Genealogy of Masonry Facade Repairs
2017 TMS Annual Meeting – LaJolla, CA

Ed Gerns and Rachel Will

Outline

- Introduction
- Wall Construction Typology and Evolution
- Masonry Deterioration and Distress
- Masonry Repairs
  - 1900 to 1950: Addition by Subtraction: Amputation
  - 1950 to 1970: Demolition
  - 1970 to 2000: Rise of Restoration
  - 2000 to 2020: Second/Third Generation Distress/Repairs
- Conclusions
Typology Evolution

Chronology - Masonry Construction

- Pre 1870: Load Bearing Construction
- 1870-1920: The Age of Experimentation
- 1920-1945: The Age of Transition
- 1945-1970: Modernism
- 1970-2010: Post Modernism
- 2010 and Beyond
Fireproof Construction

Code Provisions, 1905

New York

Chicago
Elisha Otis- 1853/1854

Traditional Walls- Load Bearing
Skeleton Frame

Hybrid Walls: Definition

- Three to five wythe; steel or concrete frame
- Exterior wythe supported by rolled steel shapes attached to the main structural system
- Interior wythes header bonded to each other and to some extent into the outer wythe
- Intended to function as a barrier system to manage water infiltration.
Construction Progression

Building Size and Complexity

1870 1930 1945 1960

Industrial Revolution  Stock Market Crash  End of WWII

Load Bearing  Non-load Bearing

Empirical Design  Rational Design

Deterioration and Distress

Sources of Deterioration/Distress

- Moisture
  - Water infiltration
  - Corrosion
- Building movement due to:
  - Gravity
  - Differential Settlement
  - Wind loads
  - Earthquake

- Material Properties
  - Thermal cycles
- Design
- Workmanship

Deterioration/Distress Manifestations

- Deterioration of joints
- Spalling
- Crazing
- Visible Cracking
- In-plane Cracks
- Displacements
- Loss of lateral anchorage
- Failure
Shallow Spalling

- Differential expansion
- Organic growth
- Abuse

Deep Spalling

- Corrosion
- F-T damage
- Differential expansion
Crazing
Cracking
In-plane cracks

- Unaccommodated stress
- Corrosion
- Differential expansion
Restrained Compression

Mixed stress
Displacement

Fabrication/Design
Installation Modifications/Workmanship

Lessons Learned
Lessons Learned

- Unit geometry and support
- Incorporation of expansion joints and/or provisions
- Differential movement
  - Frame shrinkage
  - Creep
- Corrosion protection
- Water provisions:
  - Flashing and drips
  - Weeps

Fabrication Detailing

1914 1927
Expansion Provisions

- Vertical expansion provisions
- Horizontal expansion provisions

Fabrication Detailing, cont.
Maintenance and Repair

Repair Chronology

- 1900 to 1950: Addition by Subtraction: Amputation
- 1950 to 1970: Demolition
- 1970 to 2000: Rise of Restoration
- 2000 to 2020: Second/Third Generation Distress
1900 to 1950: Addition by Subtraction

New York Life Insurance Building, Chicago
Chapin and Gore Building, Chicago

Chicago City Hall
1950 to 1970: Demolition
1970 to 2000: Rise of Restoration

Economics/Progress
Iterative Repairs
Aesthetics: Cleaning and Coating
Surface Treatments: Coatings and Sealers

Sealers
Parge Coats

Repair: Treating the Symptoms
Substrate Issues

[Images of substrate issues]

Substrate Issues

[Images of substrate issues]
“Newer” Considerations
Code Compliance: Energy

- Understanding proposed alterations relative to the enclosure
- Determine existing conditions
- Insulation retrofit design considerations
- Evaluate risk on enclosure
- Consider budget constraints that may affect material selection or influence enclosure design
- Have clearly stated design and energy performance goals
- Evaluate whether structural elements will impact performance of the enclosure

E3, F1, F2, G
Evaluation of Existing Conditions

Existing Material Performance
Facade-ism
Relocation
2000 to 2020: Second/Third Generation

- Loss of Protection
- Initiation of Distress
- Significant Distress
- Second/Third Generation Distress

30 years  60 years  90 years

??
MIRA Shearwave

Scan Surface
Possible reflection (severe) from planar defect near wall surface
Opposite Surface

GPR

Distance (in.)  Scan Surface  Opposite Surface  Kerf Strap

Depth (in.)
Infrared Thermography
Conclusion

- Potential for distress: Maintenance
- Lessons learned: Modifications
- Understanding cause and potential remediation(s)
- Detecting/predicting distress

“Those who don’t study history are doomed to repeat it. Yet those who do study history are doomed to stand by helplessly while everyone else repeats it.”