INTERNATIONAL MASONRY INSTITUTE

HISTORIC MASONRY REPAIR & RESTORATION

SEPTEMBER 19, 2022

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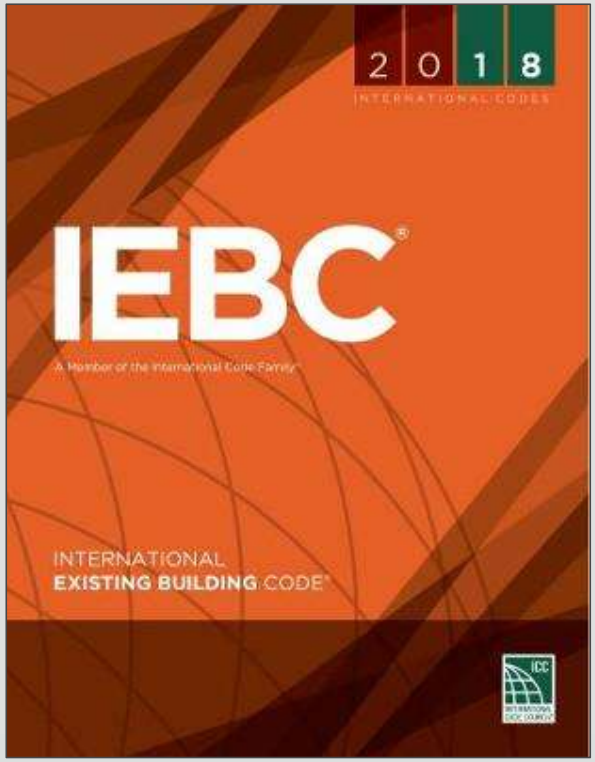
SEMINAR OUTLINE

- Codes & Standards
- Condition Assessment
- Designing a Restoration Plan
- Contractor Qualifications
- Question & Answer

CODES & STANDARDS

CODES – INTERNATIONAL EXISTING BUILDING CODE (IEBC)



CHAPTER TOPICS

Chapter	Subjects
1–2	Administrative Requirements and Definitions
3	Provisions for all Compliance Methods
4	Repairs
5	Prescriptive Compliance Method for Existing Buildings
6–12	Work Area Compliance Method for Existing Buildings
13	Performance Compliance Method for Existing Buildings
14	Relocated Buildings
15	Construction Safeguards
16	Referenced Standards
Appendix A	Guidelines for Seismic Retrofit of Existing Buildings
Appendix B	Supplementary Accessibility Requirements for Existing Buildings
Appendix C	Guidelines for Wind Retrofit of Existing Buildings
Appendix D	Board of Appeals
Resource A	Guidelines on Fire Ratings of Archaic Materials and Assemblies

RESOURCE A – GUIDELINES ON FIRE RATINGS OF ARCHAIC MATERIALS AND ASSEMBLIES

- Not all materials and assemblies have UL ratings; many units and wall systems were built before UL ratings were developed
- While there are many walls in Resource A, calculated fire resistance can be used to determine fire ratings

TABLE 1.1.2 MASONRY WALLS 4″ TO LESS THAN 6″ THICK

ITEM CODE	THICKNESS	CONSTRUCTION DETAILS	PERFORMANCE		REFERENCE NUMBER			NOTES	REC. HOURS
			LOAD	TIME	PRE-BMS-92	BMS-92	POST-BMS-92		
W-4-M-1	4″	Solid 3″ thick, gypsum blocks laid in 1:3 sanded gypsum mortar; Facings: $^1/_2$″ of 1:3 sanded gypsum plaster (both sides).	N/A	2 hrs.		1		1	2
W-4-M-2	4″	Solid clay or shale brick.	N/A	1 hr. 15 min		1		1, 2	$1^1/_4$
W-4-M-3	4″	Concrete; No facings.	N/A	1 hr. 30 min.		1		1	$1^1/_2$
W-4-M-4	4″	Clay tile; Illinois surface clay; single cell thick; No face plaster; Design “B,” Construction “C.”	N/A	25 min.			2	3-7, 36	$^1/_3$
W-4-M-5	4″	Solid sand-lime brick.	N/A	1 hr. 45 min.		1		1	$1^3/_4$
W-4-M-6	4″	Solid wall; 3″ thick block; $^1/_2$″ plaster each side; $17^3/_4$″ ×	N/A	1 hr.			7	2	$1^3/_4$

REQUIREMENTS AND TRIGGERS FOR INSPECTING FACADES

- International Property Maintenance Code (IPMC)
  - Adoption of the IPMC produces façade ordinances or façade inspection requirements enacted by cities or other jurisdictions
  - Two states – New York and Virginia – and more than 600 local jurisdictions (Pittsburgh & Philadelphia) have adopted the IPMC with modifications

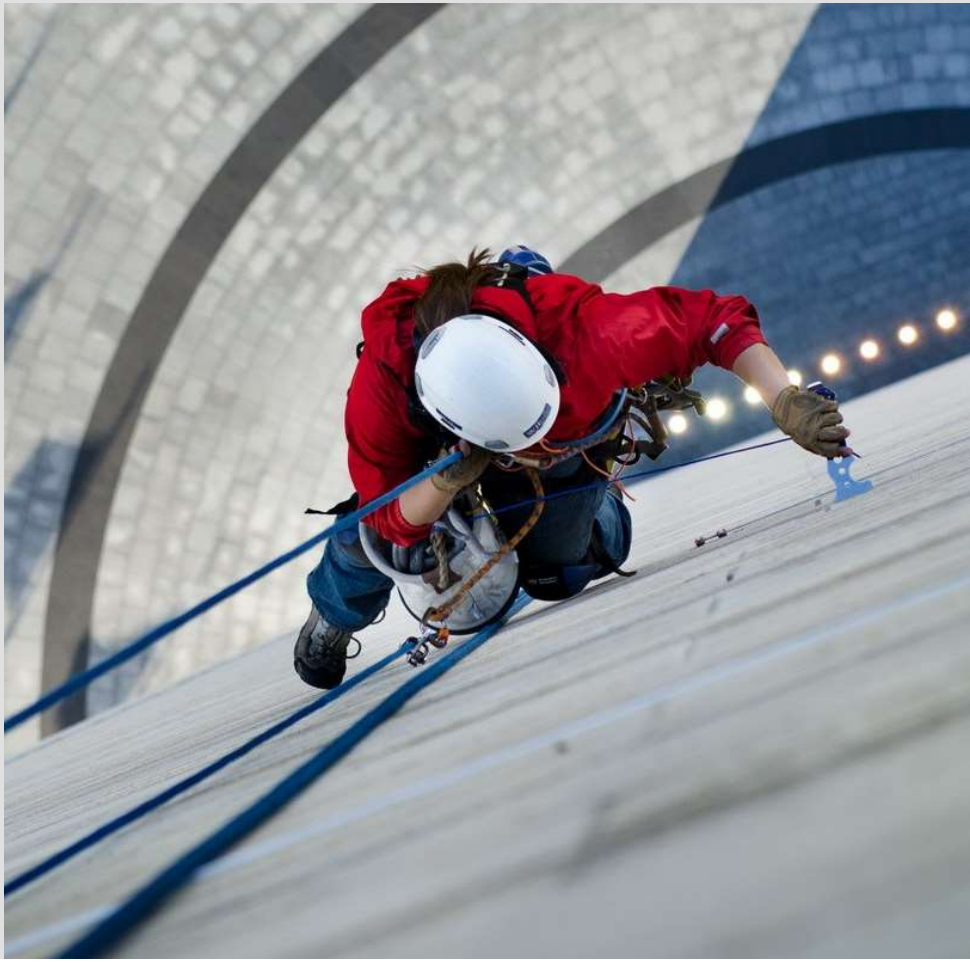


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Photo Source: WJE.com

INT'L PROPERTY MAINTENANCE CODE (IPMC)

Section 304 – Exterior Structure

304.1 General – The exterior of a structure shall be maintained in good repair, structurally sound and sanitary so as not to pose a threat to the public health, safety or welfare.

304.1.1 Unsafe Conditions – The following conditions shall be determined as unsafe and shall be replaced or repaired…

7. Exterior walls that are not anchored to supporting and supported elements…

10. Veneer…not properly anchored or that are anchored with connections not capable of supporting all nominal loads and resisting all load effects.

CITY OF PITTSBURGH

Section 304.1.1. reads:

304.1.1 Required Inspections: All buildings and structures except Use Group R-3, shall be inspected by a licensed professional engineer or registered architect to determine the structural soundness of items covered in Sections 304.8, 304.9 and 304.11, and their reports shall bear their signature and seal. All inspections made prior to the adoption of this code shall continue on their previous schedule at five year intervals. All new inspections shall be completed within one year of the adoption of this code and successive inspections shall be made every fifth year after the date of the original inspection.

- *304.8 Decorative features.* All cornices, belt courses, corbels, terra cotta trim, wall facings, and similar decorative features shall be maintained in good repair with proper anchorage and in a safe condition.
- *304.9 Overhang extensions.* All overhang extensions including, but not limited to canopies, marquees, signs, metal awnings, fire escapes, standpipes and exhaust ducts shall be maintained in good repair and be properly anchored so as to be kept in a sound condition. When required, all exposed surfaces of metal or wood shall be protected from the elements and against decay or rust by periodic application of weather-coating materials, such as paint or similar surface treatment.
- *304.11 Chimneys and towers.* All chimneys, cooling towers, smoke stacks, and similar appurtenances shall be maintained structurally safe and sound, and in good repair. All exposed surfaces of metal or wood shall be protected from the elements and against decay or rust by periodic application of weather-coating materials, such as paint or similar surface treatment.

FAÇADE ORDINANCE

Philadelphia (2010):

- 4 maintenance inspection ordinances:
  - **EXTERIOR WALLS AND APPURTENANCES OF BUILDINGS (FACADES)**
  - Fire escapes and fire escape balconies
  - Private bridges
  - Piers and other waterfront structure
- 6 or more stories in height or 60 feet
- 5-year inspection cycle
- PA-licensed PE experienced in structural engineering or RA knowledgeable in design, construction, and inspection of building facades

- **Philadelphia**
- New York City
- Boston
- Chicago
- Cincinnati
- Cleveland
- Columbus
- Detroit
- Milwaukee
- Pittsburgh
- San Francisco
- St. Louis

STANDARDS

THE SECRETARY OF THE INTERIOR'S **STANDARDS** FOR THE TREATMENT OF HISTORIC PROPERTIES

WITH

GUIDELINES FOR PRESERVING, REHABILITATING, RESTORING & RECONSTRUCTING HISTORIC BUILDINGS

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US SECRETARY OF THE INTERIOR STANDARDS

The Secretary of the Interior's Standards for the Treatment of Historic Properties

"intended to provide guidance to historic building owners and building managers, preservation consultants, architects, contractors, and project reviewers prior to treatment."

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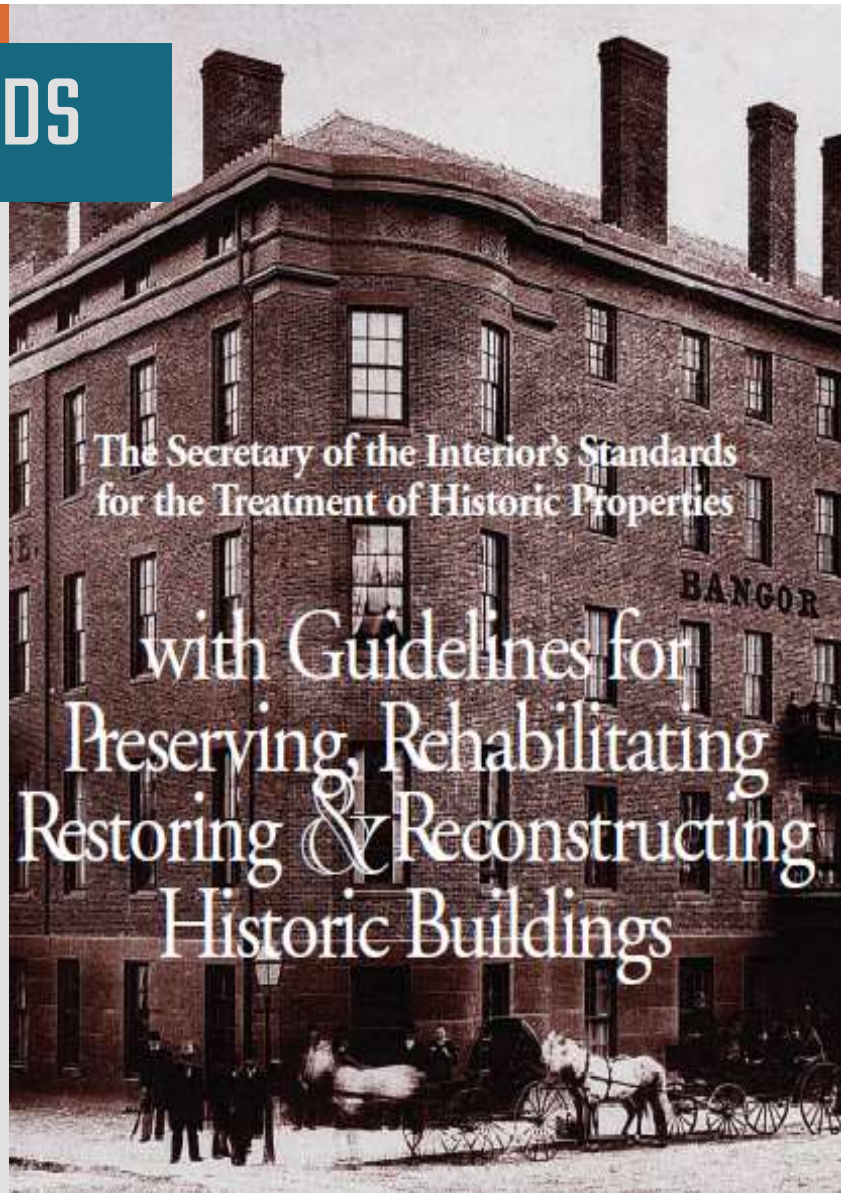

US SECRETARY OF THE INTERIOR STANDARDS

The Secretary of the Interior's Standards for the Treatment of Historic Properties

GUIDELINES FOR:
P*RESERVATION*
R*EHABILITATION*
R*ESTORATION*
R*ECONSTRUCTION*
...OF HISTORIC BUILDINGS

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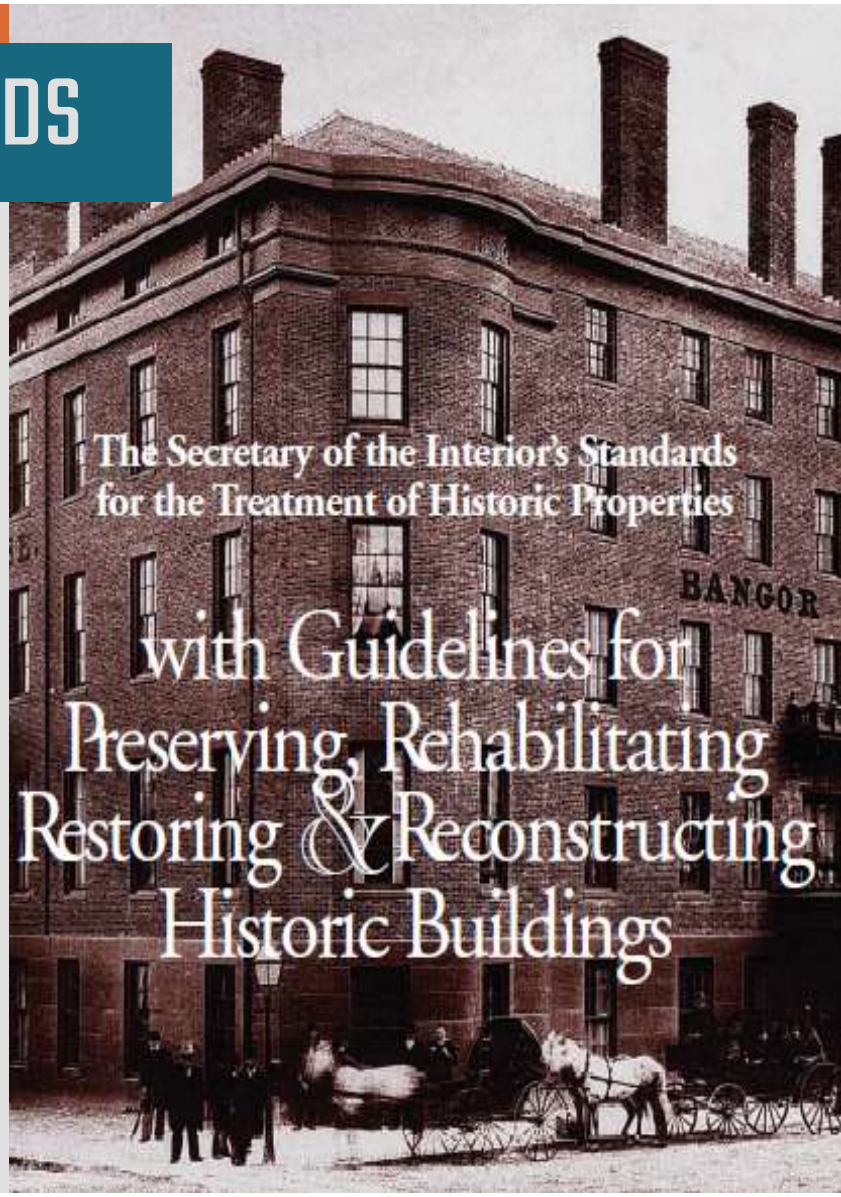

US SECRETARY OF THE INTERIOR STANDARDS

PRESERVATION

REHABILITATION

RESTORATION

RECONSTRUCTION

Least Invasive, Most Regulated

Most Invasive, Least Regulated

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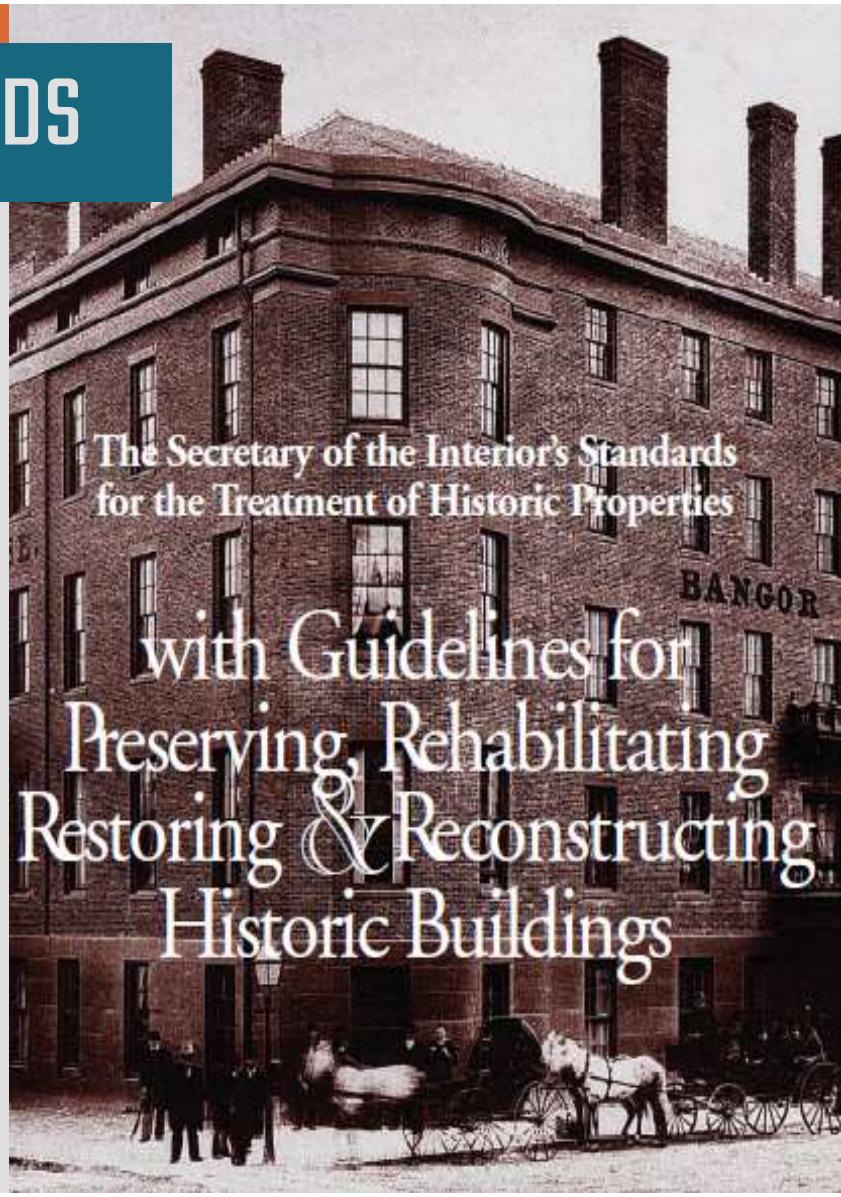


STANDARDS FOR THE TREATMENT OF HISTORIC PROPERTIES

Preservation

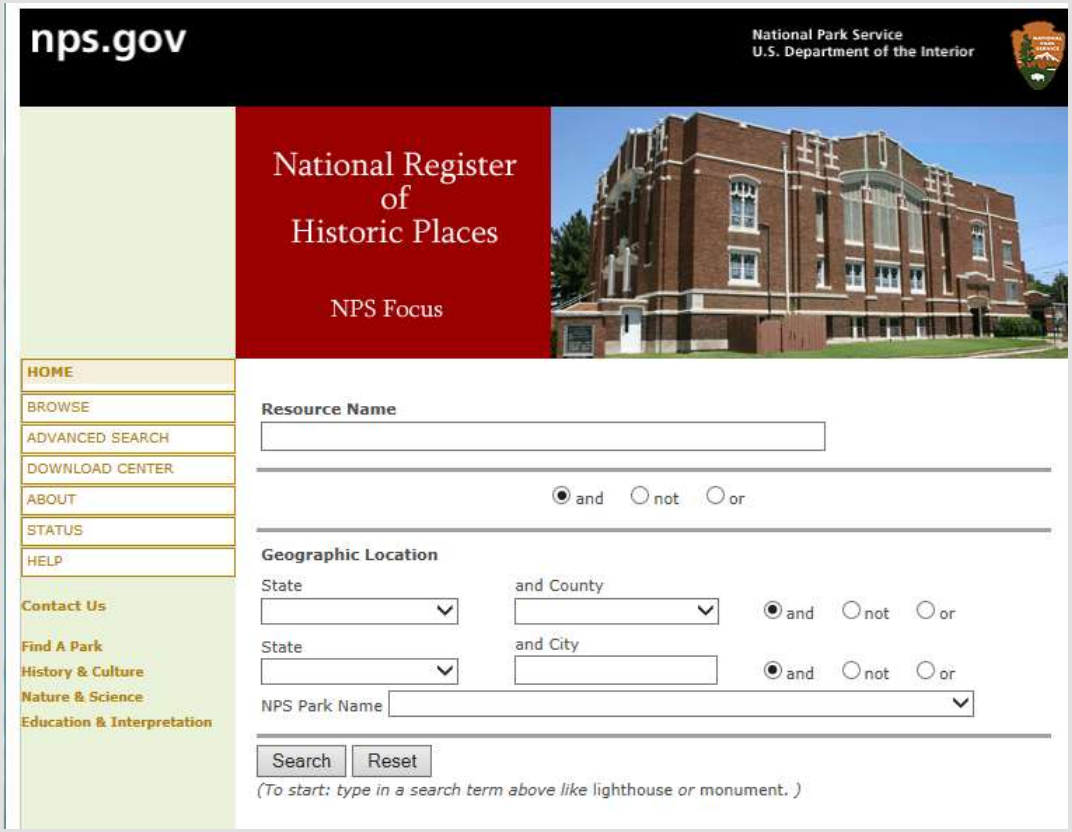
Rehabilitation

Restoration

Reconstructions

- Focus is on preservation of original material, aesthetic, reversibility, and using the gentlest means possible
- The Guidelines are advisory, not regulatory except:
  - For all grant-in-aid projects assisted through the national Historic Preservation Fund
  - For the review of rehabilitation work in the Historic Preservation Tax Incentives program

NATIONAL REGISTER OF HISTORIC PLACES



INTERNATIONAL MASONRY INSTITUTE

NATIONAL REGISTER OF HISTORIC PLACES

Districts, sites, buildings, structures, and objects that are **at least 50 years old** represent significance in American history, architecture, archeology, engineering, and culture and possess integrity of location, design, setting, materials, workmanship, feeling, and association

A. *That are associated with events that have made a significant contribution to the broad patterns of our history; or*

B. *That are associated with the lives of significant persons in or past; or*

C. *That embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or*

D. *That have yielded or may be likely to yield, information important in history or prehistory.*

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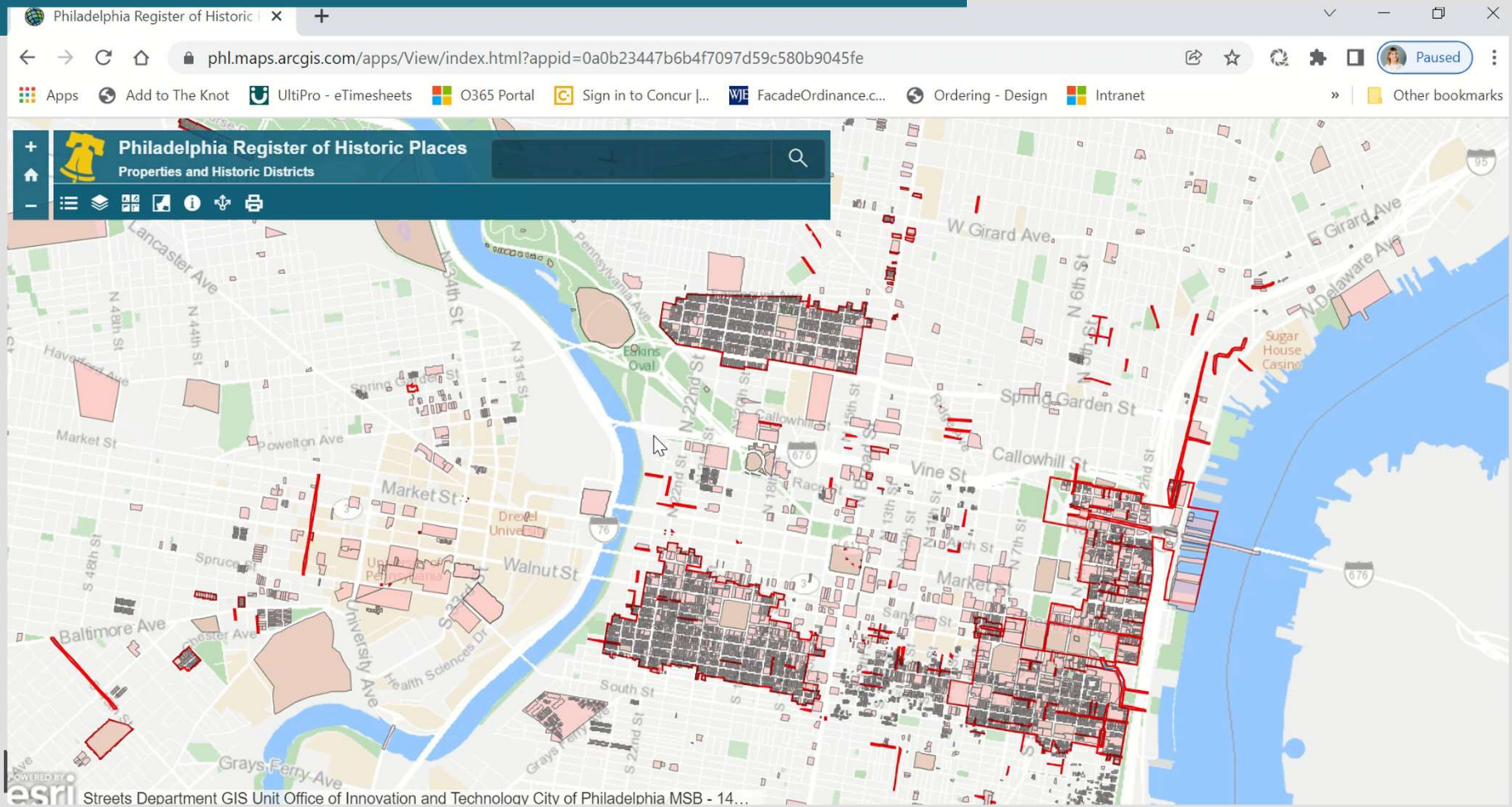
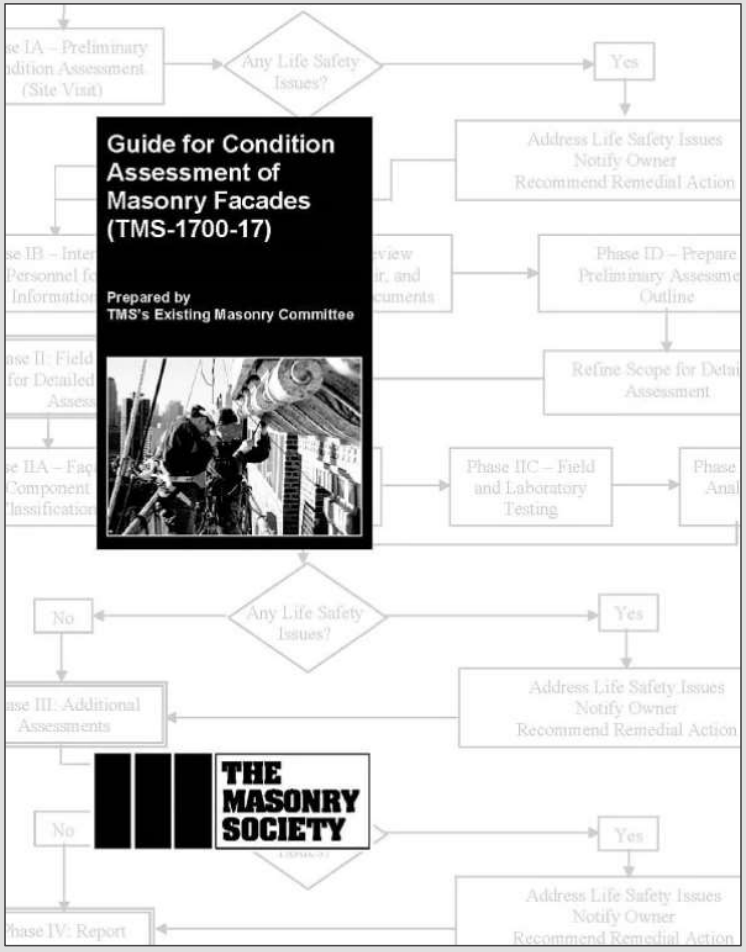
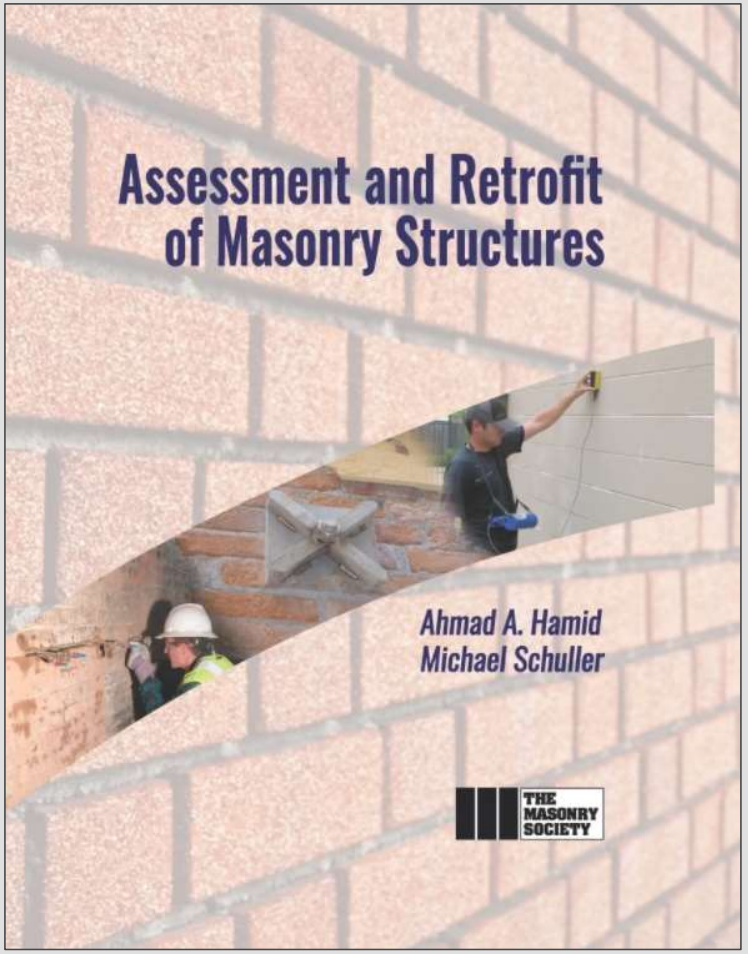
LOCAL REGISTER OF HISTORIC PLACES



GUIDES - THE MASONRY SOCIETY





GUIDES – NPS PRESERVATION BRIEFS & TECH NOTES

2 PRESERVATION BRIEFS

Repointing Mortar Joints in Historic Masonry Buildings

Robert C. Mack, FAIA
John P. Speweik

U.S. Department of the Interior
National Park Service
Cultural Resources
Heritage Preservation Services

Figure 1. After removing deteriorated mortar, an experienced mason repoints a portion of this early-20th century limestone building. Photo: Robert C. Mack, FAIA.

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 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.

PRESERVATION
Tech Notes

U.S. Department of the Interior
National Park Service
Cultural Resources
Heritage Preservation Services

MASONRY
NUMBER 4

Non-destructive Evaluation Techniques for Masonry Construction

Marilyn E. Kaplan
Preservation Architecture

Marie Ennis, P.E.
Einhorn Yaffee Prescott
Architecture & Engineering, P.C.

Edmund P. Meade, P.E.
Robert Silman Associates, P.C.

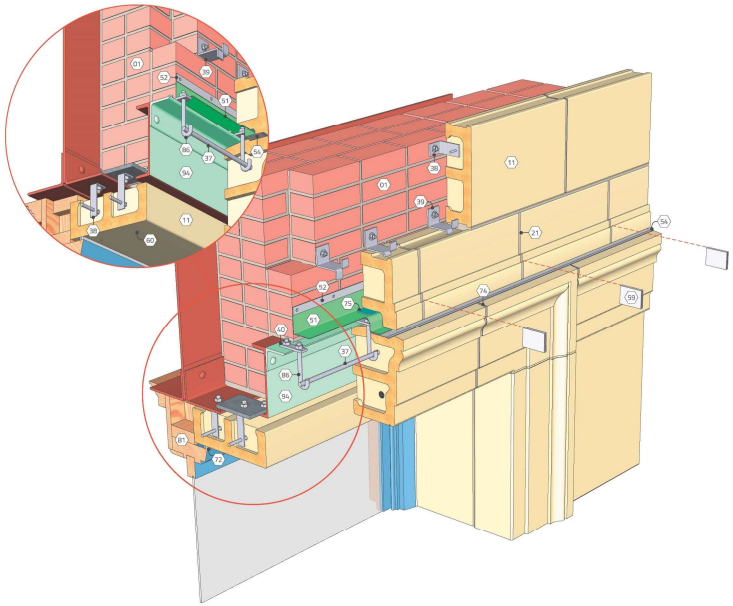
Introduction

While non-destructive evaluation (NDE) techniques have been applied to historic preservation projects in Europe as well as in other countries for many years, their use in the United States has been relatively limited. Most of the American literature about NDE is in the fields of manufacturing and civil engineering works. In manufacturing, for example, dye penetrant tests, x-ray analysis, and ultrasonic techniques aid the evaluation of welds in pipes and pressure vessels. Civil engineers use impact echo testing for the evaluation of concrete bridge decks; ultrasonic methods to determine steel thicknesses in other bridge elements; and electromagnetic equipment to verify the placement of reinforcing bars in concrete structures.

NDE techniques now need to be recognized for their potential value to engineers and architects who work on *historic structures*. Historic construction hidden from view may be successfully understood and conditions assessed while minimizing destructive probe work. The data obtained from conventional probe techniques are generally more limited in accuracy because the data is collected at discrete locations and must be interpolated to estimate the conditions at points between the probes. While it may not be possible to eliminate completely the use of conventional-

Non-destructive evaluation techniques can be of significant value in historic preservation projects.

GUIDES – IMI DETAILS AND TECH BRIEFS



KEY NOTES

(01) (E) Masonry backup, multi-wythe construction
(11) Architectural terra cotta, hand pressed
(21) Mortar
(37) Stainless steel rod
(38) Stainless steel strap and pin anchor
(39) Stainless steel split tail anchor
(40) Stainless steel strap anchor
(51) Flashing system with end dams as required
(52) Termination bar with continuous sealant
(54) Stainless steel drip edge; seal and adhere to substrate
(59) Weep vent
(60) Weep hole at underside of each overhanging TC unit
(72) Sealant and backer rod
(74) Sealant or lead T-caps at all horizontal skyward-facing joints
(75) Plastic setting shims as required
(81) (E) Window assembly
(86) Stainless steel J-bolt
(94) (E) Structural steel treated with corrosion-inhibiting coating

GENERAL NOTES

This drawing references Lintel-Original Plate 36.

Where anchors penetrate flashing, seal with compatible sealant.

DELIMITATION

This detail exhibits rebuild strategies with hand pressed architectural terra cotta (TC). Other options may be appropriate. It is best to consult a professional team of engineers, architects, and architectural conservators when crafting a repair or rebuild scenario for historic architectural TC.

CONSIDERATIONS

- Architect/engineer to verify condition and soundness of existing (E) masonry backup. Perform testing as necessary.
- Rebuild or replace backup as necessary.
- Replacing anchors requires performing anchorage pull-testing.
- Accessible existing sound steel that is to remain, requires cleaning and coating with a corrosion inhibitor.
- Corroded steel to be evaluated and painted, repaired, or replaced with stainless steel based on condition
- Original TC units are to be replaced in-kind or removed, repaired, and reinstalled and not filled.
- Install new TC units not filled.
- Weep holes in units must be kept clear and free of mortar and debris to prevent trapping of moisture after installation.
- Design considerations include:
  - Tolerances
  - Shims
  - Shoring
  - Modifications to units
  - (E) Anchor removal

KEYWORDS

Terra cotta, Rebuild, Pressed, Hand pressed, Lintel, Brick, Restoration, Anchor, Repair, Window, Flashing, 10.030.0632

WJE
Developed in cooperation with Wiss, Janney, Elstner & Associates, Inc.

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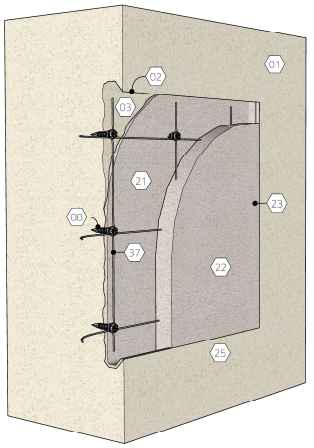
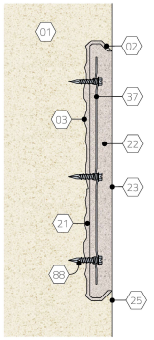
TERRA COTTA DETAILING SERIES

TITLE	SCALE	REV.	INTERACTIVE MODEL	SHEET NO.
Lintel rebuild | Terra cotta, pressed	None	02/01/21	https://imisketchupmodels.blogspot.com/2021/01/100300632-lintel-rebuild-terra-cotta.html	10.030.0632



3D view



Section view

INTERNATIONAL MASONRY INSTITUTE
MASONRY DETAILING SERIES

KEY NOTES

(01) Existing masonry unit (e.g. stone, terra cotta, cast stone, etc.)
(02) Saw-cut and key perimeter edge
(03) Chip unit to rough surface; clean surface of dust and debris; prior to mortar placement, surface must be saturated surface dry (SSD) or surface moisture as required by composite mortar manufacturer
(21) Base coat
(22) Composite mortar
(23) Finish to match existing profile and color; apply coating to match existing glaze or finish if required
(25) Clean surface of unit after repair
(88) Stainless steel masonry screw, appropriate type, size, spacing, and embedment depth
(37) Stainless steel wire wrapped around screws, gauge as appropriate

KEYWORDS

Restoration, Repair, Masonry, Stone, Terra cotta, Cast stone, Composite mortar, Small patch, 10.410.0502

TITLE	SCALE	REV.	SHEET NO.
Composite mortar repair | Small area (1 s.f. ±)	Varies	05/06/20	10.410.0502

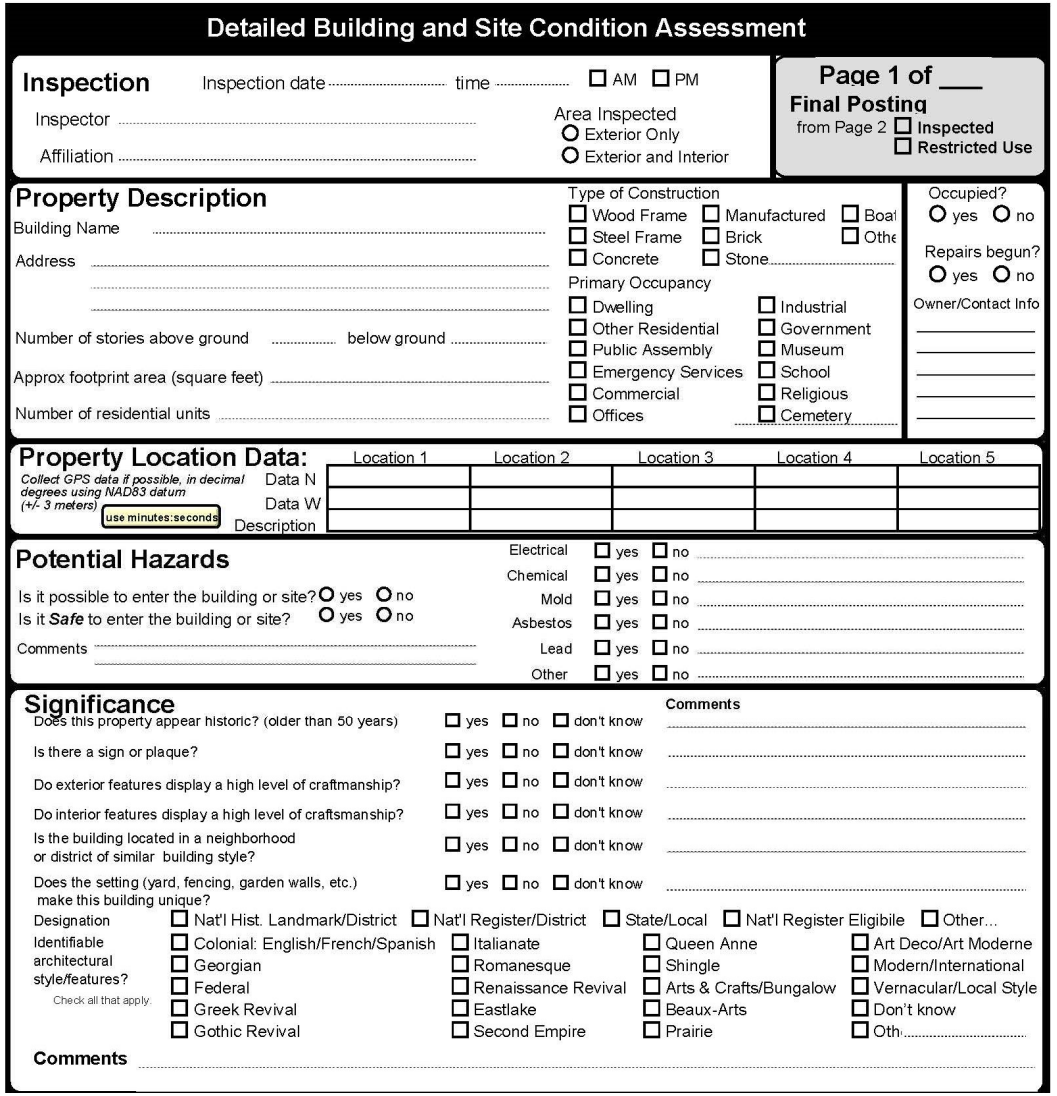
CONDITION ASSESSMENT

GATHERING ALL THE INFORMATION

Understanding:

- Building significance
- Materials/properties
- Type of construction
- Unit and system conditions
- Sources of deterioration
- Project goals
- Budget and scheduling restrictions

Helps develop appropriate repair and restoration solutions



Detailed Building and Site Condition Assessment

Inspection Inspection date ..... time ..... ☐ AM ☐ PM
Inspector .....
Affiliation .....
Area Inspected: ○ Exterior Only ○ Exterior and Interior

Page 1 of ___
Final Posting from Page 2 ☐ Inspected ☐ Restricted Use

Property Description
Building Name .....
Address .....
Number of stories above ground ..... below ground .....
Approx footprint area (square feet) .....
Number of residential units .....

Type of Construction: ☐ Wood Frame ☐ Manufactured ☐ Boat ☐ Steel Frame ☐ Brick ☐ Other ☐ Concrete ☐ Stone .....
Primary Occupancy: ☐ Dwelling ☐ Other Residential ☐ Public Assembly ☐ Emergency Services ☐ Commercial ☐ Offices ☐ Industrial ☐ Government ☐ Museum ☐ School ☐ Religious ☐ Cemetery

Occupied? ○ yes ○ no
Repairs begun? ○ yes ○ no
Owner/Contact Info

Property Location Data:
Collect GPS data if possible, in decimal degrees using NAD83 datum (+/- 3 meters) use minutes:seconds

	Location 1	Location 2	Location 3	Location 4	Location 5
Data N					
Data W					
Description					

Potential Hazards
Is it possible to enter the building or site? ○ yes ○ no
Is it ***Safe*** to enter the building or site? ○ yes ○ no
Comments .....

Electrical ☐ yes ☐ no .....
Chemical ☐ yes ☐ no .....
Mold ☐ yes ☐ no .....
Asbestos ☐ yes ☐ no .....
Lead ☐ yes ☐ no .....
Other ☐ yes ☐ no .....

Significance

		Comments
Does this property appear historic? (older than 50 years)	☐ yes ☐ no ☐ don't know	
Is there a sign or plaque?	☐ yes ☐ no ☐ don't know	
Do exterior features display a high level of craftmanship?	☐ yes ☐ no ☐ don't know	
Do interior features display a high level of craftsmanship?	☐ yes ☐ no ☐ don't know	
Is the building located in a neighborhood or district of similar building style?	☐ yes ☐ no ☐ don't know	
Does the setting (yard, fencing, garden walls, etc.) make this building unique?	☐ yes ☐ no ☐ don't know	

Designation: ☐ Nat'l Hist. Landmark/District ☐ Nat'l Register/District ☐ State/Local ☐ Nat'l Register Eligibile ☐ Other...

Identifiable architectural style/features? Check all that apply.
☐ Colonial: English/French/Spanish ☐ Georgian ☐ Federal ☐ Greek Revival ☐ Gothic Revival ☐ Italianate ☐ Romanesque ☐ Renaissance Revival ☐ Eastlake ☐ Second Empire ☐ Queen Anne ☐ Shingle ☐ Arts & Crafts/Bungalow ☐ Beaux-Arts ☐ Prairie ☐ Art Deco/Art Moderne ☐ Modern/International ☐ Vernacular/Local Style ☐ Don't know ☐ Oth.....

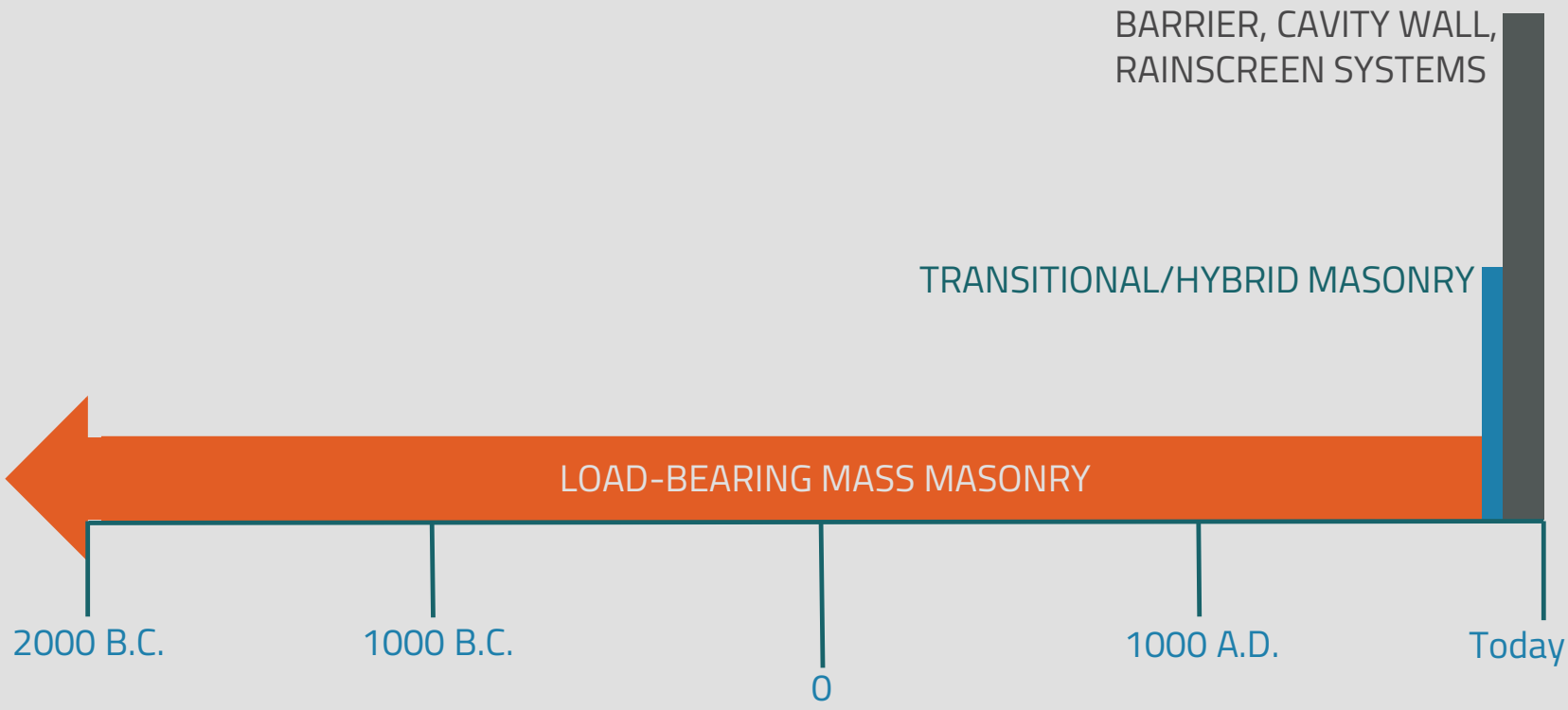
Comments .....

CONDITION ASSESSMENT METHODS

- Document Review
- Visual/Sight Survey
- Physical Survey
- Non-Destructive Testing
- Exploratory Openings
- Destructive Testing – Taking Samples
- Lab Testing/Microscopy

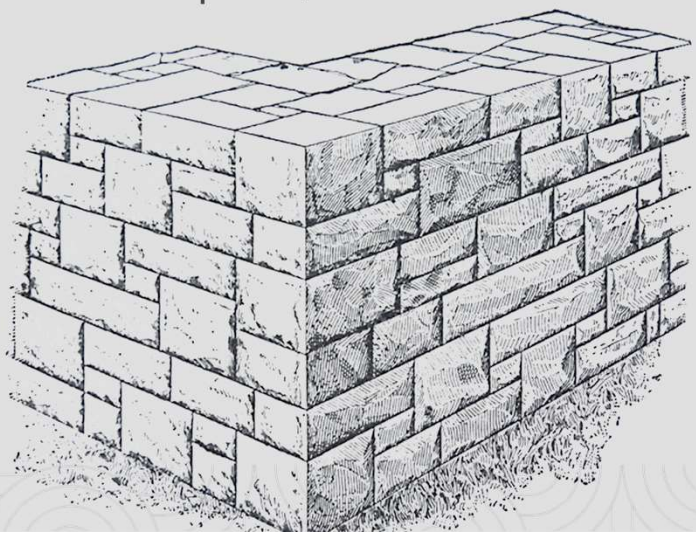
Historic Masonry Wall Assemblies

Masonry Timeline



Load Bearing Construction

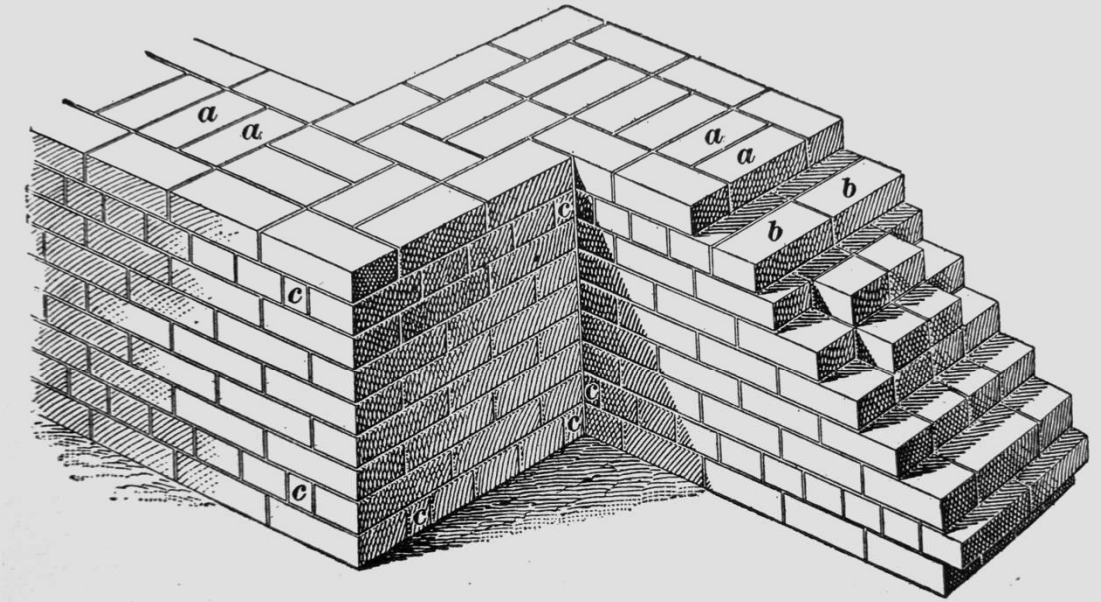
- Thick bearing walls that supported floors
- Thickness of wall depended on height of building
- Mass restrained movement, lime mortars allowed for settling
- Limited lighting, interior footprint, and height



MASS MASONRY BRICK

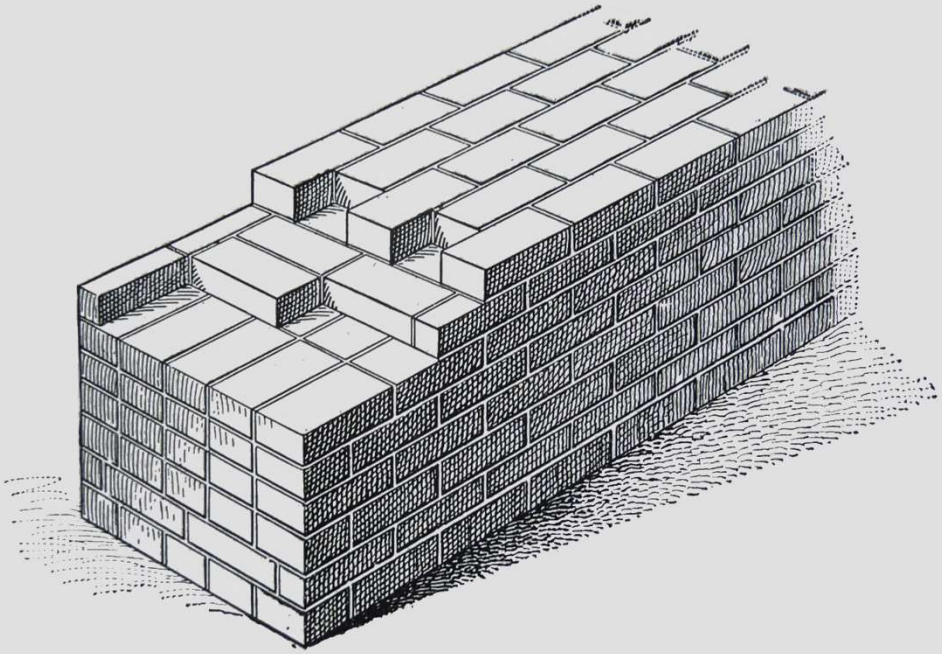
"To build a strong, substantial, and solid wall with bricks requires careful arrangement so that they shall be tied together and form a cohesive mass of masonry."

- Common Bond
- English Bond
- Flemish Bond
- Etc.

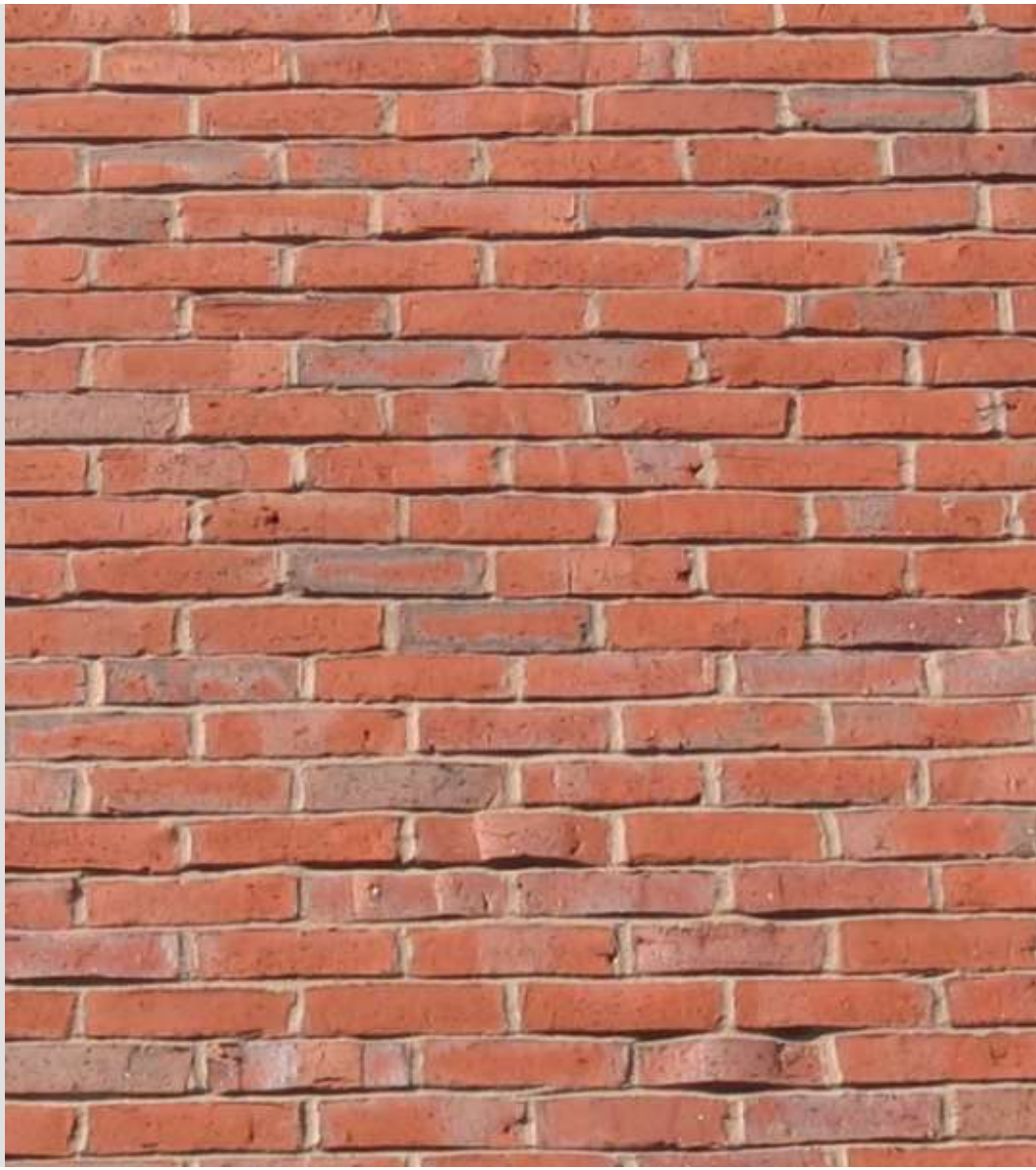


Common Bond

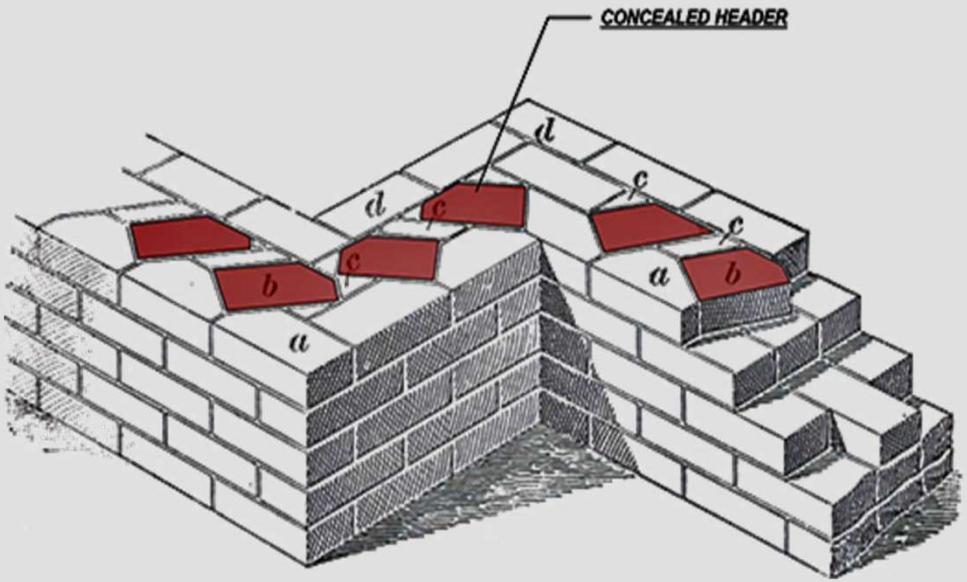
MASS MASONRY BRICK



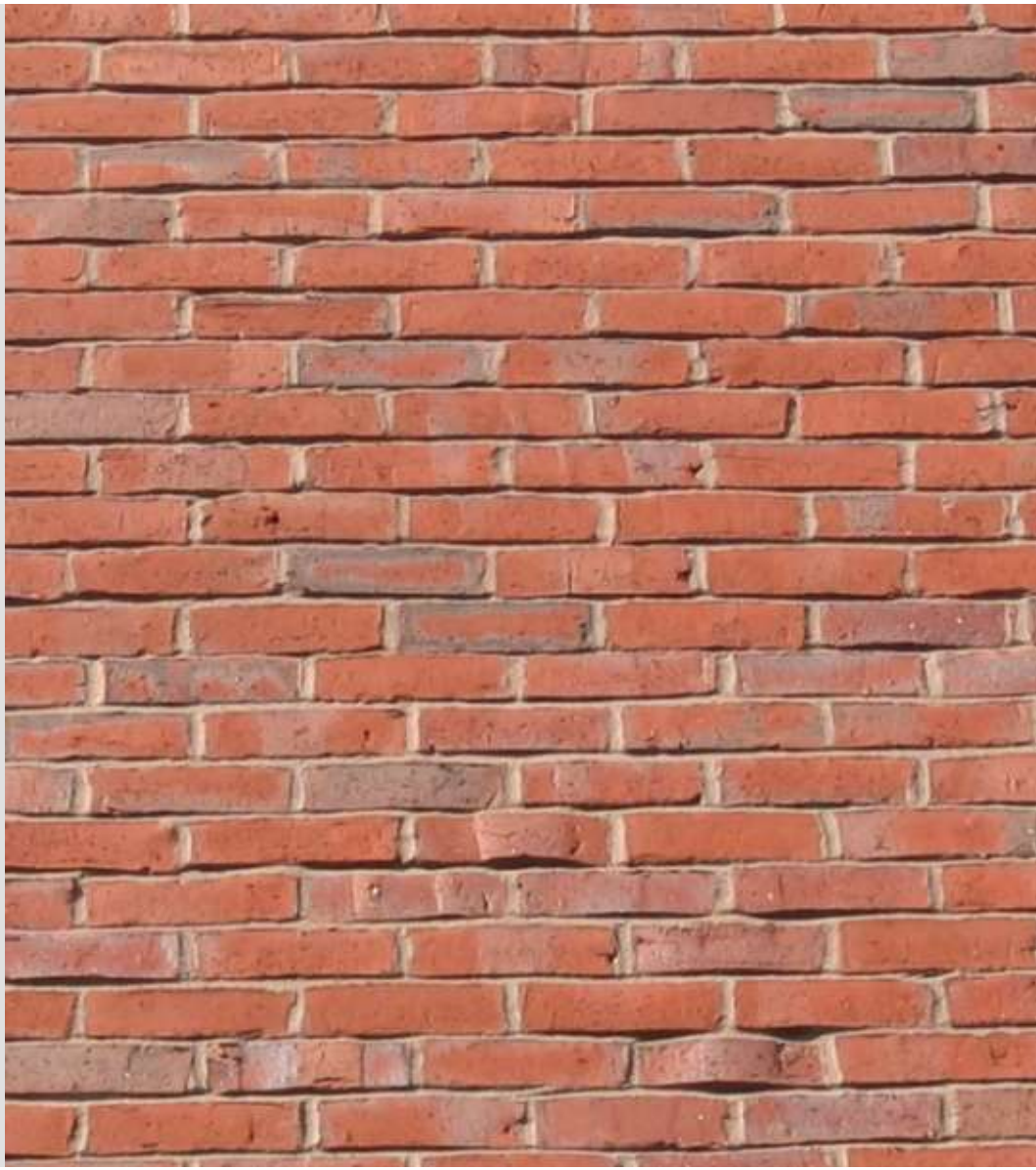
Running Bond (Queen)



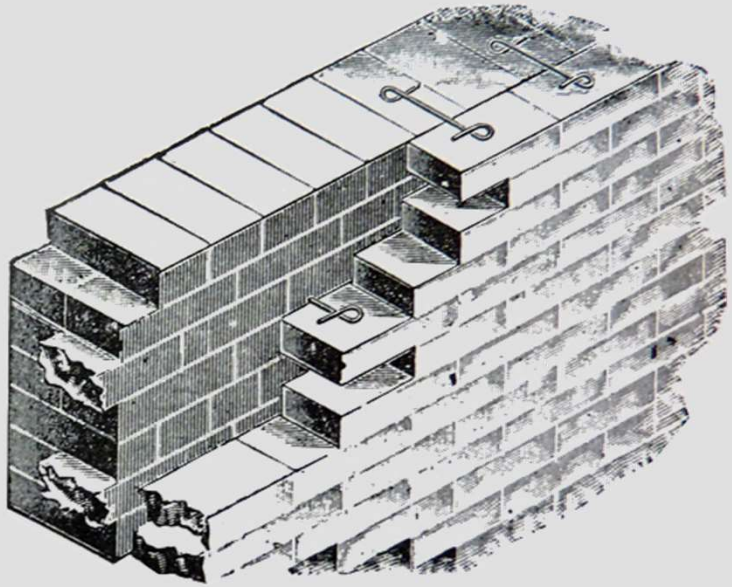
MASS MASONRY BRICK



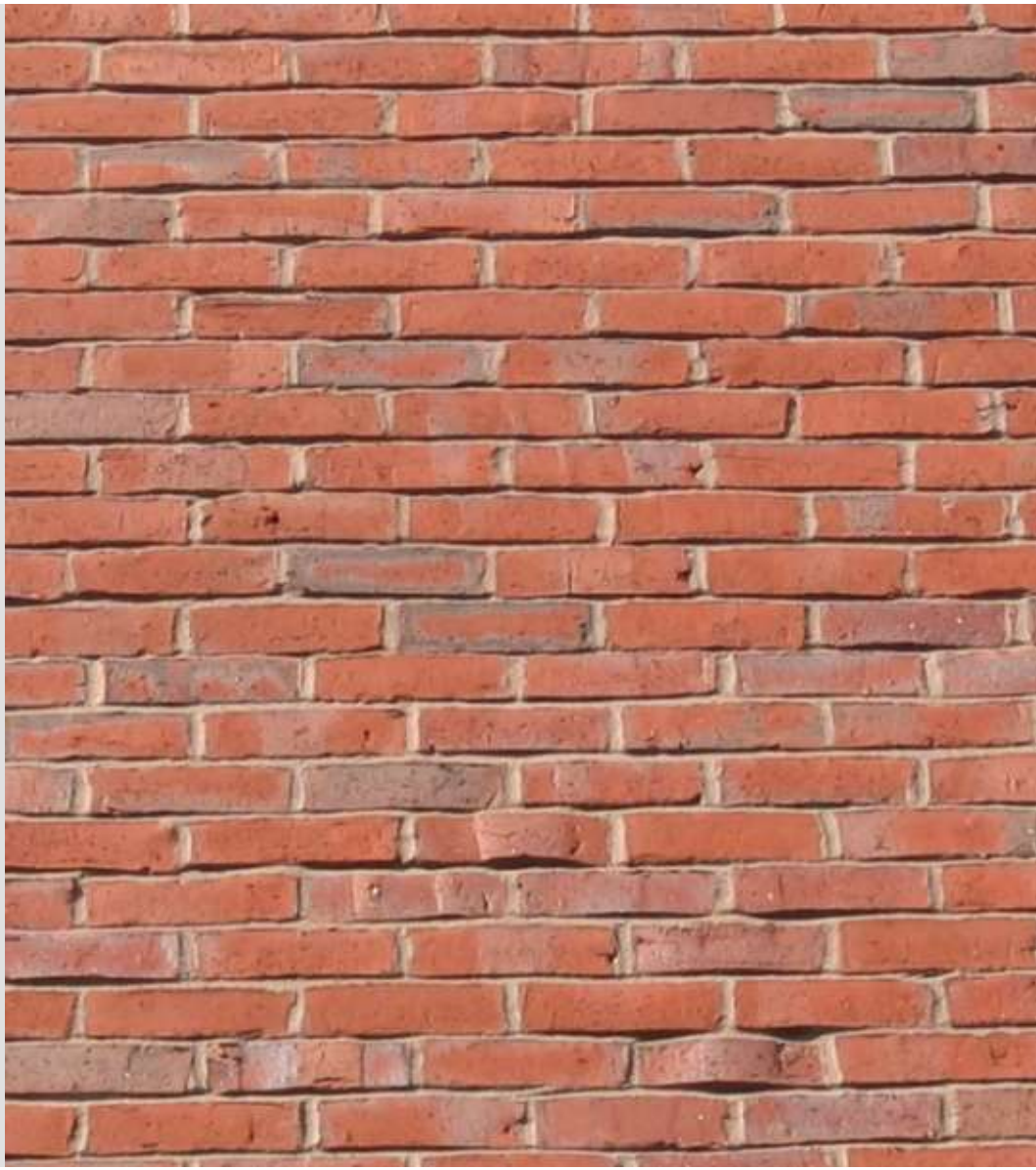
Running Bond (Concealed)



MASS MASONRY BRICK

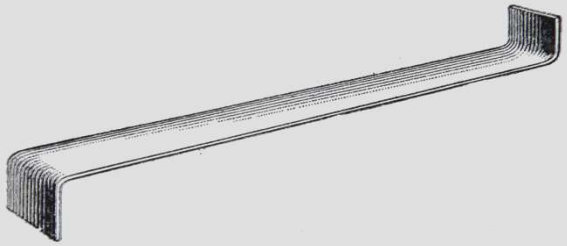


Running Bond (Venner Tie)

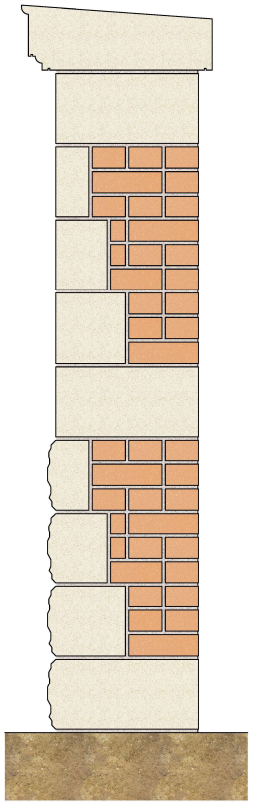


MASS MASONRY
STONE VENEER

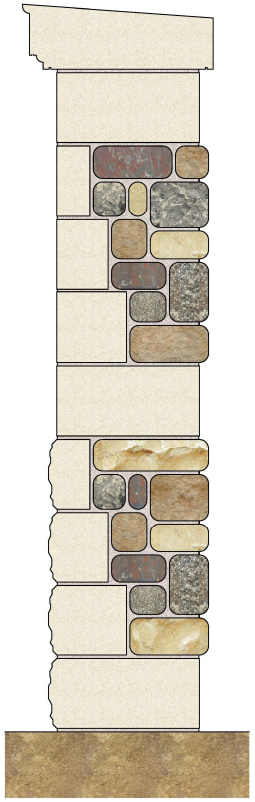
"All iron clamps or anchors should either be galvanized or dipped in hot tar or asphalt to prevent the formation of rust."



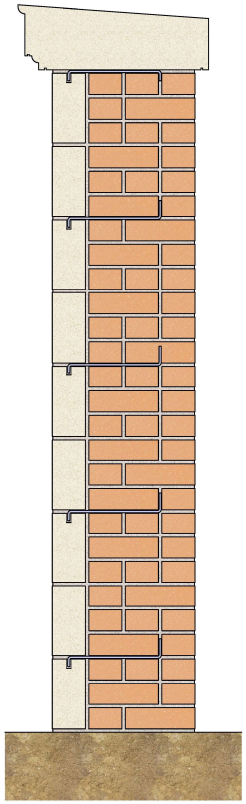
INTERNATIONAL MASONRY INSTITUTE
MASONRY DETAILING SERIES



03.020.0217
Coursed ashlar wall w/ brick backing
<Wall 3>



03.020.0218
Ashlar w/ rubble backing
<Wall 4>

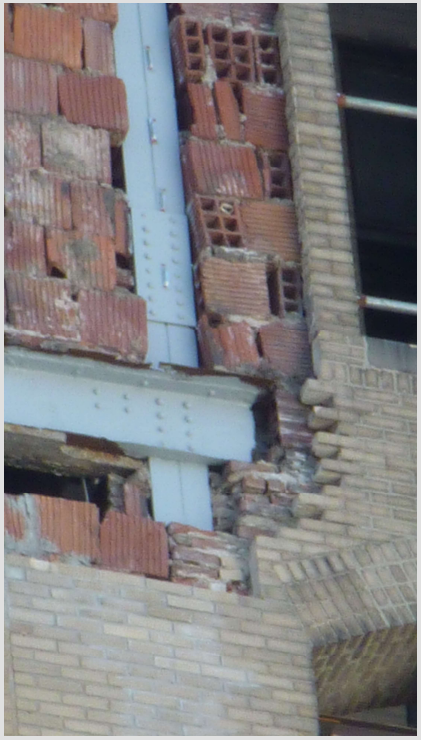


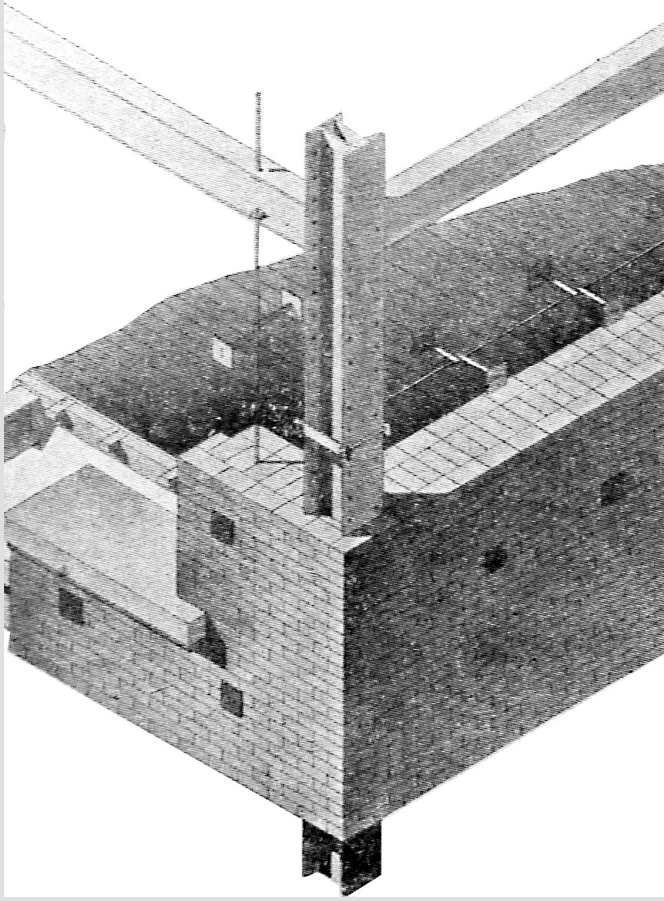
03.020.0219 4-in. ashlar veneer w/ brick backing
<Wall 5>

Transitional Masonry

"Early generation high rise buildings built between 1890 and World War II, represent a technical transition between traditional load bearing masonry construction and modern curtain wall systems".

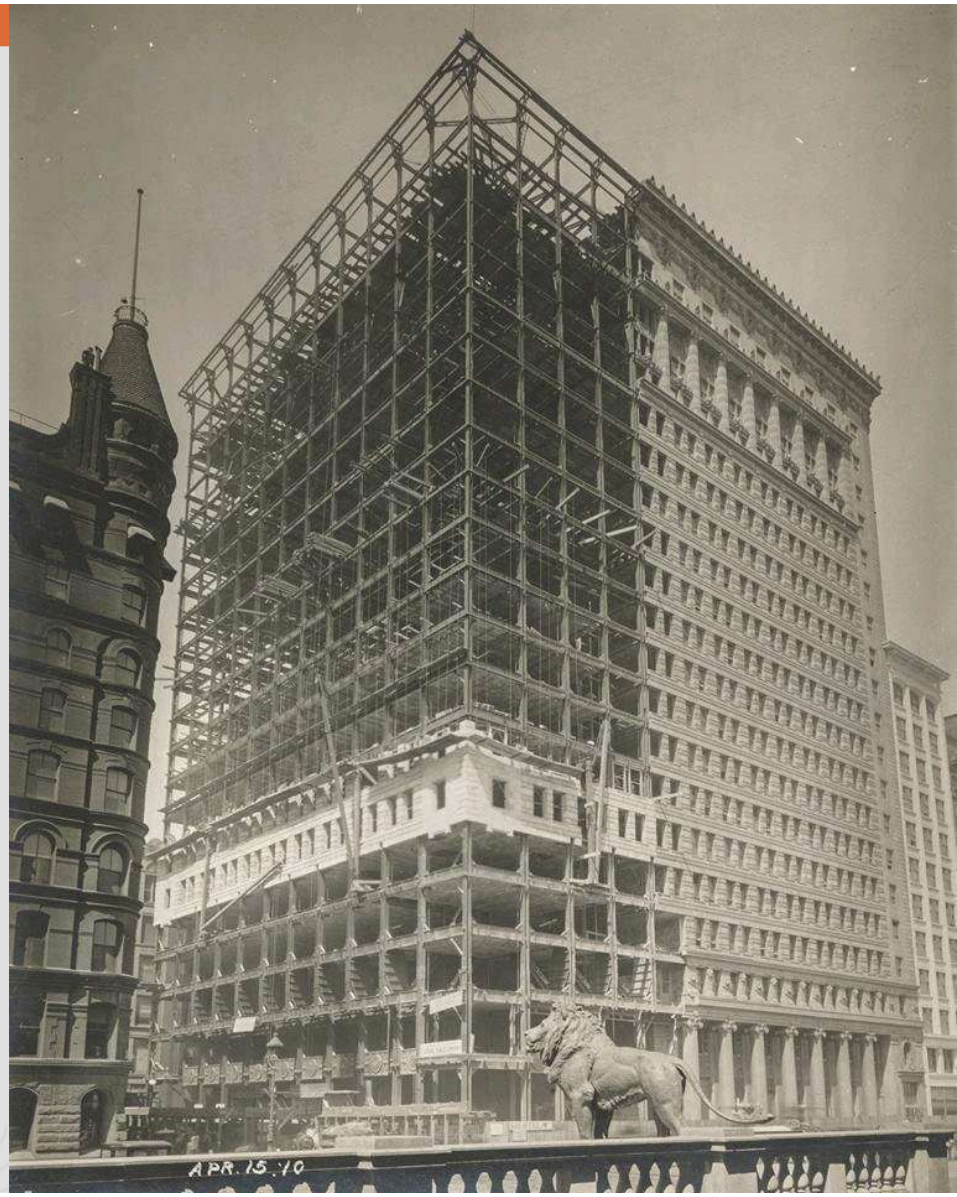
-(Buntrock, Rebecca 2010)





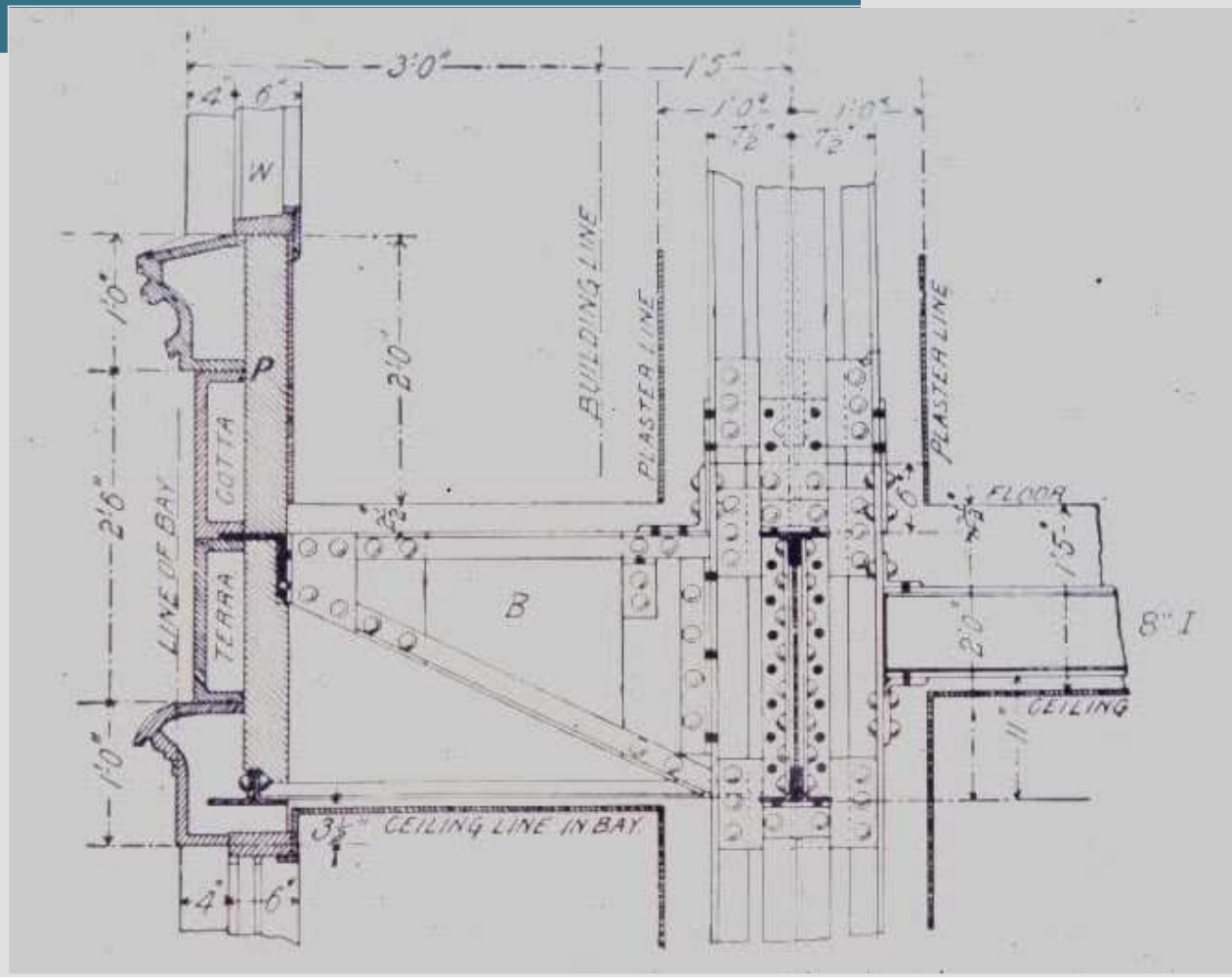
Transitional Masonry

- Steel provided structure
- Masonry acted as “skin” and was hung onto steel structure
- Curtain wall construction



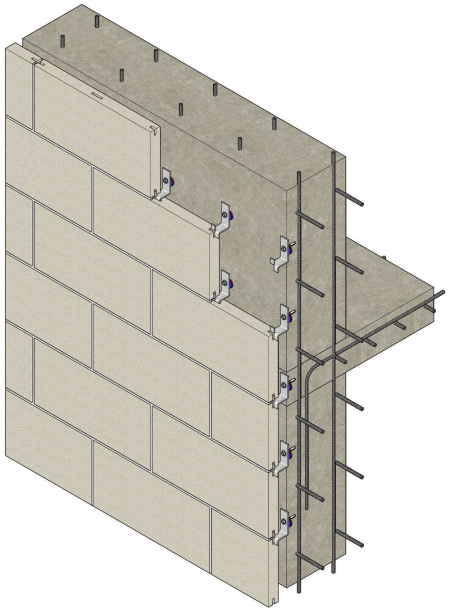
TRANSITIONAL MASONRY WALL SYSTEM

Flatiron Building (1902) New York City, NY
http://www.nycvintageimages.com/content/flatiron-building-under-construction-1902



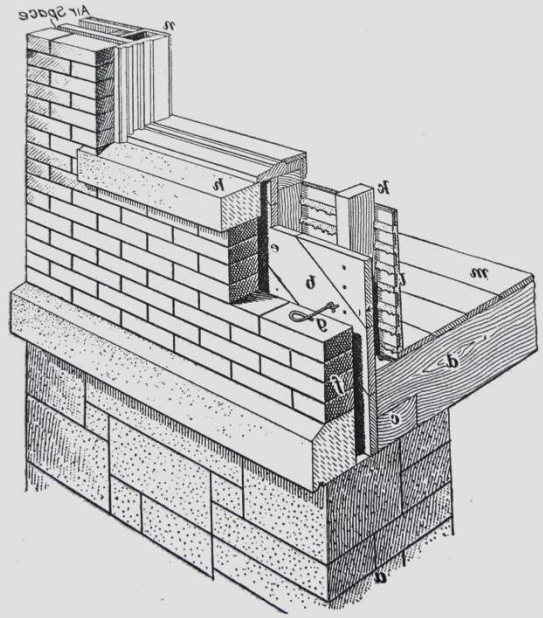
Barrier Wall Construction

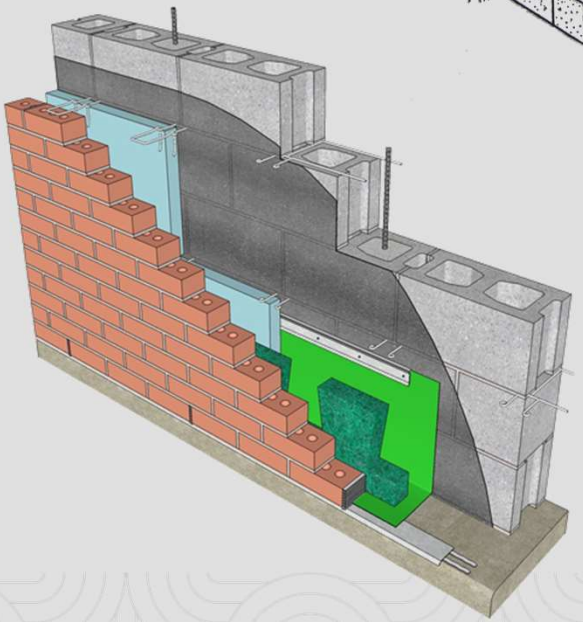
- Midcentury to present
- Interior structure supports floors and exterior cladding
- Exterior cladding becomes thinner and is anchored back to interior structure
- No weeps or moisture path – expectation that no moisture will get in



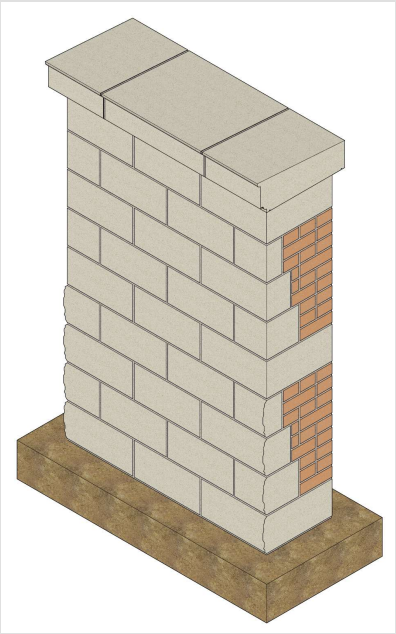
Cavity Wall Construction

- Began in late 19th-century, but didn't become the norm until later 20th century
- Reducing damp and temperature transfer from exterior to interior
- Brick headers replaced with metal ties

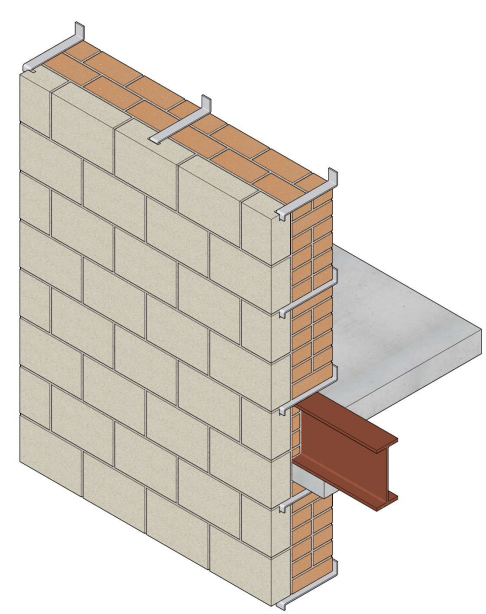




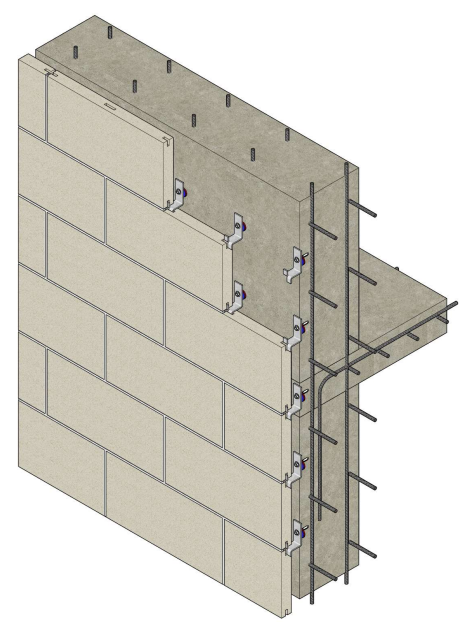
HISTORIC STRUCTURES



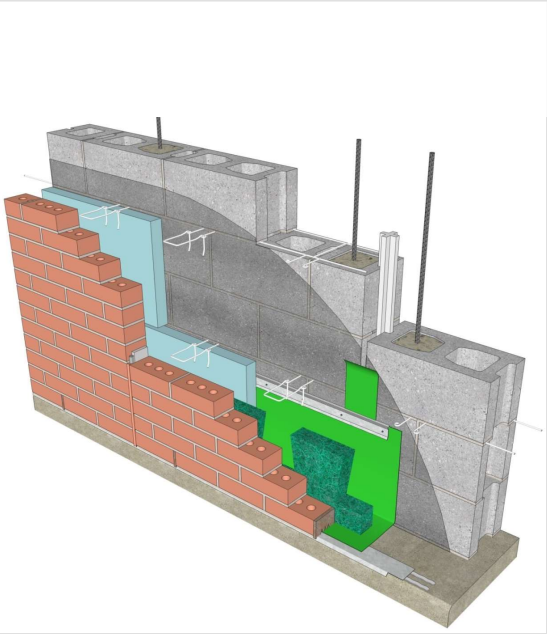
Mass Wall



Transitional Wall



Barrier Wall



Cavity Wall

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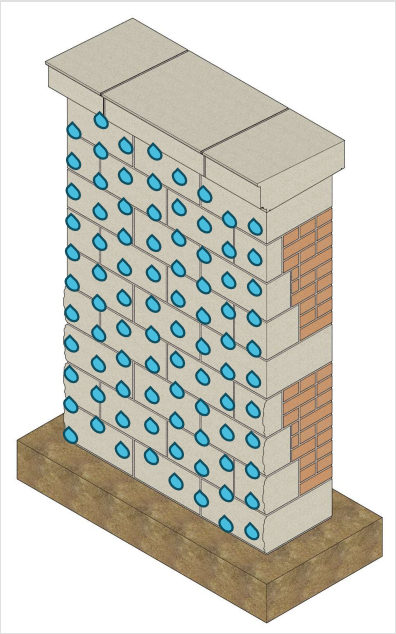
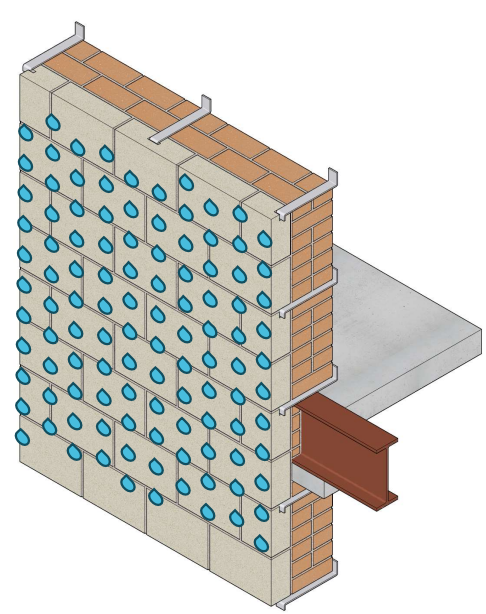
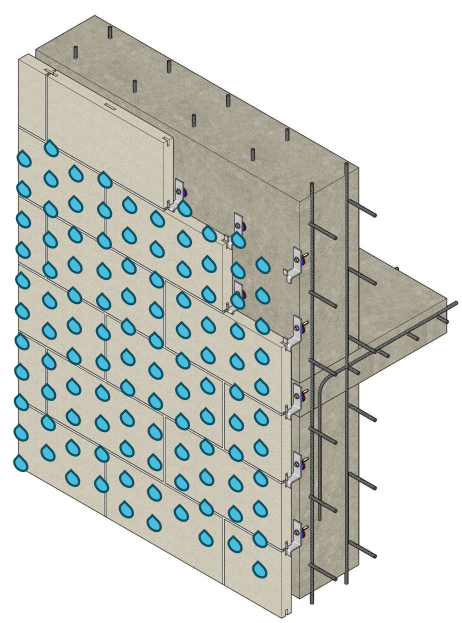
WATER MANAGEMENT



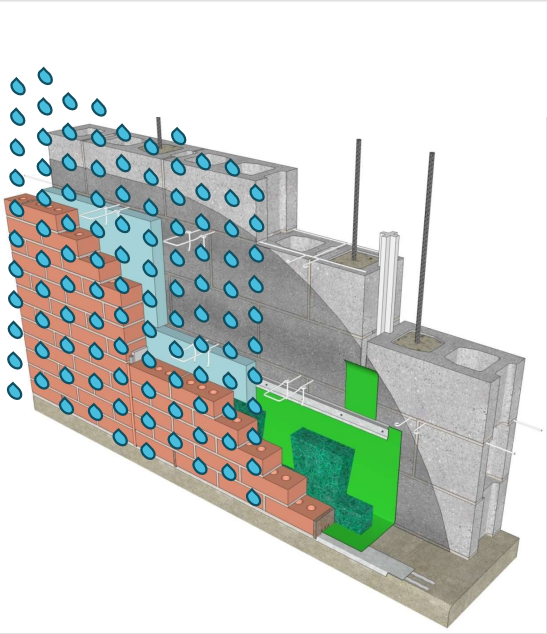
Mass Wall



Transitional Wall



Barrier Wall



Cavity Wall

INTERNATIONAL MASONRY INSTITUTE

Masonry Materials

Building Materials

- Building materials have different material properties that are the product of the ways in which they were formed or manufactured

- The ways in which these materials were made directly effect how these building materials will perform, weather and deteriorate over time

- **Understanding material properties will determine appropriate repairs**

Materials Properties

- Strength
- Density
- Porosity
- Water Absorption

MASONRY MATERIALS

Masonry types:

Natural Stone:

- Granite, limestone, marble, sandstone, slate, regional stone

Ceramic:

- Brick, terra cotta, tile

Cementitious:

- Mortar
- Cast Stone
- Concrete

MASONRY PROPERTIES

Masonry type:

Acid sensitive (calcareous):

- Natural stone: limestone and marble
- Concrete, cast stone, mortar

Alkaline sensitive:

- Granite
- Indiana limestone
- Some sandstones

Not sensitive (siliceous):

- Natural stone: sandstone, granite
- Ceramic: brick, terra cotta, tile

HAZARDOUS MATERIALS

- Lead Paint
- PCBs
- Asbestos
- Silica

Deterioration Mechanisms & Conditions

Deterioration Mechanisms

Water Infiltration

- Original design/material deficiencies
- Deferred maintenance
- Salt contamination
- Inappropriate repairs, coatings, mortar that trap moisture

At-Risk Façade Elements

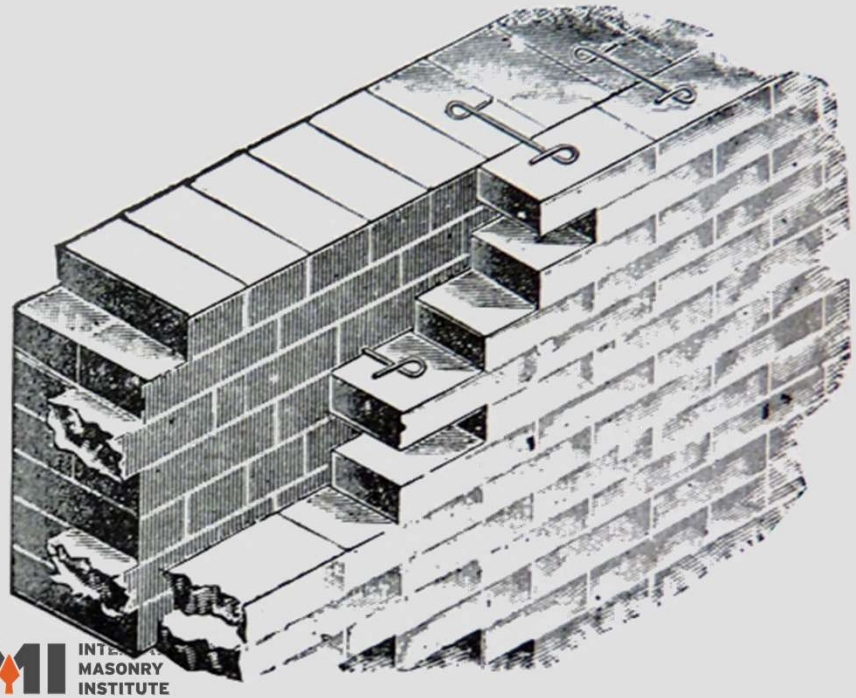
- Exterior and interior horizontal surfaces
- Parapets, cornices
- Skyward-facing joints
- Corners
- Roof-wall interface

Structural Conditions

- Walls out of plane
- Separation of outer wythe of brick
- Failure of corroded steel supports

- Cracking
- Spalling
- Bulging

SEPARATION OF MASONRY BRICK TIE FAILURE



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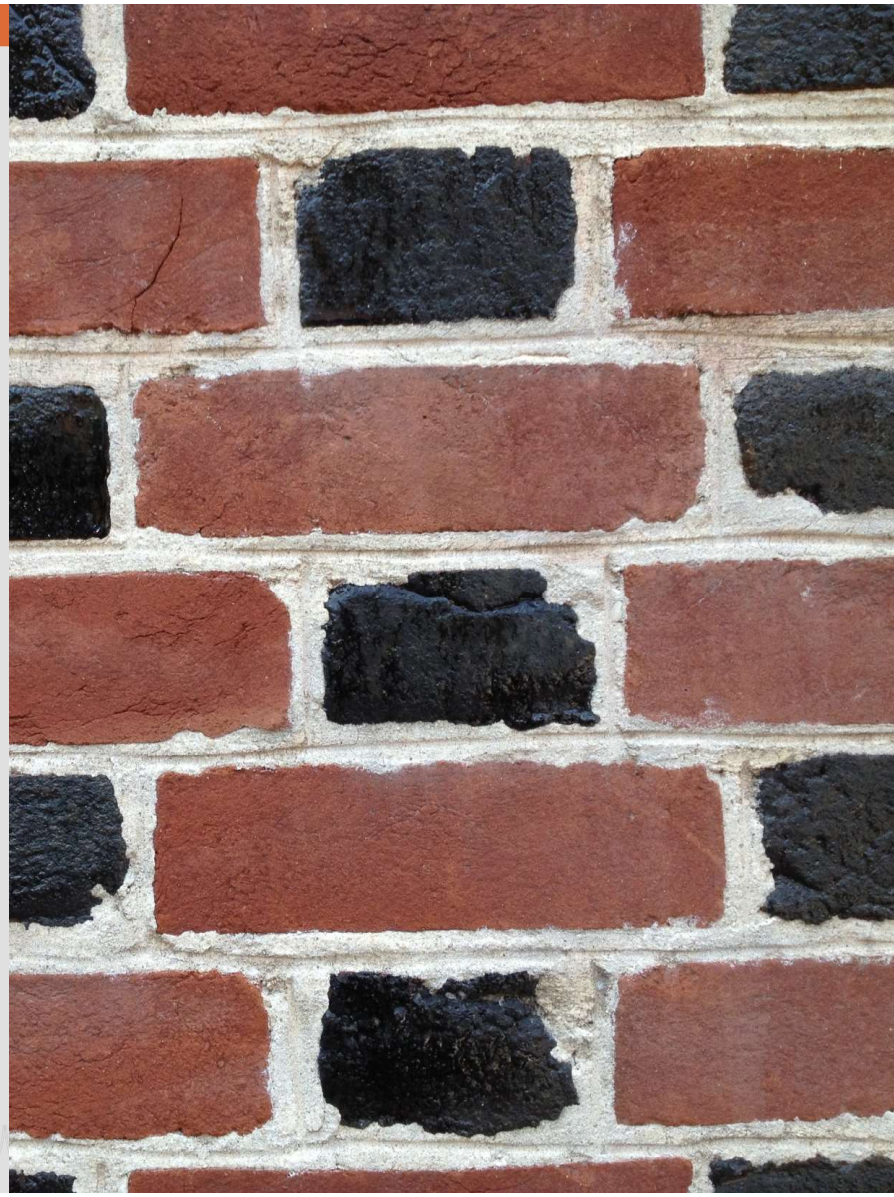
Intrinsic Brick Conditions

Manufacturing process

- Poor quality control
- Additives
- Inadequate firing temperature/time
- Cooling rates

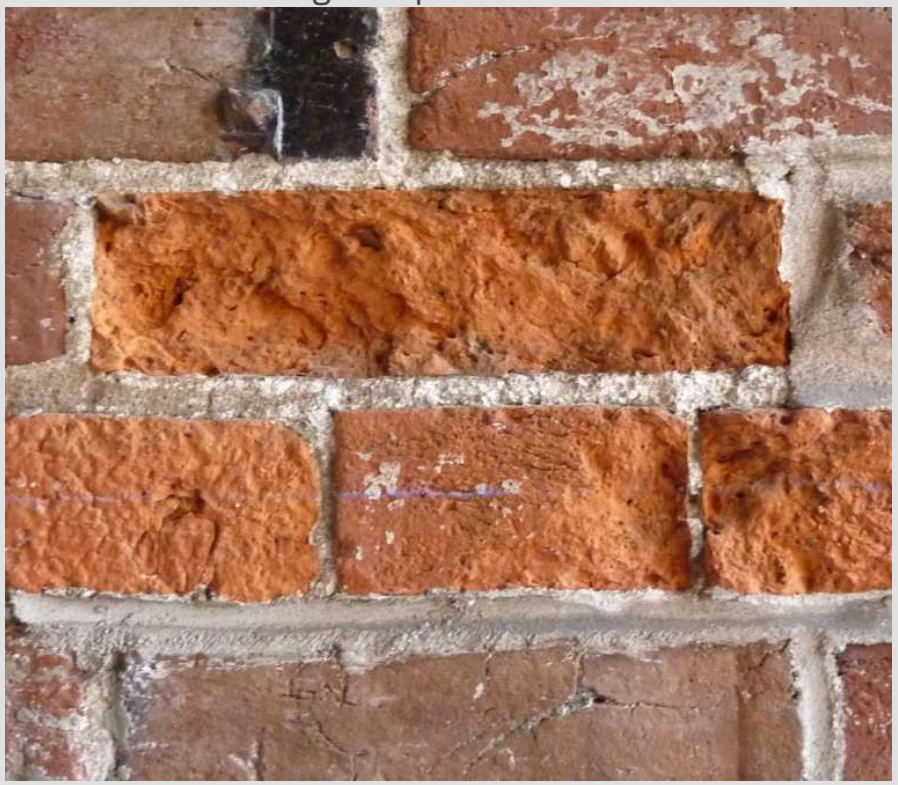
- Glaze adhesion
- Unit porosity
- Unit density



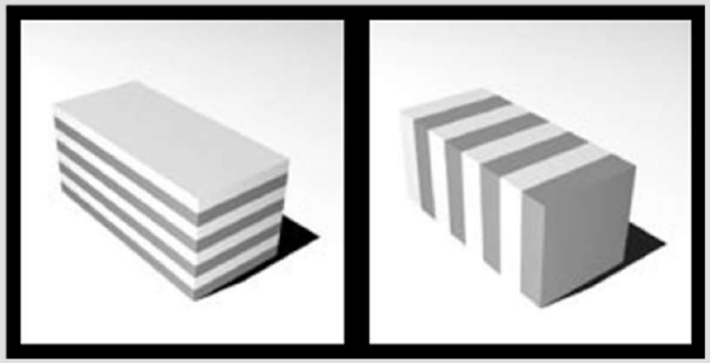
Intrinsic Brick Conditions

Poor Quality Unit Crack

Low Firing Temperature Exfoliation

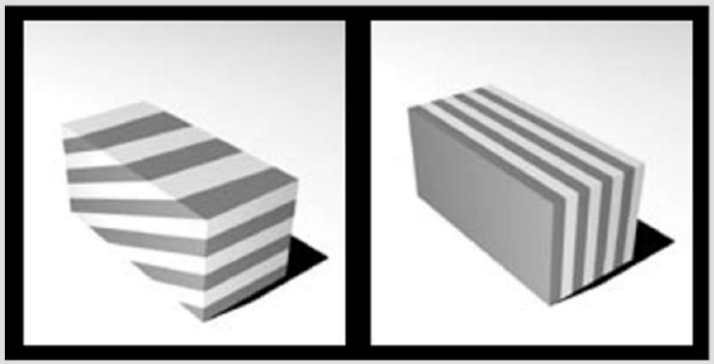


Sedimentary Delamination



(a) Edge oriented horizontal

(b) Edge oriented vertical



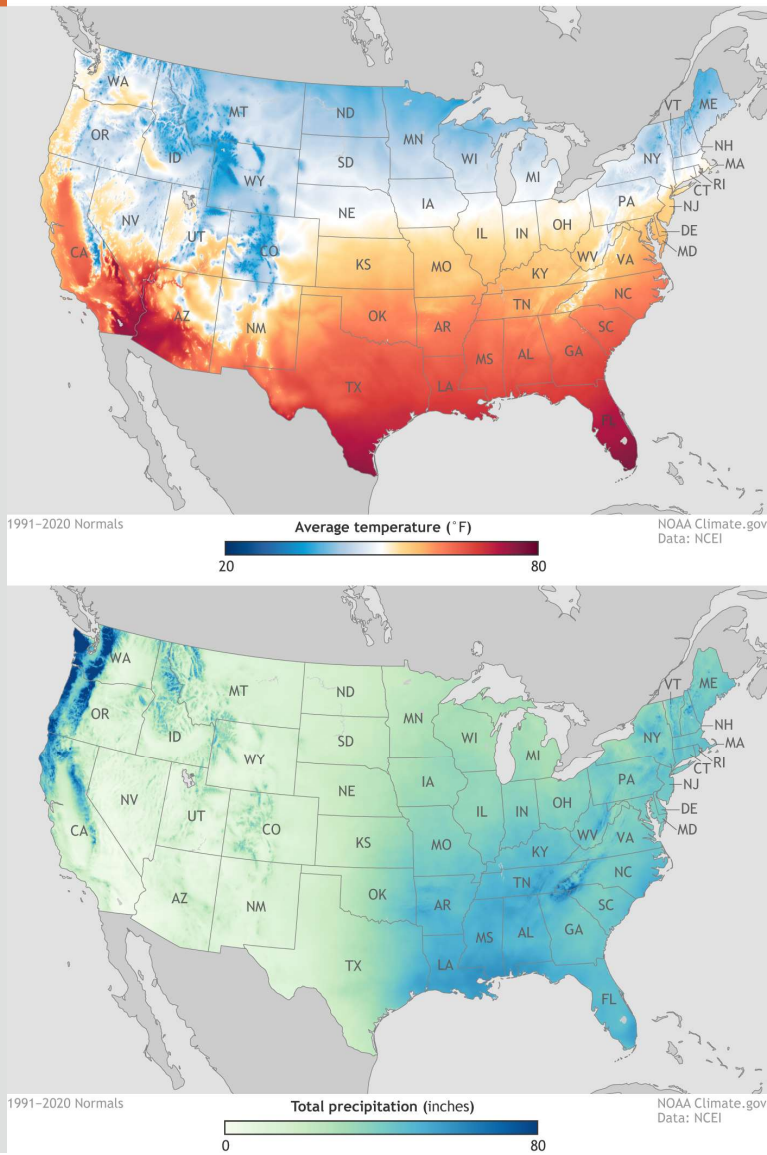
(c) Edge oriented diagonal

(d) Face oriented parallel

FREEZE-THAW CYCLING

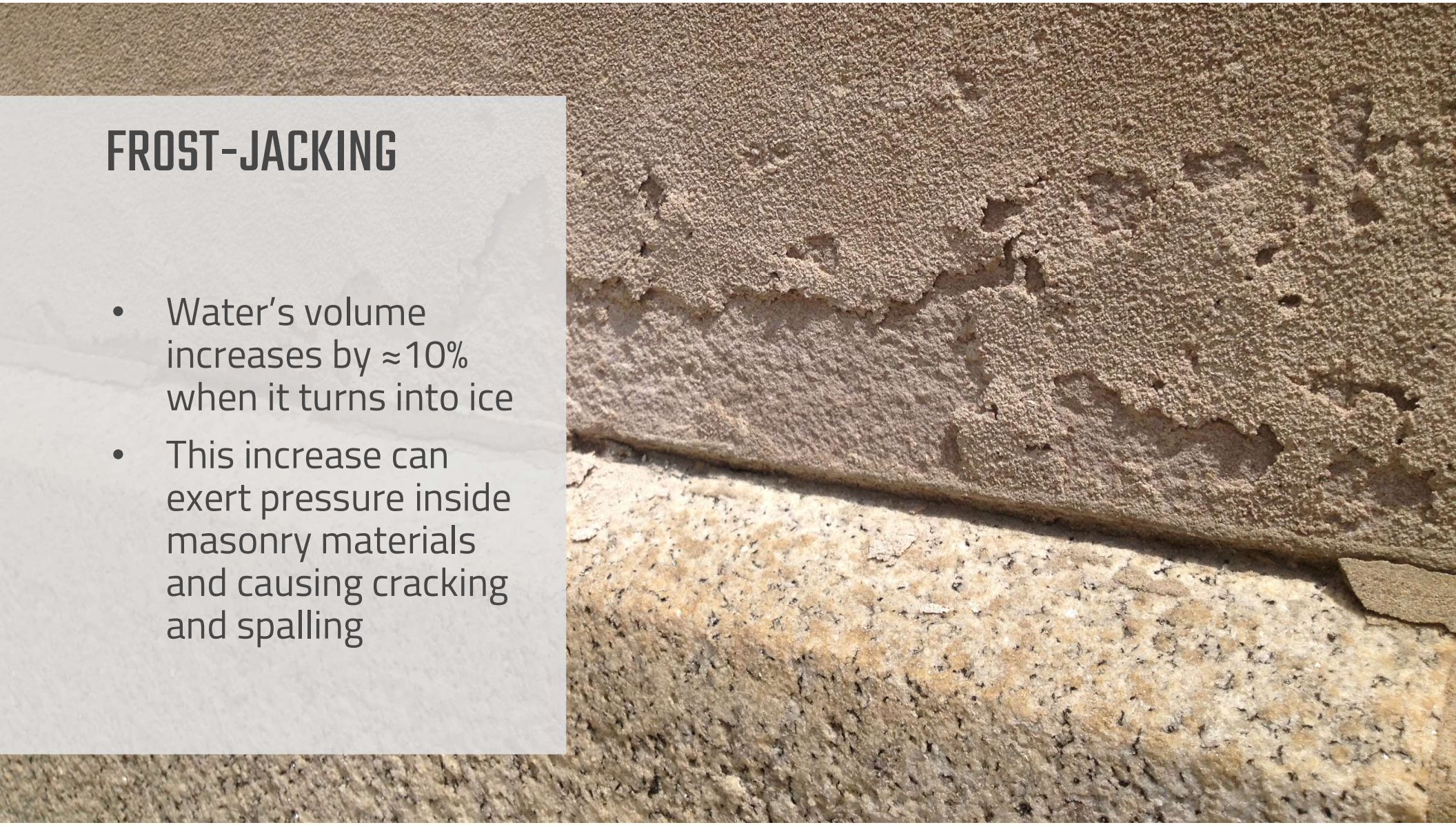
- Freeze-Thaw: when the temperate swings above and below freezing (32° F) multiple times a year
- Can weaken masonry materials from cycles of material stress

U.S. annual average temperature and precipitation (1991–2020)



FROST-JACKING

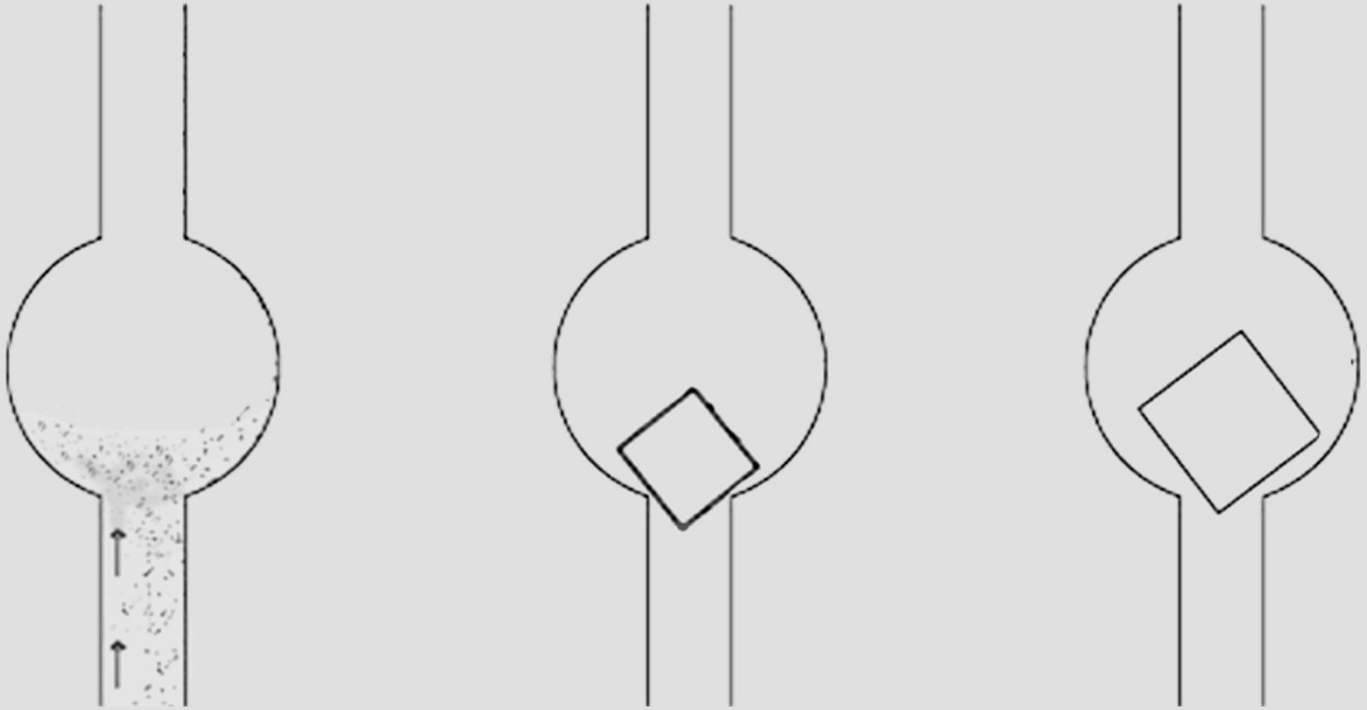
- Water's volume increases by ≈10% when it turns into ice
- This increase can exert pressure inside masonry materials and causing cracking and spalling



CONDITIONS

EFFLORESCENCE/SUBFLOURESCENCE

SOLUBLE SALTS (EFFLORESCENCE)



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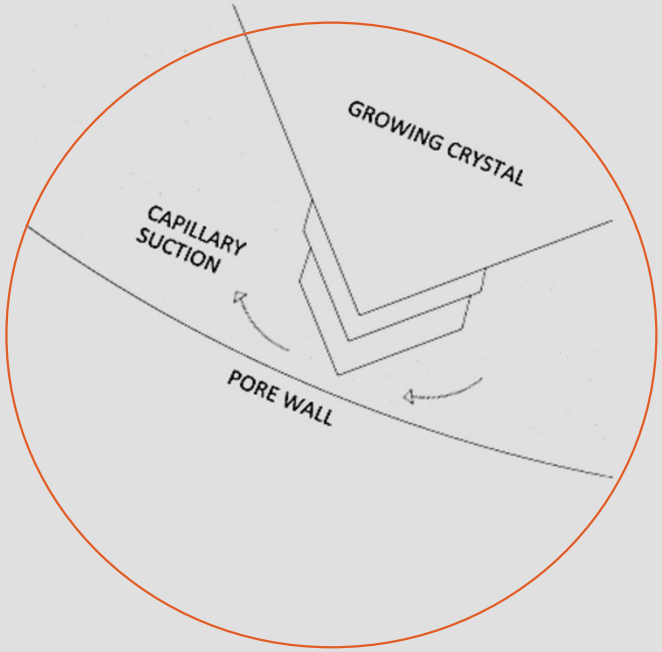
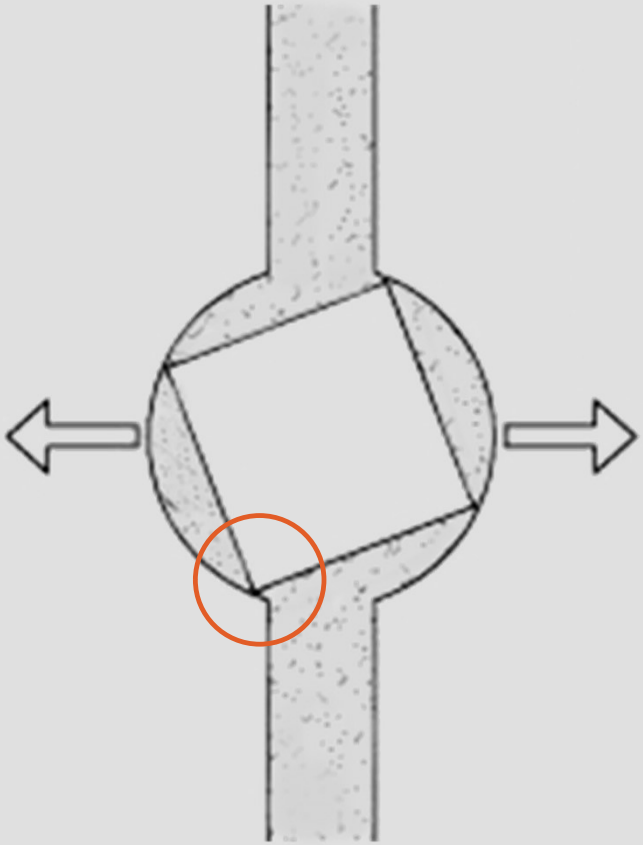
SOLUBLE SALTS (EFFLORESCENCE)





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CONDITIONS

SULFATE GYPSUM CRUSTS

GYPSUM ($CaSO_4 \cdot 2H_2O$)

CONDITIONS

METAL MINERAL STAINING

CONDITIONS

RUST-JACKING

CONDITIONS

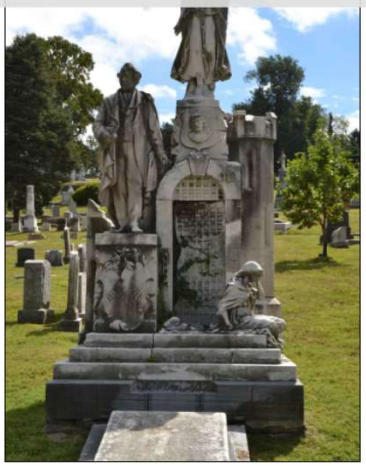
Too hard/dense repointing mortar

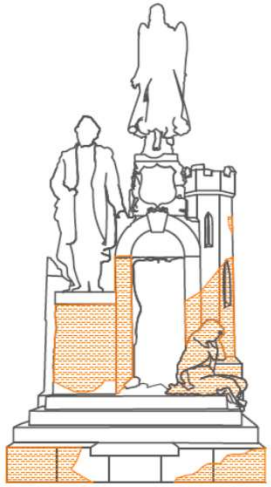

CONDITIONS

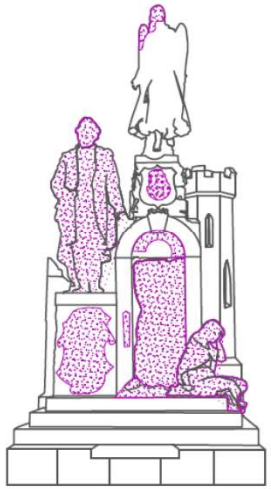

COATINGS

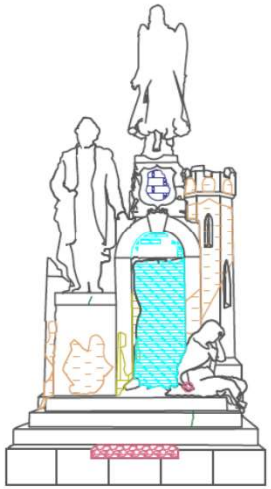
Improper Installation Techniques

CONDITION SURVEY









- Biogrowth
- Oxalate Patina
- Erosion: Rounding/Sugaring
- Black Crust: Gypsum
- Vegetation
- Differential Erosion
- Missing Part
- Pitting
- Replacement in Kind
- Crack
- Exfoliation/Delamination

The Prisoner's Friend

William J. Mullen Burial Monument

Laurel Hill Cemetery
3822 Ridge Ave,
Philadelphia, PA
19132

TPF-AX1.0

drawn by CW
scale 1/4":1'
date 25 October 2015

DESIGNING A RESTORATION PLAN

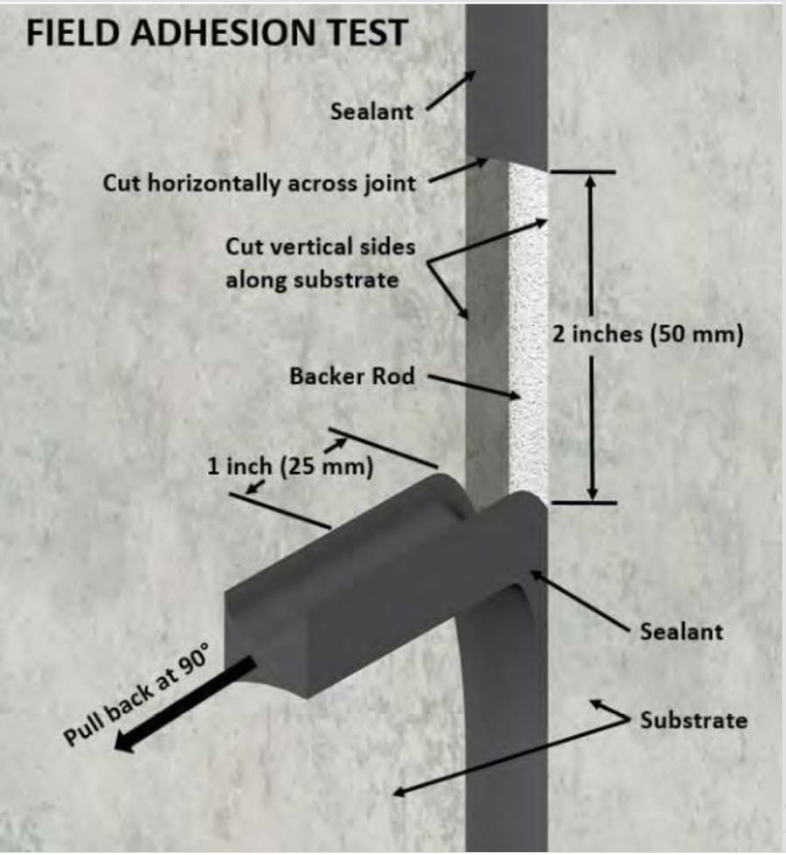
PRIORITIES

Treat root cause – not symptom

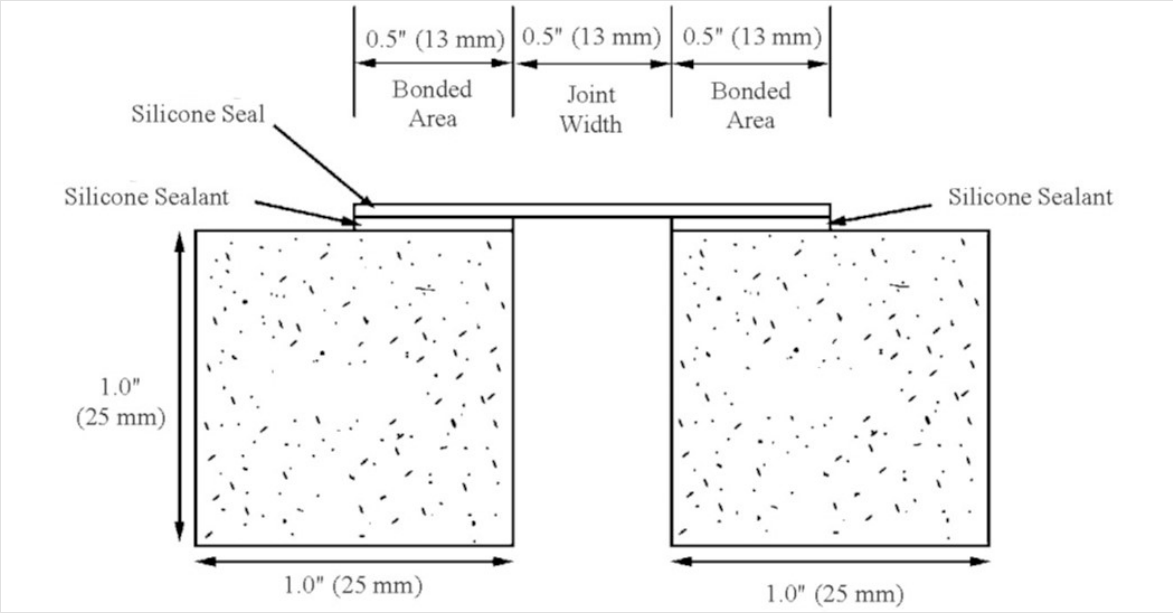
- Make-safe repairs
- Short term repairs followed by
- Long term repairs
- Cyclical maintenance

- Prevent water infiltration
- Protect/repair horizontal surfaces, skyward-facing joints
- Protect/replace structural steel and attachments

Protect Skyward Facing Joints



Protect Skyward Facing Joints



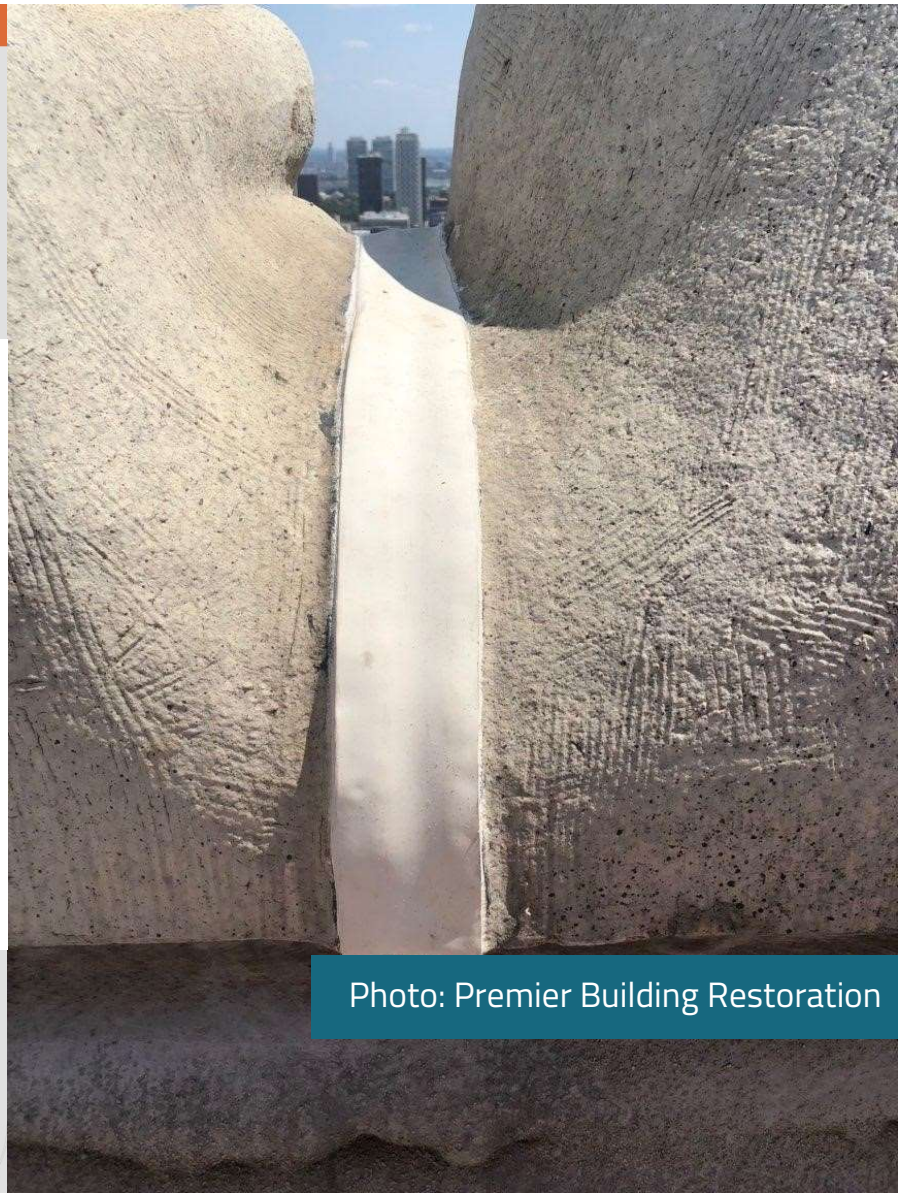
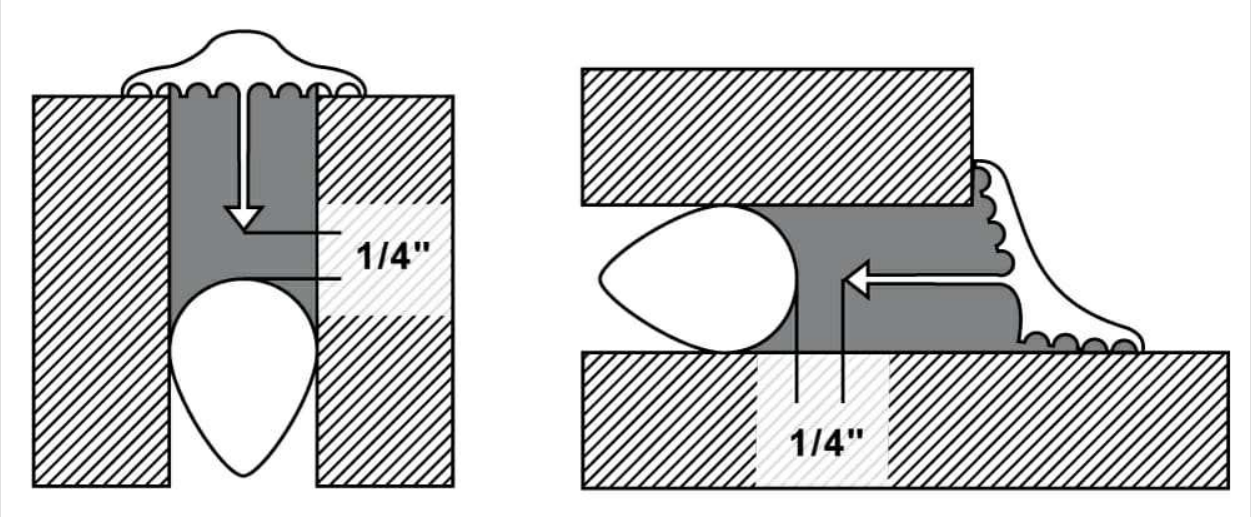


Photo: Premier Building Restoration

Protect Skyward Facing Joints



Flashing Over Horizontal Surfaces

Retrofit through-wall flashing at copings

Installing coping caps

Install sheet metal flashing over horizontal surfaces

- Copper
- Galvanized, painted
- Stainless steel

For curved or ornamental projecting elements, options are

- Liquid reinforced membrane
- Tin-zinc alloy copper sheeting

Protect Internal Horizontal Surfaces

Disassemble sections of masonry

Remove surface corrosion & treat steel with corrosion inhibitor

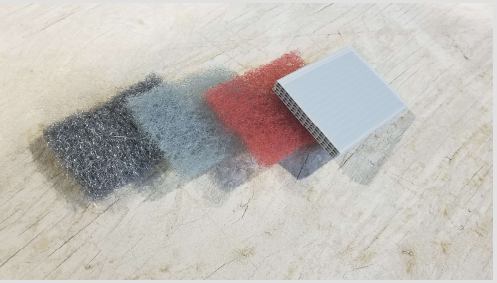
Retrofit flashing with termination bar, end dams, drip edge and weeps & reinstall original masonry

Photo Credit: Pullman/SST

Flashing Materials

Water Management

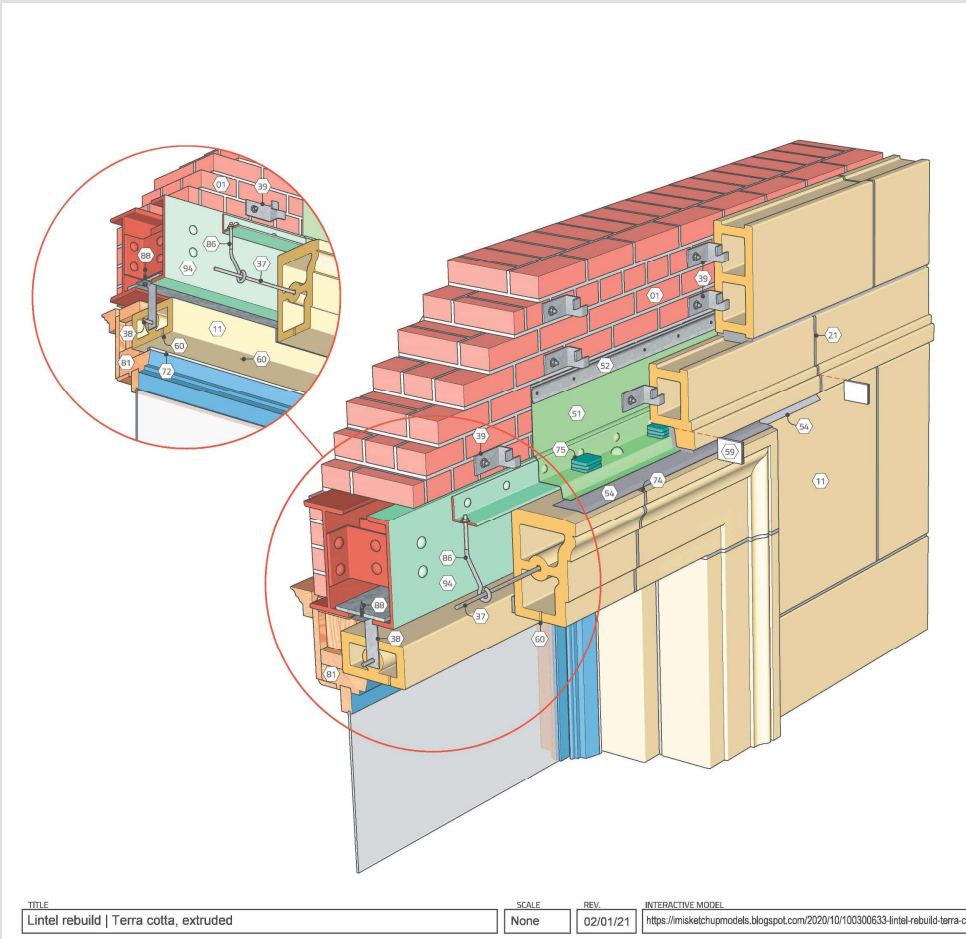
- Flashing / End Dams
- Weeping & Venting



Weeps

Self-adhering Membranes

Stainless Steel



Reinstallation of Units

- Anchorage varies depending if TC is hand-pressed or extruded or alt. material
- Replace ferrous anchors with stainless steel or hot dipped galvanized steel
- Units should be anchored with only one fixed point

Photo Credit: WJE

SUBFLORESCENCE

- Vacuum/Brush

- Clean potable water can be added to poultice media to desalinate masonry

Poultice Media

- Paper Pulp
- Clay
    - Kaolin
    - Diatomaceous Earth
    - Fuller's Earth

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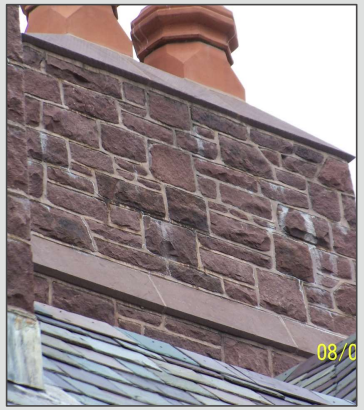
MINERAL DEPOSITS (LIME RUN)

Siliceous Masonry

- Chemical Methods
  - Acids

Calcareous Masonry

- Mechanical Methods
  - Micro-abrasives
  - Mechanical hand tools & abrasives

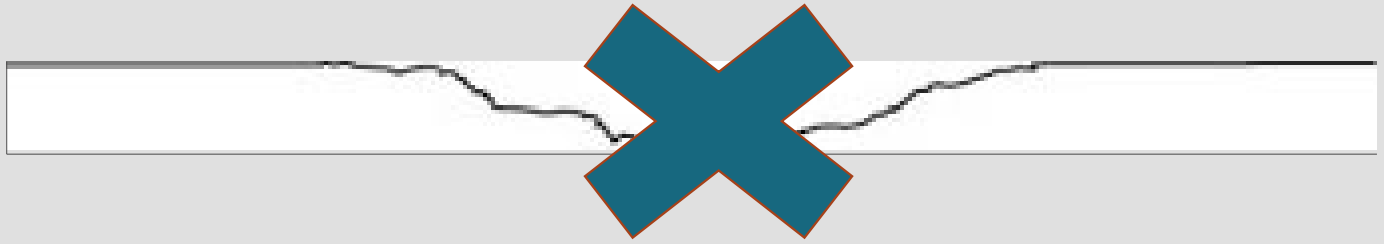


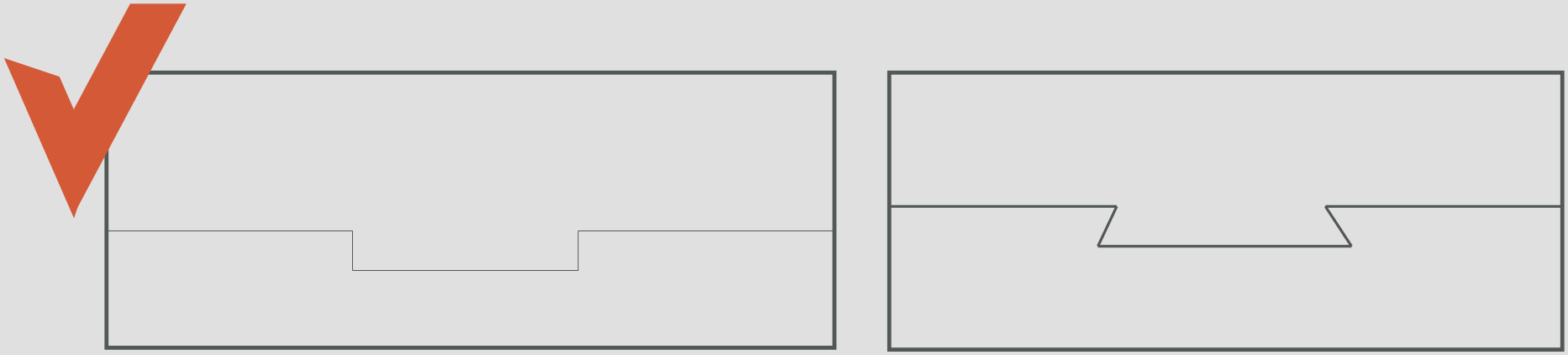
Unit Repair

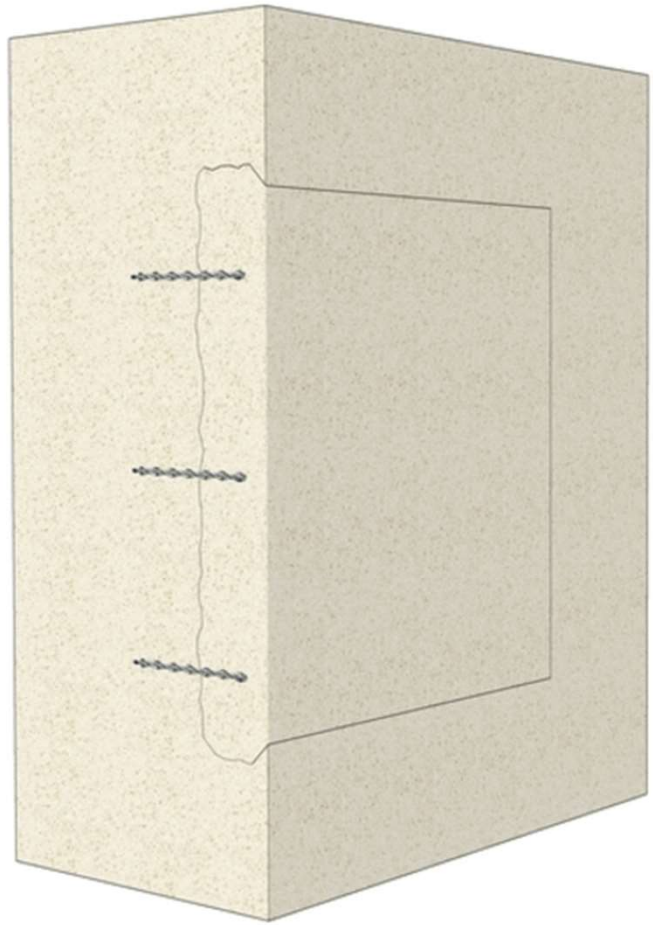
- Replacement units, patch materials should **match the characteristics of the original material it's replacing**
- Match aesthetic as closely as possible
- Surface prep is key
- Remove inappropriate repairs

Unit Replacement & Dutchman Repairs

Repair Mortars







REPOINTING MORTARS

- ASTM C1713 Standard Specification for Mortars for the Repair of Historic Masonry
- Same as original in properties

OR

- Weaker and more permeable than masonry unit
- Non-hydraulic lime/sand
- Natural Hydraulic Lime/sand
- Natural Cement/sand
- Non-hydraulic lime/cement/sand (ASTM C270)

- Mortar Analysis – ASTM C1324
  - Petrographic Analysis
  - Acid-Digestion/Gravimetric Analysis

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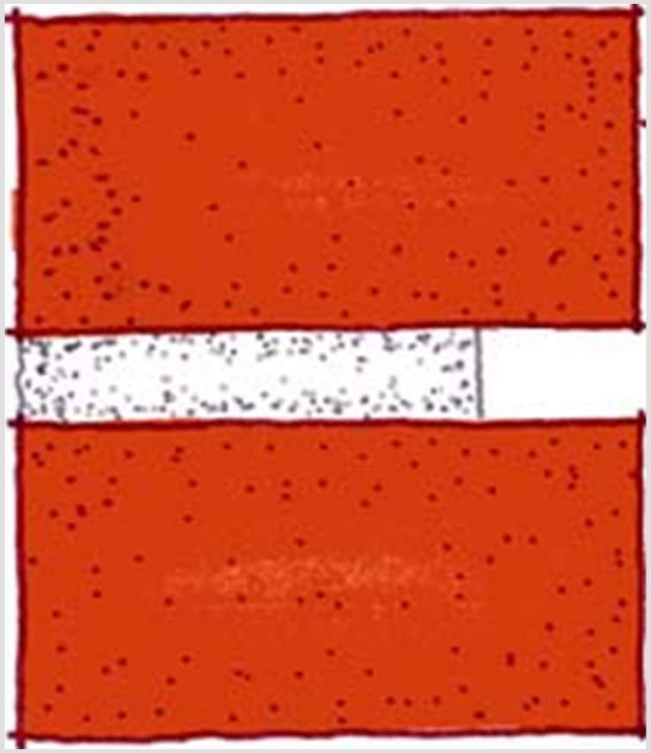
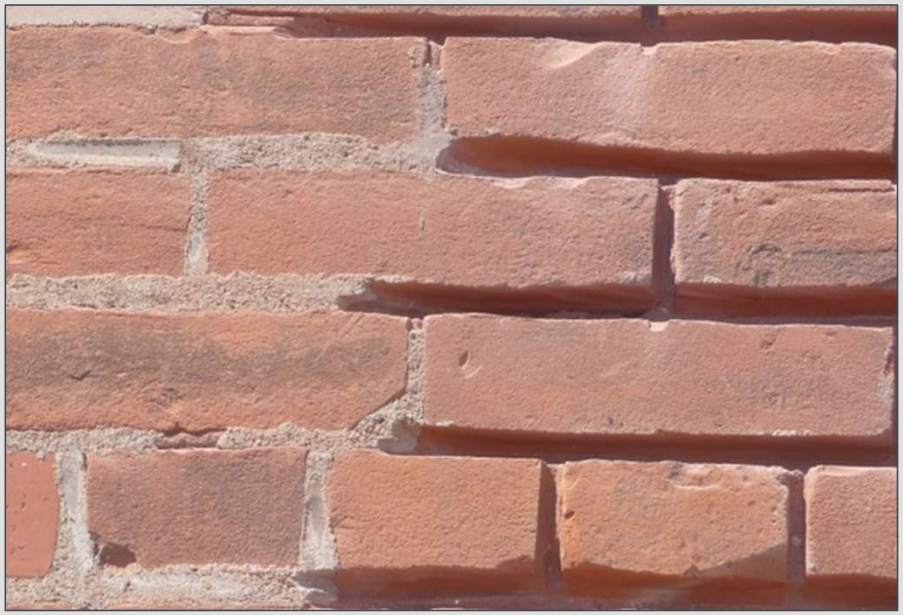
MORTAR REMOVAL

Defective mortar should be removed to a depth of between **2 and 2-1/2 x** the width of the joint and no more than half the width of the masonry unit



USING THE RIGHT TOOL FOR THE JOB

Correct Method –
Vacuum Extraction



Incorrect Method
Unskilled Worker

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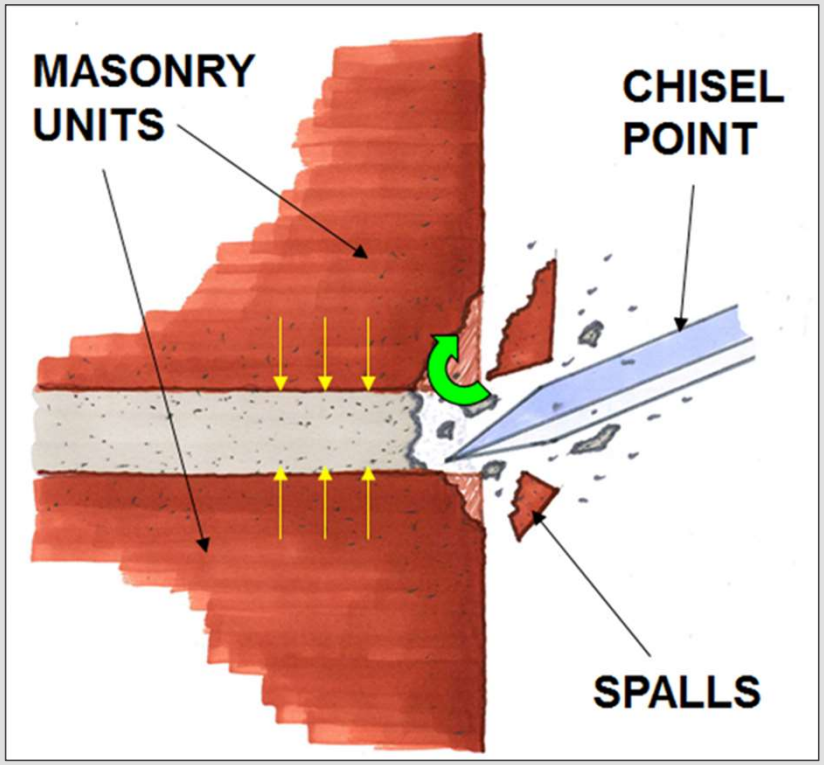
USING THE RIGHT TOOL FOR THE JOB



CURING-HOT WEATHER

- Non-Hydraulic Lime, NHLs, and Natural Cements need moisture to cure - mist for several days
- Flash-drying can cause brightening

PROTECTION – COLD WEATHER

Prevent Non-Hydraulic Mortar from freezing for minimum - 14 days

Prevent NHL and Natural Hydraulic Lime from freezing for minimum - 7 days

Prevent ASTM C270 Mortars for at minimum – 24 hours

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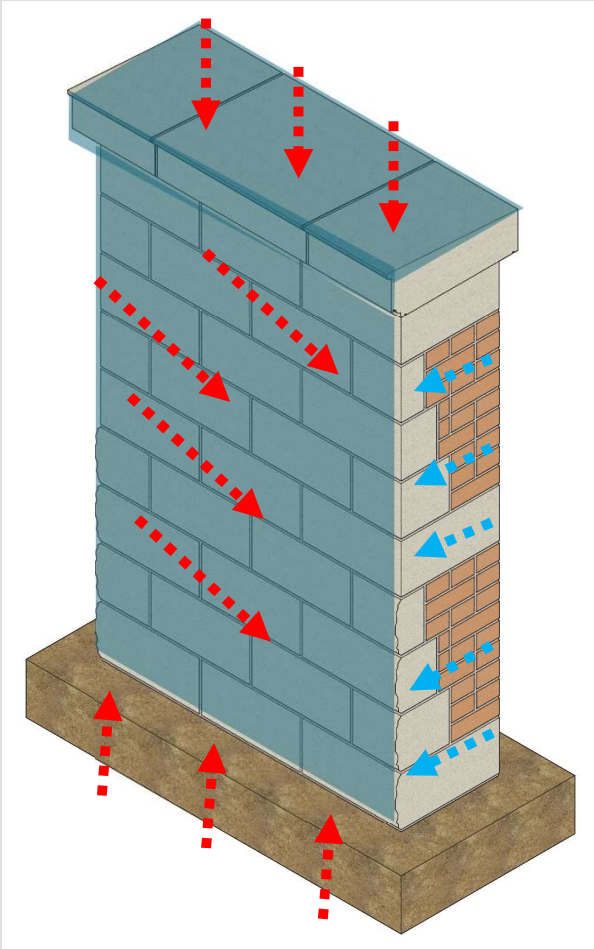
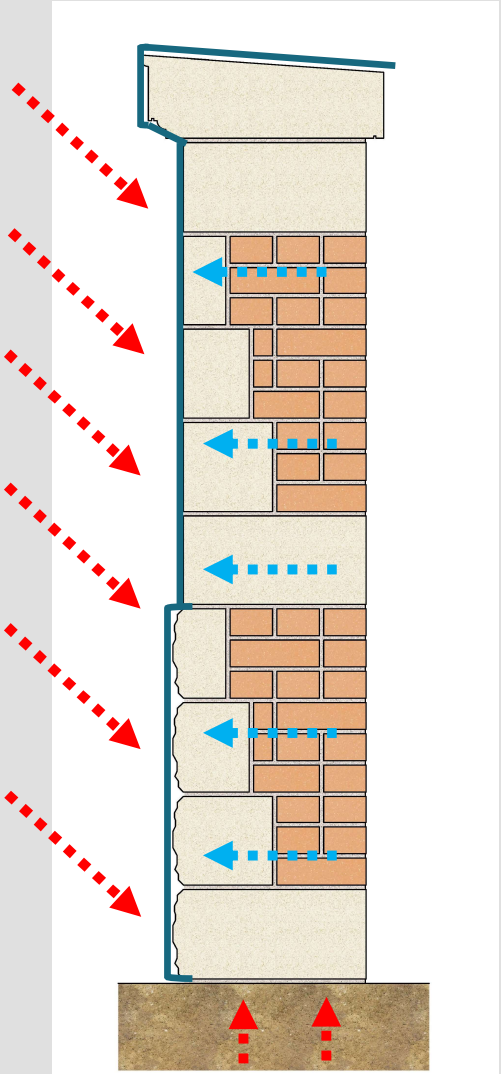
COATINGS

Depends on formulation of coating, layers of coatings, and overall thickness





Capillary Rise or “Rising Damp”

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DUE DILIGENCE

- Grade
- Gutters & downspouts
- Capillary action (rising damp)
- Sills
- Flashing installation or upgrades
- Cracks
- Mortar joints
- Top-of-wall

CONTRACTOR QUALIFICATIONS

QA/QC WITHIN THE SPECIFICATION

Be clear about objective and result expectations

Require a qualified and experienced masonry restoration contractor

May require assistance of architectural conservator

Mock-ups:

- State a specific size
- Require a project team review of mock-ups and final acceptance
- Require mock-up to be protected and remain for duration of repairs

Offer options of materials and methods within reason

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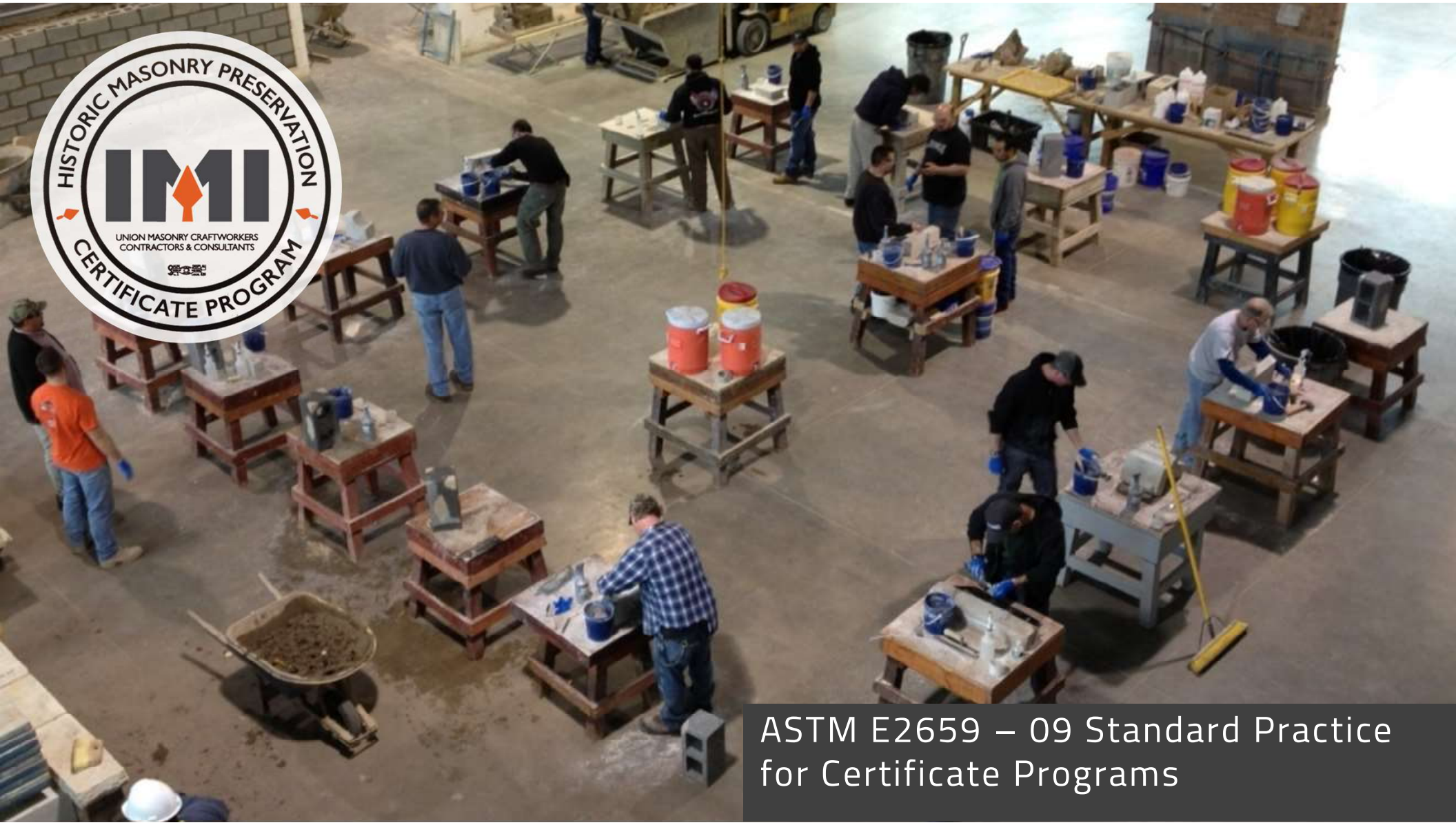

ASTM E2659 – 09 Standard Practice for Certificate Programs

Core Modules

- Fundamentals of Historic Preservation & Conservation
- Introduction to Architecture/Building Technology
- Introduction to Materials/Deterioration
- Historic Structure, Condition, & Testing Reports
- Mortars in Preservation

Training Modules

- Historic Mortars and Tooling
- Brick Restoration
- Terra Cotta Restoration
- Stone Restoration Dutchman Repair
- Masonry Cleaning
- Mold Making & Casting
- Consolidants & Coatings
- Pinning & Grouting


HISTORIC MASONRY PRESERVATION
IMI
UNION MASONRY CRAFTWORKERS
CONTRACTORS & CONSULTANTS
CERTIFICATE PROGRAM
St. Agnes Cathedral
Physical and visual investigation
• Items identified
• Failing previous repairs from 1997
WESTERN
Jason Bateman
Timothy Koutnik
Shane Jarrett
Joseph Colantoni

IMIweb.org/restoration

Pre-Project Training Qualifications

"Bidders will be required to provide a statement of the firm's commitment to enroll the key journey-level masons assigned to this project in a masonry preservation training program prior to the start of the project, such as provided by the International Masonry Institute (or equal), (BAC/IMI/IMTEF National Training Center Program Contact 1-800-464-0988)"

Project-Specific Training Program

"Bidders will be required to provide a statement of the firm's commitment to implement a pre-job masonry preservation training program prior to the start of the project for all masons assigned to this project, such as provided by the International Masonry Institute (or equal), (BAC/IMI/IMTEF National Training Center Program Contact 1-800-464-0988)". The training program should be structured so that it is relevant to the scope of work.

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SEPTEMBER 19, 2022

THANK YOU!

Casey Weisdock, MSc
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