Historic Architecture & Preservation/Restoration
Track Sponsors

AMR
ADVANCED MASONRY
RESTORATION
A HISTORY OF PRESERVING HISTORY

JEDUNN CONSTRUCTION

GRAHAM
ARCHITECTURAL PRODUCTS

RJM CONSTRUCTION
What Architects Must Know About Masonry Restoration and Preservation
MINNESOTA CONCRETE & MASONRY CONTRACTORS ASSOC
“We believe preserving old buildings is a beautiful, economically sound and sustainable way to improve our communities and make the most of our unique assets…”

Preservation Alliance of MN

MC&MCA  Elena Peltsman AIA
elenapeltsman@comcast.net
612. 747. 8932
website: mcmca.com
LIFE CYCLE COST SAVINGS

Non-Disposable Buildings

Cost Savings, Value and Efficiency are in the Reuse of Existing Structures

Low lifetime maintenance costs

“Preservation is the Queen of Green, Old is the New Green”

The Greenest Buildings Today are Those Already Built

Saving Existing Buildings Preserves our Heritage and Strengthens the Cultural Fabric of the Communities

St. Paul Building Exec Suites, 6 East 5th Street Saint Paul, MN
LEARNING OBJECTIVES:

1. Recognize the historic, economic and cultural value of preserving, repurposing and maintaining existing buildings

2. Review how have masonry preservation philosophy and practice evolved in the past 5 years

3. Learn how timely selection of the proper testing and material availability affects project phasing and overall schedule

4. Understand the difference in designing for restoration or conversion project in comparison to new construction and how best prepare for the unforeseen conditions, recognizing early signs of potential problems

5. Examine how to restore a unique historic building using new techniques and materials without changing the look of the building

6. Recognize the importance of getting owner to complete as much front end exploratory and assessment work prior to bidding, to reduce change orders and project delays
How Has Masonry Preservation Changed?

Philosophical Changes
fire damaged beam before  

fire damaged beam after
Things stay the same

Understand construction and cause for the problem
But masonry-specific things change, too
Standard Specification for Mortar for Unit Masonry

1. Scope

1.1 This specification covers mortars for use in the construction of non-load-bearing and reinforced unit masonry structures. Four types of mortar are covered: (1) proprieion mortars, (2) property mortars, (3) type of mortars are covered in each of two alternative specification (1) procedure specification and (2) property specification.

Note 1: When the property specification is used to qualify mortar, the mortar quality, performance, and test methods should be evaluated in accordance with Practice C 1093.

1.2 The proportion or property specification shall govern as specified.

1.3 When neither property or performance specification is specified, the property specification shall govern, unless data are provided in such a manner that the property specification shall be determined by the supplier to be the requirements of the property specification.

1.4 The test of this specification references notes and footnotes which provide explanatory material. These notes and footnotes (including those in tables and figures) shall not be considered as requirements of the standard.

1.5 The terms used in this specification are identified in Terminology C 1180 and C 1232.

1.6 The values stated in inch-pound units are to be regarded as standard. The values in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.7 The following safety hazards caveat pertains only to the test methods section of this specification: This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. Referenced Documents

C 1180 Specifications for Mortar for Masonry Units
C 1181 Terminology of Mortar and Mortar for Masonry Units
C 1182 Terminology of Masonry Units
C 1232 Terminology of Masonry Units

This specification is the subject of ASTM C 1180 and C 1232 and is the standard of the American Society for Testing and Materials (ASTM).


*For information on ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For a complete list of ASTM standards, visit the ASTM website.
TABLE 1. Proportion Specification Requirements

<table>
<thead>
<tr>
<th>Mortar</th>
<th>Type</th>
<th>Portland Cement or Gypsum</th>
<th>Mortar Cement</th>
<th>Mortar</th>
<th>Mortar Cement</th>
<th>Mortar</th>
<th>Mortar</th>
<th>Hydrated Lime or Lime Mortar</th>
<th>Aggregate</th>
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Note 1. The amount of cement shall be determined by determining the proportion of cement to water that will produce a proper consistency. The proportion of Portland cement or gypsum to water is determined by the chemical analysis of the Portland cement or gypsum. The proportion of hydrated lime or lime mortar to water is determined by the chemical analysis of the hydrated lime or lime mortar. The proportion of aggregate to water is determined by the chemical analysis of the aggregate.

Note 2. The amount of water shall be determined by the chemical analysis of the water.

Note 3. The physical properties of the Portland cement and hydrated lime or lime mortar shall be determined by the chemical analysis of the Portland cement and hydrated lime or lime mortar.

Note 4. The aggregate shall be determined by the physical analysis of the aggregate.

Note 5. The amount of water shall be determined by the physical analysis of the water.

Note 6. The amount of cement shall be determined by the physical analysis of the cement.

Note 7. The amount of hydrated lime or lime mortar shall be determined by the physical analysis of the hydrated lime or lime mortar.

Note 8. The amount of aggregate shall be determined by the physical analysis of the aggregate.

Note 9. The amount of water shall be determined by the physical analysis of the water.

TABLE 2. Proportion Tolerance Requirements

<table>
<thead>
<tr>
<th>Mortar</th>
<th>Type</th>
<th>Average Consistency (Williams, min. 3.0)</th>
<th>Water</th>
<th>Air</th>
<th>Aggregate</th>
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Note 6. The amount of cement shall be determined by the physical analysis of the cement.

Note 7. The amount of hydrated lime or lime mortar shall be determined by the physical analysis of the hydrated lime or lime mortar.

Note 8. The amount of aggregate shall be determined by the physical analysis of the aggregate.

Note 9. The amount of water shall be determined by the physical analysis of the water.

Note 10. The amount of cement shall be determined by the physical analysis of the cement.

Note 11. The amount of hydrated lime or lime mortar shall be determined by the physical analysis of the hydrated lime or lime mortar.

Note 12. The amount of aggregate shall be determined by the physical analysis of the aggregate.

Note 13. The amount of water shall be determined by the physical analysis of the water.

Note 14. The amount of cement shall be determined by the physical analysis of the cement.

Note 15. The amount of hydrated lime or lime mortar shall be determined by the physical analysis of the hydrated lime or lime mortar.

Note 16. The amount of aggregate shall be determined by the physical analysis of the aggregate.

Note 17. The amount of water shall be determined by the physical analysis of the water.

Note 18. The amount of cement shall be determined by the physical analysis of the cement.

Note 19. The amount of hydrated lime or lime mortar shall be determined by the physical analysis of the hydrated lime or lime mortar.

Note 20. The amount of aggregate shall be determined by the physical analysis of the aggregate.

Note 21. The amount of water shall be determined by the physical analysis of the water.

Note 22. The amount of cement shall be determined by the physical analysis of the cement.

Note 23. The amount of hydrated lime or lime mortar shall be determined by the physical analysis of the hydrated lime or lime mortar.

Note 24. The amount of aggregate shall be determined by the physical analysis of the aggregate.

Note 25. The amount of water shall be determined by the physical analysis of the water.

Note 26. The amount of cement shall be determined by the physical analysis of the cement.

Note 27. The amount of hydrated lime or lime mortar shall be determined by the physical analysis of the hydrated lime or lime mortar.

Note 28. The amount of aggregate shall be determined by the physical analysis of the aggregate.

Note 29. The amount of water shall be determined by the physical analysis of the water.

Note 30. The amount of cement shall be determined by the physical analysis of the cement.

Note 31. The amount of hydrated lime or lime mortar shall be determined by the physical analysis of the hydrated lime or lime mortar.

Note 32. The amount of aggregate shall be determined by the physical analysis of the aggregate.

Note 33. The amount of water shall be determined by the physical analysis of the water.

Note 34. The amount of cement shall be determined by the physical analysis of the cement.

Note 35. The amount of hydrated lime or lime mortar shall be determined by the physical analysis of the hydrated lime or lime mortar.

Note 36. The amount of aggregate shall be determined by the physical analysis of the aggregate.

Note 37. The amount of water shall be determined by the physical analysis of the water.

Note 38. The amount of cement shall be determined by the physical analysis of the cement.

Note 39. The amount of hydrated lime or lime mortar shall be determined by the physical analysis of the hydrated lime or lime mortar.

Note 40. The amount of aggregate shall be determined by the physical analysis of the aggregate.

Note 41. The amount of water shall be determined by the physical analysis of the water.

Note 42. The amount of cement shall be determined by the physical analysis of the cement.

Note 43. The amount of hydrated lime or lime mortar shall be determined by the physical analysis of the hydrated lime or lime mortar.

Note 44. The amount of aggregate shall be determined by the physical analysis of the aggregate.

Note 45. The amount of water shall be determined by the physical analysis of the water.

6. Test Methods

6.1. Proportion of Materials for Test Specimens—Laboratory mixed mortar used for determining conformance to this property specification shall contain a portion of each material specified. Measure materials by weight for laboratory mixed batch. Convert proportions, by volume, to proportions, by weight, using a batch factor calculated as follows:
Standard Specification for Mortars for the Repair of Historic Masonry

1. Scope
1.1. This specification covers mortar for the repair of masonry that was constructed with methods and materials that predate the adoption of current standards of construction that are compatible with it. The mortar may be used for non-structural purposes such as repointing of the masonry, or for structural purposes such as, but not restricted to, reconstruction or repair of masonry piers that contribute to the structural integrity of the masonry.

1.2. Masonry includes the following units held in masonry: (1) cast stone, (2) clay brick, siliceous brick, and clay tile, (3) concrete masonry units, (4) natural stone, and (5) Terra cotta.

1.3. This specification may be used to pre-qualify mortars for a project.

1.4. Mortar tested using this specification are laboratory-prepared mortars and do not represent in-use, site mortars.

1.5. Use of this specification should be based on thorough understanding of the function, maintenance, and repair requirements for the preservation and continued performance of the masonry in the context of the building structure and long-term performance. The user of this specification is responsible for considering all criteria and selecting the appropriate mortar formulation and properties required.

1.6. The values stated in inch-pound units are the standard values used for those units. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.7. This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. Referenced Documents
2.1. ASTM Standards

2.2. Specification for Quicklime for Structural Purposes

C300 Specification for Natural Cement
C610 Specification for Gypsum Kentucky Cement
C911 Specification for Masonry Mortar
C1098C09M Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2 in. or 51-mm Cube Specimen)
C110 Test Methods for Physical Testing of Quicklime, Hydraulic Lime, and Limestone
C136 Test Method for Slake Durability of Fine and Coarse Aggregate

C141 Specification for Hydraulic Hydrated Lime for Structural Purposes
C144 Specification for Aggregate for Masonry Mortar
C150 Specification for Portland Cement
C207 Specification for Hydraulic Lime for Masonry Purposes
C216 Specification for Facing Brick (Solid Masonry Units Made From Clay or Shale)
C270 Specification for Mortar for Unit Masonry
C285 Practice for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency
C281 Specification for Mortar for Unit Masonry
C282 Practice for Laboratory Mix and Testing of Hydraulic Cement Mortars
C285 Practice for Blended Hydraulic Cement
C370 Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry
C374 Test Method for Determining Water Absorption, and Apparent Porosity of Thin Sections of Glass-Fiber Reinforced Concrete
C409 Specification for Pigments for Integrally Colored Concrete
C410 Practice for Acceleration of Testing Agendas for Masonry
C1517 Performance Specification for Hydraulic Cement
C1306 Terminology of Mortar and Grout for Unit Masonry
C1292 Specification for Mortar Cement
C1127 Test Methods for Evaluating Masonry Bond Strength
C1384 Specification for Admixtures for Masonry Mortars
C1403 Test Methods for Rate of Water Absorption of Masonry Mortars
C1409 Specification for Lime Putty for Structural Purposes
Technologies change, too
DISPERSED HYDRATED LIME
Material Safety Data Sheet

COMPANY ID: U.S. Heritage Group, 3516 North Kostner Ave. Chicago, IL 60641
Date Issued: May 6, 2009
Emergency Contact: 773-286-2100

SECTION I: PRODUCT GROUP
PRODUCT GROUP: Dispersed Putty Lime Injection Mortar/Spatch
PRODUCTS:
Dispersed Putty Lime Mortar Ca(OH)2

SECTION II: INGREDIENTS
MATERIALS:
High Calcium Lime: 40-50% by weight
Water: 40-50% by weight
Aggregate: 10-20% marble, silica, Quartz

SECTION III: PHYSICAL DATA
Boiling Point: 1000
pH @ 25°C (Saturated): >11
Appearance and Odor: White to light gray putty with low odor

SECTION IV: FIRE AND EXPLOSION HAZARD DATA
Flash Point (Method Used): None
Extinguishing Media: Not Combustible
Special Fire Fighting Procedures: Fire fighters should avoid all contact with this material. Self-contained breathing apparatus approved by NIOSH should be used if this material is present.
Unusual Fire & Explosion Hazards: Product will not burn.

SECTION V: HEALTH HAZARD DATA EFFECTS OF OVEREXPOSURE
Acute: May cause chronic irritation of nose, nasal ulcers, bronchitis or other lung problems. May cause skin rash, dermatitis. May cause eye irritation, conjunctivitis. When mixed with water as in mortar, may cause alkali burns if it comes in contact with skin or eyes.
Eyes: Reduced visibility, may cause unpleasant deposits in eyes.
Sample testing methodology

- Choose Sample (some have two)
- Reduce it to aggregate/powder
- Weigh it
- Separate out the aggregate, wash if desired
- Weigh it (you will get the paste/aggregate proportion)

- Assess aggregate
- Put sample through sieve
- Weigh each component
- Compare it to existing sand if available
ASSESSING THE CONDITION OF MASONRY

Restoration architect Max Ferron and masonry conservator Tom Burack have devised a scale which quantifies the deterioration of brick by assessing its relative hardness (or softness). To use this simple method, you'll need only a mason’s hammer, a cold chisel (1/2 to 1-1/2 inches), and a sturdy slotted screwdriver. Because the method is destructive, use it sparingly and only for areas you suspect are deteriorating. There is a separate scale for both mortar and brick. Both scales go from 0 to 10, with 0 being most deteriorated, and 10 being the hardest. When you scratch brick, always scratch both vertically and horizontally. When you strike mortar joints, always strike them along their center lines.

BRICK CLASSIFICATION

رغ
1 Bricks have a fairly intact face, but rounded, scored corners. Surface can be loosened by rubbing with the hand, or powdered by scraping with a fingernail.
2 Bricks are spalling in small layers that can be pulled apart by hand. Their component crystalline, jagged fragments are better bonded, and do not powder.
3 Bricks cannot be scratched 1/4 inch with fingernail, nor crumbled by hand, but can be broken apart with poking and picking of the screwdriver. Crystalline pieces can be semi-hard, or weathered and crumbling, compacted clay.
4 The screwdriver carves into the surface of the brick approximately 1/4 inch by hand, but bricks won’t crumble after a dozen jabs. This is the first classification of stable, structurally sound brick.
5 The screwdriver must be driven in with the hammer to make the 1/4 inch indent. In doing so, it causes enough cracking to dislodge crystalline pieces.
6 The screwdriver no longer penetrates, but does make a weak impression when hit with the hammer. A slight ring and boxwood attent to the solidity of the brick.
8 The chisel is needed to successfully crack the brick, first indenting the surface before causing a fissure to develop.
9 The chisel makes no indentation or impression, but shears brick cleanly. Strong vibration of face. Creep edges and corners.
10 A new brick, with absolute crispness of corners, and a clear ringing sound when struck by a chisel.

Use this scale to document the condition of your brickwork (colored-blasted or otherwise). If your bricks rate a “4” or below, they are for all intents and purposes unusable. In that case, an engineer should be consulted to determine the structural integrity of the building. If your bricks rate somewhere between “6” and “7,” you might consider some of the remedial steps outlined in this article (sealing, painting, etc.).

A brick building typically (especially if it’s been blasted) has some masonry units that are deteriorated, while others are sound. In that case, you can use this scale to decide which units should be selectively replaced, which side of the building would benefit most from sealing, etc.

MORTAR EVALUATIONS

0 No mortar present at least within 1-1/2 of the face of the wall. Mortar has leached or weathered away.
0 Mortar can be scraped away freely with a screwdriver or poked out with a finger. It crumbles freely and has an irregular surface. Joint treatment is unrecognizable and mortar appears sandlike.
0 Mortar can be raked out easily with the screwdriver, but the face of the joint is still intact, with few surface irregularities.
0 Scoring the joint along its center line with the screwdriver, it is easy to collapse it and break its adhesion with the brick. The mortar disengages freely and cleanly.
0 When the mortar joint is scored and tapped with the screwdriver and the mortar protruded out, there is slight spalling at the edges and corners of the brick.
0 The mortar resists all attempts with the screwdriver. Scored with a chisel, it disengages and pops free from the face of the brick without damaging the brick.
0 When mortar is lightly scored with a chisel, it disengages. The edges and corners of the brick are marred slightly because of mortar’s adhesion to brick.
0 Successive blows of the hammer and chisel are necessary to crack the joint, but when the mortar disengages, there is still little damage to the brick.
0 Several blows with hammer and chisel are necessary to crack the mortar into short pieces, as in #7. The bricks are noticeably marred in the process.
0 The mortar is tougher than the bricks, cracking the bricks after successive blows with the hammer and chisel. Rich mortar color, well-defined troweling marks. Solid adhesion apparent throughout brick-mortar interface.
0 The mortar has high content of Portland cement, approaching the strength of concrete. When removed with hammer and chisel, the adjoining brickwork is pulverized.

Again, this scale is used for comparison. If mortar rates between “1” and “4,” repointing is in order. If it rates “5” or “6,” and the bricks are fairly soft, the mortar is too hard. In that case, it may be wise to have the rock-hard mortar ground out and replaced with softer mortar. Overly-hard mortar will damage the brick with seasonal and daily thermal expansion and contraction.
Repointing Mortar Joints in Historic Masonry Buildings

Robert C. Mack, FAIA
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 (Fig. 1). 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 Brief 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.

*Repainting technically describes a primarily decorative application of a new mortar joint or lime putty joint on top of flush mortar joints.
Look for the simple solution
Controlling change orders due to unforeseen conditions
Using new materials and techniques to restore older structures
But first...Categories of Repairs
Restoration:

• “Depicts a property at a particular period in its history, while removing evidence of other periods.”

Preservation Briefs

• By definition, most projects do not fall into this category.
• Tuckpointing
• Demolition of areas
• Rebuilding of areas
• Patching
• May need SHPO approval
Rehabilitation:

• “Acknowledges the need to alter or add to a historic property to meet continuing changing uses while retaining the property’s historic character.” preservation brief

• Tuckpointing
• Replacement
• Patching
• Blending of new and old materials
• May need SHPO approval
Repair:

The action of mending or fixing something

- Flashing Repair
- Brick Replacement
- Window Replacement
- Steel Replacement
Maintenance

Upkeep of a property or equipment

• Tuckpointing
• Caulking
• Façade material repair

We do this to prevent restoration and/or repair
Controlling change orders due to unforeseen conditions

- Owner input
- Assessment of the building
- Predesign Inspections
Gathering as much information as possible to assist in a more defined specification.

The Owner wants? or needs?
Controlling change orders due to unforeseen conditions

- Owner input
- Assessment of the building
- Predesign Inspections
Repurpose?
Repairs or General Maintenance?

- Deteriorated joints
- Broken Brick
- Peeling paint
- Caulking
Assessment of the building

- Type of construction
- Height
- Are original plans available?
- What materials were used in the construction
- How is the building being used or going to be used.
Type of Construction

Solid Masonry Wall?

Cavity Wall?
Height

After the first few feet you’re making educated guesses as to conditions.
Are the original plans available?
Building Materials
Mortar

- Very important component of a masonry building
- Holds the masonry units in place
- Should be the sacrificial component of the wall
How old is the building?
Most brick within the last 50 years are a modular size
Colors and shades change
Stone

- What type of stone is it
- All stone weathers differently.
Block or Stand up plank
Case in Point- Terra Cotta  Soo Line City Apartments

• 2200 + Pieces of terra cotta
• 12 different Shapes
• 12 month schedule from start to finish
• 102 Days for shipping of Terra Cotta from approval of shop drawings.
• Material was ordered 6 months in advance of start
• An additional 420 pieces were found to need replacement in May, project was to be completed by November.
• Additional cost of approximately $80,000.00 to re rig the swing stages for access.
• Engineer completed the inspection from the ground and looking out windows, per owners instruction
Predesign Inspections

- Rigging of the building with swing stage
- Using a Ground supported lift
- Ground Observations
- Inspection openings
- Material Testing
Swing Stage

- Most Costly
- Can access upper reaches of the building.
- For multi story buildings most in depth inspection.
Ground Lift

- Quick set up
- Limited access to heights
- Mobile
Ground Observations

• Least effective on taller buildings
• Least expensive.
• Issues /damage may not be visible.
Inspection Openings

• Identify the as-built conditions
• Identify source of a problem
• Size of opening can vary
Material Testing

- Identify right materials
- Identify the correct procedures
Using New Materials and Techniques to restore older buildings.

• Lovness Residence
TWO COTTAGES FOR MR. AND MRS. DON LOVNESS
STILLWATER, MINNESOTA
FRANK LLOYD WRIGHT
ARCHITECT

NORTH ELEVATION

WEST ELEVATION

SOUTH ELEVATION

EAST ELEVATION

SCALE 1/2
Cottage
Gaustavino tile patching
Summary

• Not all owners will be agreeable to anything but a ground inspection. But it is in their best interest to know the ramifications of a limited inspection.

• The cost for an on site assessment can run from $2,000-$40,000 or more, much depends on the size of the project.

• Even with original plans, there are still many unknowns. The as-built condition may not match the plan.

• Many repairs can be accomplished with new materials. This saves the cost of replacement and preserves the original material as much as possible.

• When putting plans together stay away from “AS NECESSARY”
  • Define quantities
  • Highlight area
  • Anything to help get “apple to apple” bids
  • Always carry a contingency for unknowns. And there will be unknowns.

The more you know, the more detailed the plan, the less potential for change orders.
What Architects Must Know About Masonry Restoration & Preservation
Occupied vs. Vacant
What’s Going On Here?

LINTELS
Water Tables
Unforeseen Conditions
Make Your Plan
Execute The Plan
What Trades Will Be Coordinating?
What Material Do We Need?
Cleaning Samples
Brick
Indiana Limestone
Mortar Sample Review
Terra Cotta
Terra Cotta Samples
Finished Product
QUESTIONS?