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Common Problems and Repair of Masonry Construction

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CONCRETE REPAIR
Restore | Repurpose | Renew

Presentation Outline

- Reasons for Repair and Maintenance
- Life Cycles of Repairs
- Common Problems
- Case Study Examples
- Strategies for Project Success

Reasons for Repair and Maintenance

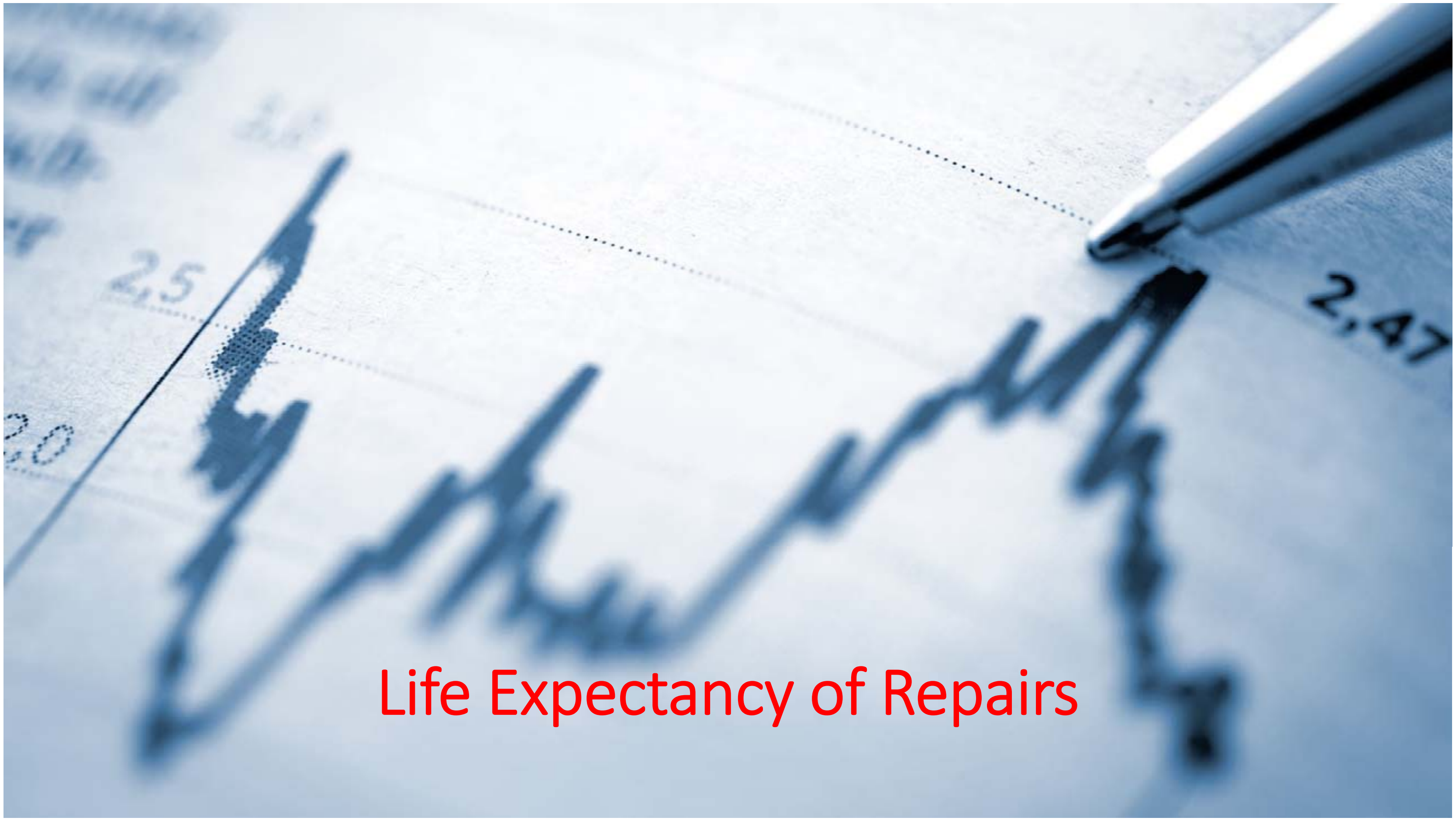
EXPECTED REASONS FOR MAINTENANCE/REPAIR

- Exposure to weather causing gradual deterioration
- Changes in occupant's use
- Material property changes , i.e., expansion, shrinkage, embrittlement
- Interaction between materials such as corrosion, differential movement

UNEXPECTED REASONS

- Unintended consequences -

Fig. 1 Shelf angle sealed at front edge preventing water drainage



Life Expectancy of Repairs

REPAIR APPROACHES

- Shorter Term, Intermediate Term and Longer Term determined by:
  - ❑Extent of repair
  - ❑Repair methods

Fig. 6 Marble dutchman repair matches adjacent stone very closely

  - ❑Material type
  - ❑ Let's not forget Owner's budget.

REPAIR LIFE EXPECTANCIES

SHORTER TERM – TYPICALLY 5-10 YRS

EXAMPLES

- PEEL & STICK (RUBBERIZED ASPHALT) FLASHINGS
- CORREGATED TIES
- URATHANE BASED SEALANTS

REPAIR LIFE EXPECTANCIES

INTERMEDIATE TERM – TYPICALLY 15-25 YRS

EXAMPLES

- EPDM FLASHINGS
- HOT-DIPPED GALVAINZED TIES
- HYBRID SEALANTS

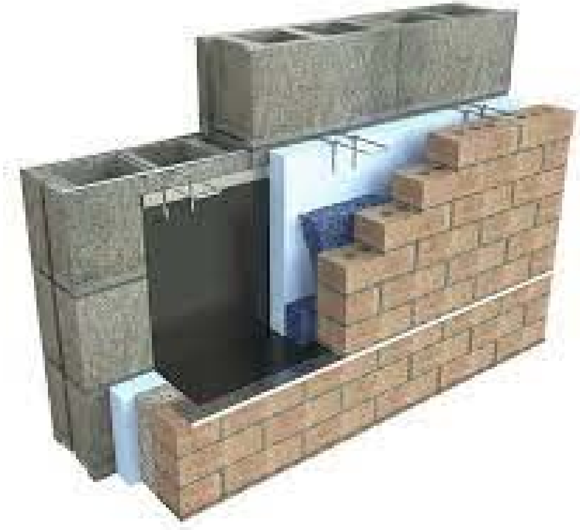


Image courtesy of Wire-Bond

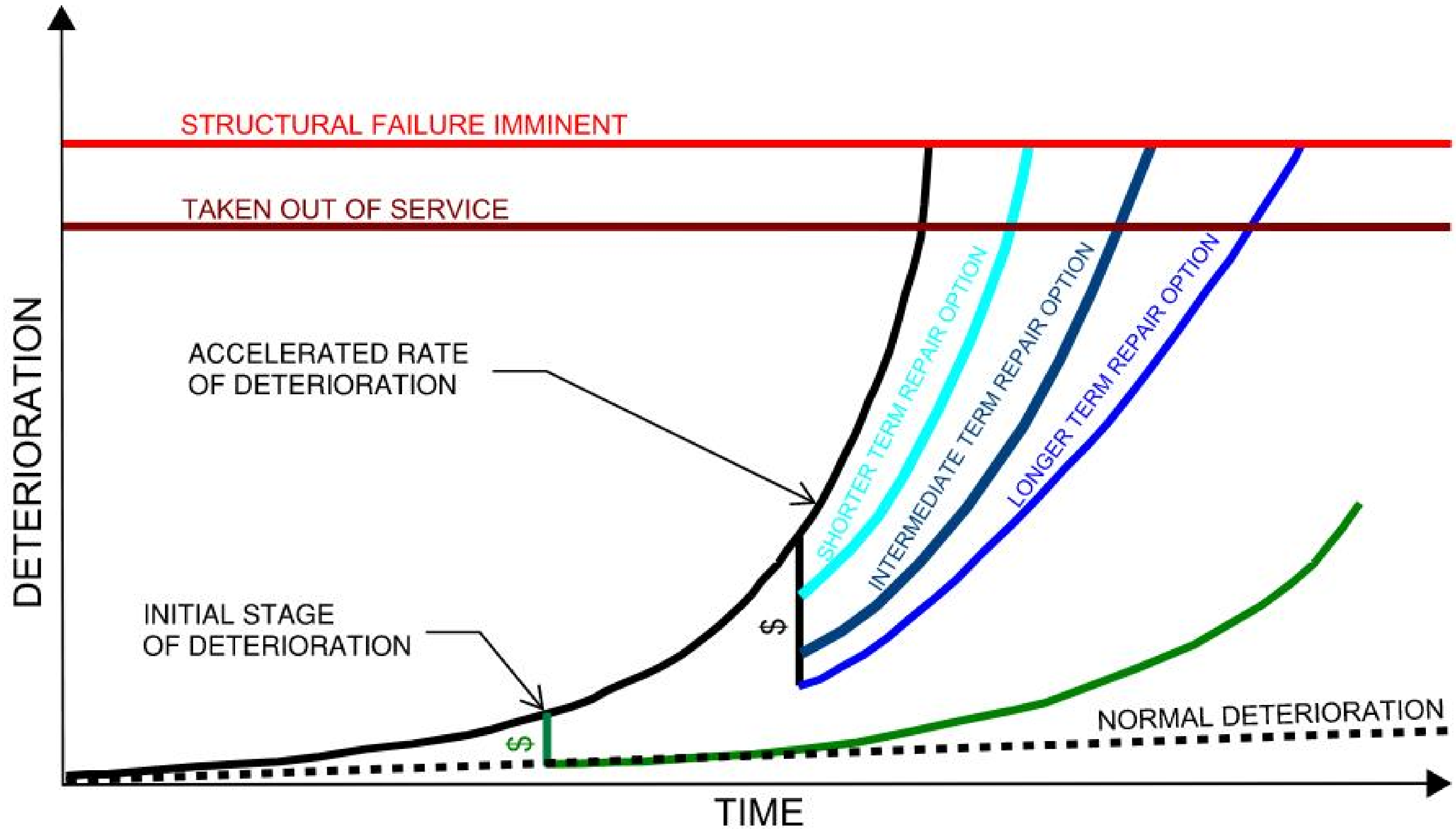
REPAIR LIFE EXPECTANCIES

LONGER TERM – TYPICALLY 50-100+ YRS

EXAMPLES

- COPPER FLASHINGS
- 316 STAINLESS-STEEL TIES
- SILCONE SEALANTS (20 YRS)

REPAIR APPROACH LIFE EXPECTANCE



Common Problems

THE "WHY" OF COMMON MISTAKES

- Imperfect World
- Masonry is a natural material
- Hindsight by repair designer –
    - ❑What defects were built in?
    - ❑How does structure response to weather and temperature?
    - ❑Where do defects develop and how rapidly?
    - ❑When do defects become noticeable?

If concerns addressed = successful project

If not = failure

Fig. 2 This wall was repaired twice, after the roof leaked for many years

GENERAL CATEGORIES OF "WHY" OF UNSUCCESSFUL PROJECTS

- Poor understanding of masonry as a system
- Improper material selection
- Inadequate management of moisture
- Incompatibility of building components
- Lack of provisions for movement
- Poor workmanship
- Many more

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MASONRY AS A SYSTEM - EXAMPLE

(interactive components, dependent upon each other)

- Bond development = water tightness
- Workmanship = bond development
- Mortar bridging = workmanship
- Impediment of water movement = mortar bridges
- Flashing workmanship = affects conveyance of water also
- Compatibility of flashing materials = flashing workmanship
- Weep material choice = flashing position, flashing type, masonry installation, mortar workmanship, all interrelated

IMPROPER MATERIAL SELECTION

The existing materials:

- have undergone expansion or shrinkage
- have experienced weathering
- may have distress to the structural components
- may be responding to conditions not considered during the original design

IMPROPER MATERIAL SELECTION
Other Examples

- Ties and anchors from plain steel to stainless steel – selection based on life expectancy
- Flashing materials – copper, lead to plastic fabrics – PVC embrittlement
- Mortar additives – Well know bond enhancer caused corrosion problems
- Stone type – thin cladding with Carrara marble – irreversible distortion due to grain re-orientation from thermal gradient

Case Studies of Common Problems

IMPROPER MATERIAL SELECTION
Case Study

- Finding brick compatible with existing

Fig. 3 Special curved roping brick units were replaced after an extensive search for a source

IMPROPER MATERIAL SELECTION
Case Study

- Finding compatible terra cotta –

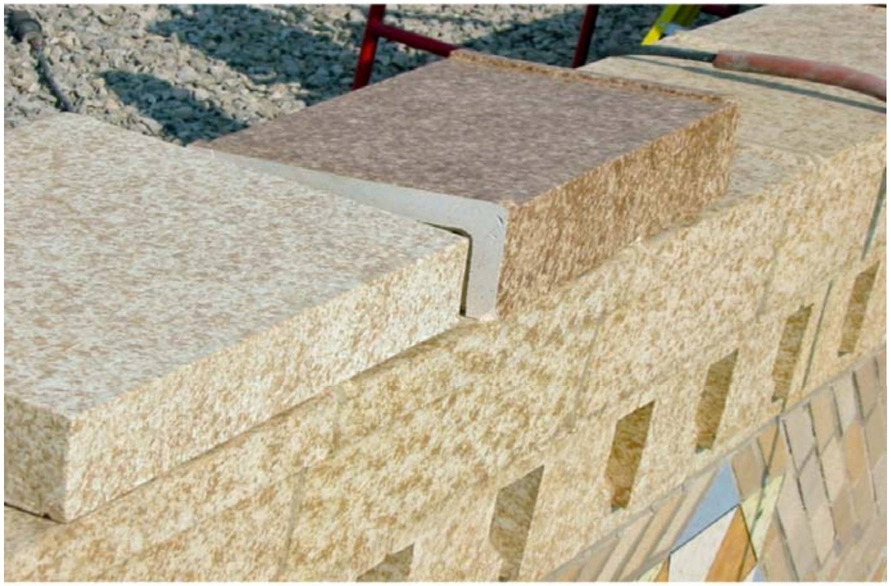

Fig. 4 Matching terra-cotta was a time-consuming, exacting process. Note the too-dark mockup piece on the right.

IMPROPER MATERIAL SELECTION
Case Study

- Finding stone sources
- Mild steel angles – but OK

Fig. 5 Existing shelf angles were left in place, even though there was no through-wall flashing or other protection

INADEQUATE MOISTURE MANAGEMENT

- Shallow barrier walls are common as result of 60's construction

Fig.7 This wall has many inherent defects with the flashing and cavity wall drainage

INADEQUATE MOISTURE MANAGEMENT

- More recent past had cavity walls also have problems –

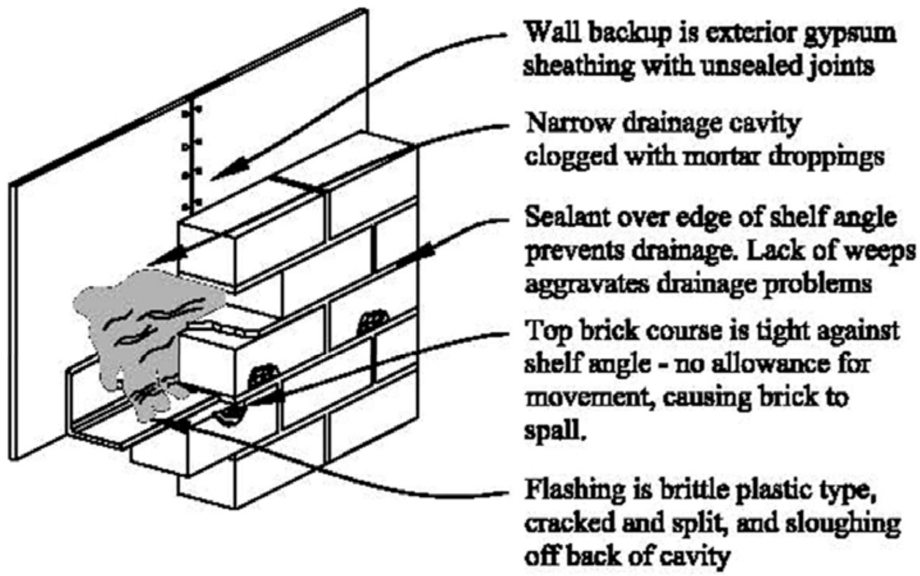

Figure 8: Shelf Angle Without Provision For Movement and Drainage

INADEQUATE MOISTURE MANAGEMENT

Other commonly encountered problems include:

- Flashing terminated incorrectly -
  - ❑Reversed lapped
  - ❑Horizontal leg cut too short
  - ❑Not extended around/over anchors
- Lack of flashing end dams
- No termination bar – just mastic or stuck to backup
- Flashing torn or punctured caused by-
  - ❑Unsealed penetrations from ties or other anchorages
  - ❑Careless handling of material and tools
  - ❑Displacement or damage by other trades

INADEQUATE MOISTURE MANAGEMENT

- Lack of provision for drainage –
  - ❑Lack of water exit, such as weeps
  - ❑Attempt to correct for lack of weeps by drilling, but puncturing flashing
  - ❑Mortar droppings and bridges
  - ❑Unfortunately, in older barrier walls, the primary seal is the sealant

INADEQUATE MOISTURE MANAGEMENT

- Lack of provision for drainage – Case Study

Fig. 9 Cracked stone panel at horizontal joint.
Note lack of weeps in joint

INADEQUATE MOISTURE MANAGEMENT

- Lack of provision for drainage – Case Study

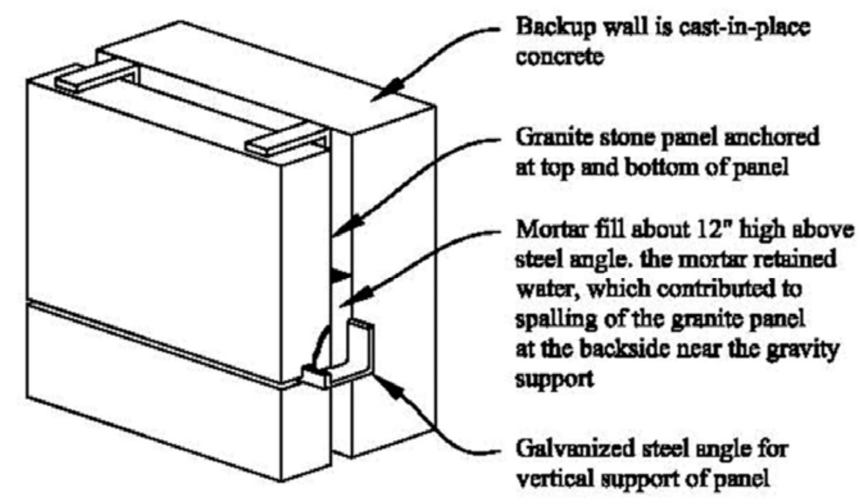

Figure 10: Granite Panel with Concealed Spalling

INADEQUATE MOISTURE MANAGEMENT

- Lack of provision for drainage – Case Study

Fig. 11 (Color online) Spalled stone corner reveals corroded support

INCOMPATIBLE BUILDING COMPONENTS

Case Study for Example – The Devil in the Details

- Newly constructed school
- Sophisticated owner
- Detailed drawings including how to fold end dams step by step
- 3-inch air cavity, water barrier, CMU backup, duel asphaltic copper flashing system at window openings w/custom stainless steel pan flashings
- Knowledgeable third-party inspection
- Inspector when reviewing specs noted incompatibility between flashing mastic and window sealant

INCOMPATIBLE BUILDING COMPONENTS

- Other examples include
  - ❑Coatings that become vapor barriers on masonry surfaces

Fig. 12 Example of surface coating entrapping water beneath the coating

INCOMPATIBLE BUILDING COMPONENTS

- Other examples include
  - ❑Impermeable patching materials

Fig. 13 Stone matching material has weathered poorly and is incompatible with the parent brownstone

LACK OF PROVISIONS FOR MOVEMENT

Cracked masonry usually occurs at predictable locations:

- Many times, from the absence of movement joints
  - At building corners – differential movement
  - From wall opening corners – discontinuities and materials
  - Field of masonry – too narrow or infrequent
- False joints – partially raked back mortar and filled w/sealant
- Bridged joints
- Past repair did not extend completely through masonry

LACK OF PROVISIONS FOR MOVEMENT

Example of False Joint

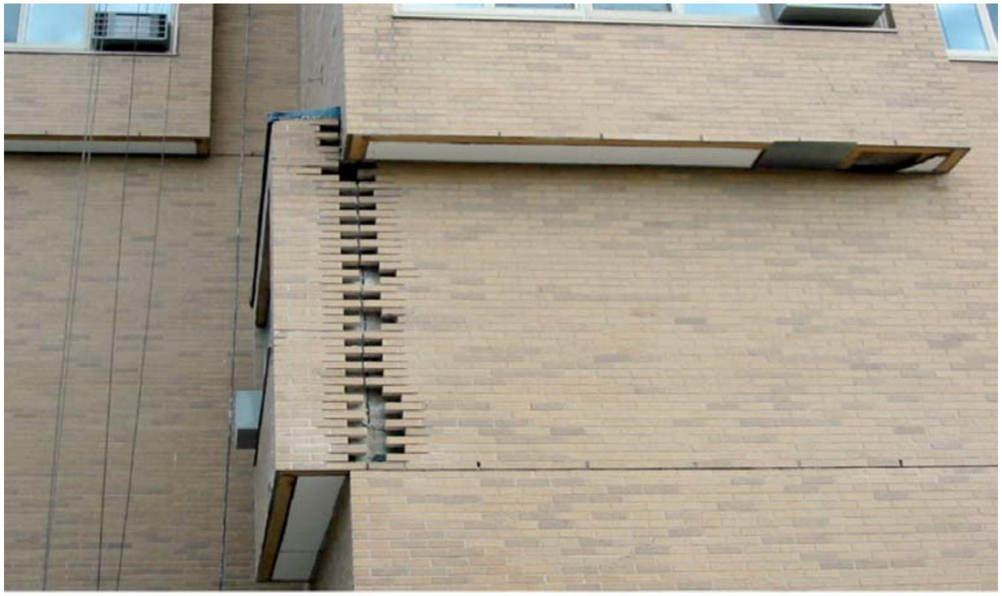

Fig. 14 Toothing brick at building corner where original joint construction was ineffective

LACK OF PROVISIONS FOR MOVEMENT

Case Study

Fig. 15 Corner restraint at Carrera marble panel has a repair that has also failed

POOR WORKMANSHIP

Case Study

- Residential hi-rise – 23 stories
- Brick veneer w/ narrow cavity
- Original work scope included:
  - ❑No study done
  - ❑BCG retained to do inspections
  - ❑Spot re-pointing, reseal wall joints, and widened EJs
- At first cut for re-pointing at building corner noted crack began to develop, upon further investigation we found the adjacent shelf angle was not anchored. This prompted further investigation. At other test cuts we found 25% of the shelf angles had:

POOR WORKMANSHIP

Case Study

- ❑No anchors

Fig. 16 Missing anchor at shelf angle

POOR WORKMANSHIP

Case Study

- ❑ Inadequate shims

Fig. 17 The shelf angle is shimmed with haphazardly placed washers

POOR WORKMANSHIP

Case Study

- ❑Grossly undersized anchors for spacing (3/8 in. dia. at 6’ o.c.) – 2 stories per shelf angle
- ❑Flame cut holes in shelf anchor with haphazard arrangement of anchor nut.
- ❑Displacement of shelf angles upward from brick masonry expansion – Original construction used askew wedge type anchors
- ❑Although not found on this project, another common problem is under sizing of the shelf angles.

- Why did these defects occur?

Strategies of Successful Repair Projects

CONCLUSIONS

CONSIDERATIONS FOR A SUCCESSFUL REPAIR PROJECT

- Planning and communication key
- Initial consultation with Owner to establish needs, desires and expectations
- Perform a pre-design investigation at areas of known problems as well as at locations perceived as function as intended
- Make sure budget matches anticipated work scope and Owner's expectations

CONCLUSIONS

CONSIDERATIONS FOR A SUCCESSFUL REPAIR PROJECT

- Make adjustments or compromises where appropriate and reevaluate as project progresses
  - ❑If cash flow is problem, can repairs be extended over multiple years or phases?
  - ❑Is a shorter life expectancy repair approach sufficient to meet buildings immediate need and Owner's budget and desires?

- Provide the Owner with choices of repair approaches with varying life expectancies , initial costs, and associated maintenance costs. Thoroughly communicate differences, not just initial costs, but anticipated future costs associated with each approach.

CONCLUSIONS

CONSIDERATIONS FOR A SUCCESSFUL REPAIR PROJECT

- Select materials and techniques that are appropriate for the building and repair approach. Keep in mind the performance of products, as well as their interaction with adjacent materials and the building as a whole.
- Provide through, yet concise and understandable repair documents using proven materials and techniques.

CONCLUSIONS

CONSIDERATIONS FOR A SUCCESSFUL REPAIR PROJECT

- Choose design professionals and others with sufficient experience and familiarity with the type of construction, project size and complexity of the project. Masonry repair is a specialty field and most new construction designers and contractors do not have the knowledge to undertake such projects.
- Prepare and expect changes due to hidden conditions or unknowns. It is the nature of repair. Insist a contingency budget be established.

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Questions?

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