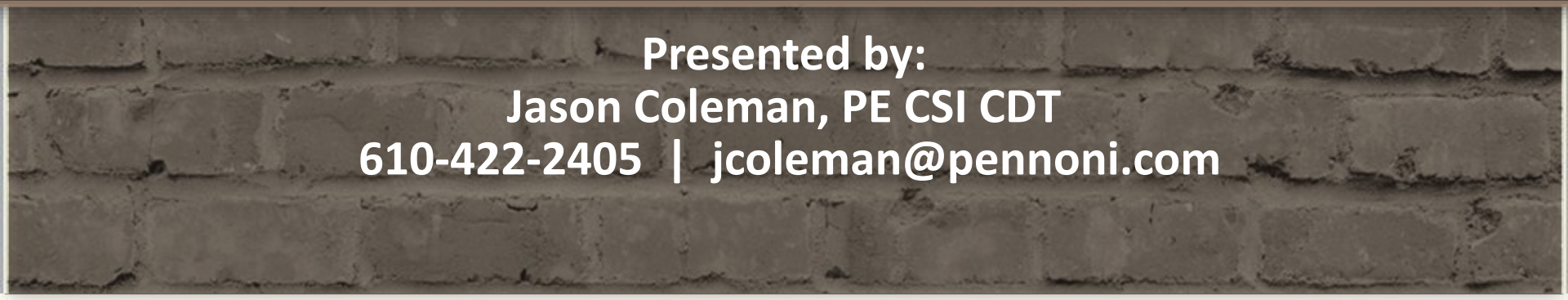
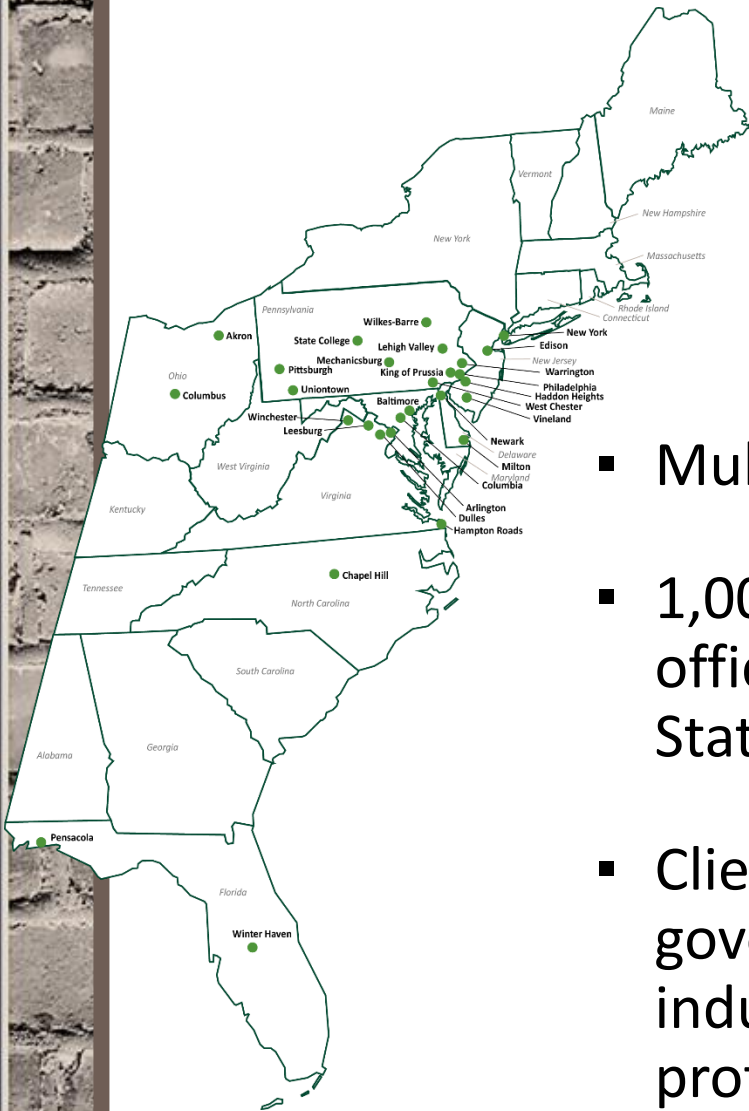




Emergency Repairs to a Post Tensioned and Prefabricated Brick Masonry Façade Panel

Presented by:
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- Multidiscipline engineering & design firm
- 1,000 professionals & support staff in offices throughout the Eastern United States
- Clients are local, state, and federal governments, private, commercial, industrial, and construction, and other professional firms

Prefabricated Masonry Panel Background

- Typically designed as reinforced masonry
- Panels need to support erection loads encountered during lifting and transporting
- Aesthetically it is unacceptable for panels to crack
- Best resources –
 - Brick Industry Association
 - Technical note #40 – “Prefabricated Specific Masonry”
 - ASTM International
 - ASTM C901-01 – “Standard Specification for Prefabricated Masonry Panels”



TECHNICAL NOTES on Brick Construction

1850 Centennial Park Drive, Suite 301, Reston VA 20191 | www.gobrick.com | 703-620-0010

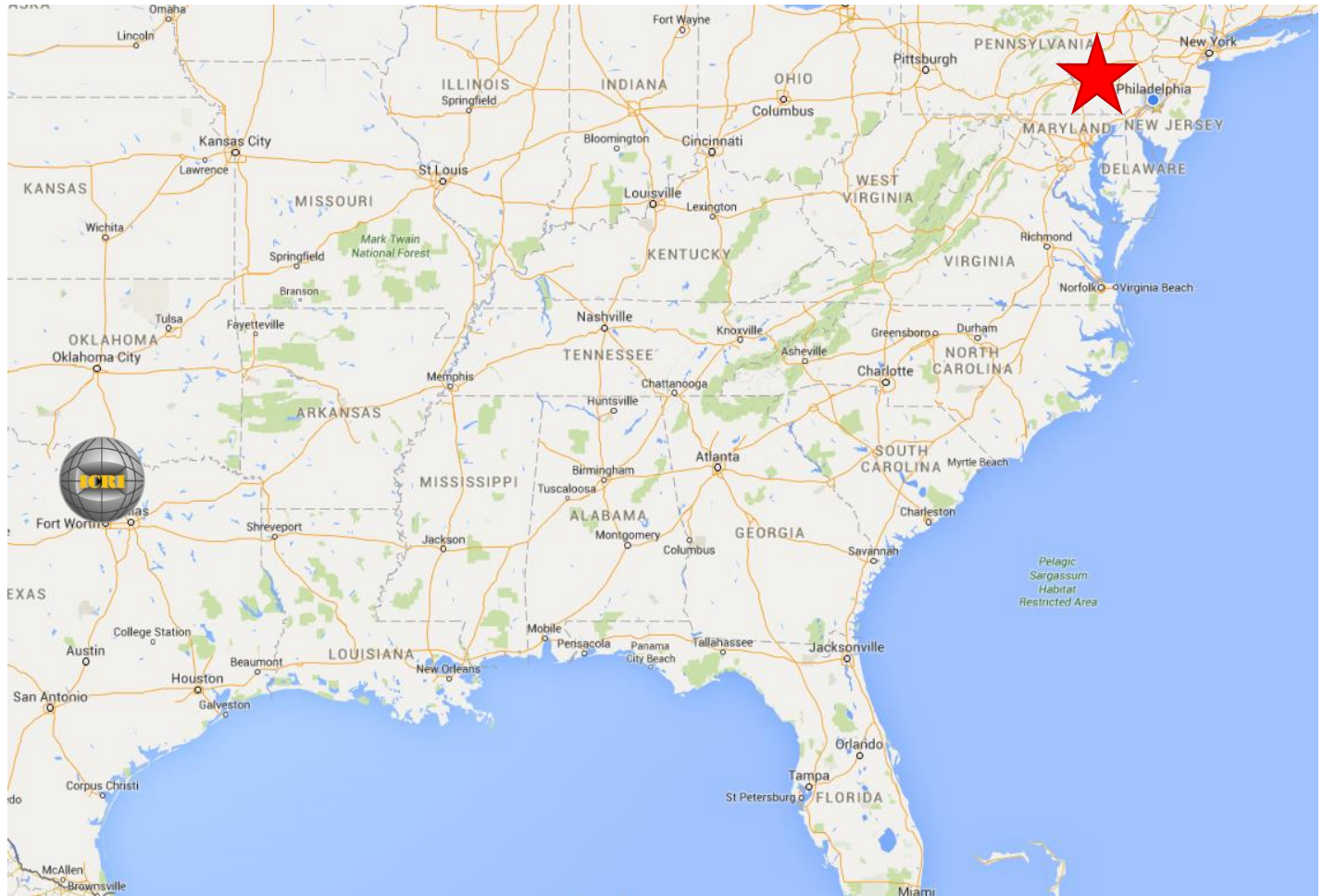


Designation: C901 – 09

Standard Specification for
Prefabricated Masonry Panels¹

Case Study Background

- 10-story, 350,000 SF structure, above a 3-story below grade parking garage



Case Study Background

- Building functions as a county office building
- Constructed in 1973
 - Steel frame structure
 - Vertical columns of glass curtain wall
 - Vertical pre-fabricated brick masonry columns
 - Exposed aggregate precast concrete ornamental units



Problem Call

- Engineer for parking garage rehabilitation
- Emergency call
 - Bricks were observed at the 8th floor level that appeared ready to fall



The sky
is falling,
the sky
is falling!

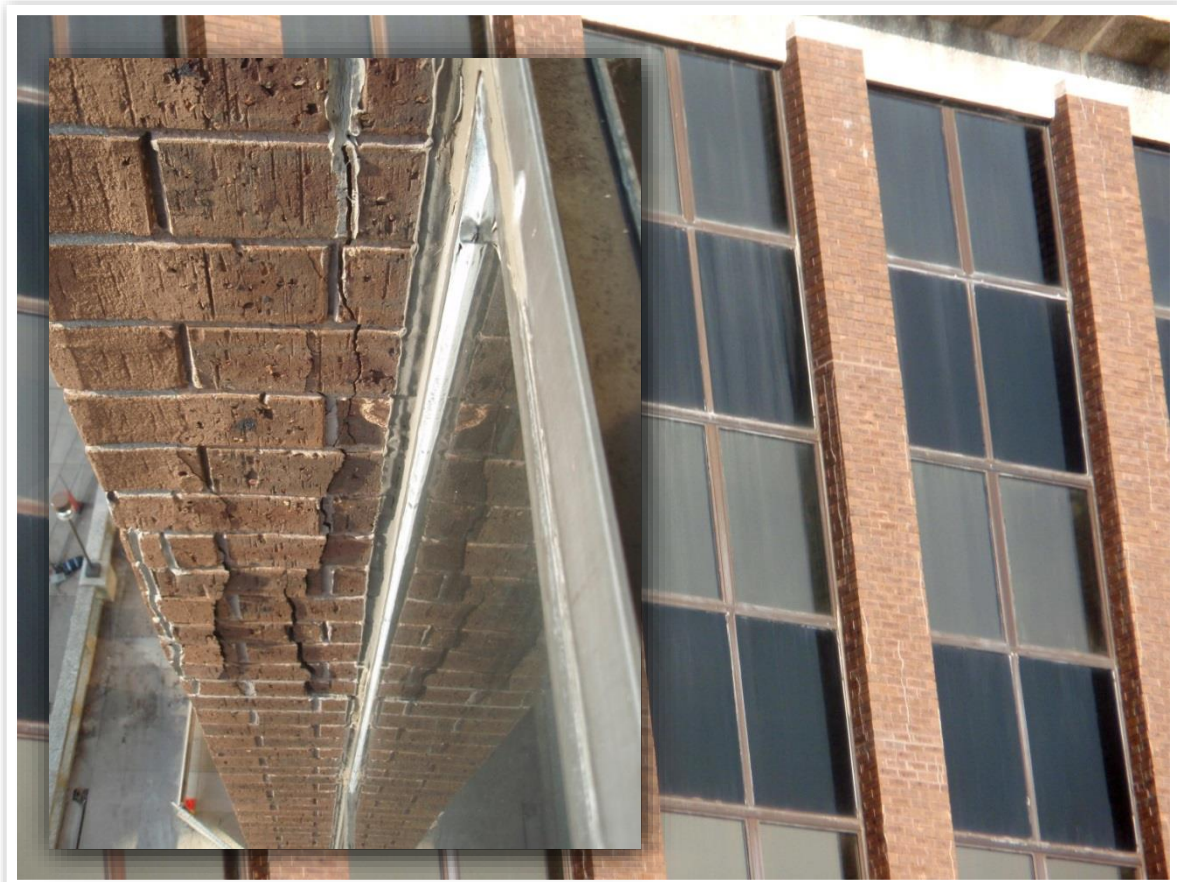
Problem Call

- 2nd time emergency condition at the building



Initial Site Visit

- Visit from the ground and from operable windows adjacent to panel



Local Brick Masonry Prefabricated Panel History

- Admixture added to mortar to increase bond strength required complete removal of pre-fabricated panels at 11-story building in Philadelphia, PA
- Owner concern same admixture was used



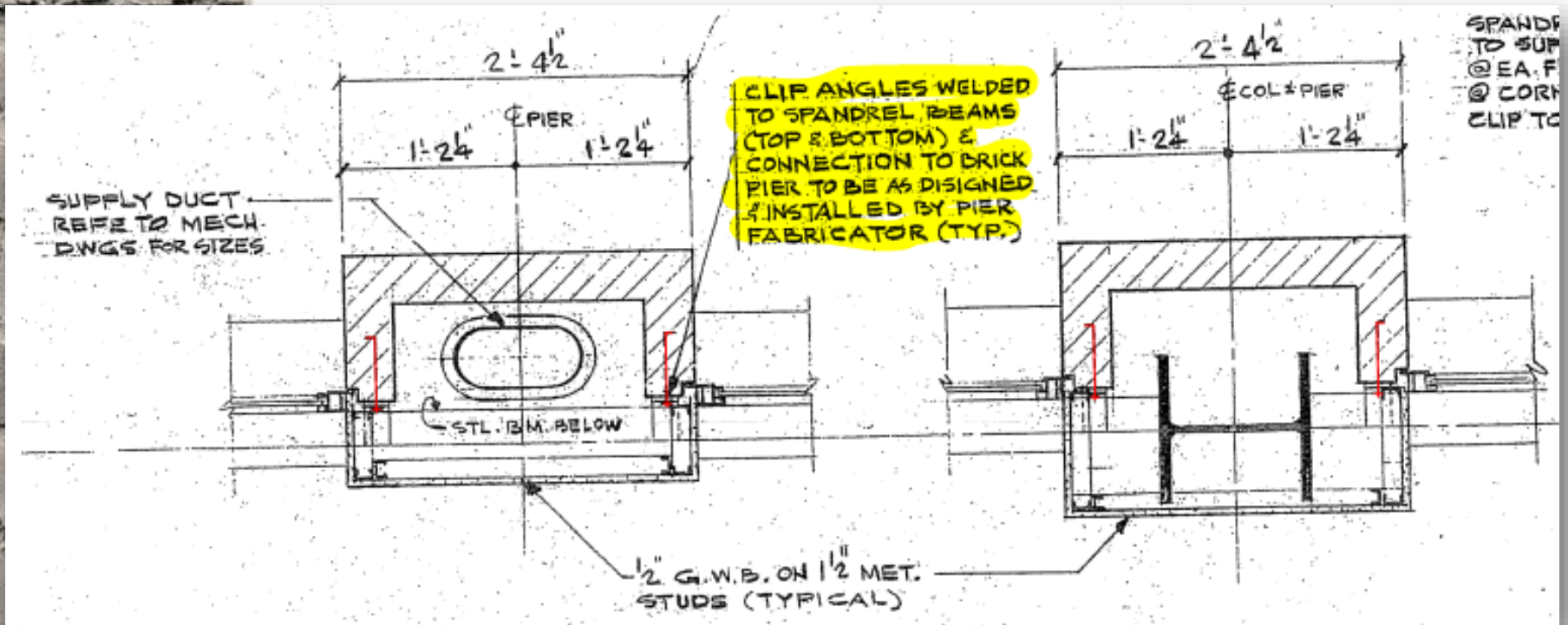


Scope of Investigation

- Drawing review
- Perform exploratory investigation
- Perform material testing
- Prepare repair/replacement design
- Provide report

Drawing Review

- 6 different panel types



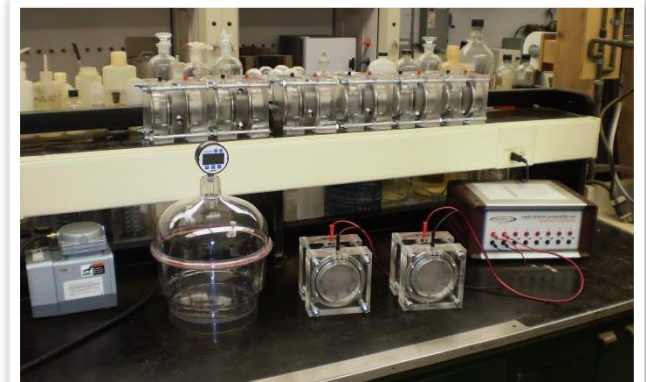
Exploratory Panel Investigation

- Panel construction deviated from design drawings
- Panel construction method used steel post-tensioned rods
- No intermediate support of relief



Material Testing

- Testing of duplicate attic stock brick in accordance with ASTM C67
- Water soluble chloride content testing of mortar samples removed from damaged panel
- Petrographic analysis of mortar samples removed from the damaged panel



Material Testing Results

- Brick performed well and yielded results consistent with SW (Severe Weathering Brick)
- Chloride content, 0.014%, was just below tolerable levels 0.15%
- Petrographic analysis revealed 8:1:1 mix ratio, excess sand
 - Excess sand resulted in entrapped air





Analysis

- Corrosion of embedded steel classified as severe
- Damages to brick classified as severe and poor quality of joint mortar

Solution

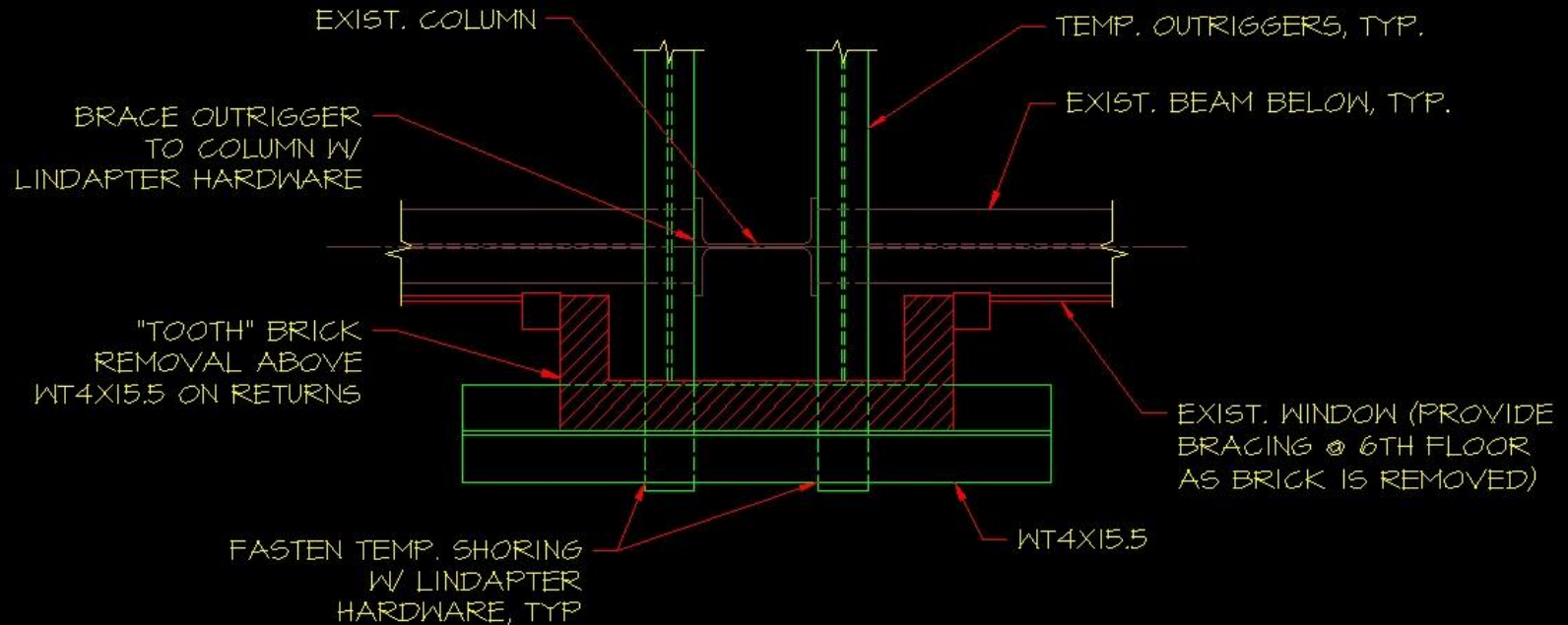
- Replace panel

Challenges

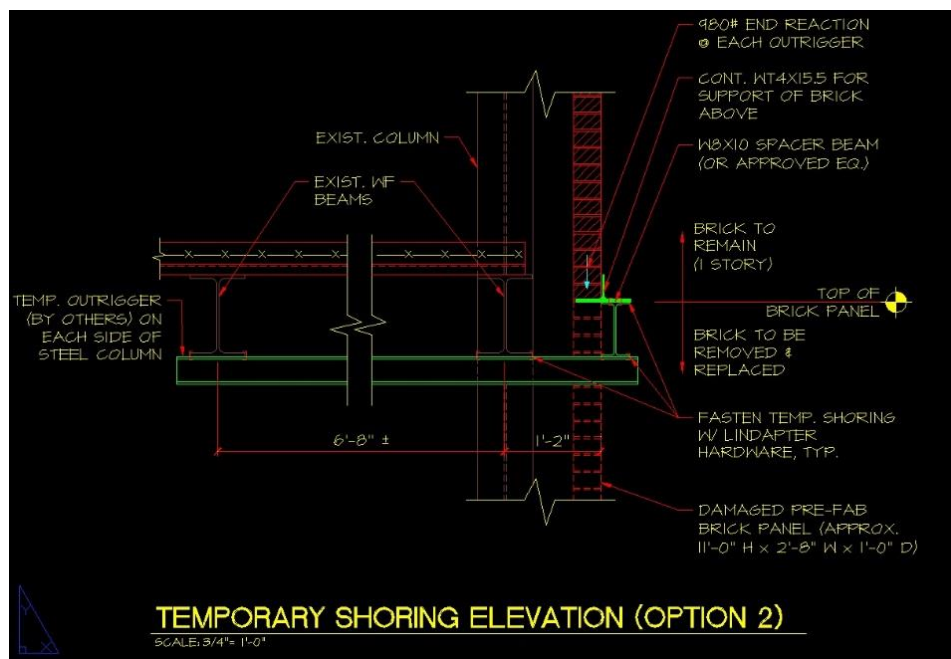
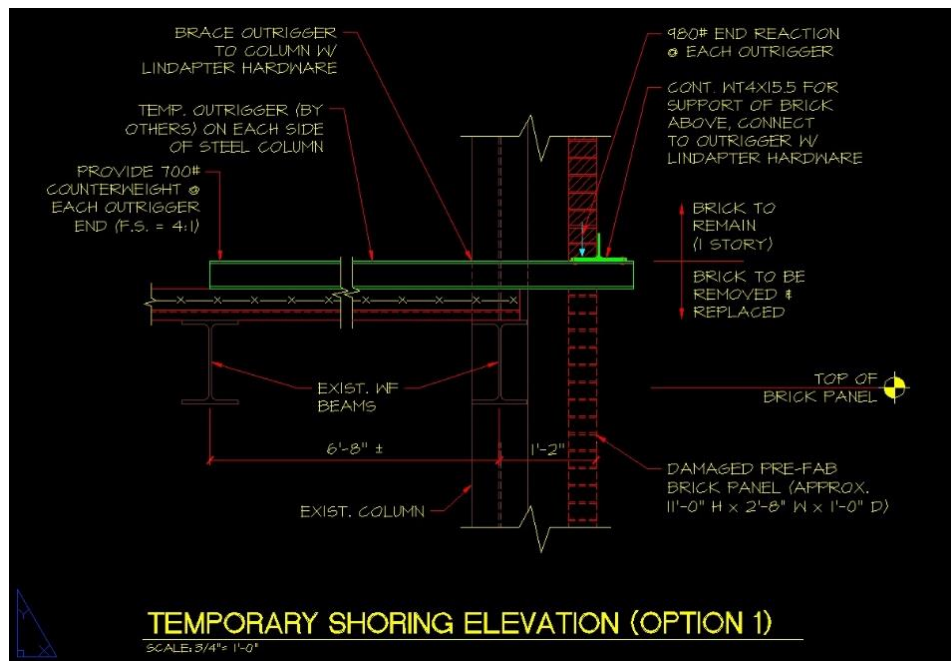
- Inability to replace pre-fab panel
 - Time constraints
- Requirement to support remaining panels and ornamental precast above
- Curtain wall braced to backside of panel
- No back-up wall
- Non-conformance with current code requirements



Temporary Shoring



Temporary Shoring

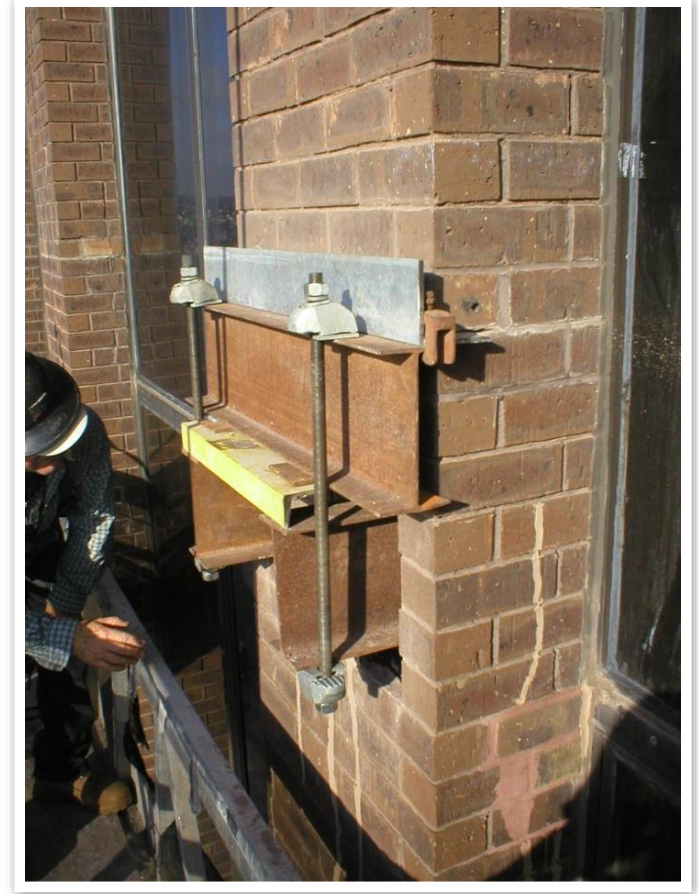


Factor of Safety



Temporary Shoring

- Install temporary shoring from existing structure to allow demolition of panel



Code Requirements

- ACI 530, Section 6.2.2.2
 - Connect anchored veneer to the backing with anchors that comply with Section 6.2.2.5 and Article .24 of ACI 530.1



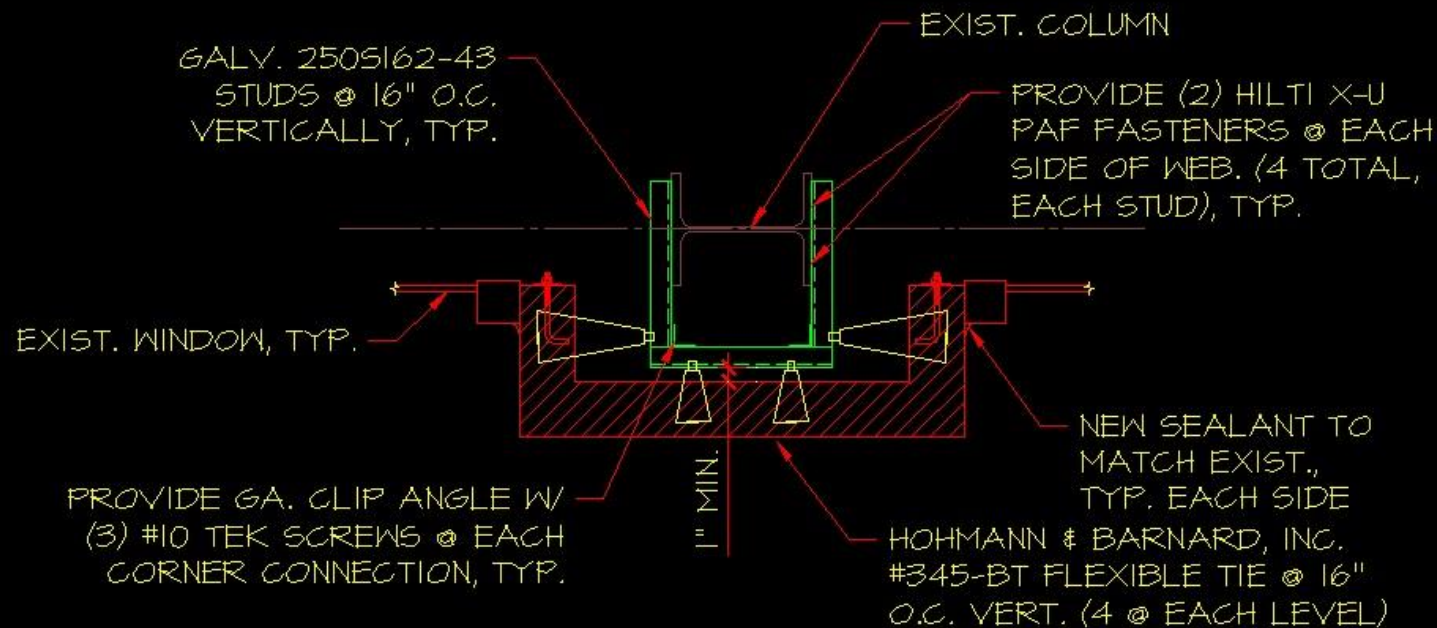


Code Requirements

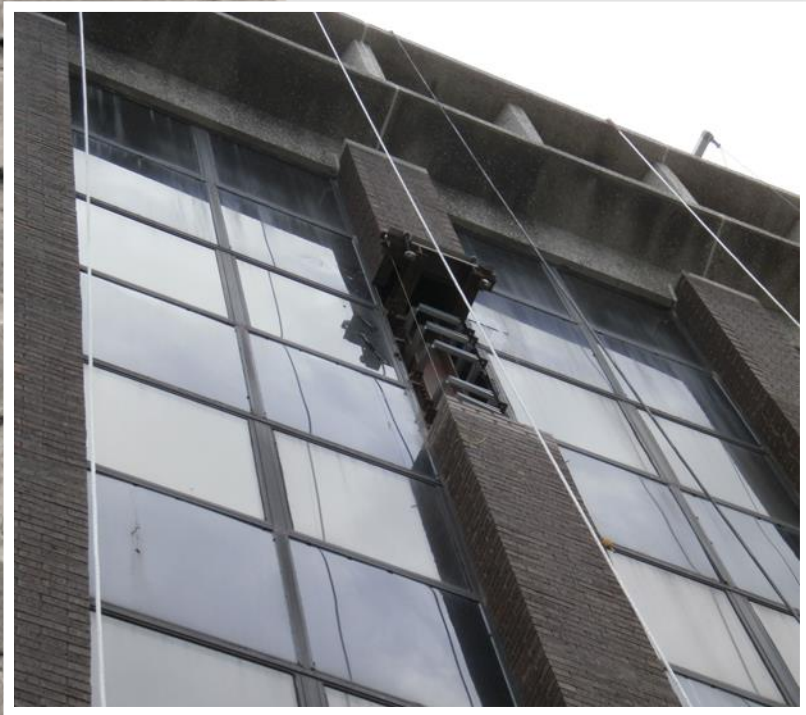
- *Section 6.2.2.5.6 Anchor Spacing*
 - *Section 6.2.2.5.6.1, For adjustable two-piece anchors, anchors of wire size W1.7, and 22 gage corrugated sheet-metal anchors, provide at least one anchors for each 2.67 ft² of wall area*
 - *Section 6.2.2.5.6.2, For other anchors, provide at least one anchor for each 3.5 ft² of wall area*
 - *Section 6.2.2.5.6.3, Space anchors at a maximum distance of 32" horizontally and 18" vertically*

Solution

- Add metal stud bracing to steel column for connection of metal ties

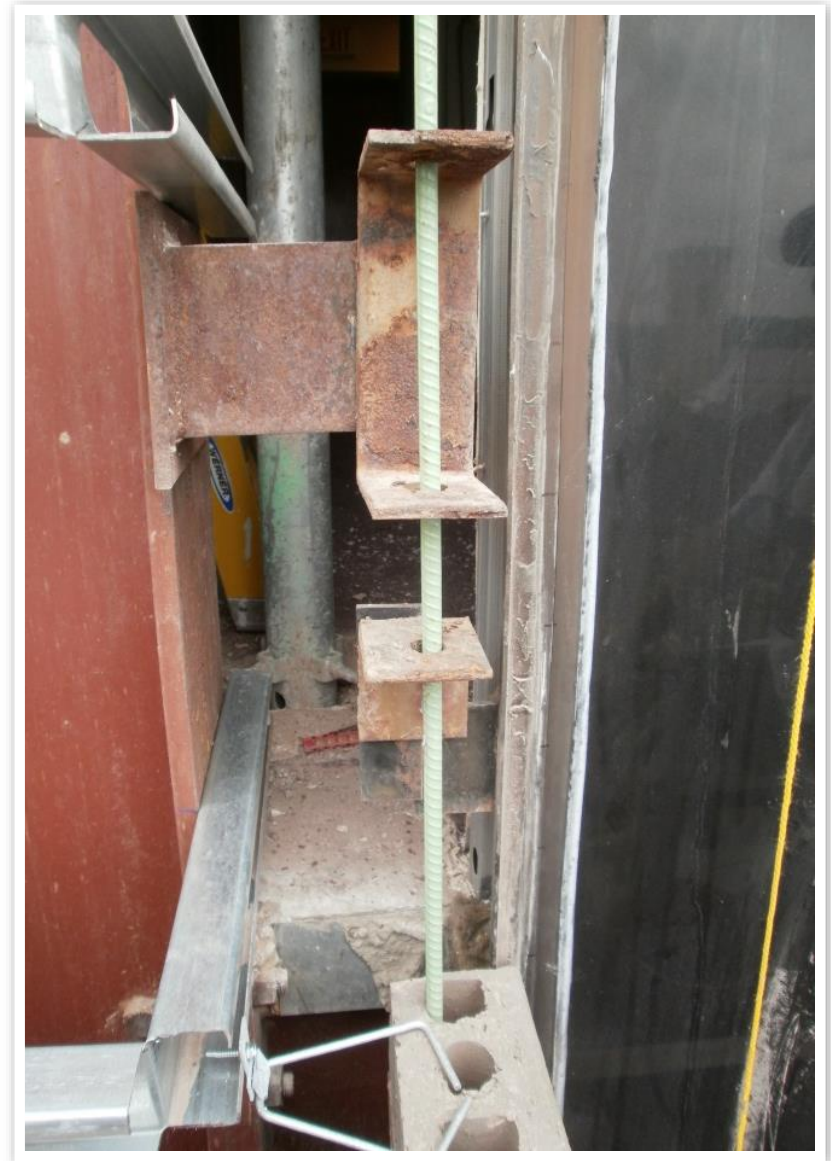


Repair



Final Replacement

- Maintained existing curtain wall connections



Final Replacement & Future Plan

- Perform comprehensive façade investigation of remaining panels for similar deficiencies



Questions