JOINTS WILL BE SO THIN THAT A STANDARD POINTING TOOL WILL NEED TO BE GROUND DOWN TO FIT THE JOINT.

3. Thoroughly compact each layer of mortar and allow to set until thumb-print hard before applying the next layer of mortar.

4. Fill the joints so that they are slightly recessed from the masonry face. Avoid leaving a joint which is visually wider than the actual historical appearance.

5. Continuously keep all excess and spilled mortar brushed off the faces of masonry units, ledges and other surfaces before it sets or stains the work.

B. Joint Finishing:

1. Begin when mortar attains "thumb print" hardness.

2. Tool the joint to match the old mortar.

NOTE: IT IS IMPORTANT TO TOOL THE JOINT AT THE RIGHT STAGE; IF THE JOINT IS TOO SOFT, THE COLOR WILL BE LIGHTER THAN EXPECTED AND HAIRLINE SHRINKAGE CRACKS ARE LIKELY TO OCCUR; IF THE JOINT IS TOO HARD WHEN TOOLED, DARK STREAKS MAY APPEAR (TOOL BURNING) AND GOOD CLOSURE OF THE MORTAR AGAINST THE MASONRY WILL NOT BE ACHIEVED. EXCESSIVE TOOLING MAY BRING LIME AND FINE AGGREGATES TO THE SURFACE, CREATING A VISUAL CHANGE IN THE TEXTURE AND A SURFACE SUBJECT TO EARLY DETERIORATION.

3. To produce a roughened texture, lightly spray the mortar with water after the initial set, stipple the mortar with a stiff bristle brush or dab the mortar with coarse sacking.

4. Protect finished work from direct sun and rain until the face has dried and hardened.

3.04 ADJUSTING/CLEANING

A. Cleaning Up:

1. Use masking and drop cloths to prevent mortar stains on adjacent work and ledges.

2. Keep work areas clean and free from mortar drips, spills and residue of waste mortars or wash-off.

3. Clean off excess mortar as work proceeds using masonry brushes before mortar sets.

4. Wash completed repointing work when finished mortar joints are set with clean water and masonry brushes, scrubbing only as required to clean mortar stains off masonry without scouring the units and joint faces.

5. Do not use acid or detergent cleaning agent to aid mortar removal and clean-up without written approval from RHPO.

B. Curing:

1. Schedule work only when moderate weather is forecast.

2. Protect completed work from adverse weather, heavy rainfall, freezing, and drying by direct sunlight and winds until cured.

3. Sprinkle or mist repointed work as required to achieve cure in mortar joints for a minimum of 72 hours after completion.

4. Lime Mortar: Cures by drying and crystallization, not by hydration; and can be washed out of joints if not protected before it cures.

C. Final Cleaning:

1. After mortar has fully hardened, thoroughly clean exposed masonry surfaces of excess mortar and foreign matter using stiff nylon or bristle brushes and clean water spray applied at low pressure.

NOTE: USE OF METAL SCRAPERS OR BRUSHES IS NOT PERMITTED. USE OF ACID OR ALKALI CLEANING AGENTS IS NOT PERMITTED.

D. Some efflorescence, called new construction "bloom," occasionally appears on the surface within the first few months following a repointing project. These deposits normally are harmless and are removed by the natural washing of the rain. If not removed by natural weathering, they can be removed with dry brushing with a bristle brush. The use

of chemical cleaners to remove this type of efflorescence normally is not necessary. AVOID USING ACIDS, PARTICULARLY MURIATIC ACID.

1.1.3.8 General cleaning of brick masonry (GSA 2017c)

U.S. General Services Administration

General Cleaning of Exterior Brick Masonry

Procedure code:

421104S

Source:

National Capitol Region Specifications

Division:

Masonry

Section:

Brick Unit Masonry

Last Modified:

12/22/2017

GENERAL CLEANING OF EXTERIOR BRICK MASONRY

PART 1---GENERAL

1.01 SUMMARY

A. This procedure includes guidance on cleaning exterior brick masonry.

B. Safety Precautions:

1. The work specified herein requires knowledge of older materials and methods and a high degree of skill to execute properly. This work should be performed only by an experienced, pre-qualified contractor. It is not recommended that building maintenance personnel perform this work.

2. This outline specification contains recommended materials which may be toxic. The manufacturer's literature on application techniques, appropriate protection for workers and disposal procedures for materials should be complied with in conjunction with all regulatory requirements referenced in this document.

C. See 01100-07-S for general project guidelines to be reviewed along with this procedure. These guidelines cover the following sections:

1. Safety Precautions
2. Historic Structures Precautions
3. Submittals
4. Quality Assurance

5. Delivery, Storage and Handling

6. Project/Site Conditions

7. Sequencing and Scheduling

8. General Protection (Surface and Surrounding)

D. These guidelines should be reviewed prior to performing this procedure and should be followed, when applicable, along with recommendations from the Regional Historic Preservation Officer (RHPO).

1.02 SUBMITTALS

A. Product Data:

1. Submit manufacturer's product literature instructions for use, and Material Safety Data Sheets(MSDS) to the Contracting Officer or the designated representative for all cleaning materials.
2. Prior to commencing the cleaning operations, the Contractor shall submit to the Contracting Officer or the designated representative a written description of the entire methods and procedures proposed for cleaning the masonry including, but not limited to: Method of application, dilution of application, temperature of application, length of time of surface contact, method of rinsing surface (temperature, pressure, and duration), repetition of procedures, etc.
3. Prior to commencing the cleaning operations, the Contractor shall submit to the Contracting Officer or the designated representative for approval, a written description of proposed materials and methods of protection for preventing damage to adjacent materials, vehicular and pedestrian traffic, and the building interior during the cleaning of masonry.

B. Samples:

1. The Contractor shall clean a sample panel(s), approximately 3' x 3' in area, on each type of masonry included in the work of this section for approval by the Contracting Officer. Locations of sample panels to be selected by the Contracting Officer or the designated representative.
2. Adjust the chemical concentrations, working pressures and methodologies during test panel cleaning, as directed by the Contracting Officer or the designated representative.
3. Sample panels shall be cleaned by the Contractor using methods, materials, and working pressures previously submitted and approved. Sample panel cleaning shall be performed in the presence of the Contracting Officer or the designated representative. The working pressures during sample panel cleaning shall be varied up to the previously submitted and approved capacities to determine the best working pressure.
4. Where chemical cleaners and poultices are tested, the manufacturer's representative shall be present during testing.
5. The Contractor shall obtain written approval from the Contracting Officer or the designated representative of cleaning methods, working pressures, materials, equipment used and sample panels before proceeding with building cleaning operations. For this written approval purpose, the Contractor shall allow a minimum of seven calendar days after completion of sample cleaning to permit the Contracting Officer or the designated representative to study the sample panels for negative

reaction. Retain approved panels in unaltered condition, suitably designated during construction as a standard for judging completed work.

1.03 QUALITY ASSURANCE

A. Qualifications:

1. Comply with municipal and federal regulations governing all work included in this section and including, but not limited to waste disposal.
2. General Objective: The objectives of masonry cleaning are to remove dirt, grime and coatings from masonry without damaging underlying material and to give all masonry a clean, uniform appearance without blotches, streaks, runs, or any other kind of spotty appearance. Too aggressive cleaning shall not be acceptable.
3. Cleaning Standard: Prepare sample panels for approval which shall establish a standard for general brick and stone cleaning. General cleaning shall not commence until written approval is obtained from the Contracting Officer or the designated representative.
4. Contractor: The work of this section shall be performed by a specialist possessing a minimum of five (5) years of specialized experience in the cleaning of historic architectural masonry similar to that which is required by this project. Contractors shall submit to the Contracting Officer or the designated representative references of previous work justifying their experience. The Contracting Officer or the designated representative reserves the right to approve or disapprove the use of Contractors contingent upon their experience.
5. In the event that the Contractor wishes to modify any cleaning method specified, he shall submit his proposal in writing for consideration and review. The Contracting Officer or the designated representative will have the right to ask for test samples before final approval. Any such modifications or changes shall be at no additional cost to the Government.

B. Regulatory Requirements: Comply with municipal and Federal regulations governing the cleaning, chemical waste disposal, product safety, scaffolding and protection to workers and adjacent properties.

1.04 PROJECT/SITE CONDITIONS

A. Environmental Requirements:

1. No cleaning shall be executed when air or masonry surface temperature is below 45 degrees (F.), unless adequate, approved means are provided for maintaining a 45 degrees (F.), temperature of the air and materials during, and for 48 hours subsequent to, cleaning.
2. Perform cleaning and washing of the exterior masonry only during hours of natural daylight

PART 2---PRODUCTS

2.01 MANUFACTURERS

A. ProSoCo, Inc.

B. Diedrich Technologies, Inc.

2.02 MATERIALS

A. Masonry Cleaner: Commercially available very mild blend of inhibited acidic ingredients and wetting agents specifically formulated for restorative cleaning of brick and natural stone surfaces such as "Sure Klean Restoration Cleaner" (ProSoCo, Inc.), "101 G Granite, Terra Cotta and Brick Resoration Cleaner" (Diedrich Technologies), or approved equal.

Masonry cleaner should have the following physical characteristics:

Form: Clear liquid

pH: 1.2

Specific Gravity (Typical): 1.05

B. Water: Potable, non-staining and free of oils, acids, alkalis and organic matter.

C. Liquid Strippable Masking Agent: Manufacturer's standard liquid, film forming, strippable masking material for protecting glass, metal and polished stone surfaces from damaging effect of acidic and alkaline masonry cleaners, such as "Sure Klean Strippable Masking" (ProSoCo, Inc.), or approved equal.

2.03 EQUIPMENT

A. Brushes: Natural fiber bristle only. The use of wire brushes or steel wool is not permitted.

B. Garden hose with fan tip nozzles

PART 3---EXECUTION

3.01 PREPARATION

A. Protection:

1. Take all necessary precautions and measures to protect surrounding materials on the site, surfaces of the building not being cleaned, adjacent buildings, pedestrians and vehicles from coming in contact with cleaning chemicals, over spray, or runoff. Products used for masonry cleaning may be harmful to painted, polished, glazed, or metallic surfaces. Any damage to materials caused by the cleaning operations is unacceptable and shall be repaired or replaced by the Contractor to the satisfaction of the Contracting Officer or the designated representative at no cost to the Government.

2. Provide protection from water damage to building, structure, or building contents as required.

3. Protect trees and plants around the building from contamination or damage as directed by the Contracting Officer or the designated representative. The Contractor shall be responsible for replacing with new stock any trees, shrubs, perennials, annuals, or grass damaged by the cleaning operations.

4. Test all drains and other water removal systems to assure that drains and systems are functioning properly prior to performing any cleaning operations. Notify Contracting Officer or the designated representative immediately of any and all drains or systems that are found to be stopped or blocked. Contractor shall repair drains if so directed by the Contracting

Officer or the designated representative. Do not begin work of this Section until the drains are in working order.

5. Provide a method to prevent solids such as stone or mortar residue from entering the drains or drain lines. Contractor shall be responsible for cleaning out drains and drain lines that become blocked or filled by sand or other solids because of work performed under this Contract.

3.03 ERECTION, INSTALLATION, APPLICATION

A. Dilute masonry cleaner with 16 parts water to 1 part concentrate, or use appropriate dilution based on sample panel cleaning. When diluting, always pour water into empty bucket first, then carefully add concentrate. Handle in rubber or polyethylene buckets only. Acidic liquids and fumes will attack metal.

B. After protecting all non-masonry surfaces, thoroughly wet the area to be cleaned.

C. Apply the cleaning solution liberally using low pressure spray (50 psi), roller or densely filled (tampico) masonry washing brush. Do not apply restoration cleaner with high pressure spray. Such application will drive the chemicals deep into the surface, making it difficult to rinse completely. Discoloration to the surface may result.

D. Allow the cleaning solution to remain on the surface for three to five minutes in accordance with approved test procedures. Light scrubbing of the surface will improve cleaning results. Caution: Do not allow cleaning solution to "dry in" to the masonry as bleaching may result.

1. Begin rinsing with low pressure flood rinse to remove initial acidic residue with minimum risk of wind drift.

2. Then rinse the treated area thoroughly using pressurized cold water. Rinse water pressure shall not exceed 300 psi, and shall be sprayed through nozzles fitted with 15 to 20" wide tips. Nozzles shall be held perpendicular to the surface at a working distance of 1.4 to 2.0 feet. All pressure pumps shall be equipped with working pressure gauges.

3. Rinse from the bottom of the treated area to the top flushing each section of the surface with a concentrated stream of water. To avoid streaking on vertical walls, take care to keep the wall below wet and rinsed free of cleaner and residues.

4. Application of rinse water is extremely important to assure that all surface staining matters and cleaning residues are thoroughly flushed from the treated surface.

E. Surrounding stone surfaces below the section of brick to be cleaned shall be pre-wetted and rinsed periodically during cleaning operations to prevent etching of stone.

F. The surfaces below the sections of brick to be cleaned shall be protected from run-off.

G. Repeat procedures if necessary to remove heavier build-up of soiling.

1.1.3.9 Dangers of abrasive cleaning – Preservation Brief #6 (Grimmer 1979)

Technical Preservation Services

National Park Service
U.S. Department of the Interior

[Home](#) > [How to Preserve](#) > [Preservation Briefs](#) > 6 Dangers of Abrasive Cleaning

Some of the web versions of the Preservation Briefs differ somewhat from the printed versions. Many illustrations are new and in color; Captions are simplified and some complex charts are omitted. To order hard copies of the Briefs, see [Printed Publications](#)®.

PRESERVATION BRIEFS

6

Dangers of Abrasive Cleaning to Historic Buildings

Anne E. Grimmer

[What is Abrasive Cleaning?](#)

[Why are Abrasive Cleaning Methods Used?](#)

[Problems of Abrasive Cleaning](#)

[How Building Materials React to Abrasive Cleaning](#)

[When is Abrasive Cleaning Permissible?](#)

[Do Not Abrasively Clean these Historic Interiors](#)

[Mitigating the Effects of Abrasive Cleaning](#)

[Summary and References](#)

[Reading List](#)

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Undamaged historic brick (above). Sandblasted brick (below). Photo: Courtesy, Illinois Historic Preservation Agency.

"Chemical or physical treatments, such as sandblasting, that cause damage to historic materials shall not be used. The surface cleaning of structures, if appropriate, shall be undertaken using the gentlest means possible." —**The Secretary of the Interior's Standards for Rehabilitation.**

Abrasive cleaning methods are responsible for causing a great deal of damage to historic building materials. To prevent indiscriminate use of these potentially harmful techniques, this brief has been prepared to explain abrasive cleaning methods, how they can be physically and aesthetically destructive to historic building materials, and why they generally are not acceptable preservation treatments for historic structures. There are alternative, less harsh means of cleaning and removing paint and stains from historic buildings. However, careful testing should precede general cleaning to assure that the method selected will not have an adverse effect on the building materials. A historic building is irreplaceable, and should be cleaned using only the "gentlest means possible" to best preserve it.

What is Abrasive Cleaning?

Abrasive cleaning methods include all techniques that physically abrade the building surface to remove soils, discolorations or coatings. Such techniques involve the use of certain *materials* which impact or abrade the surface under pressure, or abrasive *tools and equipment*. Sand, because it is readily available, is probably the most commonly used type of grit material. However, any of the following materials may be substituted for sand, and all can be classified as abrasive substances: ground slag or volcanic ash, crushed (pulverized) walnut or almond shells, rice husks, ground corncobs, ground coconut shells, crushed eggshells, silica flour, synthetic

particles, glass beads and micro-balloons. Even *water* under pressure can be an abrasive substance. Tools and equipment that are abrasive to historic building materials include wire brushes, rotary wheels, power sanding disks and belt sanders.

The use of water in combination with grit may also be classified as an abrasive cleaning method. Depending on the manner in which it is applied, water may soften the impact of the grit, but water that is too highly pressurized can be very abrasive. There are basically two different methods which can be referred to as "wet grit," and it is important to differentiate between the two. One technique involves the addition of a stream of water to a regular sandblasting nozzle. This is done primarily to cut down dust, and has very little, if any, effect on reducing the aggressiveness, or cutting action of the grit particles. With the second technique, a very small amount of grit is added to a pressurized water stream. This method may be controlled by regulating the amount of grit fed into the water stream, as well as the pressure of the water.

Abrasive cleaning can cause permanent damage to historic fabric, such as this brick wall. Photo: NPS files.

Why Are Abrasive Cleaning Methods Used?

Usually, an abrasive cleaning method is selected as an expeditious means of quickly removing years of dirt accumulation, unsightly stains, or deteriorating building fabric or finishes, such as stucco or paint.

Brick molding next to the window has been severely abraded by sandblasting to remove paint. Photo: NPS files.

The fact that sandblasting is one of the best known and most readily available building cleaning treatments is probably the major reason for its frequent use.

Many mid-19th century brick buildings were painted immediately or soon after completion to protect poor quality brick or to imitate another material, such as stone. Sometimes brick buildings were painted in an effort to produce what was considered a more harmonious relationship between a building and its natural surroundings. By the 1870s, brick buildings were often left unpainted as mechanization in the brick industry brought a cheaper pressed brick and fashion decreed a sudden preference for dark colors. However, it was still customary to paint brick of poorer quality for the additional protection the paint afforded.

It is a common 20th century misconception that all historic masonry buildings were initially unpainted. If the intent of a modern restoration is to return a building to its original appearance, removal of the paint not only may be historically inaccurate, but also harmful. Many older buildings were painted or stuccoed at some point to correct recurring maintenance problems caused by faulty construction techniques, to hide alterations, or in an attempt to solve moisture problems. If this is the case, removal of paint or stucco may cause these problems to reoccur.

Another reason for paint removal, particularly in rehabilitation projects, is to give the building a "new image" in response to contemporary design trends and to attract investors or tenants. Thus, it is necessary to consider the purpose of the intended cleaning. While it is clearly important to remove unsightly stains, heavy encrustations of dirt, peeling paint or other surface coatings, it may not be equally desirable to remove paint from a building which originally was painted. Many historic buildings which show only a slight amount of soil or discoloration are much better left as they are.

A thin layer of soil is more often protective of the building fabric than it is harmful, and seldom detracts from the building's architectural and/or historic character. Too thorough cleaning of a historic building may not only sacrifice some of the building's character, but also, misguided cleaning efforts can cause a great deal of damage to historic building fabric. Unless there are stains, graffiti or dirt and pollution deposits which are destroying the building fabric, it is generally preferable to do as little cleaning as possible, or to repaint where necessary. It is important to remember that a historic building does not have to look as if it were newly constructed to be an attractive or successful restoration or rehabilitation project.

Problems of Abrasive Cleaning

The crux of the problem is that abrasive cleaning is just that--abrasive. An abrasively cleaned historic structure may be physically as well as aesthetically damaged. Abrasive methods "clean" by eroding dirt or paint, but at the same time they also tend to erode the surface of the building material. In this way, abrasive cleaning is destructive and causes irreversible harm to the historic building fabric. If the fabric is brick, abrasive methods remove the hard, outer protective surface, and therefore make the brick more susceptible to rapid weathering and deterioration.

Grit blasting may also increase the water permeability of a brick wall. The impact of the grit particles tends to erode the bond between the mortar and the brick, leaving cracks or enlarging existing cracks where water can enter. Some types of stone develop a protective

patina or "quarry crust" parallel to the worked surface (created by the movement of moisture towards the outer edge), which also may be damaged by abrasive cleaning. The rate at which the material subsequently weathers depends on the quality of the inner surface that is exposed.

Abrasive cleaning can destroy, or substantially diminish, decorative detailing on buildings such as a molded brickwork or architectural terra-cotta, ornamental carving on wood or stone, and evidence of historic craft techniques, such as tool marks and other surface textures.

In addition, perfectly sound and/or "tooled" mortar joints can be worn away by abrasive techniques. This not only results in the loss of historic craft detailing but also requires repointing, a step involving considerable time, skill and expense, and which might not have been necessary had a gentler method been chosen. Erosion and pitting of the building material by abrasive cleaning creates a greater surface area on which dirt and pollutants collect. In this sense, the building fabric "attracts" more dirt, and will require more frequent cleaning in the future.

In addition to causing physical and aesthetic harm to the historic fabric, there are several adverse environmental effects of dry abrasive cleaning methods. Because of the friction caused by the abrasive medium hitting the building fabric, these techniques usually create a considerable amount of dust, which is unhealthy, particularly to the operators of the abrasive equipment. It further pollutes the environment around the job site, and deposits dust on neighboring buildings, parked vehicles and nearby trees and shrubbery. Some adjacent materials not intended for abrasive treatment such as wood or glass, may also be damaged because the equipment may be difficult to regulate.

Wet grit methods, while eliminating dust, deposit a messy slurry on the ground or other objects surrounding the base of the building. In colder climates where there is the threat of frost, any wet cleaning process applied to historic masonry structures must be done in warm weather, allowing ample time for the wall to dry out thoroughly before cold weather sets in. Water which remains and freezes in cracks and openings of the masonry surface eventually may lead to spalling. High-pressure wet cleaning may force an inordinate amount of water into the walls, affecting interior materials such as plaster or joist ends, as well as metal building components within the walls.

On the left, grit blasting has obliterated the vertical tooling marks from granite, a very dense stone. Photo: NPS files.

Variable Factors

The greatest problem in developing practical guidelines for cleaning any historic building is the large number of variable and unpredictable factors involved. Because these variables make each cleaning project unique, it is difficult to establish specific standards at this time. This is particularly true of abrasive cleaning methods because their inherent potential for causing damage is multiplied by the following factors:

- the type and condition of the material being cleaned
- the size and sharpness of the grit particles or the mechanical equipment
- the pressure with which the abrasive grit or equipment is applied to the building surface
- the skill and care of the operator, and
- the constancy of the pressure on all surfaces during the cleaning process.

Pressure: The damaging effects of most of the variable factors involved in abrasive cleaning are self evident. However, the matter of pressure requires further explanation. In cleaning specifications, pressure is generally abbreviated as "psi" (pounds per square inch), which technically refers to the "tip" pressure, or the amount of pressure at the nozzle of the blasting apparatus. Sometimes "psig," or pressure at the gauge (which may be many feet away, at the other end of the hose), is used in place of "psi." These terms are often incorrectly used interchangeably.

Despite the apparent care taken by most architects and building cleaning contractors to prepare specifications for pressure cleaning which will not cause harm to the delicate fabric of a historic building, it is very difficult to ensure that the same amount of pressure is applied to all parts of the building. For example, if the operator of the pressure equipment stands on the ground while cleaning a two-story structure, the amount of force reaching the first story will be greater than that hitting the second story, even if the operator stands on scaffolding or in a cherry picker, because of the "line drop" in the distance from the pressure source to the nozzle. Although technically it may be possible to prepare cleaning specifications with tight controls that would eliminate all but a small margin of error, it may not be easy to find professional cleaning firms willing to work under such restrictive conditions. The fact is that many professional building cleaning firms do not really understand the extreme delicacy of historic building fabric, and how it differs from modern construction materials. Consequently, they may accept building cleaning projects for which they have no experience.

Bronze statuary may be cleaned gently using crushed walnut shells. Photo: NPS files.

The amount of pressure used in any kind of cleaning treatment which involves pressure, whether it is dry or wet grit, chemicals or just plain water, is crucial to the outcome of the cleaning project. Unfortunately, no standards have been established for determining the correct pressure for cleaning each of the many historic building materials which would not cause harm. The considerable discrepancy between the way the building cleaning industry and architectural conservators define "high" and "low" pressure cleaning plays a significant role in the difficulty of creating standards.

Non-historic/Industrial: A representative of the building cleaning industry might consider "high" pressure water cleaning to be anything over 5,000 psi, or even as high as 10,000 to 15,000 psi! Water under this much pressure may be necessary to clean industrial structures or machinery, but would destroy most historic building materials. Industrial chemical cleaning commonly utilizes pressures between 1,000 and 2,500 psi.

Historic: By contrast, conscientious dry or wet abrasive cleaning of a historic structure would be conducted within the range of 20 to 100 psi at a range of 3 to 12 inches. Cleaning at this low pressure requires the use of a very fine 00 or 0 mesh grit forced through a nozzle with a 1/4-inch opening. A similar, even more delicate method being adopted by architectural conservators uses a micro-abrasive grit on small, hard-to-clean areas of carved, cut or molded ornament on a building facade. Originally developed by museum conservators for cleaning sculpture, this technique may employ glass beads, micro-balloons, or another type of micro-abrasive gently powered at approximately 40 psi by a very small, almost pencil-like pressure instrument. Although a slightly larger pressure instrument may be used on historic buildings, this technique still has limited practical applicability on a large scale building cleaning project because of the cost and the relatively few technicians competent to handle the task. In general, architectural conservators have determined that only through very controlled conditions can most historic building material be abrasively cleaned of soil or paint without measurable damage to the surface or profile of the substrate.

Yet some professional cleaning companies which specialize in cleaning historic masonry buildings use chemicals and water at a pressure of approximately 1,500 psi, while other cleaning firms recommend lower pressures ranging from 200 to 800 psi for a similar project. An architectural conservator might decide, after testing, that some historic structures could be cleaned properly using a moderate pressure (200-600 psi), or even a high pressure (600-1800 psi) water rinse. However, cleaning historic buildings under such high pressure should be considered an exception rather than the rule, and would require *very careful* testing and supervision to assure that the historic surface materials could withstand the pressure without gouging, pitting or loosening.

These differences in the amount of pressure used by commercial or industrial building cleaners and architectural conservators point to one of the main problems in using abrasive means to clean historic buildings: misunderstanding of the potentially fragile nature of historic building materials. There is no one cleaning formula or pressure suitable for all situations. Decisions regarding the proper cleaning process for historic structures can be made only after careful analysis of the building fabric, and testing.

How Building Materials React to Abrasive Cleaning

Brick and Architectural Terra-cotta: Abrasive blasting does not affect all building materials to the same degree. Such techniques quite logically cause greater damage to softer and more porous materials, such as brick or architectural terra-cotta. When these materials are cleaned abrasively, the hard, outer layer (closest to the heat of the kiln) is eroded, leaving the soft, inner core exposed and susceptible to accelerated weathering. Glazed architectural terra-cotta and ceramic veneer have a baked on glaze which is also easily damaged by abrasive cleaning. Glazed architectural terra-cotta was designed for easy maintenance, and generally can be cleaned using detergent and water; but chemicals or steam may be needed to remove more persistent stains. Large areas of brick or architectural terra-cotta which have been painted are best left painted, or repainted if necessary.

Plaster and Stucco: Plaster and stucco are types of masonry finish materials that are softer than brick or terra-cotta; if treated abrasively these materials will simply disintegrate. Indeed, when plaster or stucco is treated abrasively it is usually with the intention of removing the plaster or stucco from whatever base material or substrate it is covering. Obviously, such abrasive techniques should not be applied to clean sound plaster or stuccoed walls, or decorative plaster wall surfaces.

Building Stones: Building stones are cut from the three main categories of natural rock: dense, igneous rock such as granite; sandy, sedimentary rock such as limestone or sandstone; and crystalline, metamorphic rock such as marble. As opposed to kiln-dried masonry materials such as brick and architectural terra-cotta, building stones are generally homogeneous in character at the time of a building's construction. However, as the stone is exposed to weathering and

environmental pollutants, the surface may become friable, or may develop a protective skin or patina. These outer surfaces are very susceptible to damage by abrasive or improper chemical cleaning.

Building stones are frequently cut into ashlar blocks or "dressed" with tool marks that give the building surface a specific texture and contribute to its historic character as much as ornately carved decorative stonework. Such detailing is easily damaged by abrasive cleaning techniques; the pattern of tooling or cutting is erased, and the crisp lines of moldings or carving are worn or pitted.

Occasionally, it may be possible to clean small areas of rough-cut granite, limestone or sandstone having a heavy dirt encrustation by using the "wet grit" method, whereby a small amount of abrasive material is injected into a controlled, pressurized water stream. However, this technique requires very careful supervision in order to prevent damage to the stone. Polished or honed marble or granite should never be treated abrasively, as the abrasion would remove the finish in much the way glass would be etched or "frosted" by such a process. It is generally preferable to underclean, as too strong a cleaning procedure will erode the stone, exposing a new and increased surface area to collect atmospheric moisture and dirt. Removing paint, stains or graffiti from most types of stone may be accomplished by a chemical treatment carefully selected to best handle the removal of the particular type of paint or stain without damaging the stone. (See section on the "Gentlest Means Possible.")

Very high-pressure water has scarred this granite. Photo: NPS files.

Wood: Most types of wood used for buildings are soft, fibrous and porous, and are particularly susceptible to damage by abrasive cleaning. Because the summer wood between the lines of the grain is softer than the grain itself, it will be worn away by abrasive blasting or power tools, leaving an uneven surface with the grain raised and often frayed or "fuzzy." Once this has occurred, it is almost impossible to achieve a smooth surface again except by extensive hand sanding, which is expensive and will quickly negate any costs saved earlier by sandblasting. Such harsh cleaning treatment also obliterates historic tool marks, fine carving and detailing, which precludes its use on any interior or exterior woodwork which has been hand planed, milled or carved.

Metals: Like stone, metals are another group of building materials which vary considerably in hardness and durability. Softer metals which are used architecturally, such as tin, zinc, lead, copper or aluminum, generally should not be cleaned abrasively as the process deforms and destroys the original surface texture and appearance, as well as the acquired patina.

Decorative pressed metal interior or exterior features should not be cleaned abrasively. Photo: NPS files.

Much applied architectural metal work used on historic buildings--tin, zinc, lead and copper--is often quite thin and soft, and therefore susceptible to denting and pitting. Galvanized sheet metal is especially vulnerable, as abrasive treatment would wear away the protective galvanized layer.

In the late 19th and early 20th centuries, these metals were often cut, pressed or otherwise shaped from sheets of metal into a wide variety of practical uses such as roofs, gutters and flashing, and facade ornamentation such as cornices, friezes, dormers, panels, cupolas, oriel windows, etc. The architecture of the 1920s and 1930s made use of metals such as chrome, nickel alloys, aluminum and stainless steel in decorative exterior panels, window frames, and doorways. Harsh abrasive blasting would destroy the original surface finish of most of these metals, and would increase the possibility of corrosion.

However, conservation specialists are now employing a sensitive technique of glass bead peening to clean some of the harder metals, in particular large bronze outdoor sculpture. Very fine (75125 micron) glass beads are used at a low pressure of 60 to 80 psi. Because these glass beads are completely spherical, there are no sharp edges to cut the surface of the metal. After cleaning, these

statues undergo a lengthy process of polishing. Coatings are applied which protect the surface from corrosion, but they must be renewed every 3 to 5 years. A similarly delicate cleaning technique employing glass beads has been used in Europe to clean historic masonry structures without causing damage. But at this time the process has not been tested sufficiently in the United States to recommend it as a building conservation measure.

Sometimes a very fine smooth sand is used at a low pressure to clean or remove paint and corrosion from copper flashing and other metal building components. Restoration architects recently found that a mixture of crushed walnut shells and copper slag at a pressure of approximately 200 psi was the only way to remove corrosion successfully from a mid-19th century terne-coated iron roof. Metal cleaned in this manner must be painted immediately to prevent rapid recurrence of corrosion. It is thought that these methods "work harden" the surface by compressing the outer layer, and actually may be good for the surface of the metal. But the extremely complex nature and the time required by such processes make it very expensive and impractical for large-scale use at this time.

Cast and wrought iron architectural elements may be gently sandblasted or abrasively cleaned using a wire brush to remove layers of paint, rust and corrosion. Sandblasting was, in fact, developed originally as an efficient maintenance procedure for engineering and industrial structures and heavy machinery--iron and steel bridges, machine tool frames, engine frames, and railroad rolling stock--in order to clean and prepare them for repainting. Because iron is hard, its surface, which is naturally somewhat uneven, will not be noticeably damaged by controlled abrasion. Such treatment will, however, result in a small amount of pitting. But this slight abrasion creates a good surface for paint, since the iron must be repainted immediately to prevent corrosion. Any abrasive cleaning of metal building components will also remove the caulking from joints and around other openings. Such areas must be recaulked quickly to prevent moisture from entering and rusting the metal, or causing deterioration of other building fabric inside the structure.

Cast iron may be abrasively cleaned, but must be painted immediately to prevent rust. Photo: NPS files.

When is Abrasive Cleaning Permissible?

For the most part, abrasive cleaning is destructive to historic building materials. A limited number of special cases have been explained when it may be appropriate, if supervised by a skilled conservator, to use a delicate abrasive technique on some historic building materials. The type of "wet grit" cleaning which involves a small amount of grit injected into a stream of low pressure water may be used on small areas of stone masonry (i.e., rough cut limestone, sandstone or unpolished granite), where milder cleaning methods have not been totally successful in removing harmful deposits of dirt and pollutants. Such areas may include stone window sills, the tops of cornices or column capitals, or other detailed areas of the facade.

Industrial interiors that are not finely milled may be abrasively cleaned, in some instances. Photo: NPS files.

This is still an abrasive technique, and without proper caution in handling, it can be *just as harmful to the building surface as any other abrasive cleaning method*. Thus, the decision to use this type of "wet grit" process should be made only after consultation with an experienced building conservator.

Remember that it is very time consuming and expensive to use any abrasive technique on a historic building in such a manner that it does not cause harm to the often fragile and friable building materials.

At this time, and only under certain circumstances, abrasive cleaning methods may be used in the rehabilitation of interior spaces of warehouse or industrial buildings for contemporary uses.

Interior spaces of factories or warehouse structures in which the masonry or plaster surfaces do not have significant design, detailing, tooling or finish, and in which wooden architectural features are not finished, molded, beaded or worked by hand, may be cleaned abrasively in order to remove layers of paint and industrial discolorations such as smoke, soot, etc. It is expected after such treatment that brick surfaces will be rough and pitted, and wood will be somewhat frayed or "fuzzy" with raised wood grain. These nonsignificant surfaces will be damaged and have a roughened texture, but because they are interior elements, they will not be subject to further deterioration caused by weathering.

Historic Interiors That Should Not Be Cleaned Abrasively

Those instances (generally industrial and some commercial properties), when it may be acceptable to use an abrasive treatment on the interior of historic structures have been described. But for the majority of historic buildings, the Secretary of the Interior's *Guidelines for Rehabilitation* do not recommend "changing the texture of exposed wooden architectural features (including structural members) and masonry surfaces through sandblasting or use of other abrasive techniques to remove paint, discolorations and plaster.

Thus, it is not acceptable to clean abrasively interiors of historic residential and commercial properties which have *finished* interior spaces featuring milled woodwork such as doors, window and door moldings, wainscoting, stair balustrades and mantelpieces. Even the most modest historic house interior, although it may not feature elaborate detailing, contains plaster and woodwork that is architecturally significant to the original design and function of the house. Abrasive cleaning of such an interior would be destructive to the historic integrity of the building.

Decorative wood exterior or interior features should not be cleaned abrasively. Photo: NPS files.

Abrasive cleaning is also impractical. Rough surfaces of abrasively cleaned wooden elements are hard to keep clean. It is also difficult to seal, paint or maintain these surfaces which can be splintery and a problem to the building's occupants. The force of abrasive blasting may cause grit particles to lodge in cracks of wooden elements, which will be a nuisance as the grit is loosened by vibrations and gradually sifts out. Removal of plaster will reduce the thermal and insulating value of the walls. Interior brick is usually softer than exterior brick, and generally of a poorer quality. Removing surface plaster from such brick by abrasive means often exposes gaping mortar joints and mismatched or repaired brickwork which was never intended to show. The resulting bare brick wall may require repointing, often difficult to match. It also may be necessary to apply a transparent surface coating (or sealer) in order to prevent the mortar and brick from "dusting." However, a sealer may not only change the color of the brick, but may also compound any existing moisture problems by restricting the normal evaporation of water vapor from the masonry surface.

"Gentlest Means Possible"

There are alternative means of removing dirt, stains and paint from historic building surfaces that can be recommended as more efficient and less destructive than abrasive techniques. The "gentlest means possible" of removing dirt from a building surface can be achieved by using a low-pressure water wash, scrubbing areas of more persistent grime with a natural bristle (never metal) brush. Steam cleaning can also be used effectively to clean some historic building fabric. Low-pressure water or steam will soften the dirt and cause the deposits to rise to the surface, where they can be washed away.

A third cleaning technique which may be recommended to remove dirt, as well as stains, graffiti or paint, involves the use of commercially available chemical cleaners or paint removers, which, when applied to masonry, loosen or dissolve the dirt or stains. These cleaning agents may be used in combination with water or steam, followed by a clear water wash to remove the residue of dirt and the chemical cleaners from the masonry. A natural bristle brush may also facilitate this type of chemically assisted cleaning, particularly in areas of heavy dirt deposits or stains, and a wooden scraper can be useful in removing thick encrustations of soot. A limewash or absorbent talc, whitening or clay poultice with a solvent can be used effectively to draw out salts or stains from the surface of the selected areas of a building facade. It is almost impossible to remove paint from masonry surfaces without causing some damage to the masonry, and it is best to leave the surfaces as they are or repaint them if necessary.

Some physicists are experimenting with the use of pulsed laser beams and xenon flash lamps for cleaning historic masonry surfaces. At this time it is a slow, expensive cleaning method, but its initial success indicates that it may have an increasingly important role in the future.

There are many chemical paint removers which, when applied to painted wood, soften and dissolve the paint so that it can be scraped off by hand. Peeling paint can be removed from wood by hand scraping and sanding. Particularly thick layers of paint may be softened with a heat gun or heat plate, providing appropriate precautions are taken, and the paint film scraped off by hand. Too much heat applied to the same spot can burn the wood, and the fumes caused by burning paint are dangerous to inhale, and can be explosive. Furthermore, the hot air from heat guns can start fires in the building cavity. Thus, adequate ventilation is important when using a heat gun or heat plate, as well as when using a chemical stripper. A torch or open flame should never be used.

Preparations for Cleaning: It cannot be overemphasized that all of these cleaning methods must be approached with caution. When using any of these procedures which involve water or other liquid cleaning agents on masonry, it is imperative that all openings be tightly covered, and all cracks or joints be well pointed in order to avoid the danger of water penetrating the building's facade, a circumstance which might result in serious moisture related problems such as efflorescence and/or subflorescence. Any time water is used on masonry as a cleaning agent, either in its pure state or in combination with chemical cleaners, it is very important that the work be done in warm weather when there is no danger of frost for several months. Otherwise water which has penetrated the masonry may freeze, eventually causing the surface of the building to crack and spall, which may create another conservation problem more serious to the health of the building than dirt.

Each kind of masonry has a unique composition and reacts differently with various chemical cleaning substances. Water and/or chemicals may interact with minerals in stone and cause new types of stains to leach out to the surface immediately, or more gradually in a delayed reaction. What may be a safe and effective cleaner for certain stain on one type of stone, may leave unattractive discolorations on another stone, or totally dissolve a third type.

Testing: Cleaning historic building materials, particularly masonry, is a technically complex subject, and thus, should never be done without expert consultation and testing. No cleaning project should be undertaken without first applying the intended cleaning agent to a representative test patch area in an inconspicuous location on the building surface. The test patch or patches should be allowed to weather for a period of time, preferably through a complete seasonal cycle, in order to determine that the cleaned area will not be adversely affected by wet or freezing weather or any by-products of the cleaning process.

Mitigating the Effects of Abrasive Cleaning

There are certain restoration measures which can be adopted to help preserve a historic building exterior which has been damaged by abrasive methods. Wood that has been sandblasted will exhibit a frayed or "fuzzed" surface, or a harder wood will have an exaggerated raised grain. The only way to remove this rough surface or to smooth the grain is by laborious sanding. Sandblasted wood, unless it has been extensively sanded, serves as a dustcatcher, will weather faster, and will present a continuing and ever worsening maintenance problem. Such wood, after sanding, should be painted or given a clear surface coating to protect the wood, and allow for somewhat easier maintenance.

There are few successful preservative treatments that may be applied to grit-blasted exterior masonry. Harder, denser stone may have suffered only a loss of crisp edges or tool marks, or other indications of craft technique. If the stone has a compact and uniform composition, it should continue to weather with little additional deterioration. But some types of sandstone, marble and limestone will weather at an accelerated rate once their protective "quarry crust" or patina has been removed.

Softer types of masonry, particularly brick and architectural terra-cotta, are the most likely to require some remedial treatment if they have been abrasively cleaned. Old brick, being essentially a soft, baked clay product, is greatly susceptible to increased deterioration when its hard, outer skin is removed through abrasive techniques. This problem can be minimized by painting the brick. An alternative is to treat it with a clear sealer or surface coating but this will give the brick a glossy, or shiny look. It is usually preferable to paint the brick rather than to apply a transparent sealer since sealers reduce the transpiration of moisture, allowing salts to crystallize as subflorescence that eventually spalls the brick. If a brick surface has been so extensively damaged by abrasive cleaning and weathering that spalling has already begun, it may be necessary to cover the walls with stucco, if it will adhere.

Of course, the application of paint, a clear surface coating (sealer), or stucco to deteriorating masonry means that the historical appearance will be sacrificed in an attempt to conserve the historic building materials. However, the original color and texture will have been changed already by the abrasive treatment. At this point it is more important to try to preserve the brick, and there is little choice but to protect it from "dusting" or spalling too rapidly. As a last resort, in the case of severely spalling brick, there may be no option but to replace the brick--a difficult, expensive (particularly if custom-made reproduction brick is used), and lengthy process. As described earlier, sandblasted interior brick work, while not subject to change of weather, may require the application of a transparent surface coating or painting as a maintenance procedure to contain loose mortar and brick dust. (See [Preservation Briefs No. 1](#) for a more thorough discussion of coatings.)

Metals, other than cast or wrought iron, that have been pitted and dented by harsh abrasive blasting usually cannot be smoothed out. Although fillers may be satisfactory for smoothing a painted surface, exposed metal that has been damaged usually will have to be replaced.

Summary and References

Sandblasting or other abrasive methods of cleaning or paint removal are by their nature destructive to historic building materials and should not be used on historic buildings except in a few well-monitored instances. There are exceptions when certain types of abrasive cleaning may be permissible, but only if conducted by a trained conservator, and if cleaning is necessary for the preservation of the historic structure.

There is no one formula that will be suitable for cleaning all historic building surfaces. Although there are many commercial cleaning products and methods available, it is impossible to state definitively which of these will be the most effective without causing harm to the building fabric. It is often difficult to identify ingredients or their proportions contained in cleaning products; consequently it is hard to predict how a product will react to the building materials to be cleaned. Similar uncertainties affect the outcome of other cleaning methods as they are applied to historic building materials. Further advances in understanding the complex nature of the many variables of the cleaning techniques may someday provide a better and simpler solution to the problems. But until that time, the process of cleaning historic buildings must be approached with caution through trial and error.

It is important to remember that historic building materials are neither indestructible, nor are they renewable. They must be treated in a responsible manner, which may mean little or no cleaning at all if they are to be preserved for future generations to enjoy. If it is in the best interest of the building to clean it, then it should be done "using the gentlest means possible."

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1.1.3.10 Removing dirt from brick (GSA 2016c)

U.S. General Services Administration

Removing Dirt from Brick Masonry

Procedure code:

421109S

Source:

The Brick Industry Association. "Technical Note 20. Cleaning Brickwork". June, 2006.

Division:

Masonry

Section:

Brick Unit Masonry

Last Modified:

08/12/2016

PREFACE

The cleaning or removal of stains from masonry may involve the use of liquids, detergents or solvents which may run off on adjacent material, discolor the masonry or drive the stains deeper into the porous masonry. Use the products and techniques described here only for the combinations of dirt/stain and masonry specified.

PART 1---GENERAL

1.01 SUMMARY

- A. This specification provides guidance on cleaning brick masonry to remove accumulations of surface dirt.
- B. Read "General Project Guidelines" along with this specification. These guidelines should be reviewed prior to performing this procedure and should be followed, when applicable, along with recommendations from the Regional Historic Preservation Officer (RHPO). The guidelines cover the following sections:
  - 1. Safety Precautions
  - 2. Historic Structures Precautions
  - 3. Submittals
  - 4. Quality Assurance
  - 5. Delivery, Storage and Handling
  - 6. Project/Site Conditions
  - 7. Sequencing and Scheduling
  - 8. General Protection (Surface and Surrounding)

PART 2---PRODUCTS

2.01 MANUFACTURERS

A. Diedrich Technologies, Inc.

Schenectady, NY 12303

1-800-283-3888

B. ProSoCo, Inc.

Lawrence, KS 66117

1-800-255-4255

2.02 MATERIALS

A. For Light Dirt:

1. Trisodium Phosphate:

- a. NOTE: THIS CHEMICAL IS BANNED IN SOME STATES SUCH AS CALIFORNIA. REGULATORY INFORMATION AS WELL AS ALTERNATIVE OR EQUIVALENT CHEMICALS MAY BE REQUESTED FROM THE ENVIRONMENTAL PROTECTION AGENCY (EPA) REGIONAL OFFICE AND/OR THE STATE OFFICE OF ENVIRONMENTAL QUALITY.
- b. Strong base-type powdered cleaning material sold under brand names.
- c. Other chemical or common names include Sodium Orthophosphate, Tribasic sodium phosphate, Trisodium orthophosphate, TSP*, Phosphate of soda*.
- d. Potential Hazards: CAUSTIC TO FLESH.
- e. Available from chemical supply house, grocery store or supermarket or hardware store.

2. Laundry detergent.

B. For Heavy Dirt: Muriatic acid (generally available in 18 degree and 20 degree Baume solutions):

1. CAUTION: DO NOT USE MURIATIC ACID ON LIGHT-COLORED BRICKS. THEY ARE MORE SUSCEPTIBLE TO "ACID BURN" THAN DARKER BRICKS.
2. A strong corrosive irritating acid.
3. Other chemical or common names include Chlorhydric acid; Hydrochloric Acid (30-35%); Hydrogen chloride; Marine acid*; Spirit of salt*; Spirit of sea salt*.
4. Potential Hazards: TOXIC; CAUSTIC TO FLESH; CORROSIVE TO CONCRETE, STEEL, WOOD AND GLASS; FLAMMABLE.
5. Available from chemical supply house, drugstore or pharmaceutical supply distributor, or hardware store.

C. For Rough-textured Brick: Oxalic acid (COOH)₂ or (H₂C₂O₄):

1. A poisonous strong acid that occurs in various plants as oxalates and is used especially as a bleaching or cleaning agent and in making dyes.
2. Other chemical or common names include ethanedioic acid.
3. Potential Hazards: TOXIC; CORROSIVE TO CONCRETE, STEEL, WOOD AND GLASS.
4. Available from chemical supply house, dry cleaning supply distributor, drugstore or pharmaceutical supply distributor, hardware store, or photographic supply distributor (not camera shop).

5. Often sold under a manufacturer's brand name; the chemical name may appear on the label.

D. White vinegar or commercial neutralizer such as "101 Masonry Restorer Super Concentrate" (Diedrich Technologies, Inc.) or approved equal.

E. Clean, potable water.

2.02 EQUIPMENT

A. Non-metallic container.

B. Stiff bristle brush.

C. Wooden or other non-metallic scraper.

PART 3---EXECUTION

3.01 ERECTION, INSTALLATION, APPLICATION

NOTE: WHEN CLEANING, AVOID OVERCLEANING. AIM FOR ACHIEVING 85% CLEAN. MOST DAMAGE OCCURS WHEN ATTEMPTING TO CLEAN THE LAST 15%.

NOTE: BEGIN CLEANING BY USING THE GENTLEST METHOD POSSIBLE. TEST CLEAN A SMALL AREA BEFORE ATTEMPTING TO CLEAN LARGE AREAS.

A. Mix solution or cleaner:

1. For light dirt: Mix 1/2 cup (0.14 L) trisodium phosphate and 1/2 cup (0.14 L) laundry detergent in 1 gallon (3.79 L) clean, clear water.

2. For heavy dirt:

a. Mix 9 parts clean water with 1 part muriatic acid in a non-metallic container. POUR ACID INTO WATER, NEVER POUR WATER INTO ACID AS IT MAY CAUSE WATER TO BE SUPER-HEATED.

CAUTION: DO NOT ALLOW METAL TOOLS TO COME IN CONTACT WITH THE ACID. DO NOT MIX THE ACID SOLUTION STRONGER THAN RECOMMENDED AS A STRONGER CONCENTRATION MAY STAIN THE MASONRY SURFACE.

-OR-

b. Use a commercial cleaning compound suitable for use on brick (follow manufacturer's recommended dilution and application instructions).

3. For rough-textured brick: Mix 1 lb (0.45 kg) oxalic acid crystals with 1 gallon (3.79 L) of water.

B. Apply the solution to the brick and scrub the surface using a stiff bristle brush. Allow the solution to remain on the brick for 5 to 10 minutes or as recommended by manufacturer (if proprietary product is used).

C. Use a wooden scraper to remove heavy crusts as necessary. DO NOT USE METAL SCRAPERS OR CHISELS AS METAL MARKS LEFT ON THE BRICK WILL OXIDIZE AND CAUSE STAINING.

D. Thoroughly rinse the surface with clean, clear water and allow to dry.

E. Repeat the process as necessary to achieve the desired level of cleanliness.

F. If acid or commercial cleaner is used, neutralize the surface using white vinegar or a proprietary chemical neutralizer. A neutral pH (7 pH) should be achieved.

1. Allow neutralizer to stand on wall about three minutes before rinsing. DO NOT ALLOW NEUTRALIZER TO DRY!

2. Thoroughly rinse the surface with clean, clear water.
3. Test the pH with litmus paper or phenolphthalein:
  - a. Dissolve a 2" piece of phenolphthalein in denatured alcohol.
  - b. Brush the solution onto the surface.
  - c. If the color of the area where the solution was brushed turns from pink to magenta, there is still chemical residue.
4. Continue to neutralize the surface and test until there is no color change in the phenolphthalein solution or until the litmus paper registers neutral.

1.1.3.11 Removing salts/efflorescence (GSA 2016d)

Removing Salts/Efflorescence From Brick And Stone Masonry

Procedure code:

450002S

Source:

Hspg Prepared For Nps - Sero

Division:

Masonry

Section:

Masonry Restoration & Cleaning

Last Modified:

07/13/2016

REMOVING SALTS/EFFLORESCENCE FROM BRICK AND STONE MASONRY

PART 1---GENERAL

1.01 SUMMARY

- A. This procedure includes guidance on removing salt deposits/efflorescence from brick and stone masonry.
- B. Efflorescence is a condition where white (salt) deposits form on the surface of the masonry. The formation of salts is usually a sign of excessive amounts of moisture in the masonry. Salt deposits on the masonry surface may develop from:
  1. Soluble compounds within the masonry or in the soil.
    - a. In the presence of water, these compounds gradually migrate to the wall surface, where they remain when the water evaporates.
    - b. These types of surface deposits are water soluble and can usually be removed by washing the wall with water from a garden hose supplemented by scrubbing with a stiff bristle brush.
  2. Improper or insufficient rinsing of masonry after chemical cleaning or repointing.
  3. The penetration of rain into the masonry through deteriorated mortar joints and other failures in exterior envelope (lack/failing flashing, expansion joint caulking missing, etc.).
  4. Exposure to air pollution, which can result in the formation of thick sulfate (salt) crusts on the underside of moldings and eaves, areas not regularly washed by rainfall.
  5. Capillary movement of moisture through masonry, the drying out of walls associated with a damp proofing treatment or the elimination of a ground water source may increase the amount of salt at or near the wall surface.
- C. These deposits are generally not harmful to the building, just unattractive. However, they should be washed from the surface as soon as possible. Some salt deposits are water-soluble for only a brief period after reaching the atmosphere. Carbon dioxide in the atmosphere eventually converts these salts into water-insoluble carbonates, which are impossible to remove without the use of acids.

NOTE: THE REMOVAL OF SALT DEPOSITS USING ACID IS NOT DESCRIBED IN THIS PROCEDURE.

1.02 PROJECT/SITE CONDITIONS

A. Environmental Requirements:

1. Do not do exterior wet work when the air temperature is below 40 degrees F.
2. NEVER begin cleaning when there is any likelihood of frost or freezing.

PART 2---PRODUCTS

2.01 MATERIALS

- ##### A. Clean, potable water

2.02 EQUIPMENT

- ##### A. Garden hose and nozzle
- ##### B. Stiff bristle brushes (nonmetallic)
- ##### C. Wood or plastic scrapers

PART 3---EXECUTION

3.01 EXAMINATION

- ##### A. Before proceeding with steps to remove efflorescence, first decide the cause and extent of the problem and make repairs as required:
1. Determine the age of the structure: Efflorescence on older buildings is typically caused by the presence of soluble salts in the construction combined with moisture.
  2. Determine the location of the efflorescence: Examination may show where the water is entering.
    - a. Are the salt crystals accumulating on the joints or on the units?
    - b. Can any changes in the wall composition or in
    - c. the adjacent surroundings be recognized that might show the source of the problem?
  3. Examine the condition of the masonry:
    - a. CAREFULLY EXAMINE the wall for open gaps or cracks in joints and around openings that could allow water to enter the building.
      - 1) Are joints properly caulked or sealed?
      - 2) Are flashings and drips in good condition?
      - 3) Are there open or eroded mortar joints in copings or in sills?
    - b. Carefully note the condition and profile of the mortar joints.
    - c. Repair cracks in masonry and/or repoint as necessary before proceeding with the cleaning operations.
  4. Examine wall sections and details of construction: Carefully examine roof and wall junctures and flashing details for possible sources of moisture entry. Horizontal projects such as cornices and vertical elements such as parapets and chimneys are areas of potential risk.
  5. Examine laboratory test reports on the materials: The problem may stem from the composition or misuse of the material.

3.02 ERECTION, INSTALLATION, APPLICATION

- ##### A. Dry brush the surface with a stiff bristle (nonmetallic) brush, or wash it with clean, clear water from a garden hose, supplemented by scrubbing with a stiff bristle brush if necessary
- ##### B. Remove sulfate crusts using a heavy wooden scraper.

- ##### C. If efflorescence is a persistent problem, it may be necessary to reduce the level of soluble salts present within the masonry. Two methods of masonry desalination are described in 04500-03-R. Refer to this procedure for guidance.

1.1.3.12 Removing biological growth (GSA 2018c)

Removing Biological Growth from Exterior Masonry and Stucco

Procedure code:

420002S

Source:

NPS Southeast Regional Office

Division:

Masonry

Section:

Unit Masonry

Last Modified:

01/04/2018

REMOVING BIOLOGICAL GROWTH FROM EXTERIOR MASONRY AND STUCCO

PART 1---GENERAL

1.01 SUMMARY

A. This procedure includes guidance on removing biological growth such as lichens, algae, mold and mildew from masonry and stucco.

B. Biological growths such as lichens, algae, moss and fungi growing on masonry walls is usually an indication that there is excess moisture in or around the masonry. These growths should be removed, as they attract moisture to the masonry surface and hold it there, which can lead to more serious problems. Lichens and mosses in particular, produce oxalic acid which can damage certain types of historic masonry.

C. See 01100-07-S for general project guidelines to be reviewed along with this procedure. These guidelines cover the following sections:

1. Safety Precautions
2. Historic Structures Precautions
3. Submittals
4. Quality Assurance

5. Delivery, Storage and Handling

6. Project/Site Conditions

7. Sequencing and Scheduling

8. General Protection (Surface and Surrounding)

These guidelines should be reviewed prior to performing this procedure and should be followed, when applicable, along with recommendations from the Regional Historic Preservation Officer (RHPO).

PART 2---PRODUCTS

2.01 MANUFACTURERS

A. ProSoCo, Inc.

2.02 MATERIALS

A. For Removing Mold and Mildew:

1. Non-sudsing ammonia or one of the following bleaches:

CAUTION: DO NOT MIX AMMONIA WITH CHLORINE BLEACHES, A POISONOUS GAS WILL RESULT! DO NOT USE BLEACH ON BIRD DROPPINGS.

Sodium Hypochlorite (NaOCl):

- a. An unstable salt produced usually in aqueous solution and used as a bleaching and disinfecting agent.
- b. Other chemical or common names include Bleaching solution*; Household bleach*; Laundry bleach*; Solution of chlorinated soda*.
- c. Potential Hazards: CORROSIVE TO FLESH.
- d. Available from chemical supply house, grocery store or supermarket, hardware store or janitorial supply distributor.

-OR-

Hydrogen Peroxide (H₂O₂):

- a. An unstable compound used especially as an oxidizing and bleaching agent, an antiseptic, and a propellant.
- b. Other chemical or common names include Peroxide of hydrogen*; Solution of hydrogen dioxide*; Superoxol* (hydrogen peroxide is commonly sold as a 3% solution; Superoxol is a 30% solution. Superoxol causes flesh burns; 3% hydrogen peroxide does not).

c. Potential Hazards: TOXIC (when concentrated); CORROSIVE TO FLESH; FLAMMABLE (in high concentration).

d. Available from chemical supply house, drugstore, pharmaceutical supply distributor, or hardware store.

-OR-

Calcium Hypochlorite (CaCl_2O_2):

a. A white powder used especially as a bleaching agent and disinfectant.

b. Other chemical or common names include Chlorinated calcium oxide; Bleaching powder*; Calcium oxymuriate*; Chloride of lime*; Chlorinated lime*; Hypochlorite of lime*; Oxymuriate of lime*.

c. Potential Hazards: CORROSIVE TO FLESH; FLAMMABLE (WHEN IN CONTACT WITH ORGANIC SOLVENTS).

d. Available from chemical supply house, dry cleaning supply distributor, drugstore or pharmaceutical supply distributor, janitorial supply distributor, swimming pool supply distributor, or water and sanitation supply distributor.

-OR-

Chloramine-T: Chloramine is any of various compounds containing nitrogen and chlorine.

2. Trisodium Phosphate:

NOTE: THIS CHEMICAL IS BANNED IN SOME STATES SUCH AS CALIFORNIA. REGULATORY INFORMATION AS WELL AS ALTERNATIVE OR EQUIVALENT CHEMICALS MAY BE REQUESTED FROM THE ENVIRONMENTAL PROTECTION AGENCY (EPA) REGIONAL OFFICE AND/OR THE STATE OFFICE OF ENVIRONMENTAL QUALITY.

a. Strong base-type powdered cleaning material sold under brand names.

b. Other chemical or common names include Sodium Orthophosphate; Tribasic sodium phosphate; Trisodium orthophosphate; TSP*; Phosphate of soda*.

c. Potential Hazards: CORROSIVE TO FLESH.

d. Available from chemical supply house, grocery store or supermarket or hardware store.

3. Powdered detergent such as "Tide" or approved equal.

B. Proprietary cleaner such as "Limestone Restorer" (ProSoCo, Inc.), or approved equal.

C. Clean, potable water

2.03 EQUIPMENT

A. Garden hose and nozzle

B. Rubber or polyethylene bucket (DO NOT USE A METAL BUCKET AS IT MAY REACT WITH THE CHEMICAL CLEANER AND PRODUCE TOXIC FUMES)

C. Glass or ceramic mixing bowl

D. Knife blade

E. Stiff, natural bristle brushes (non-metallic)

F. Tampico brush, roller or low pressure (50 psi maximum) spray such as pneumatic garden sprayer

G. Rubber gloves

H. Safety glasses

PART 3---EXECUTION

3.01 EXAMINATION

A. Determine the source of excessive moisture, i.e. leaky downspout, standing water, roof overhang, vegetation, etc., and make any necessary repairs before continuing with this task.

B. Determine the type of stain, i.e. algae and lichens, or mold and mildew.

3.02 PREPARATION

A. Protection:

1. Provide adequate wash solutions (i.e. water, soap and towels) before starting the job.

2. Do not spray in the immediate vicinity of unprotected people and animals.

3.03 ERECTION, INSTALLATION, APPLICATION

NOTE: DO NOT ATTEMPT MORE THAN ONE TREATMENT ON A GIVEN AREA UNLESS THE CHEMICALS USED FROM ANY PRIOR TREATMENT HAVE BEEN WASHED AWAY.

A. Removing Lichens and Algae (ONLY):

1. Remove as much plant growth as possible using a knife blade and stiff bristle brush.

2. Water rinse the surface to remove most of the plant material.

a. If the substrate is sound and dense, use low to medium water pressure (100-400 psi).

b. If the masonry is softer, use standard water pressure from the spigot.

3. Allow water to soak plant growth for approximately 30 minutes.

4. Gently scrub the surface with a stiff, natural bristle brush.

5. Thoroughly rinse the surface again with clean, clear water at low pressure from a garden hose.

NOTE: DO NOT USE ANY CHEMICALS WITHOUT FIRST CONSULTING WITH RHPO.

B. Removing Mold and Mildew (ONLY):

CAUTION: DO NOT MIX AMMONIA WITH CHLORINE BLEACHES, A POISONOUS GAS WILL RESULT!

1. Mix the following:

3 oz. (2/3 cup) trisodium phosphate (TSP) cleaner

1 oz. (1/3 cup) powdered detergent (i.e. Tide)

1 qt. 5% sodium hypochlorite bleach (laundry bleach)

3 qts. warm water

-OR-

1 part ammonia with 3 parts water

2. Apply the solution to the affected area and scrub with a medium-hard natural bristle brush. Keep the surface saturated until the stain is bleached,

CAUTION: BE SURE TO WEAR RUBBER GLOVES AND SAFETY GLASSES WHEN APPLYING THE SOLUTION.

3. Thoroughly rinse the surface with clean, clear water from a garden hose and allow to dry.

4. Repeat the process as necessary to achieve the desired level of cleanliness.

-OR-

C. For treating any of the above (lichens, algae, mold or mildew), try using a proprietary cleaner such as Limestone Restorer (ProSoCo, Inc.), or approved equal.

1. Add 1 part Limestone Restorer to 3 parts water and mix in a rubber or polyethylene bucket.

2. Apply a flood coat of this mixture to the masonry using a low pressure spray (approximately 50 psi).

CAUTION: DO NOT USE A HIGH PRESSURE SPRAY WHEN APPLYING THIS SOLUTION AS THIS MAY CAUSE THE SOLUTION TO BE DRIVEN DEEPER INTO THE PORES OF THE MASONRY, MAKING REMOVAL OF THE

SOLUTION DIFFICULT.

- a. Begin spraying at the top of the vertical surface and move across horizontally. Allow 100mm rundown.
- b. Continue the next horizontal pass across the previous run down.
- c. Allow the solution to remain on the surface approximately 5-30 minutes depending upon the thickness of the growth.
- d. Gently scrub the surface with a stiff, natural bristle brush.
- e. Thoroughly rinse the treated area using pressure-applied water (approximately 400 to 1500 psi) with a 40-60 degree fan spray or garden hose with nozzle adjusted to a tight stream. Rinse from the bottom of the treated area to the top.
- f. Allow the surface to dry a minimum of 24 hours.

1.1.3.13 Chemically removing paint and repainting (GSA 2016e)

U.S. General Services Administration

Removing Biological Growth from Exterior Masonry and Stucco

Procedure code:

420002S

Source:

NPS Southeast Regional Office

Division:

Masonry

Section:

Unit Masonry

Last Modified:

01/04/2018

REMOVING BIOLOGICAL GROWTH FROM EXTERIOR MASONRY AND STUCCO

PART 1---GENERAL

1.01 SUMMARY

A. This procedure includes guidance on removing biological growth such as lichens, algae, mold and mildew from masonry and stucco.

B. Biological growths such as lichens, algae, moss and fungi growing on masonry walls is usually an indication that there is excess moisture in or around the masonry. These growths should be removed, as they attract moisture to the masonry surface and hold it there, which can lead to more serious problems. Lichens and mosses in particular, produce oxalic acid which can damage certain types of historic masonry.

C. See 01100-07-S for general project guidelines to be reviewed along with this procedure. These guidelines cover the following sections:

1. Safety Precautions
2. Historic Structures Precautions
3. Submittals
4. Quality Assurance

5. Delivery, Storage and Handling

6. Project/Site Conditions

7. Sequencing and Scheduling

8. General Protection (Surface and Surrounding)

These guidelines should be reviewed prior to performing this procedure and should be followed, when applicable, along with recommendations from the Regional Historic Preservation Officer (RHPO).

PART 2---PRODUCTS

2.01 MANUFACTURERS

A. ProSoCo, Inc.

2.02 MATERIALS

A. For Removing Mold and Mildew:

1. Non-sudsing ammonia or one of the following bleaches:

CAUTION: DO NOT MIX AMMONIA WITH CHLORINE BLEACHES, A POISONOUS GAS WILL RESULT! DO NOT USE BLEACH ON BIRD DROPPINGS.

Sodium Hypochlorite (NaOCl):

- a. An unstable salt produced usually in aqueous solution and used as a bleaching and disinfecting agent.
- b. Other chemical or common names include Bleaching solution*; Household bleach*; Laundry bleach*; Solution of chlorinated soda*.
- c. Potential Hazards: CORROSIVE TO FLESH.
- d. Available from chemical supply house, grocery store or supermarket, hardware store or janitorial supply distributor.

-OR-

Hydrogen Peroxide (H₂O₂):

- a. An unstable compound used especially as an oxidizing and bleaching agent, an antiseptic, and a propellant.
- b. Other chemical or common names include Peroxide of hydrogen*; Solution of hydrogen dioxide*; Superoxol* (hydrogen peroxide is commonly sold as a 3% solution; Superoxol is a 30% solution. Superoxol causes flesh burns; 3% hydrogen peroxide does not).

c. Potential Hazards: TOXIC (when concentrated); CORROSIVE TO FLESH; FLAMMABLE (in high concentration).

d. Available from chemical supply house, drugstore, pharmaceutical supply distributor, or hardware store.

-OR-

Calcium Hypochlorite (CaCl_2O_2):

a. A white powder used especially as a bleaching agent and disinfectant.

b. Other chemical or common names include Chlorinated calcium oxide; Bleaching powder*; Calcium oxymuriate*; Chloride of lime*; Chlorinated lime*; Hypochlorite of lime*; Oxymuriate of lime*.

c. Potential Hazards: CORROSIVE TO FLESH; FLAMMABLE (WHEN IN CONTACT WITH ORGANIC SOLVENTS).

d. Available from chemical supply house, dry cleaning supply distributor, drugstore or pharmaceutical supply distributor, janitorial supply distributor, swimming pool supply distributor, or water and sanitation supply distributor.

-OR-

Chloramine-T: Chloramine is any of various compounds containing nitrogen and chlorine.

2. Trisodium Phosphate:

NOTE: THIS CHEMICAL IS BANNED IN SOME STATES SUCH AS CALIFORNIA. REGULATORY INFORMATION AS WELL AS ALTERNATIVE OR EQUIVALENT CHEMICALS MAY BE REQUESTED FROM THE ENVIRONMENTAL PROTECTION AGENCY (EPA) REGIONAL OFFICE AND/OR THE STATE OFFICE OF ENVIRONMENTAL QUALITY.

a. Strong base-type powdered cleaning material sold under brand names.

b. Other chemical or common names include Sodium Orthophosphate; Tribasic sodium phosphate; Trisodium orthophosphate; TSP*; Phosphate of soda*.

c. Potential Hazards: CORROSIVE TO FLESH.

d. Available from chemical supply house, grocery store or supermarket or hardware store.

3. Powdered detergent such as "Tide" or approved equal.

B. Proprietary cleaner such as "Limestone Restorer" (ProSoCo, Inc.), or approved equal.

C. Clean, potable water

2.03 EQUIPMENT

- A. Garden hose and nozzle
- B. Rubber or polyethylene bucket (DO NOT USE A METAL BUCKET AS IT MAY REACT WITH THE CHEMICAL CLEANER AND PRODUCE TOXIC FUMES)
- C. Glass or ceramic mixing bowl
- D. Knife blade
- E. Stiff, natural bristle brushes (non-metallic)
- F. Tampico brush, roller or low pressure (50 psi maximum) spray such as pneumatic garden sprayer
- G. Rubber gloves
- H. Safety glasses

PART 3---EXECUTION

3.01 EXAMINATION

- A. Determine the source of excessive moisture, i.e. leaky downspout, standing water, roof overhang, vegetation, etc., and make any necessary repairs before continuing with this task.
- B. Determine the type of stain, i.e. algae and lichens, or mold and mildew.

3.02 PREPARATION

A. Protection:

- 1. Provide adequate wash solutions (i.e. water, soap and towels) before starting the job.
- 2. Do not spray in the immediate vicinity of unprotected people and animals.

3.03 ERECTION, INSTALLATION, APPLICATION

NOTE: DO NOT ATTEMPT MORE THAN ONE TREATMENT ON A GIVEN AREA UNLESS THE CHEMICALS USED FROM ANY PRIOR TREATMENT HAVE BEEN WASHED AWAY.

A. Removing Lichens and Algae (ONLY):

- 1. Remove as much plant growth as possible using a knife blade and stiff bristle brush.
- 2. Water rinse the surface to remove most of the plant material.
  - a. If the substrate is sound and dense, use low to medium water pressure (100-400 psi).

- b. If the masonry is softer, use standard water pressure from the spigot.
3. Allow water to soak plant growth for approximately 30 minutes.
4. Gently scrub the surface with a stiff, natural bristle brush.
5. Thoroughly rinse the surface again with clean, clear water at low pressure from a garden hose.

NOTE: DO NOT USE ANY CHEMICALS WITHOUT FIRST CONSULTING WITH RHPO.

B. Removing Mold and Mildew (ONLY):

CAUTION: DO NOT MIX AMMONIA WITH CHLORINE BLEACHES, A POISONOUS GAS WILL RESULT!

1. Mix the following:

- 3 oz. (2/3 cup) trisodium phosphate (TSP) cleaner
- 1 oz. (1/3 cup) powdered detergent (i.e. Tide)
- 1 qt. 5% sodium hypochlorite bleach (laundry bleach)
- 3 qts. warm water

-OR-

- 1 part ammonia with 3 parts water

2. Apply the solution to the affected area and scrub with a medium-hard natural bristle brush. Keep the surface saturated until the stain is bleached,

CAUTION: BE SURE TO WEAR RUBBER GLOVES AND SAFETY GLASSES WHEN APPLYING THE SOLUTION.

3. Thoroughly rinse the surface with clean, clear water from a garden hose and allow to dry.
4. Repeat the process as necessary to achieve the desired level of cleanliness.

-OR-

C. For treating any of the above (lichens, algae, mold or mildew), try using a proprietary cleaner such as Limestone Restorer (ProSoCo, Inc.), or approved equal.

1. Add 1 part Limestone Restorer to 3 parts water and mix in a rubber or polyethylene bucket.
2. Apply a flood coat of this mixture to the masonry using a low pressure spray (approximately 50 psi).

CAUTION: DO NOT USE A HIGH PRESSURE SPRAY WHEN APPLYING THIS SOLUTION AS THIS MAY CAUSE THE SOLUTION TO BE DRIVEN DEEPER INTO THE PORES OF THE MASONRY, MAKING REMOVAL OF THE

SOLUTION DIFFICULT.

- a. Begin spraying at the top of the vertical surface and move across horizontally. Allow 100mm rundown.
- b. Continue the next horizontal pass across the previous run down.
- c. Allow the solution to remain on the surface approximately 5-30 minutes depending upon the thickness of the growth.
- d. Gently scrub the surface with a stiff, natural bristle brush.
- e. Thoroughly rinse the treated area using pressure-applied water (approximately 400 to 1500 psi) with a 40-60 degree fan spray or garden hose with nozzle adjusted to a tight stream. Rinse from the bottom of the treated area to the top.
- f. Allow the surface to dry a minimum of 24 hours.

1.2 Brick chimneys

The majority of the contributing houses in the USMMAHD have either one chimney or multiple brick chimneys, and most of them have been painted over the years.

1.2.1 Immediate concerns for brick chimneys

Overall care should be taken to protect the original brick and mortar. Where brick masonry is extremely deteriorated, in-kind replacement must occur. Care must be used to select sound and matching bricks for all repairs. Specialty brick is available from a variety of sources, and efforts to identify matching brick units should be required of those doing the replacement work.

The brick and mortar for chimneys are evaluated as follows (see Figure 9, Figure 10, and Figure 11):

- The brick and mortar are structurally and architecturally intact.
- Maintenance of the brick and mortar is needed for it to continue to function as it was designed.
- Cracks need to be monitored on a regular basis.

- Replacement bricks are to be used only if bricks are too deteriorated or damaged, and mortar should match the original in size, color, texture, and profile (refer to Figure 1).
- Painted bricks need to be cleaned according to the guidelines so that cleaning does not damage the painted brick (refer to Figure 8).
- Repainted brick needs to match the original paint in color and luster.
- Any brick maintenance is to be executed by a qualified professional.

Figure 9. Inspect and repair brick chimneys as needed (ERDC-CERL, 2015).

Figure 10. Painted brick chimneys should be monitored for cracking, peeling, and bubbling (ERDC-CERL, 2015).

Figure 11. Painted brick chimney on Quarters A (Neiley house) should be monitored for cracking, peeling, and bubbling (ERDC-CERL, 2013).

1.2.1 Guidelines, briefs, bulletins, and sources for brick chimneys

In addition to the information contained in this manual, the authors have compiled the following federal resource publications (reproduced here for convenience, with links for online access given in References) to inform managers about standards, guidelines, and procedures for understanding architecture and caring for, preserving, and rehabilitating historic buildings, with emphasis on historic brick (refer to subsections 1.1.3.1–1.1.3.13).

1.3 Preservation and rehabilitation guidelines for brick

According to *The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring & Reconstructing Historic Buildings*, the proper procedure for preservation and rehabilitation is to respect the significance of the original materials and features, repair and retain them wherever possible, and replace them only when absolutely necessary (Grimmer 2017) .

The following recommendations for care of historic brick elements are to be thoroughly read and understood before a treatment is specified. Table 1 (preservation) and Table 2 (rehabilitation) contain information excerpted from Grimmer 2017. Any related NPS or GSA guidelines should also be consulted to determine the appropriateness of any treatment.

Table 1. Preservation treatment for brick (Grimmer 2017, 31–36).

Preservation Treatment for Brick	
RECOMMENDED	NOT RECOMMENDED
Identifying, retaining, and preserving masonry features that are important in defining the overall historic character of the building (such as walls, brackets, railings, cornices, window and door surrounds, steps, and columns) and decorative ornament and other details, such as tooling and bonding patterns, coatings, and color.	Altering masonry features which are important in defining the overall historic character of the building so that, as a result, the character is diminished. Replacing historic masonry features instead of repairing or replacing only the deteriorated masonry. Applying paint or other coatings (such as stucco) to masonry that has been historically unpainted or uncoated. Removing paint from historically-painted masonry.
Stabilizing deteriorated or damaged masonry as a preliminary measure, when necessary, prior to undertaking preservation work.	Failing to stabilize deteriorated or damaged masonry until additional work is undertaken, thereby allowing further damage to occur to the historic building
Protecting and maintaining masonry by ensuring that historic drainage features and systems that divert rainwater from masonry surfaces (such as roof overhangs, gutters, and downspouts) are intact and functioning properly.	Failing to identify and treat the causes of masonry deterioration, such as leaking roofs and gutters or rising damp.
Cleaning masonry only when necessary to halt deterioration or remove heavy soiling.	Cleaning masonry surfaces when they are not heavily soiled to create a "like-new" appearance, thereby needlessly introducing chemicals or moisture into historic materials.
Carrying out masonry cleaning tests when it has been determined that cleaning is appropriate. Test areas should be examined to ensure that no damage has resulted and, ideally, monitored over a sufficient period of time to allow long-range effects to be predicted.	Cleaning masonry surfaces without testing or without sufficient time for the testing results to be evaluated.
Cleaning soiled masonry surfaces with the gentlest method possible, such as using low-pressure water and detergent and natural bristle or other soft-bristle brushes.	Cleaning or removing paint from masonry surfaces using most abrasive methods (including sandblasting, other media blasting, or high-pressure water) which can damage the surface of the masonry and mortar joints. Using a cleaning or paint-removal method that involves water or liquid chemical solutions when there is any possibility of freezing temperatures. Cleaning with chemical products that will damage some types of masonry (such as using acid on limestone or marble), or failing to neutralize or rinse off chemical cleaners from masonry surfaces.
Using biodegradable or environmentally-safe cleaning or paint-removal products.	
Using paint-removal methods that employ a poultice to which paint adheres, when possible, to neatly and safely remove old lead paint.	
Using coatings that encapsulate lead paint, when possible, where the paint is not required to be removed to meet environmental regulations.	
Allowing only trained conservators to use abrasive or laser-cleaning methods, when necessary, to clean hard-to-reach, highly-carved, or detailed decorative stone features.	
Removing damaged or deteriorated paint only to the next sound layer using the gentlest method possible (e.g., hand scraping) prior to repainting.	Removing paint that is firmly adhered to masonry surfaces.
Applying compatible paint coating systems to historically-painted masonry following proper surface preparation.	Failing to follow manufacturers' product and application instructions when repainting masonry features.
Repainting historically-painted masonry features with colors that are appropriate to the building and district.	Using paint colors on historically-painted masonry features that are not appropriate to the building or district.

(Table continues on next page.)

RECOMMENDED	NOT RECOMMENDED
Protecting adjacent materials when working on masonry features.	Failing to protect adjacent materials when working on masonry features.
Evaluating the overall condition of the masonry to determine whether more than protection and maintenance, such as repairs to masonry features, will be necessary.	Failing to undertake adequate measures to ensure the protection of masonry features.
Repairing masonry by patching, splicing, consolidating, or otherwise reinforcing the masonry using recognized preservation methods.	Removing masonry that could be stabilized, repaired, and conserved, or using untested consolidants, improper repair techniques, or unskilled personnel, potentially causing further damage to historic materials.
Repairing masonry walls and other masonry features by repointing the mortar joints where there is evidence of deterioration, such as disintegrating mortar, cracks in mortar joints, loose bricks, or damaged plaster on the interior.	Removing non-deteriorated mortar from sound joints and then repointing the entire building to achieve a more uniform appearance.
Removing deteriorated lime mortar carefully by hand raking the joints to avoid damaging the masonry.	
Removing damaged or deteriorated paint only to the next sound layer using the gentlest method possible (e.g., hand scraping) prior to repainting.	Removing paint that is firmly adhered to masonry surfaces.
Applying compatible paint coating systems to historically-painted masonry following proper surface preparation.	Failing to follow manufacturers' product and application instructions when repainting masonry features.
Repainting historically-painted masonry features with colors that are appropriate to the building and district.	Using paint colors on historically-painted masonry features that are not appropriate to the building or district.
Protecting adjacent materials when working on masonry features.	Failing to protect adjacent materials when working on masonry features.
Evaluating the overall condition of the masonry to determine whether more than protection and maintenance, such as repairs to masonry features, will be necessary.	Failing to undertake adequate measures to ensure the protection of masonry features.
Repairing masonry by patching, splicing, consolidating, or otherwise reinforcing the masonry using recognized preservation methods.	Removing masonry that could be stabilized, repaired, and conserved, or using untested consolidants, improper repair techniques, or unskilled personnel, potentially causing further damage to historic materials.
Repairing masonry walls and other masonry features by repointing the mortar joints where there is evidence of deterioration, such as disintegrating mortar, cracks in mortar joints, loose bricks, or damaged plaster on the interior.	Removing non-deteriorated mortar from sound joints and then repointing the entire building to achieve a more uniform appearance.
Removing deteriorated lime mortar carefully by hand raking the joints to avoid damaging the masonry.	
Cutting damaged concrete back to remove the source of deterioration, such as corrosion on metal reinforcement bars. The new patch must be applied carefully so that it will bond satisfactorily with, and match, the historic concrete.	Patching damaged concrete without first removing the source of deterioration.
Using a non-corrosive, stainless-steel anchoring system when replacing damaged stone, concrete, or terra-cotta units that have failed.	
Applying non-historic surface treatments, such as water-repellent coatings, to masonry only after repointing and only if masonry repairs have failed to arrest water penetration problems.	Applying waterproof, water-repellent, or non-original historical coatings (such as stucco) to masonry as a substitute for repointing and masonry repairs.
Applying permeable, anti-graffiti coatings to masonry when appropriate.	Applying water-repellent or anti-graffiti coatings that change the appearance of the masonry or that may trap moisture if the coating is not sufficiently permeable.
<i>The following work is highlighted to indicate that it represents the greatest degree of intervention generally recommended within the treatment Preservation, and should only be considered after protection, stabilization, and repair concerns have been addressed.</i>	
Limited Replacement in Kind	
Replacing in kind extensively deteriorated or missing components of masonry features when there are surviving prototypes, such as terra-cotta brackets or stone balusters, or when the replacement can be based on documentary or physical evidence. The new work should match the old in material, design, scale, color, and finish.	Replacing an entire masonry feature, such as a column or stairway, when limited replacement of deteriorated and missing components is appropriate. Using replacement material that does not match the historic masonry feature.

Table 2. Rehabilitation treatment for brick (Grimmer 2017, 82–87).

Rehabilitation Treatment for Brick	
RECOMMENDED	NOT RECOMMENDED
<i>Identifying, retaining and preserving</i> masonry features that are important in defining the overall historic character of the building (such as walls, brackets, railings, cornices, window and door surrounds, steps, and columns) and decorative ornament and other details, such as tooling and bonding patterns, coatings, and color.	Removing or substantially changing masonry features which are important in defining the overall historic character of the building so that, as a result, the character is diminished. Replacing or rebuilding a major portion of exterior masonry walls that could be repaired, thereby destroying the historic integrity of the building. Applying paint or other coatings (such as stucco) to masonry that has been historically unpainted or uncoated to create a new appearance. Removing paint from historically-painted masonry.
<i>Protecting and maintaining</i> masonry by ensuring that historic drainage features and systems that divert rainwater from masonry surfaces (such as roof overhangs, gutters, and downspouts) are intact and functioning properly.	Failing to identify and treat the causes of masonry deterioration, such as leaking roofs and gutters or rising damp.
Cleaning masonry only when necessary to halt deterioration or remove heavy soiling.	Cleaning masonry surfaces when they are not heavily soiled to create a “like-new” appearance, thereby needlessly introducing chemicals or moisture into historic materials.
Carrying out masonry cleaning tests when it has been determined that cleaning is appropriate. Test areas should be examined to ensure that no damage has resulted and, ideally, monitored over a sufficient period of time to allow long-range effects to be predicted.	Cleaning masonry surfaces without testing or without sufficient time for the testing results to be evaluated.
Cleaning soiled masonry surfaces with the gentlest method possible, such as using low-pressure water and detergent and natural bristle or other soft-bristle brushes.	Cleaning or removing paint from masonry surfaces using most abrasive methods (including sandblasting, other media blasting, or high-pressure water) which can damage the surface of the masonry and mortar joints. Using a cleaning or paint-removal method that involves water or liquid chemical solutions when there is any possibility of freezing temperatures. Cleaning with chemical products that will damage some types of masonry (such as using acid on limestone or marble), or failing to neutralize or rinse off chemical cleaners from masonry surfaces.
Using biodegradable or environmentally-safe cleaning or paint-removal products.	
Using paint-removal methods that employ a poultice to which paint adheres, when possible, to neatly and safely remove old lead paint.	
Using coatings that encapsulate lead paint, when possible, where the paint is not required to be removed to meet environmental regulations.	
Allowing only trained conservators to use abrasive or laser-cleaning methods, when necessary, to clean hard-to-reach, highly-carved, or detailed decorative stone features.	
Removing damaged or deteriorated paint only to the next sound layer using the gentlest method possible (e.g., hand scraping) prior to repainting.	Removing paint that is firmly adhered to masonry surfaces, unless the building was unpainted historically and the paint can be removed without damaging the surface.
Applying compatible paint coating systems to historically-painted masonry following proper surface preparation.	Failing to follow manufacturers’ product and application instructions when repainting masonry features.
Repainting historically-painted masonry features with colors that are appropriate to the historic character of the building and district.	Using paint colors on historically-painted masonry features that are not appropriate to the historic character of the building and district.
Protecting adjacent materials when cleaning or removing paint from masonry features.	Failing to protect adjacent materials when cleaning or removing paint from masonry features.

(Table continues on next page.)

RECOMMENDED	NOT RECOMMENDED
Evaluating the overall condition of the masonry to determine whether more than protection and maintenance, such as repairs to masonry features, will be necessary.	Failing to undertake adequate measures to ensure the protection of masonry features.
Repairing masonry by patching, splicing, consolidating, or otherwise reinforcing the masonry using recognized preservation methods. Repair may include the limited replacement in kind or with a compatible substitute material of those extensively deteriorated or missing parts of masonry features when there are surviving prototypes, such as terra-cotta brackets or stone balusters.	Removing masonry that could be stabilized, repaired, and conserved, or using untested consolidants and unskilled personnel, potentially causing further damage to historic materials. Replacing an entire masonry feature, such as a cornice or balustrade, when repair of the masonry and limited replacement of deteriorated or missing components are feasible.
Repairing masonry walls and other masonry features by repointing the mortar joints where there is evidence of deterioration, such as disintegrating mortar, cracks in mortar joints, loose bricks, or damaged plaster on the interior.	Removing non-deteriorated mortar from sound joints and then repointing the entire building to achieve a more uniform appearance.
Removing deteriorated lime mortar carefully by hand raking the joints to avoid damaging the masonry.	
Using power tools only on horizontal joints on brick masonry in conjunction with hand chiseling to remove hard mortar that is deteriorated or that is a non-historic material which is causing damage to the masonry units. Mechanical tools should be used only by skilled masons in limited circumstances and generally not on short, vertical joints in brick masonry.	Allowing unskilled workers to use masonry saws or mechanical tools to remove deteriorated mortar from joints prior to repointing.
Duplicating historic mortar joints in strength, composition, color, and texture when repointing is necessary. In some cases, a lime-based mortar may also be considered when repointing Portland cement mortar because it is more flexible.	Repointing masonry units with mortar of high Portland cement content (unless it is the content of the historic mortar). Using "surface grouting" or a "scrub" coating technique, such as a "sack rub" or "mortar washing," to repoint exterior masonry units instead of traditional repointing methods. Repointing masonry units (other than concrete) with a synthetic caulking compound instead of mortar.
Duplicating historic mortar joints in width and joint profile when repointing is necessary.	Changing the width or joint profile when repointing.
Repairing stucco by removing the damaged material and patching with new stucco that duplicates the old in strength, composition, color, and texture.	Removing sound stucco or repairing with new stucco that is different in composition from the historic stucco. Patching stucco or concrete without removing the source of deterioration. Replacing deteriorated stucco with synthetic stucco, an exterior finish and insulation system (EFIS), or other non-traditional materials.
Using mud plaster or a compatible lime-plaster adobe render, when appropriate, to repair adobe.	Applying cement stucco, unless it already exists, to adobe.
Sealing joints in concrete with appropriate flexible sealants and backer rods, when necessary.	
Cutting damaged concrete back to remove the source of deterioration, such as corrosion on metal reinforcement bars. The new patch must be applied carefully so that it will bond satisfactorily with and match the historic concrete.	Patching damaged concrete without removing the source of deterioration.

(Table continues on next page.)

RECOMMENDED	NOT RECOMMENDED
Using a non-corrosive, stainless-steel anchoring system when replacing damaged stone, concrete, or terra-cotta units that have failed.	
Applying non-historic surface treatments, such as water-repellent coatings, to masonry only after repointing and only if masonry repairs have failed to arrest water penetration problems.	Applying waterproof, water-repellent, or non-original historic coatings (such as stucco) to masonry as a substitute for repointing and masonry repairs.
Applying permeable, anti-graffiti coatings to masonry when appropriate.	Applying water-repellent or anti-graffiti coatings that change the historic appearance of the masonry or that may trap moisture if the coating is not sufficiently permeable.
Replacing in kind an entire masonry feature that is too deteriorated to repair (if the overall form and detailing are still evident) using the physical evidence as a model to reproduce the feature or when the replacement can be based on historic documentation. Examples can include large sections of a wall, a cornice, pier, or parapet. If using the same kind of material is not feasible, then a compatible substitute material may be considered.	Removing a masonry feature that is unrepairable and not replacing it, or replacing it with a new feature that does not match. Using substitute material for the replacement that does not convey the same appearance of the surviving components of the masonry feature.
<i>The following work is highlighted to indicate that it is specific to Rehabilitation projects and should only be considered after the preservation concerns have been addressed.</i>	
Designing the Replacement for Missing Historic Features	
Designing and installing a replacement masonry feature, such as a step or door pediment, when the historic feature is completely missing. It may be an accurate restoration based on documentary and physical evidence, but only when the historic feature to be replaced coexisted with the features currently on the building. Or, it may be a new design that is compatible with the size, scale, material, and color of the historic building.	Creating an inaccurate appearance because the replacement for the missing masonry feature is based upon insufficient physical or historic documentation, is not a compatible design, or because the feature to be replaced did not coexist with the features currently on the building. Introducing a new masonry feature that is incompatible in size, scale, material, or color.

1.4 Maintenance / management for brick

All building materials deteriorate with age and exposure to the weather. Through routine inspection and cyclical maintenance, the useful life span of a building and its historic fabric will be greatly increased. Preventive maintenance involves regular inspection of those parts of the building that are most likely to develop problems. Having a checklist for each USMMA building is advised to help the USMMA CRM and maintenance department identify and keep an accurate record or inventory of the building's problems, to facilitate systematic repair and maintenance. Begin early in project planning to ensure that design scopes, qualifications, and budgets address preservation compliance requirements.

Repair, renovation, and replacement of character-defining features to the USMMA historic district, such as historic brick, **MUST** be coordinated with the NY SHPO. If a character-defining feature has been previously removed or replaced on the contributing building, prior to this report, and as future renovations occur, these need to be replaced with elements that replicate the original character-defining features of that building. Historic photographs found in *Character-Defining Features of Contributing Build-*

ings and Structures in the United States Merchant Marine Academy Historic District report (Smith, Enscoe, and Adams, August 2014) will help guide this process in coordination with the NY SHPO.

Water damage is caused by one of two conditions: splash back or rising damp. In splash back, the continually of rain beating against the brick soaks into the mortar, causing the mortar joints or the bricks to crack. Rising damp results when ground water seeps up from below, leaving behind what is called a tide line. The moisture above the tide line will eventually evaporate, but the salt crystals that remain will, over time, cause the bricks and mortar to break down. Freezing and thawing cycles can accelerate damage to water-soaked bricks, so repairing problems early will prevent more extensive repairs in the future. Look for water damage on an annual basis, and budget for some possible repointing every five to ten years.

Repointing is necessary in places where the mortar joints have become soft or the mortar itself is cracked or damaged. The damaged mortar is removed carefully following guidelines and standards so as not to disturb the surrounding brickwork. Make sure that the mortar matches the original in strength, composition, color, and texture and duplicate the old mortar joints in width and in joint profile.

The cleaning of masonry should follow the guidelines and standards. Clean masonry only when necessary to halt deterioration or remove heavy soiling. It is highly recommended to only clean masonry surfaces using the gentlest method possible, such as low-pressure water and detergents.

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14. ABSTRACT The U.S. Merchant Marine Academy is located in Kings Point, New York. The Academy is listed on the National Register of Historic Places (#14000538). The historic district contains contributing mansions constructed during the Gold Coast Era and the Academy buildings constructed in 1942 to 1969. All buildings require regular planned maintenance and repair. The most notable cause of historic building element failure and/or decay is not the fact the historic building is old, but rather it is caused by an incorrect or inappropriate repair and/or basic neglect of the historic building fabric. This document is a maintenance manual compiled with as-is conditions of building materials at the Academy. The <i>Secretary of the Interior's Standards for the Treatment of Historic Properties on Preservation, Rehabilitation, and Repair</i> are discussed per material. This 8-volume report includes an overview volume plus volumes on each of the following elements: concrete, wood, brick, metal, roofing, stucco, and mechanical systems. All mentioned repair procedures are from the U.S. General Services Administration (GSA): Historic Preservation Technical Procedures and/or the National Park Service's series of Preservation Briefs. This report satisfies Section 110 of the National Historic Preservation Act (NHPA) of 1966, as amended.					
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