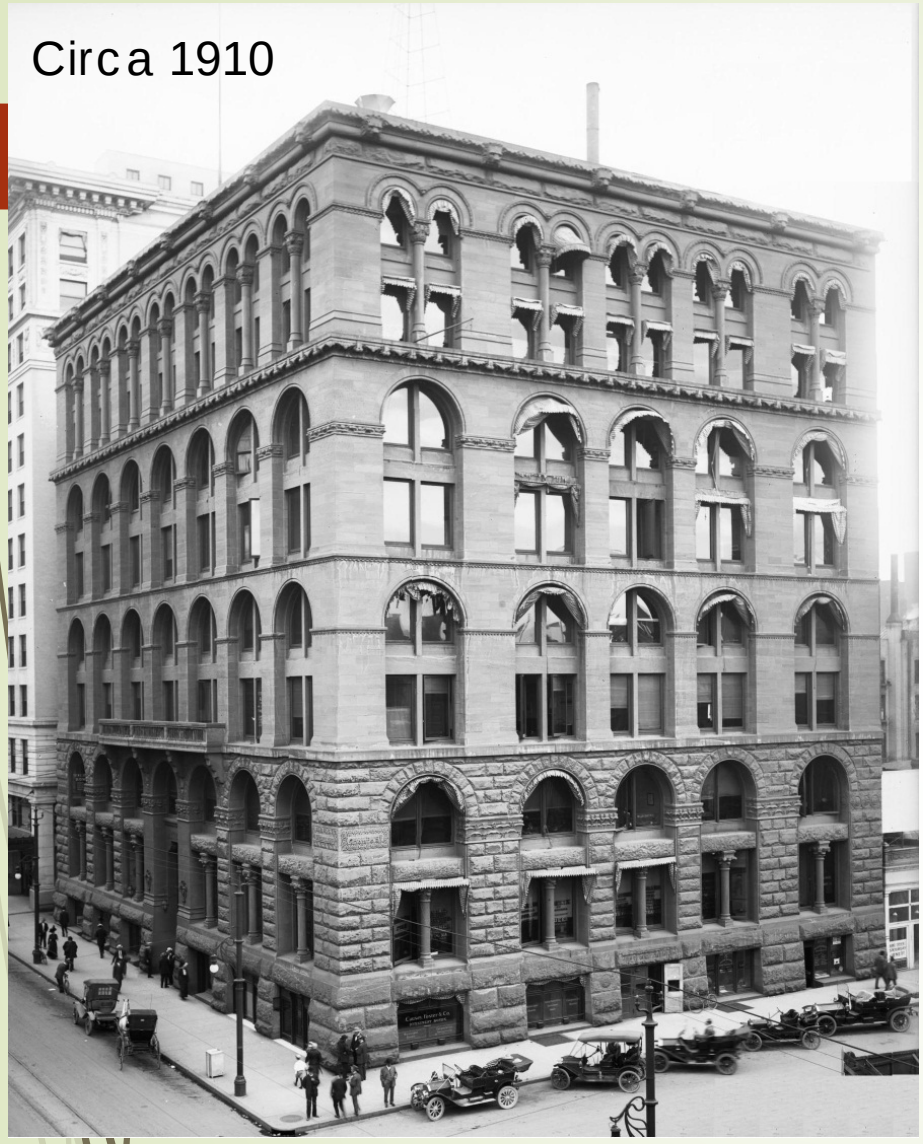

Evaluation, Restoration and Protection of Sandstone Façade on a Historic Building – The Boston Building Denver, CO

Presenter: Leo Whiteley

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Boston Loft Building History

- On Southeast corner of 17th and Champa in the middle of Denver's financial district
- Known as the 1st “Strictly Modern Office Building” to be erected in Denver

History

- Combination of Renaissance Revival and Richardson Romanesque architecture
- 9 story building faced with red sandstone quarried near Manitou Springs, Colorado

Timeline

- Constructed in approximately 1890
- 1959 the front entrance was modernized
- 1978 added to the National Registry of Historic Place
- 1997 was converted into apartment lofts
- 2011 added to Colorado Historic Society

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  - ✓ Between the 6th and 8th floors there were decorative string courses
  - ✓ Red Sandstone Balcony with Balustrade over the top of the 3 entrance arches
  - ✓ Rusticated stones at base.

Comparison

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- Exterior walls are solid sandstone blocks stacked up to 4’-0 thick, with individual blocks ranging from 2’-0 thick at the base to 5” thick at the parapet
- Solid sandstone lintels or sandstone block arches are spanning all exterior window/door openings

Sandstone Lintels and Arches

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Boston Building

OBSERVATIONS AND FINDINGS

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Failed Existing Patches

Mismatched Existing Patches

Deteriorated Existing Patches

Failed Joints

Structural Lintel Cracks

Deteriorated Sandstone

Dirt & Water Staining

Pigeon Roost

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Parapet Walls & Flashing

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Deteriorated Wood Frames

Conditional Appraisal

- In 2011 a complete Condition Appraisal was undertaken.
  - ✓ Determined the cause of stone pieces falling on the sidewalk
  - ✓ Establish the current condition of the building façade
  - ✓ Identified, located, and illustrated deterioration and/or failures on building elevations
  - ✓ Performed material testing to determine deterioration causes
  - ✓ Assessed findings in order to present and prioritize repair, maintenance, and upgrade recommendations

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- Construction Documents were developed and Construction Administration undertaken during the restoration.

Background Research

- Where did the sandstone come from?
- What are the properties of the sandstone?
- How has the sandstone behaved in this climate?
- Was this type of sandstone utilized anywhere else nearby?

Research Findings

- Greenlee Sandstone was quarried near Manitou Springs, Colorado
- Stone: Soft, medium grained red sandstone with iron oxide material properties

Research Findings

- Iron oxide is the prominent binding material in this type of sandstone which creates the warm red color
- Oxidation (rusting) of the iron in the stone has caused disintegration, and a loss of the cohesive binder.
- Material testing revealed that this stone is very absorbent, making it susceptible to saturation and freeze thaw damage.

Cored Sandstone Samples

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Deterioration Mechanisms

- Freeze/Thaw action
- 6.3% absorption characteristic holds water
- Ledges and detailed pieces suffer most damage due to collection of water

Deterioration Mechanisms

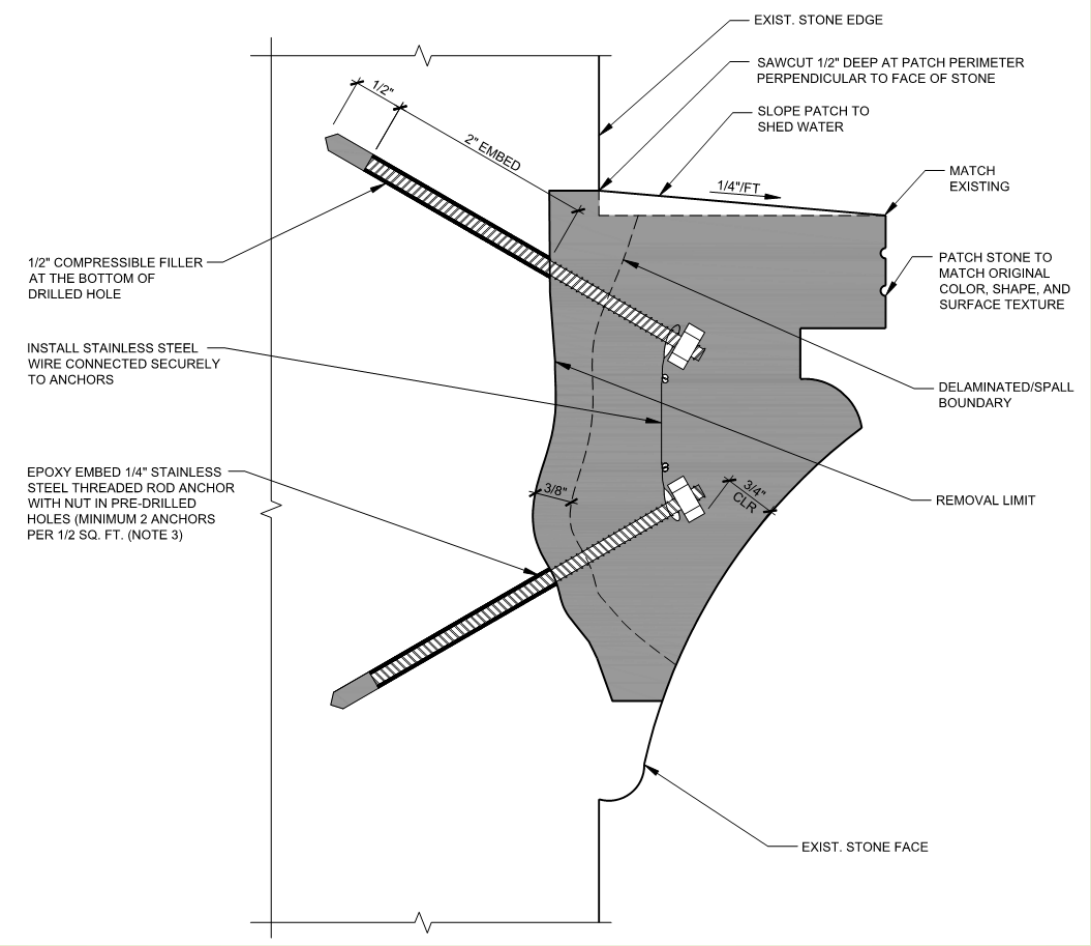
- Bedding planes of sandstone are natural lines of weakness and are strongest when horizontal
- Water is more likely to split the stone if the bedding planes are in a vertical orientation.

Identified Repairs

- Sandstone Repair
  - No major deterioration of the sandstone blocks that required replacement
  - Removal of loose, flaking and deteriorated stone surfaces
  - Modify ledge conditions
  - Patch material
  - Structural crack repairs
  - Tuck-pointing
- Waterproofing
  - Sealants
  - Flashing
- Cleaning
  - Correct Method / Product
- Sealing
  - Consolidant vs Siloxane

Modify Ledge Conditions

- Slope ledges in repairs to allow positive drainage



Patching Material

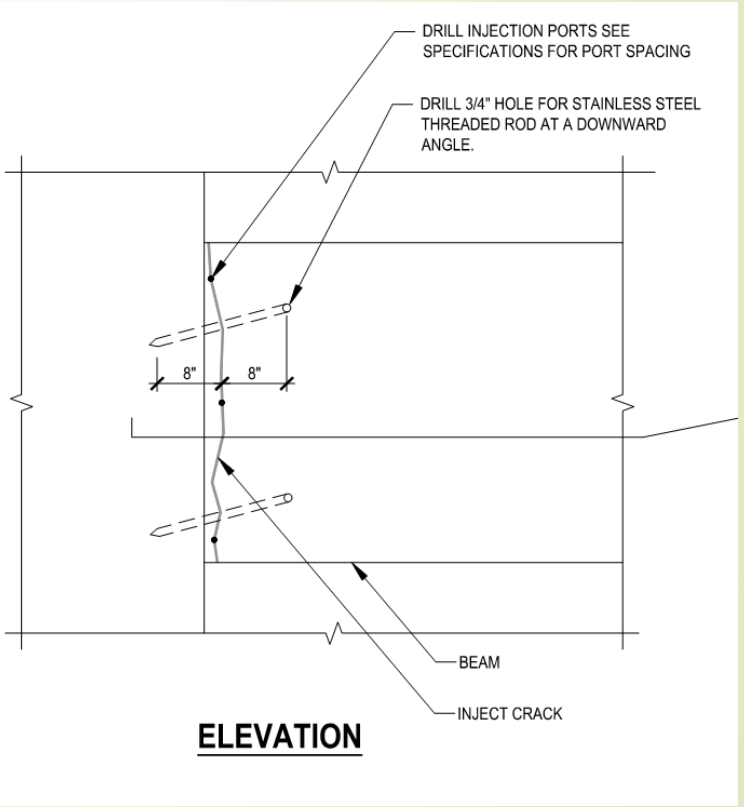
- Customized to match substrate
- 2-component
- Latex modified cementitious patching compound.
- Single custom color match was utilized

Patch Material/Appearance

- "Liquidirt"
  - ✓ Colored stain was applied to match natural variations, atmospheric staining and aging in the sandstone

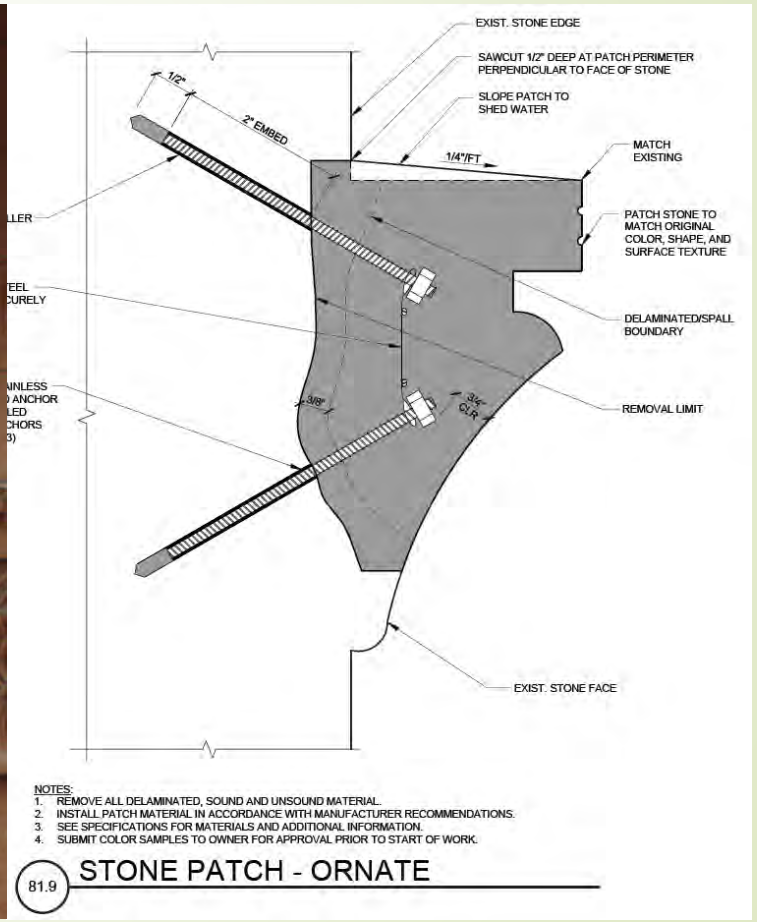
Structural Crack Repair

- Stainless steel dowels set in epoxy
- Pressure inject epoxy



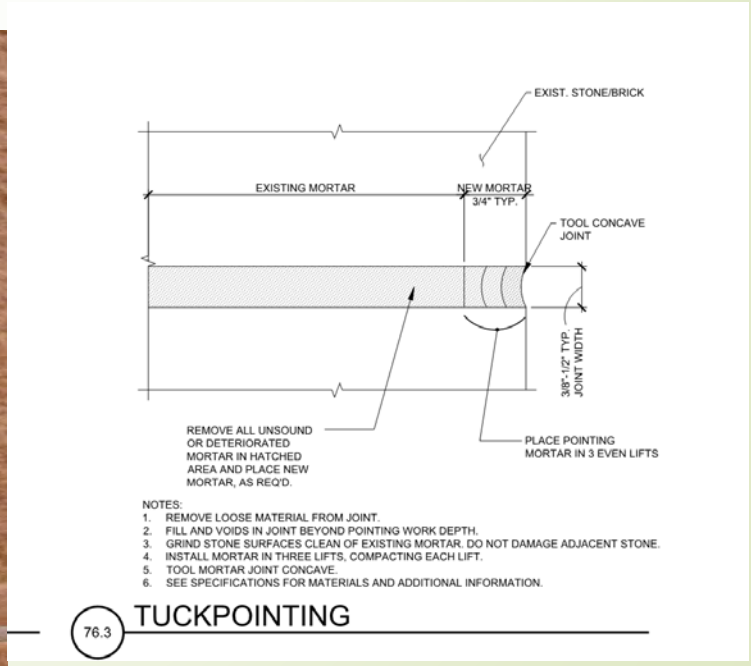
Anchoring

- Stainless steel rods set in epoxy



Tuckpointing

- Mortar joints hand cut to minimize overcutting
- Install grout in “Lifts”



Masonry Cleaning

- Cleaning the stone is important for:
  - ✓ Aesthetic Reasons
  - ✓ Remove surface contaminates: Carbon, crust, salts, pigeon droppings, mildew and atmospheric stains
  - ✓ To ensure proper saturation of the protective sealer
- Abrasive or Non-Abrasive
  - ✓ Avoid a cleaning method that is too aggressive, do not want the stone to wash away
- Tested Mild Detergents
  - ✓ Sandstone soaked up detergent and could not be rinsed out
- Hot Water & Nonacidic Liquid Cleaner
  - ✓ Medium / Low pressure hot water

PROTECTION

- ICRI Concrete Repair Terminology
  - ✓ “The process of maintaining a concrete structure in its present or restored condition by minimizing the potential for deterioration of damage in the future. (See also **maintenance** and **preservation**.)”

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- National Park Service "Preservation Briefs #47 – Maintaining the Exterior of Small and Medium Size Historic Buildings"
  - ✓ "Preservation is defined as "the act or process of applying measures necessary to sustain the existing form, integrity, and materials of an historic property."

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  - ✓ Testing is mandatory

Consolidant

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  - ✓ Stone consolidants can be divided into 4 main groups: inorganic materials, alkoxysilanes, synthetic organic polymers, and waxes. (Waxes have been used for over 2000 years)

Consolidant vs. Sealer

- ASTM E2167-01 (2008); Standard Guide for Selection and use of Stone Consolidants
  - ✓ Can be beneficial in stabilizing sandstone
  - ✓ Does keep water out
  - ✓ Does not breathe, may trap moisture in
  - ✓ May contribute to deterioration or create unanticipated problems
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- Siloxane Sealer coats pores but does not clog them
  - ✓ Does keep water out
  - ✓ Allows sandstone to breathe

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  - ✓ "Proper maintenance is the most cost effective method of extending the life of a building."
  - ✓ "Over time, the cost of maintenance is substantially less than the replacement of deteriorated historic features."

Maintenance Components

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- Openings.
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- Foundations and Perimeter Grades.
  - ✓ The foundation walls, piers and the ground immediately around a foundation serve important structural functions.

Maintenance Plan

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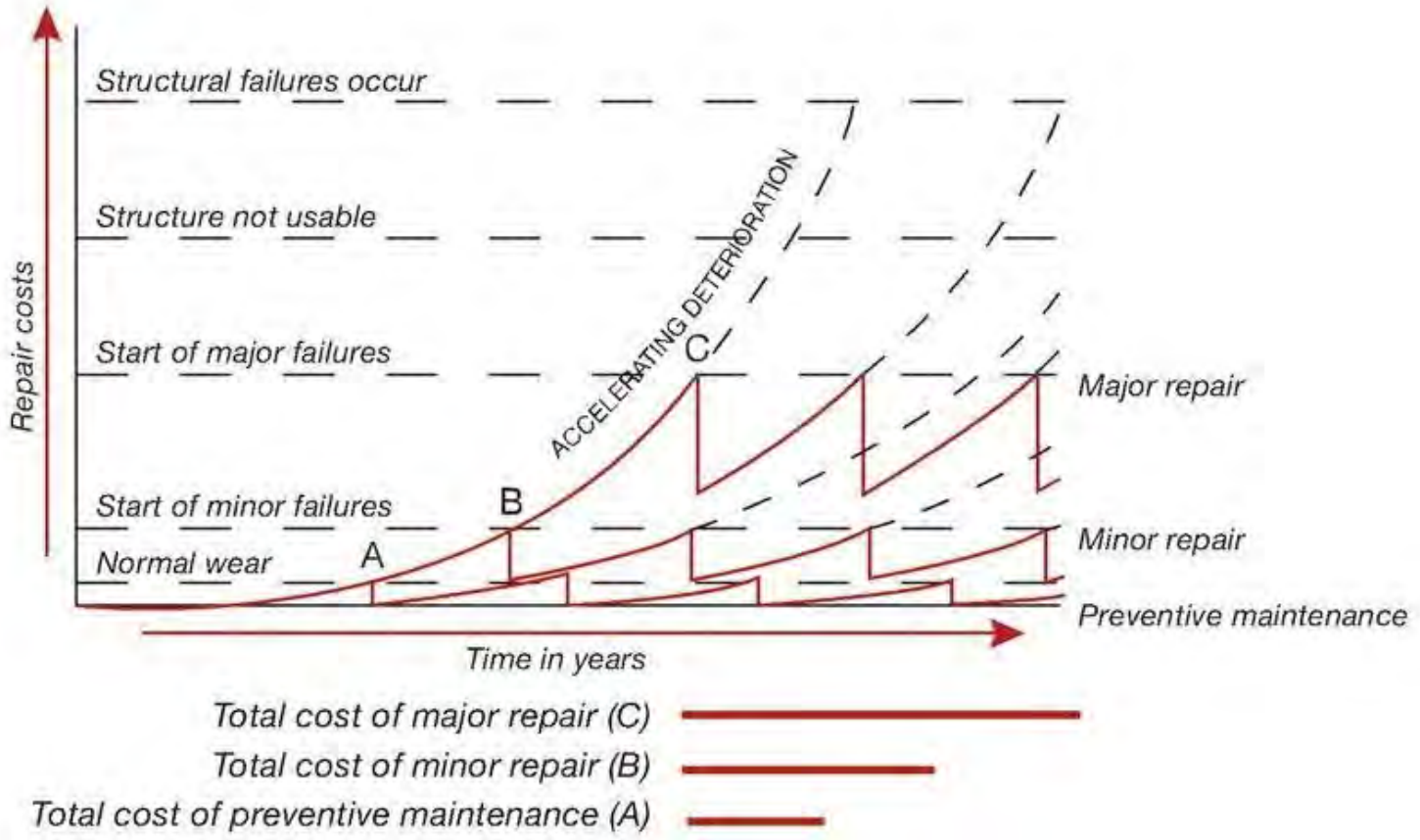
  - ✓ Written procedures should outline step-by-step approaches that are custom-tailored for the building.
  - ✓ Schedules and checklists for inspections.
  - ✓ Forms for recording work.
  - ✓ Written procedures for the appropriate care of specific materials.
  - ✓ Record keeping.

Cost of Deferred Maintenance



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After Photos

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Questions

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