Repair and Restoration of Early 20th Century Transitional Masonry Buildings

Roy Ingraffia
International Masonry Institute
ringraffia@imiweb.org
Market Development & Technical Services

- Technical Assistance
- Drawing & Specification Review
- Jobsite Troubleshooting
- Structural Masonry Support
- Research & Development
- Masonry Detailing Series
- Codes & Standards
- Software & Design Tools
Apprenticeship & Journey Level Training

- Brick & Block
- Restoration
- Tile Setting & Finishing
- Terrazzo
- Cement Finishing
- Refractory
- Marble Setting
- Stone
- Plaster
- Rainscreen Installation
The International Masonry Institute (IMI) is a strategic alliance between the International Union of Bricklayers and Allied Craftworkers and the contractors who employ those members. Through education, technical support, research and training the IMI works to provide a more efficient construction delivery system.

**STRUCTURAL SOLUTIONS**
Structural masonry software, tools and education providing access to a high value / low cost structural system

**MASSONRY DETAILING SERIES**
Details, Technology Briefs, Tool Kits and more, explaining how to use masonry to the highest value on your project.

**SYSTEM THINKING**
Building enclosure performance, control of air, moisture, vapor, sound, fire - thermal control and solutions.
Seminar Outline

1. Masonry Building Technology
2. Masonry Conditions
3. Considerations For Repairs
4. IMI Historic Masonry Certificate Program
Masonry Building Technology
Historic Masonry Materials

- Brick
- Terracotta
- Natural Stone
- Concrete
- Cast Stone
- Glass Block
- Mortar
- Tile
- Paint
- Steel
- Flashing
- Insulation
- Plaster
- Caulk
Historic Masonry Materials

- Brick
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- Glass Block
- Mortar
- Tile
- Paint
- Steel
- Flashing
- Insulation
- Plaster
- Caulk
Historic Masonry Wall Assemblages

- Mass Masonry
- Transitional Masonry
- Architectural Terracotta
- Early CMU
- Early Cavity Wall with Veneer
- Hollow Clay Tile
Mass Masonry
Stone Ashlar
Mass Masonry
Stone Rubble
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”
Mass Masonry
Brick Bonds

“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.
Brick

**Brick** – A molded rectangular block of clay baked by the sun or in a kiln until hard and used as a building and paving material.

*Common* – low fired/high porosity

*Facing* (front) – high fired/low porosity
Brick

Two main components:

- Body
- Fireskin
### Empirical Design

#### Thickness of Walls in Inches for Warehouses, etc.

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Mass Masonry
Brick Veneer With Ties
Subsurface Conditions
Performance of Load Bearing Construction

Holds Units Together

Keeps Units Apart
Performance of Load Bearing Construction

- Designed to take on a certain degree of moisture and allow it to release slowly.

- Mortar joints can be tooled different ways affecting appearance and resistance to water penetration.
Lime Mortar
Autogenous Healing

- Lime-rich mortars are referred to as Autogenous or “self-healing”. This means that if small cracks occur in the mortar due to shrinkage during the initial cure or settlement of the structure, they have the capacity to be filled with new calcium material.
Performance of Load Bearing Construction

Water Vapor Transmission

• Depending on the design and function of the wall, mortar joints can function to allow moisture, in the form of water vapor, to escape from the wall & allow the wall to dry out.
Portland Cement

• Hydraulic cement developed from natural cements made in Britain

  • 1824 – Joseph Aspdin (England)
  • 1871 – David Saylor (U.S.)

• Its name is derived from its similarity to Portland stone, a stone that was quarried on the Isle of Portland in England.
Deterioration

• Using improperly formulated mortar mixtures for historic masonry can lead to accelerated deterioration of the masonry units.
Transitional Masonry (Hybrid 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 (Hybrid Masonry)

“That 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 Types

- Brick/Stone with Imbedded Steel
Transitional Masonry Types

Transitional Masonry Types

- Brick/Stone with Imbedded Steel
  - imbedded (untreated) steel structure
  - “locked” into the porous back up brick
  - supported from above with “j”-hooks

- Architectural Terracotta
Transitional Masonry Types

- Brick/Stone with Imbedded Steel
- Architectural Terracotta
Transitional Masonry Types

- Brick/Stone with Imbedded Steel
- Architectural Terracotta
- Stone Veneer with Anchors
Early Cavity (Hollow) Wall Brick Veneer With Ties

“Provided the ties are thoroughly protected from corrosion by galvanizing...these ties make the hollow wall effective, as the ties will not carry moisture”
High Performance Masonry
Masonry Conditions
Methods of Deterioration

“Great architecture has only two natural enemies... water and stupid men”

- Richard Nickel
Types of Deterioration & Conditions

• **Intrinsic** – Deterioration being caused by internal forces either characteristics of the material as a whole (i.e. its overall structure, composition or characteristic of a particular component)

• **Extrinsic** – Deterioration being caused by an outside force which effects the performance of the material.
Corners

- More exposure
- Higher wind pressure
- Less restraint
Parapets

- More exposure
- Higher wind pressure
- Less restraint
- Roof interface detail
- Skyward joints
Bulging
Steel Corrosion – Rust Jacking
Horizontal Members – Rust Jacking

Photo Credit: Rebecca Buntrock
Vertical Members – Rust Jacking
Horizontal Members – Rust Jacking
Rust Jacking
Steel Corrosion – Rust Jacking
Terracotta
Compression Cracks
Late 19th/Early 20th Century Iron Alloys

- **Wrought Iron** – tough and stringy; has the elasticity and tensile strength needed for bolts, beams, and girders. Began to be used as a structural material around 1850. 8-inch "I" beams first rolled 1855. Produces very little corrosion product

- **Cast Iron** - Very hard and brittle. First used as a column in 1820.
Late 19\textsuperscript{th}/Early 20\textsuperscript{th} Century
Iron Alloys


- \textbf{Stainless Steel} – High in compressive strength and tension. First developed in 1902 and specified in a building project in 1928. Not used extensively because of cost. Little to No corrosion product.
“If ironwork is free from any corrosion when placed in position and is properly cleaned before it is coated (with paint) and is fixed in airtight, damp proof and water tight brickwork or masonry it is unlikely to corrode appreciably”

Charles L. Norton  
Massachusetts Institute of Technology, 1910

“Less is now required of the brick or masonry wall as a support member...much more is now demanded of it as to quality and perfection of workmanship in order that it afford to the vital steel frame within”

Architectural Engineering
Joseph Kendall Frietag, 1909

Corrosion Inhibitors

• Lead Red
• Iron Oxide Paint
• Zinc Chromate
• Black Asphaltum – Tung Oil
• Bitumen Mastic

Corrosion Inhibitors
ALL IRON WORK USED IN CONNECTION WITH ARCHITECTURAL TERRA COTTA SHOULD BE THOROUGHLY PROTECTED WITH A RUST PREVENTING PIGMENT.
Setting Ironwork.—This contractor is to set all iron plates resting on the brickwork, and all steel beams supporting brick walls; also all iron lintels, tie-rods and skewbacks used in connection with brick arches or over openings.

All such work is to be delivered at the sidewalk by another contractor, and this contractor is to set the same in such position and at such height as the superintendent shall direct. All plates are to be solidly bedded, true and level, in 1 to 2 fresh Portland cement mortar; the brickwork is to be brought to such a height that the bedding joint shall not exceed ½ an inch in thickness.
“Metal work of every description, supporting Terra Cotta, shall be imbedded thoroughly in the masonry backing and when not so imbedded, metalwork shall be protected against corrosion by encasing with cement mortar or in cement mortar masonry”
Considerations for Repairs
Performance

Repair of Original System

vs.

Alteration (introduction of new or hybrid system)

System Lifespan

Retention of durable materials that can be repaired and still have a serviceable life span

vs.

Remove existing and replace all or partial
Aesthetics

Retention of original design intent and historic character

vs.

Alteration of building appearance

Cost

Short-Term Capital Campaign vs.

Long-term Maintenance/Additional Capital Campaigns
Hazardous Materials

• Proper identification, removal and disposal of hazardous materials

• In order to determine whether or not a caulking material contains PCB’s: A sample must be sent to an analytical laboratory
Older Sealants
Hazardous Materials - Removal
Proper Removal Techniques - Mortar
Repairs

• Disassemble sections of masonry

• Remove surface corrosion & treat with Inhibitor

• Install flashing & reinstall original masonry.
Steel Lintel Repairs

- Flashing membrane or plastic bearing pad beneath bearing area of angle to create slip plane.
- Backer rod or compressible material at end of lintel to avoid restraint of movement, and at front edge of lintel to provide backer for sealant.
- Masonry expansion joint aligned with window jamb; compressible filler, backer rod & sealant.
- Flashing end dam returned into head joint.
- Flashing system w/ drip edge.
- Struct. steel lintel.
- Window system.
Partial Removal & Repair
System Upgrades & Replacement
Treatment of Accessible Steel
Treatment of Accessible Steel

Photo Credit: Pullman/Structural
Corrosion Inhibitors

- Materials to be protected
- Protection effectiveness timeframe (1 week, 1 month, 1 year, etc.)
- Method of application (dip, spray, brush, etc.)
- Type and thickness of coating residue desired
- Storage, packaging and/or shipping conditions (temperature, humidity & seasonal conditions)
Corrosion Inhibitors

- Removal methods (if required)
- Interaction with subsequent processes, if not removed
- Environmental, health and safety requirements
- Type of product (Oil/Solvent or Water-based) desired
Repairs to Imbedded Steel

Dissimilar metal welds involving stainless steels can be done using most full fusion weld methods, including TIG (Tungsten Inert Gas) and MIG (Metal Inert Gas).
Repairs to Imbedded Steel
Flashing Materials

Self-adhering Membranes

Copper

EPDM

PVC

Stainless Steel

Copper Composite
Flashing Materials

Lead-T Joint Cap
Cathodic Protection

Reduction or elimination of corrosion by making the metal a site where no corrosion occurs and current flows (cathode), through the application of a low voltage direct current.
Impressed Current Cathodic Protection System

- ICCP Systems are designed for the specific structure, using the proper type and configuration of anode type and power supply.

- Anode Types
  - Surface Mounted
  - Embedded

- Power Supply
  - Multi vs. Single Zone
  - Types of controls and monitors

Photo Credit: Pullman/Structural
Impressed Current Cathodic Protection System

Adapted from: Boston Valley & Pullman/Structural
Reinstallation of Units
Improper Installation Techniques
Improper Installation Techniques
Terra Cotta Standards

Terra Cotta

Standard Construction

Revised Edition

TERRA COTTA

STANDARD CONSTRUCTION

NATIONAL TERRA COTTA SOCIETY

USA

NEW YORK, N.Y.

1927

19 WEST 44th STREET
Terra Cotta Standards
Mortar Replication
Guiding Principles

• The new mortar should not be stronger (in compressive strength) than the masonry unit and not stronger than the original mortar.

• The new mortar should have the same – or have a better – vapor transmission rate than the old mortar.
Mortar Replication
Guiding Principles

• Never introduce a material that was not in the original construction, unless tested.

• Understand the function of the masonry wall system (i.e., load bearing vs. cavity wall)
Mortar Matching

- Properties of masonry
- Color of cleaned existing
- Texture of existing
- Profile of existing
Building Technology Heritage Library

The Building Technology Heritage Library (BTHL) is primarily a collection of American and Canadian, pre-1964 architectural trade catalogs, house plan books and technical building guides. Trade catalogs are an important primary source to document past design and technology in architecture and construction.

https://archive.org/details/buildingtechnologyheritagelibrary
Resources

• APT - Association for Preservation Technology
• NPS - National Park Service Preservation Briefs
• Cathodic Protection of Steel, Concrete, & Masonry
Historic Masonry Preservation Certificate Program
Program Curriculum

Core Modules
• Fundamentals of Historic Preservation
• Introduction to Architecture/Building Technology
• Introduction to Materials/Deterioration
• Historic Structure & Condition Reports

Additional Training Modules
• Historic Mortars and Tooling
• Brick Restoration
• Terra Cotta Restoration
• Stone Restoration/Dutchman Repair
• Concrete Restoration
• Masonry Cleaning
• Mold Making and Casting
• Caulking/Sealants
• Consolidants/Coatings
• Pinning & Grout Injection
Program Curriculum
Historic Mortars and Tooling

- Grapevine
- Vee
- Prism or Bevel
- XXX
Historic Mortars and Tooling
Designing a Preservation Project: Historic Structure & Condition Reports

In this module will offer participants an introduction to the what goes into designing a preservation/restoration project and the decision making process.
Brick Restoration
Terra Cotta Restoration
Stone Restoration & Composite Repairs
Stone Carving
Stone Carving
Mold Making & Casting
Masonry Cleaning
Historic Grouting
Structural Pinning
Structural Pinning
Consolidants & Coatings
Contributing Organizations
Qualifications - Specifications

• “Superintendent and foreman for work in this section assigned to this project shall each have a minimum of ten (10) years’ experience with this type of repair work an International Masonry Institute **Historic Masonry Preservation Certificate** (or equal) and to provide evidence of certification prior to the start of the project. References of projects they have completed shall be submitted to the Architect by the successful bidder. The project superintendent and foreman assigned to this project shall not be changed throughout the duration of the work without written request to and consent of the Architect.”
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