WJE

SOLUTIONS FOR THE BUILT WORLD

Lee County Courthouse

"*Cathedral of the Prairie*"

Twin Cities aci Spring 2013 Responsibility in Concrete Construction

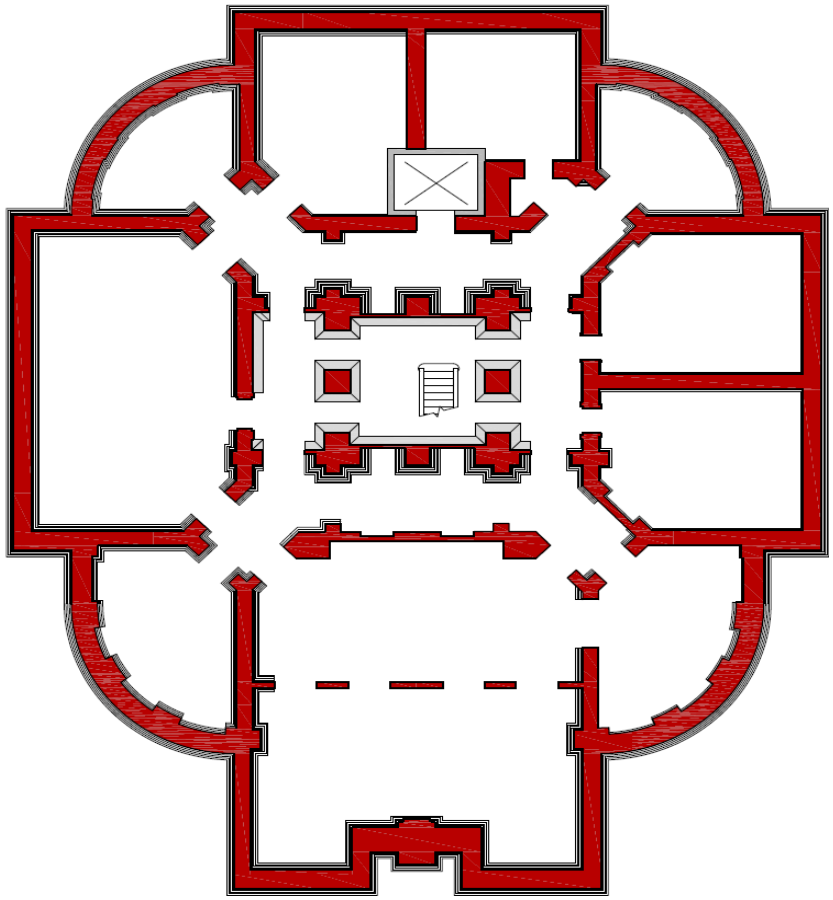
Restoration of Historic Concrete and Masonry Structures

Significant Problems

- Constructed in 1900
- Reportedly Underpinned with Concrete Footing in 1911
- Repairs in 1979
- Restored in 2001-2004 via the Texas Historical Commission's Courthouse Program
  - Site Drainage Repairs
  - Steel Tension Tie Straps around Portico Walls
  - Balcony Repairs
- WJE Assessment in 2008

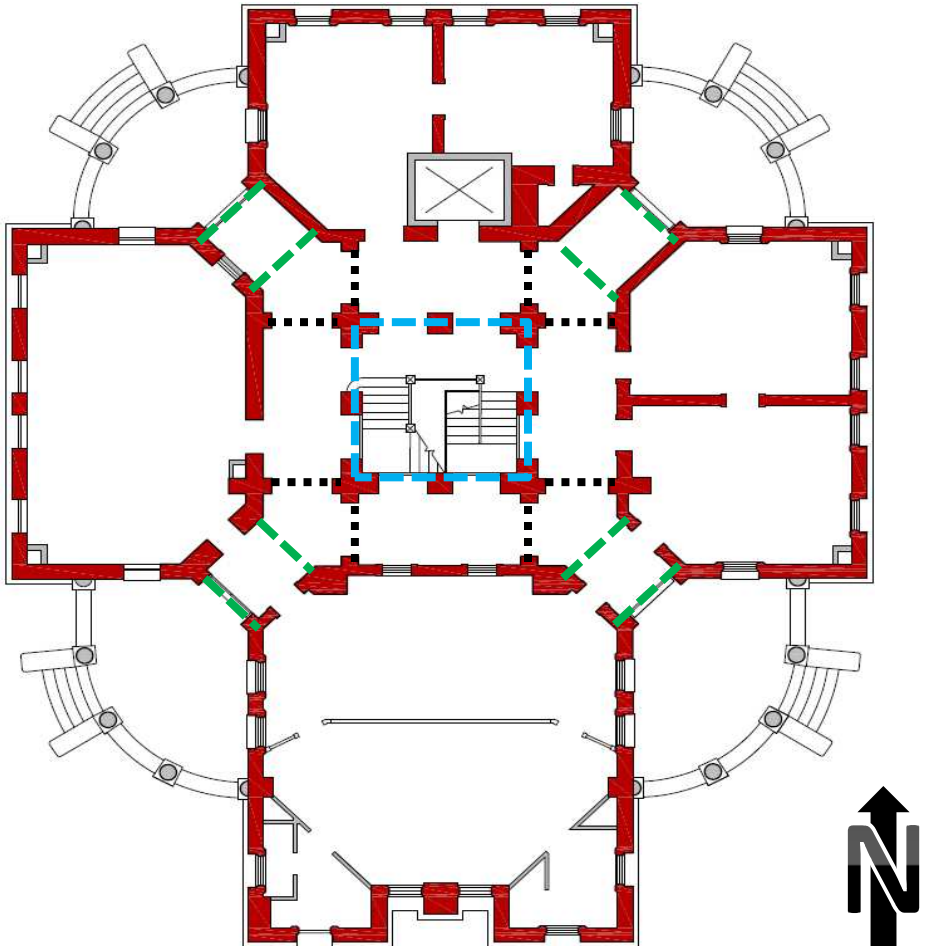
Foundation Plan

- Shallow, Unreinforced Masonry Spread Footing
- 6-Wythe Masonry Wall
- Supporting 37 Feet of 4-Wythe of Masonry Wall



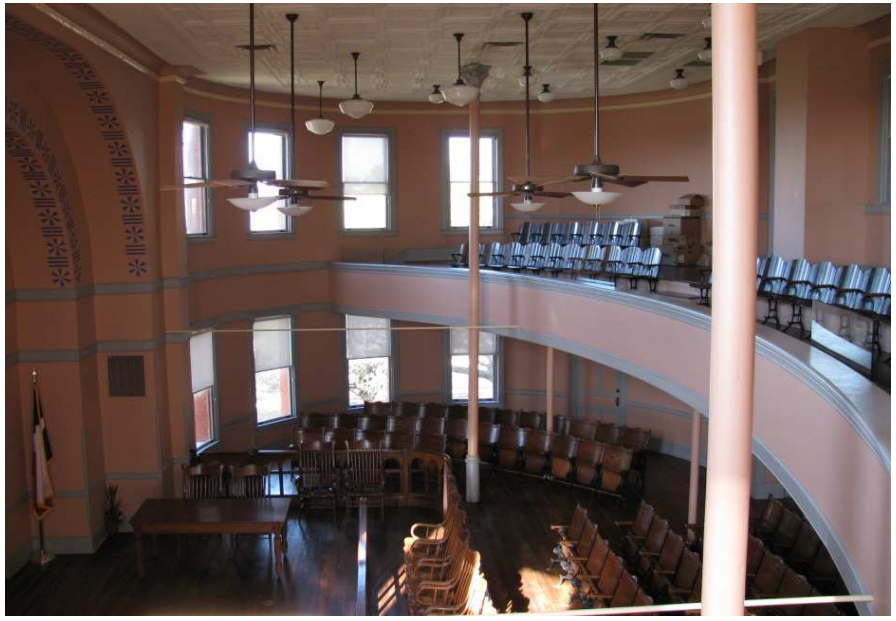
Typical Floor Plan

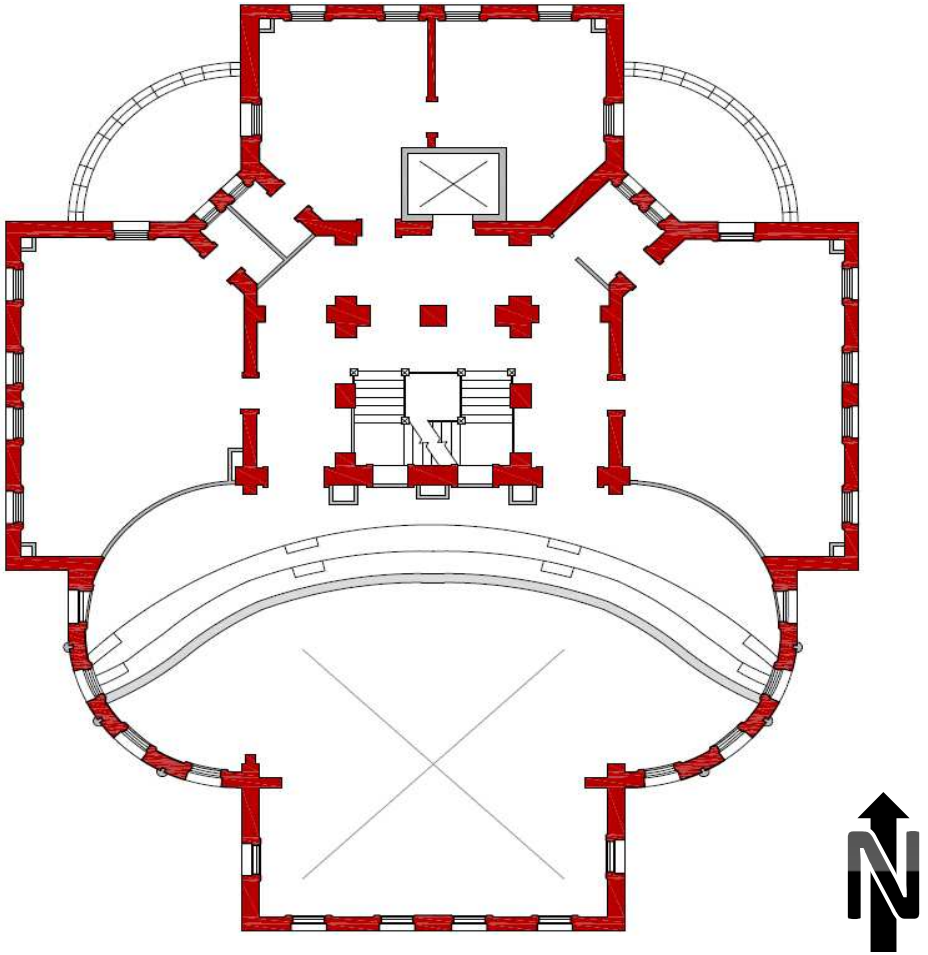
- Central stair
- Connecting Arches



Second and Third Floor Plan

- Grand Courtroom
- Balcony





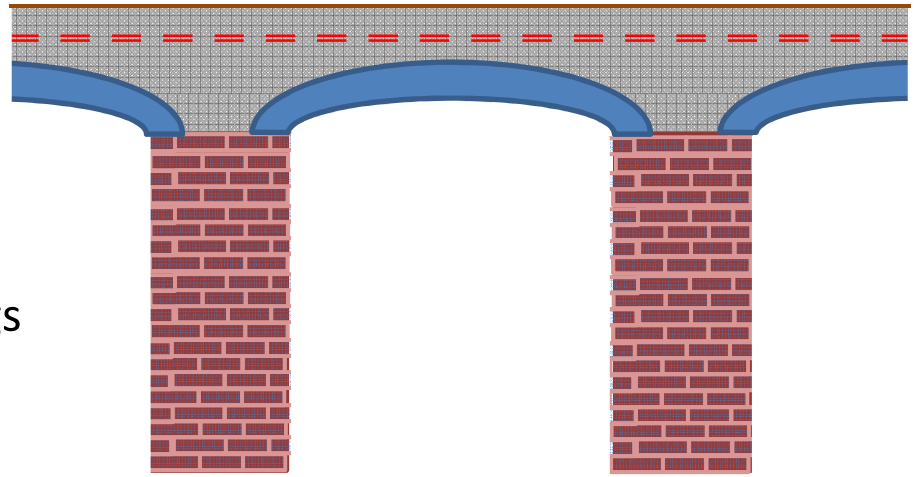
Typical Elevations

North Porticos

South Porticos

Structural System

- Typical Masonry Walls
- Reinforced Cindercrete Slabs w/ Integral Beams and Joists
  - Joists
    - 4-inch Channels with Upturned Legs
    - Slight Arch
  - Beams
    - 12-inch Deep I-Shapes Embedded in Cindercrete
  - Supported at Ends
    - Load Bearing Walls
    - 12-inch I-Shapes for Longer Spans

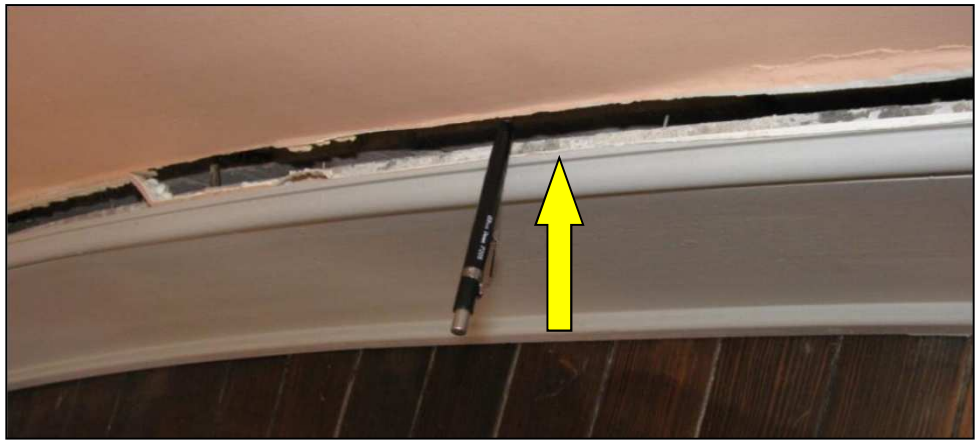


Cracking of Masonry & Finishes

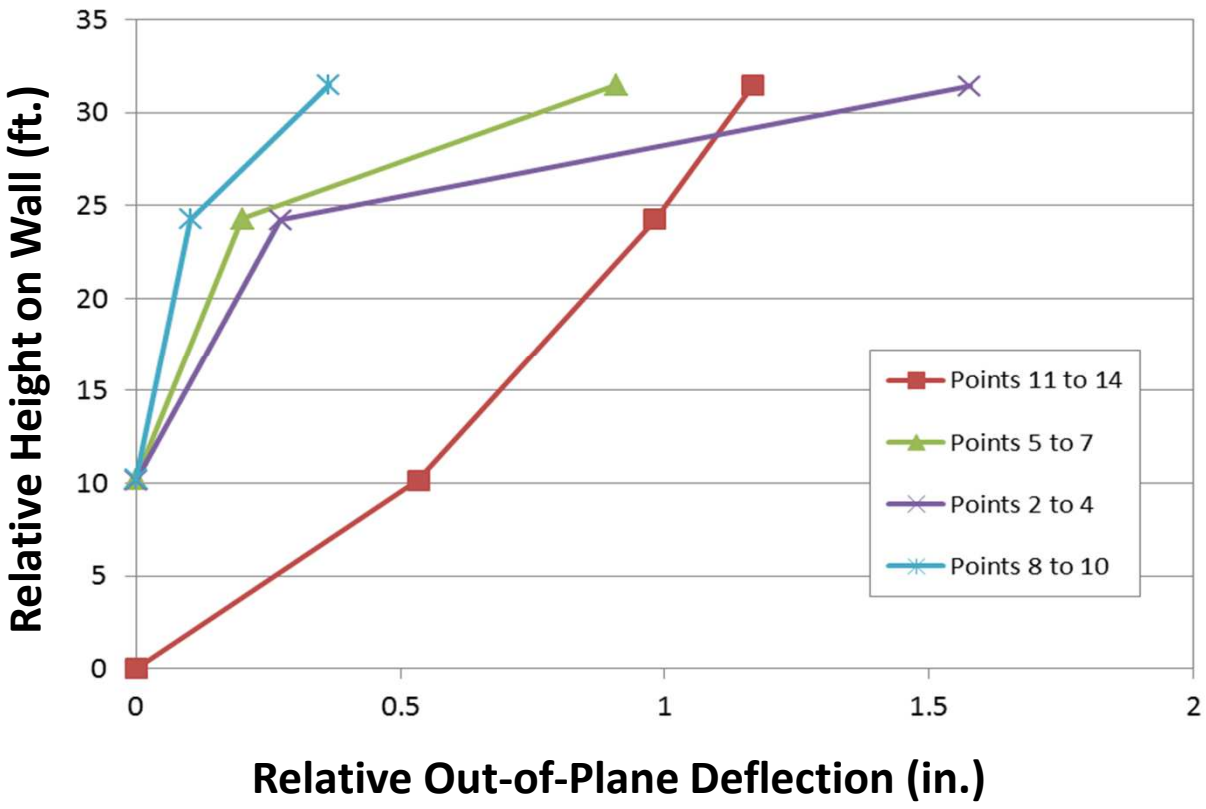
Cracking of Masonry & Finishes

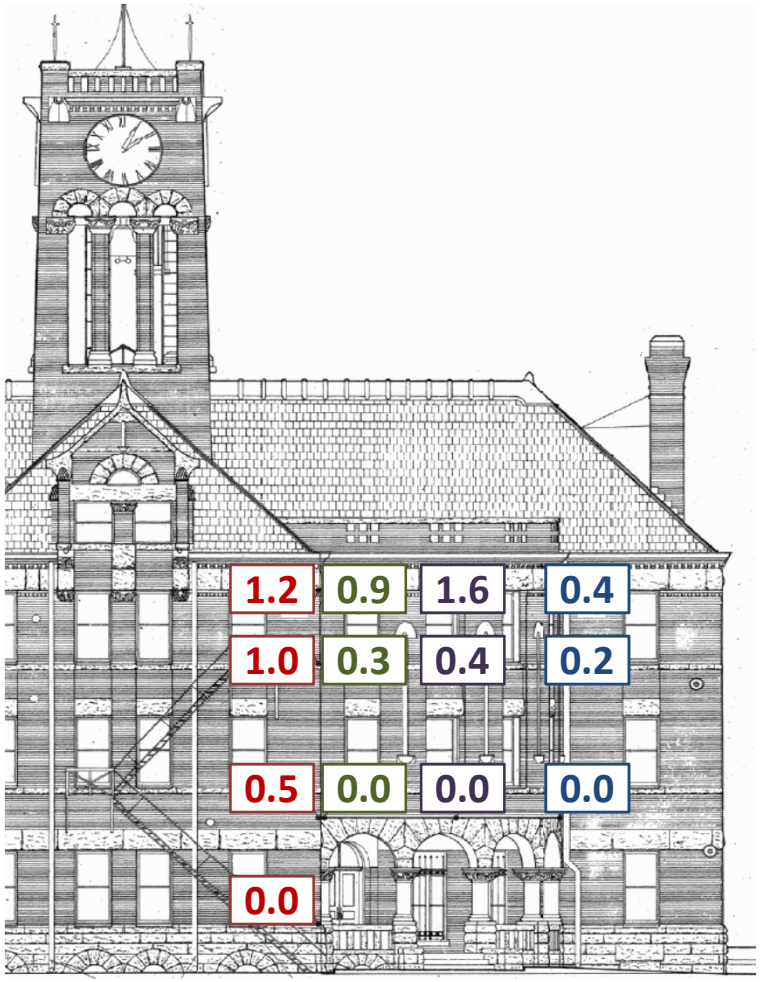
West Elevation

Out-of-Plane Walls

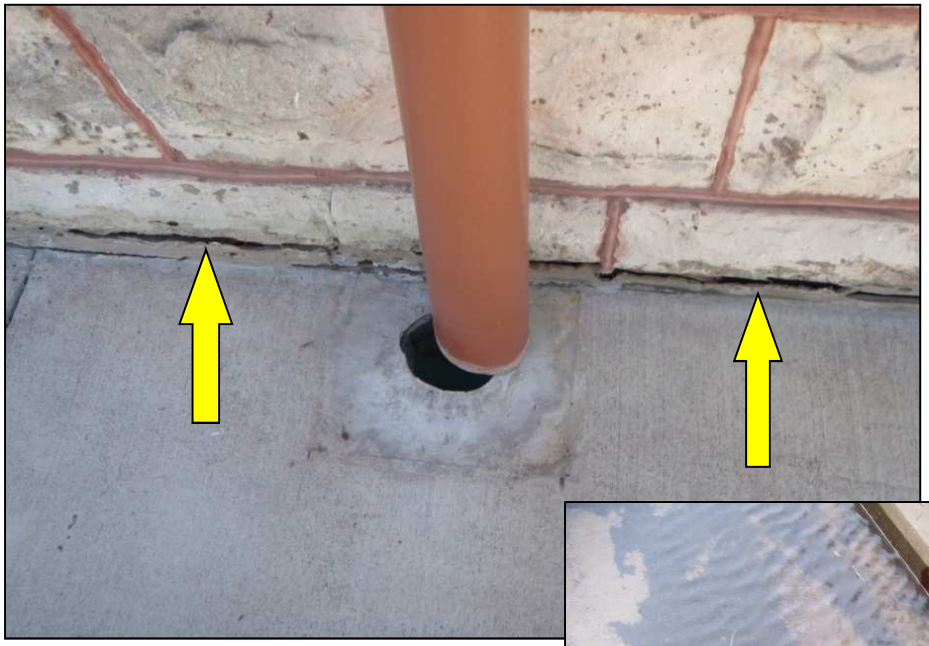


Out-of-Plane Walls



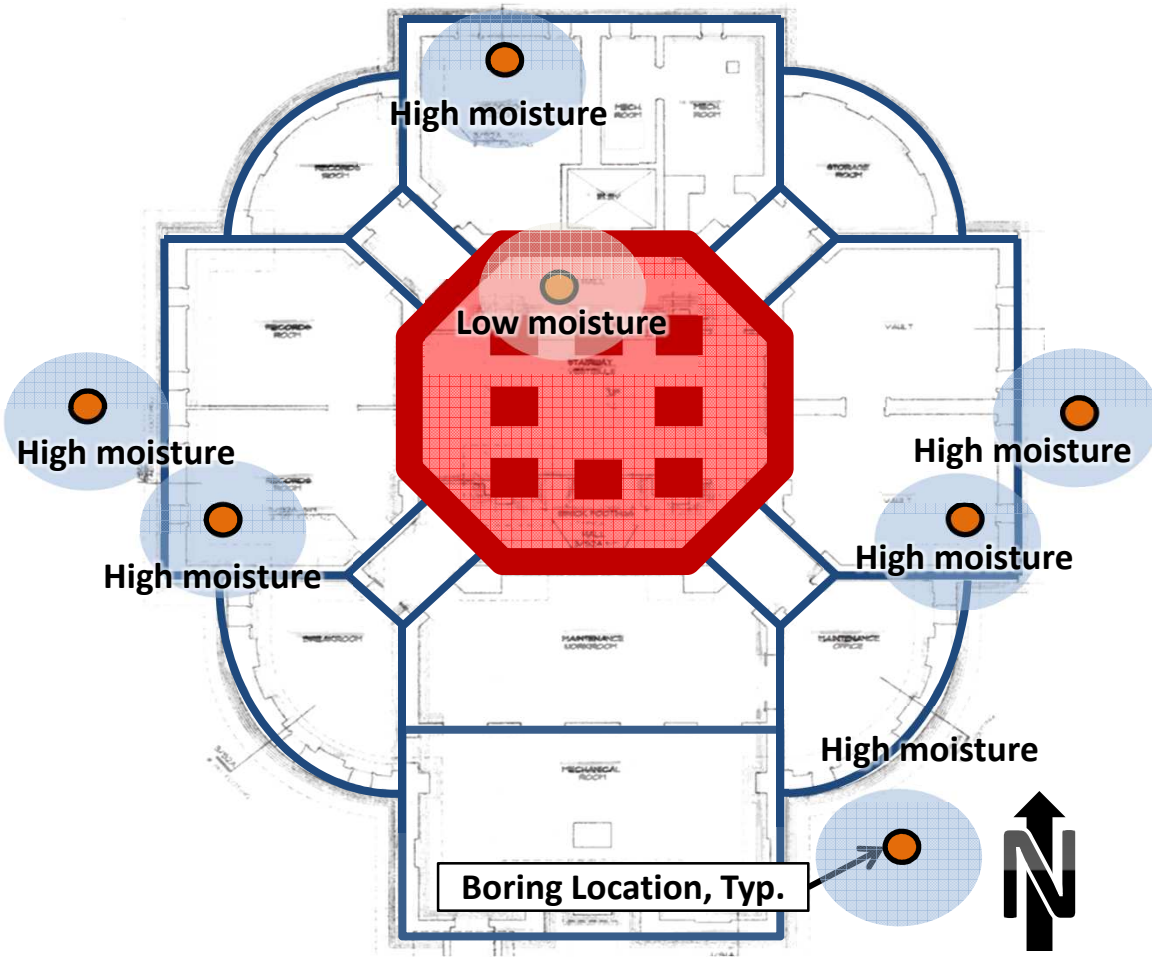


Site Drainage



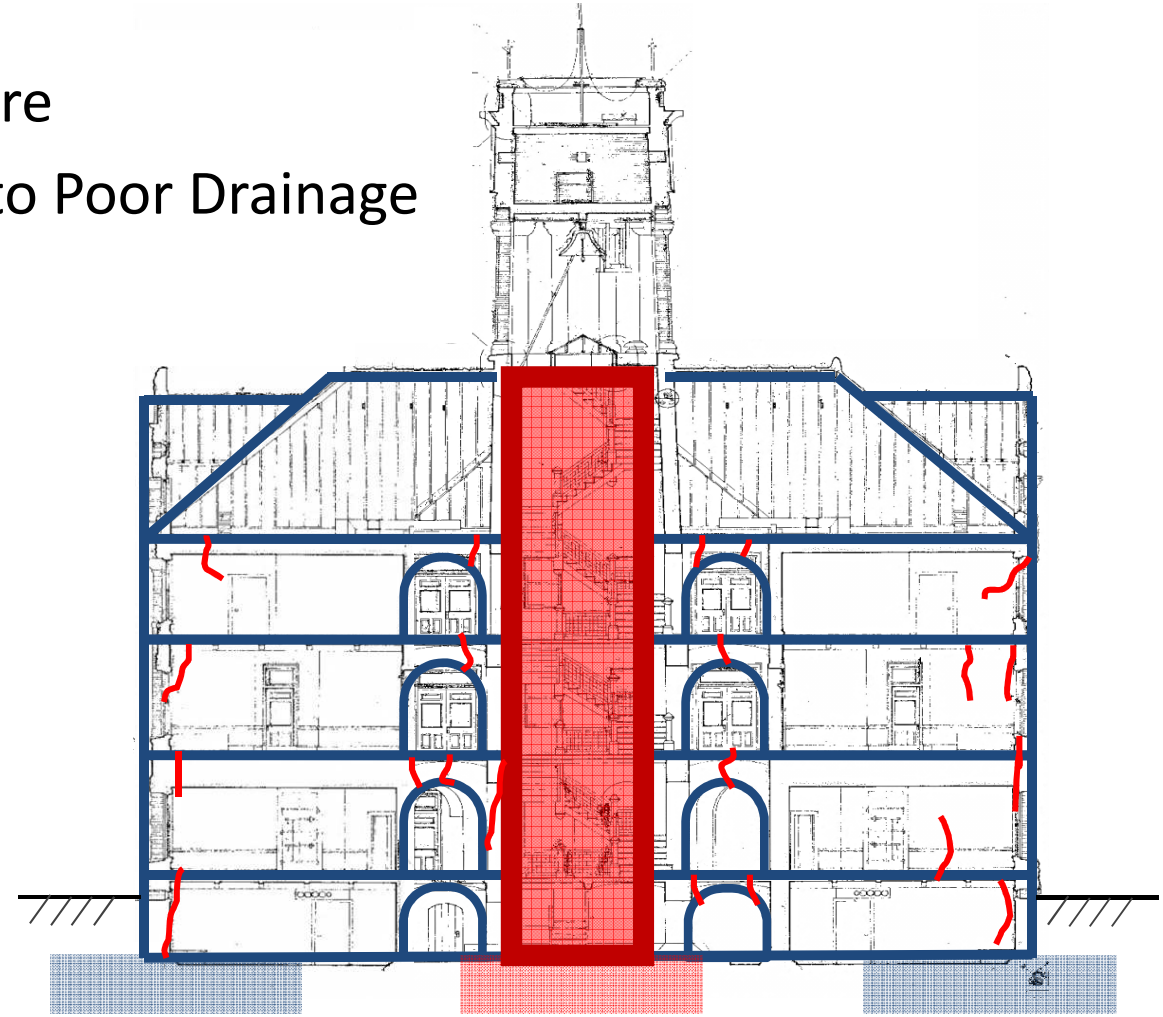
Geotechnical Investigation

- Fat Clay Soil on Site
- Plasticity Index between 32 and 64
- *Medium* to *Very High* shrink/swell potential
- Varying Moisture Level and Liquidity Index between Interior and Perimeter



What is going on?

- Relatively Stable Central Core
- Perimeter Movement Due to Poor Drainage and Expansive Clay Soil
- Unreinforced Masonry Spread Footing Unable to Transfer Tensile Stresses & Differential Movement
- Uneven Settlement Causing Out-of-Plane Wall Movement



Challenges of Repair

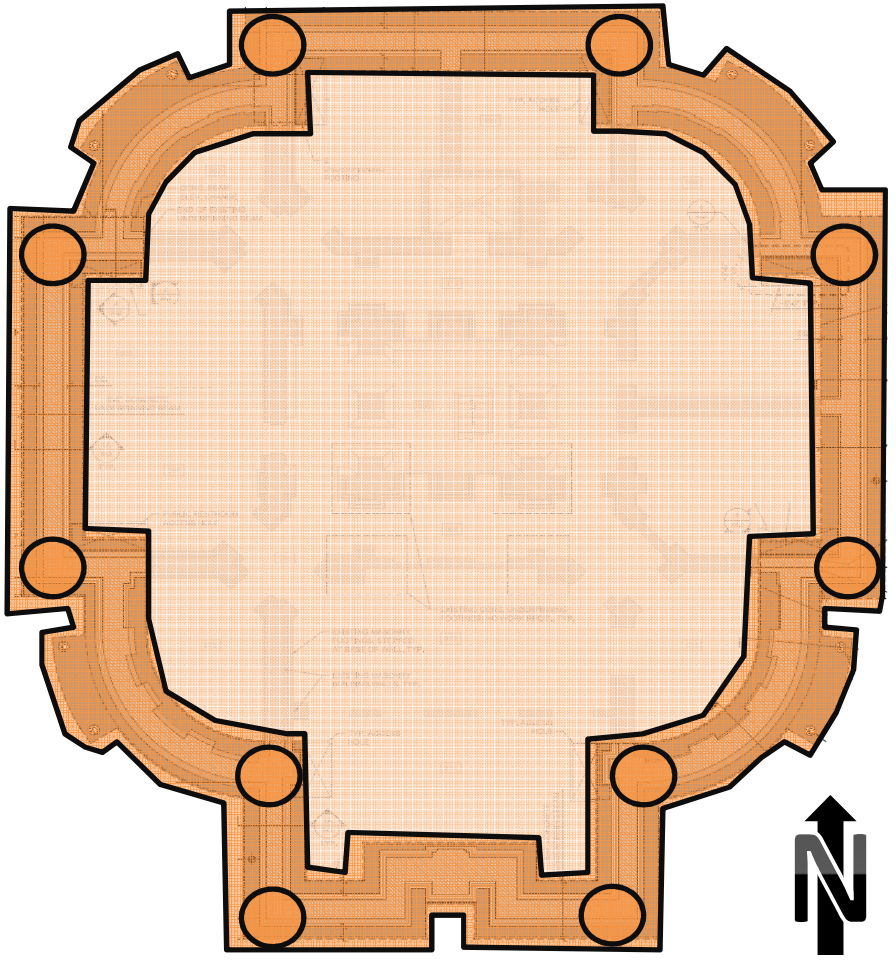
- Registered Historical Landmark
  - Repairs Must Be Consistent with Secretary of Interior's Standards
- Courthouse Open for Business
  - Noise, Vibrations, Safety, etc.
- Courthouse Employees Constantly Indicating Movement
  - Actual or Perceived??
- Accommodate Court Schedule
- Unforeseen Conditions

Real-Time Monitoring

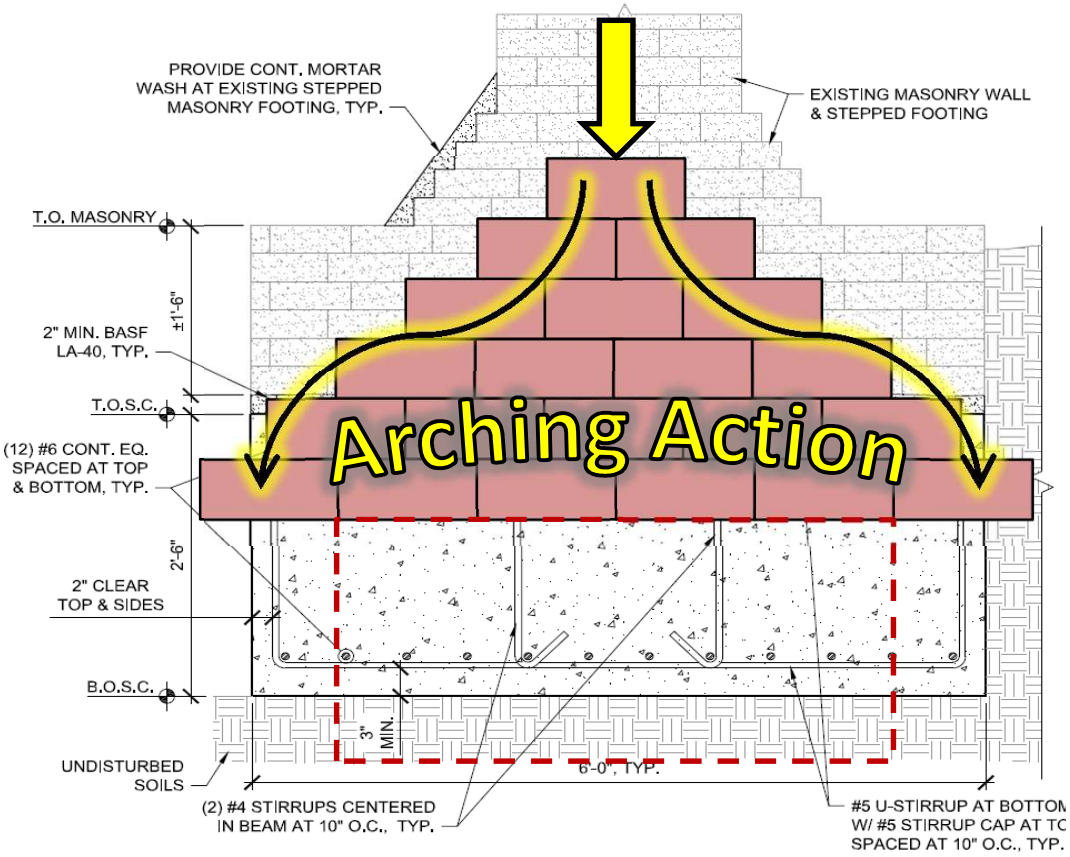
- Crack Gauges
  - Simple / Effective
  - 6 Total Gauges / Monitored Periodically
  - Locations: All Floors
- Remote Sensing System
  - Real-Time Monitoring
  - LVDT Sensors
    - 2 at Attic (East & West)
  - Tilt Sensors
    - 2 at Attic / 2 First Floor Walls

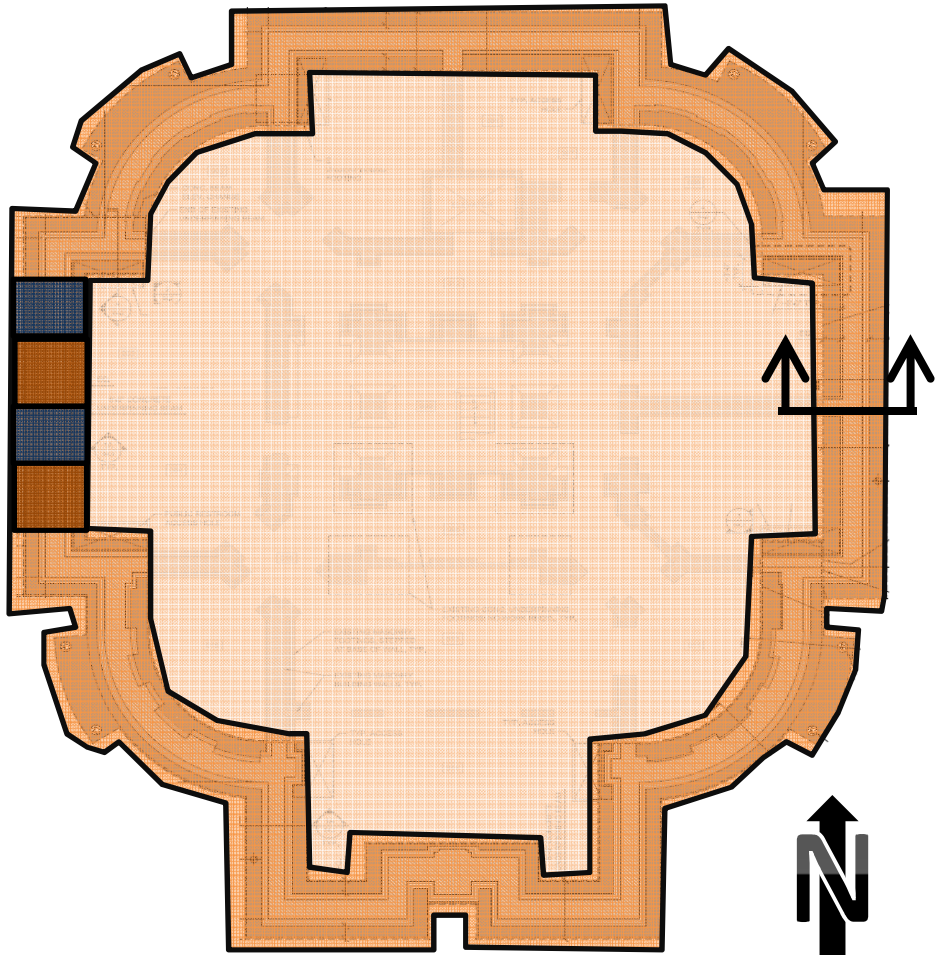
Perimeter Foundation

- Drilled Shafts
  - 25-Feet Deep
  - Load Transfer to Brittle Masonry Footing?
- Spread Footing
  - Continuously reinforced concrete footing
  - Resist local shrinking and swelling



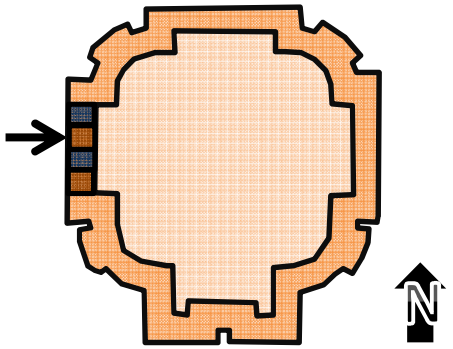
Continuous Spread Footing

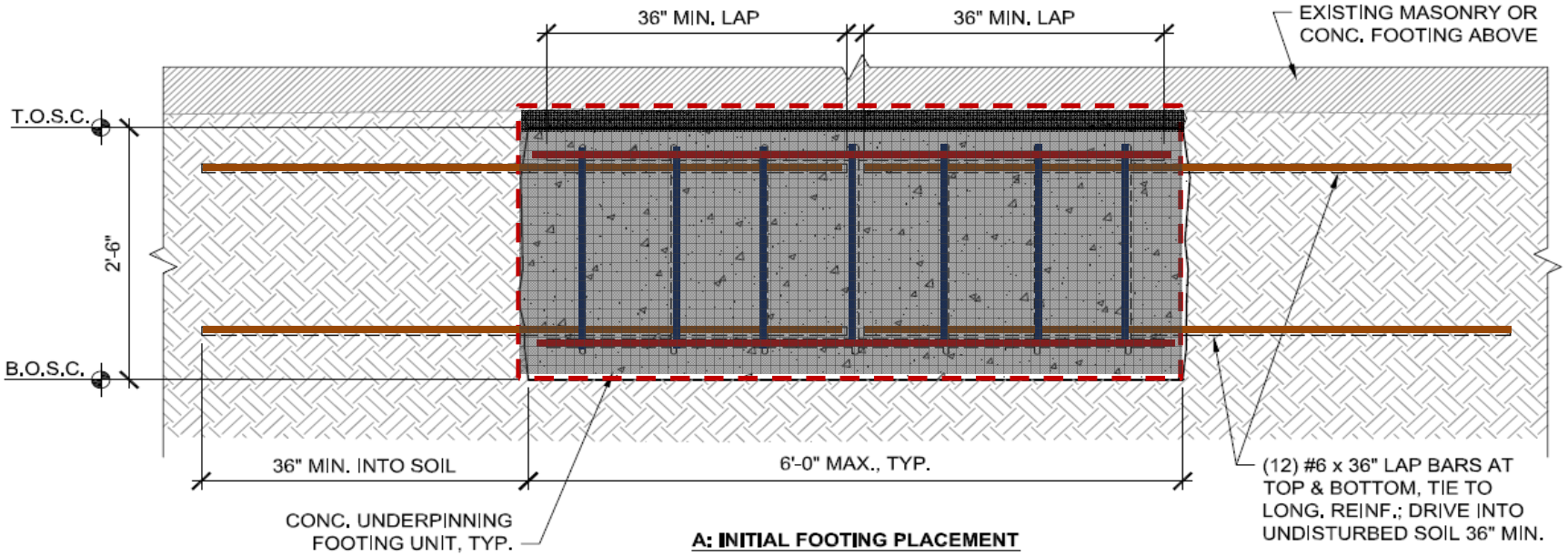




“Leg and Leg” Approach

Excavate →Dowels →Lap Reinforcement →Stirrups →Placement →Grout Strip





“Leg and Leg” Approach

Excavation

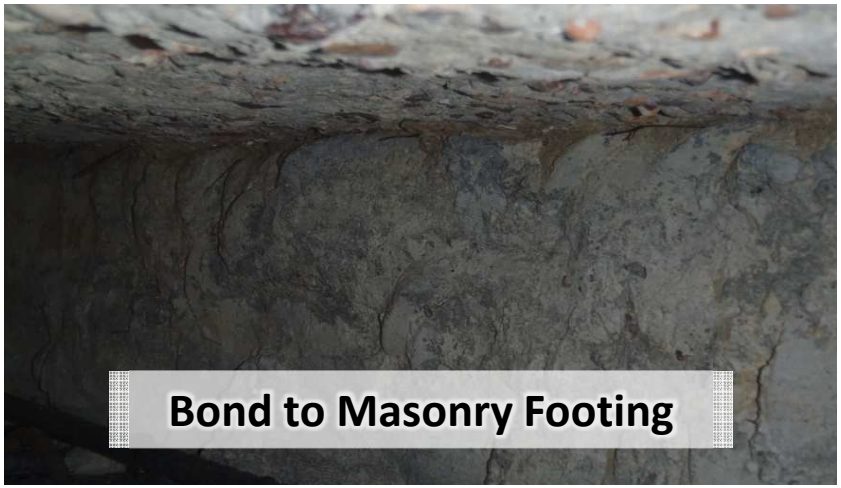
Underpinning Reinforcement

“Leg and Leg” Approach

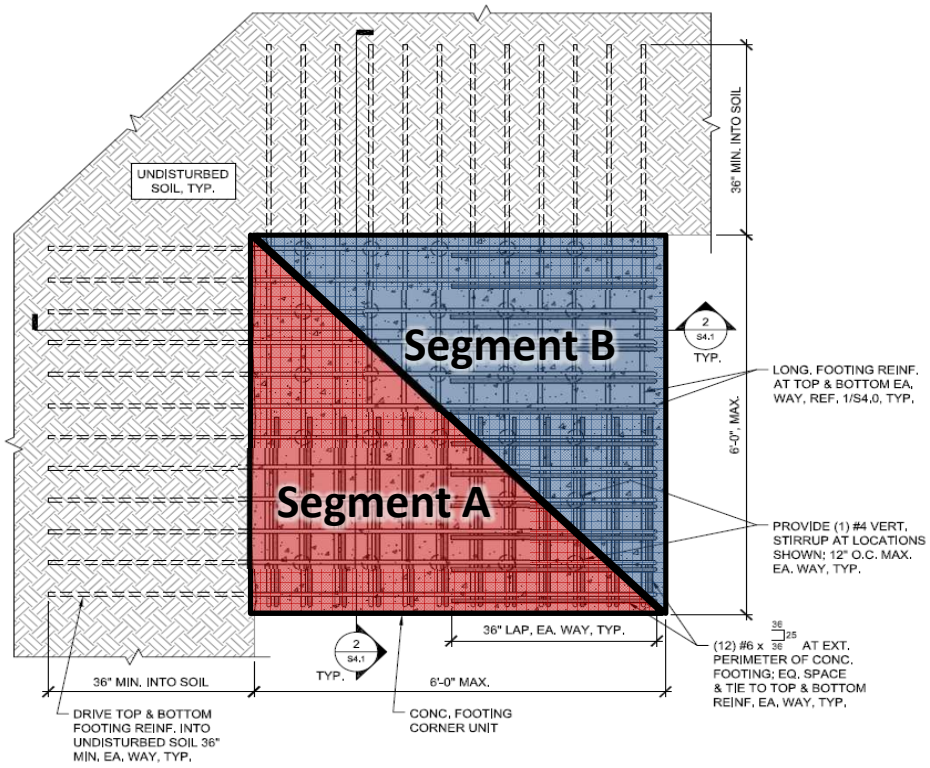
Cast Segments

Doweled Reinforcement

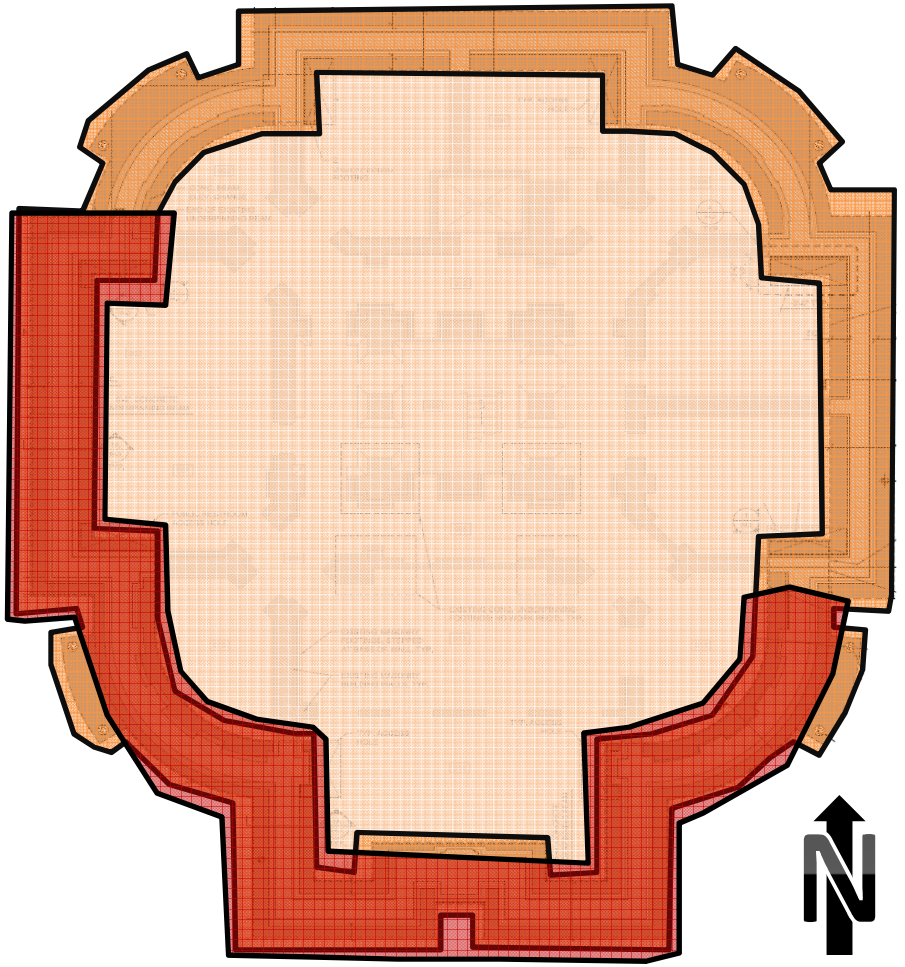
Grout Strip at Interface



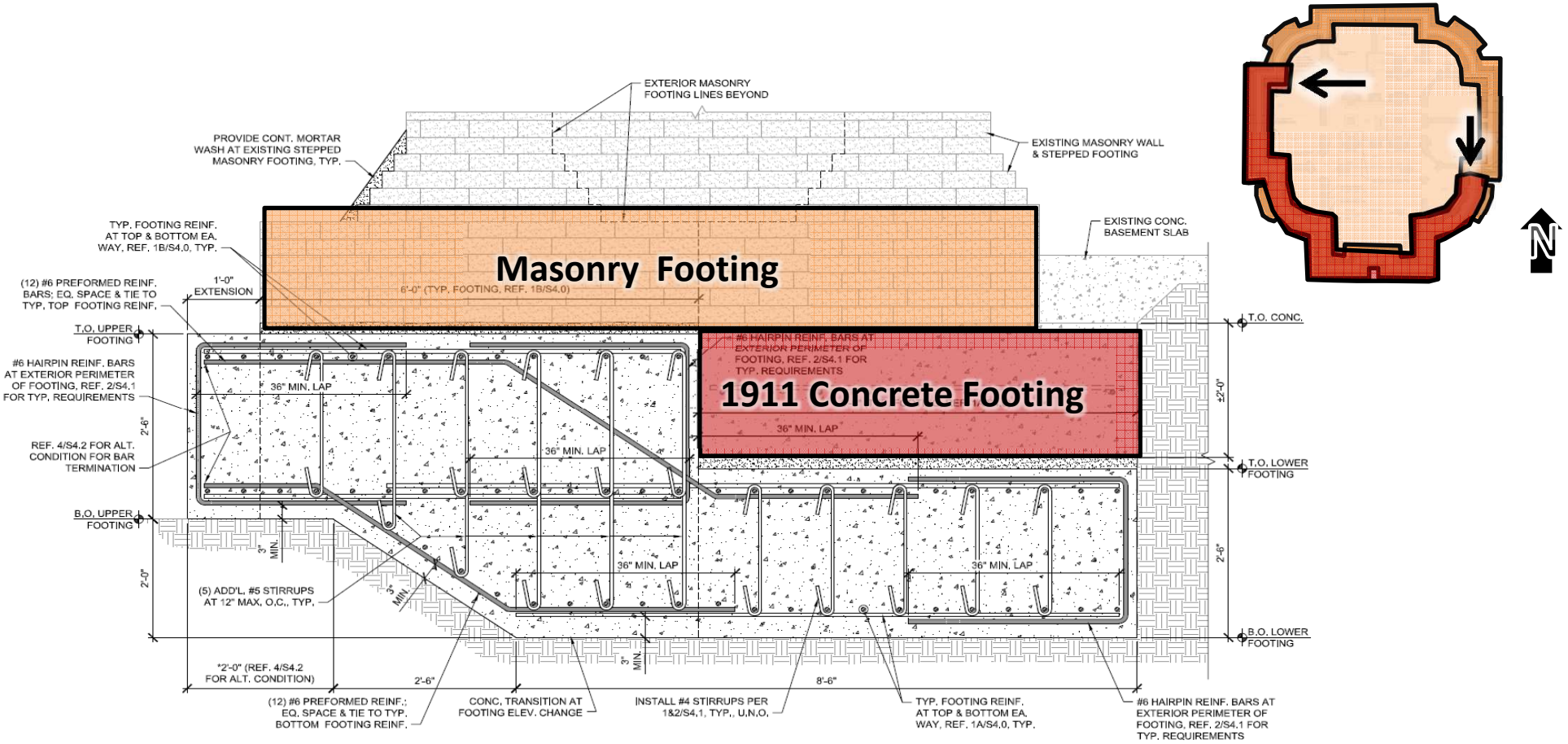
Exterior Corners



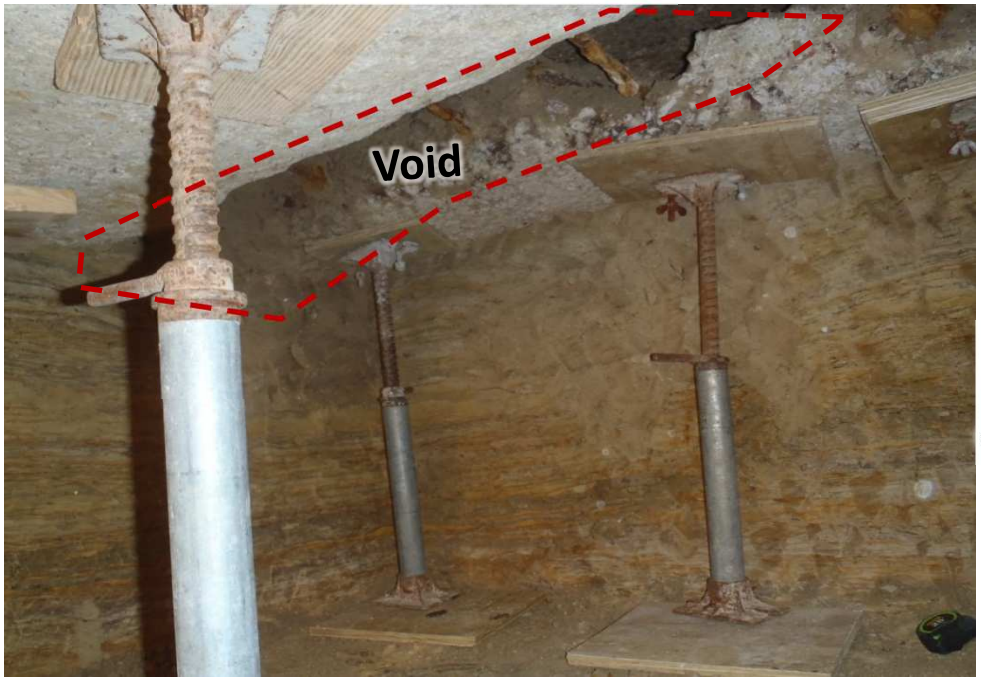
1911 Concrete Underpinning

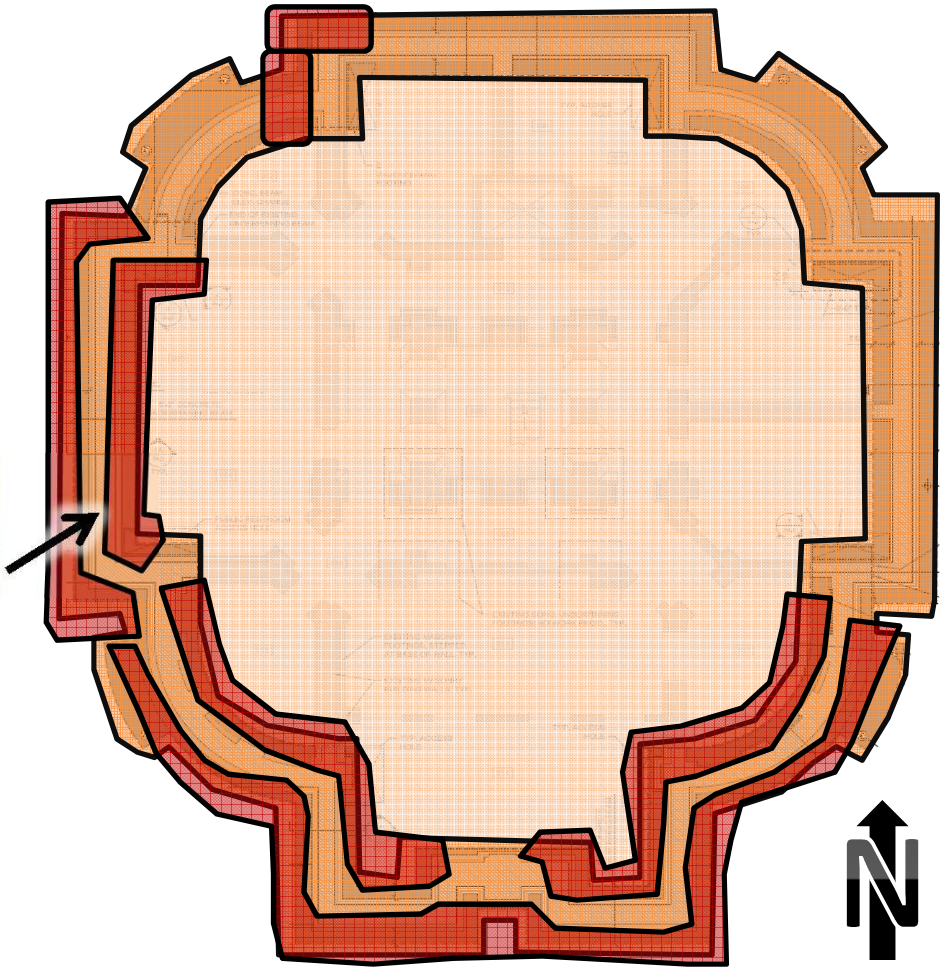


Step Transitions at 1911 Footing



Voids in 1911 Footing





Voids in 1911 Footing

Step Transitions at 1911 Footing

Step at curved portico

Step with voids

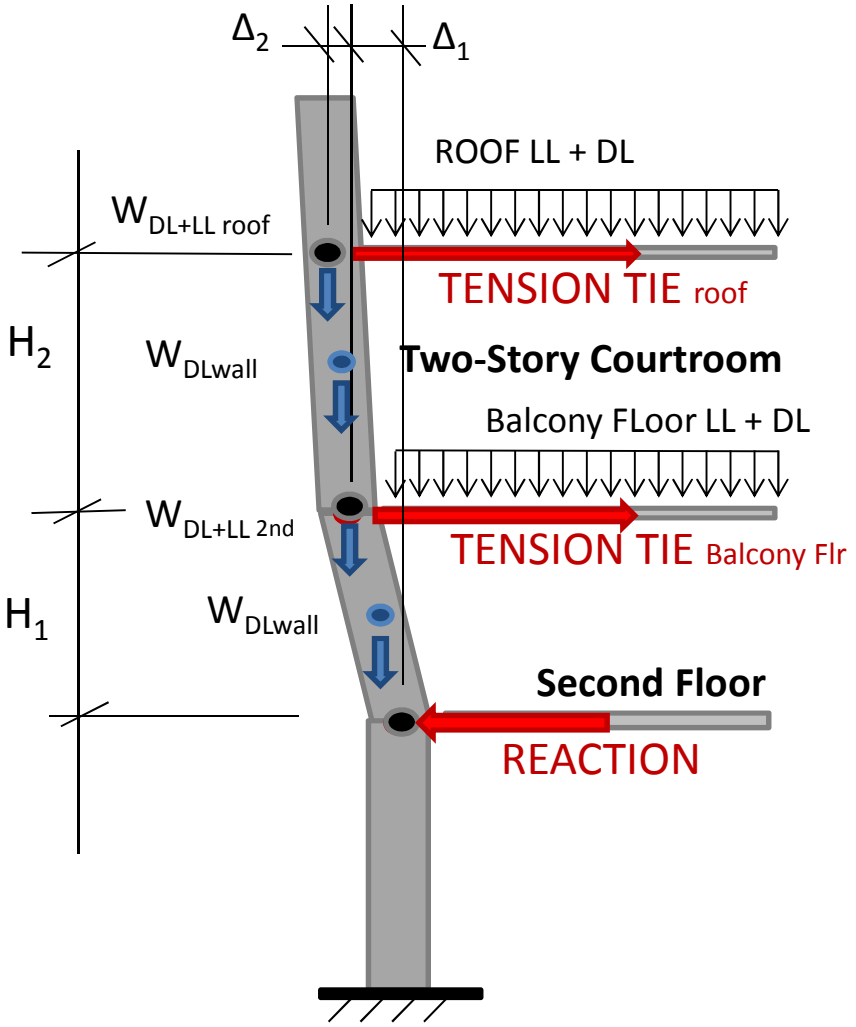
Exterior Corners

Shoring at Corner Segment

Corner Reinforcement

South Wall Stabilization - Design

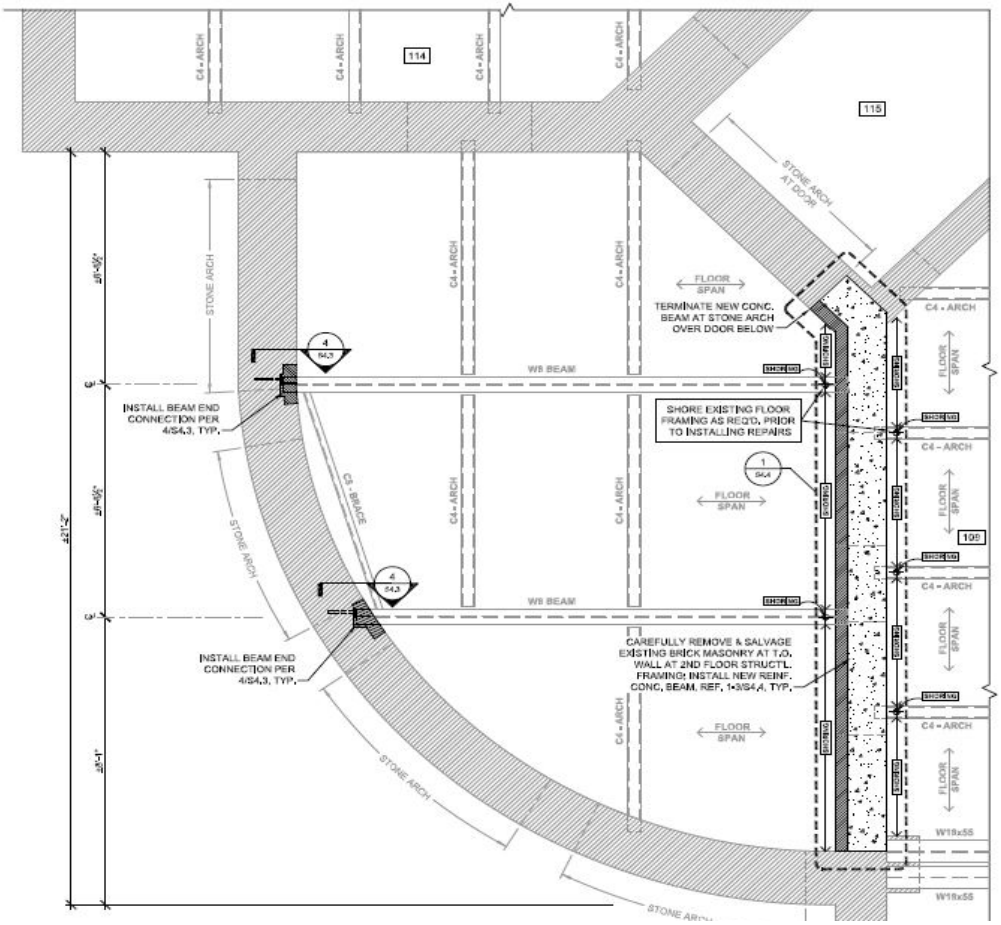
- Deflections / Lateral Load
- Mechanically Anchor Floor to Exterior Walls
  - Access to Main Elements (Core)
  - Locations – What Levels?

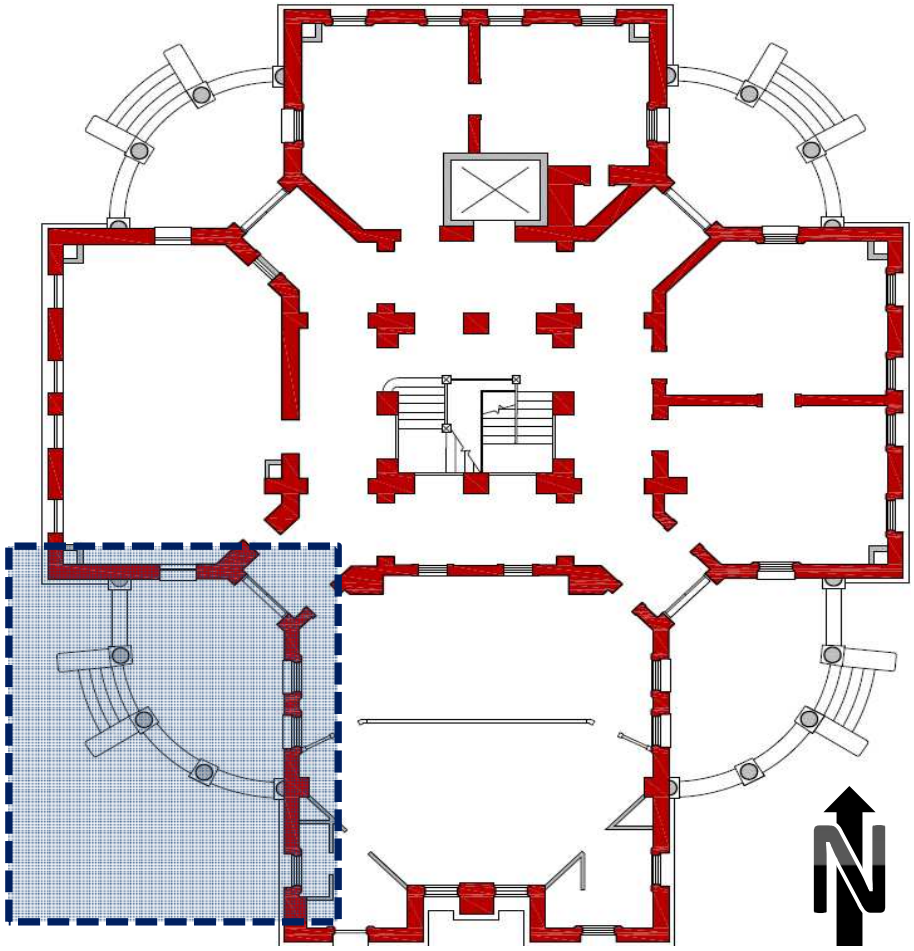


Tension Ties at Portico Walls?

- Need to Preserve Historic Finishes
- Want to Avoid Unsightly Repairs
- Steel Tie Rods with Plates or Straps?
- Steel Tie Rods Used at Upper Levels

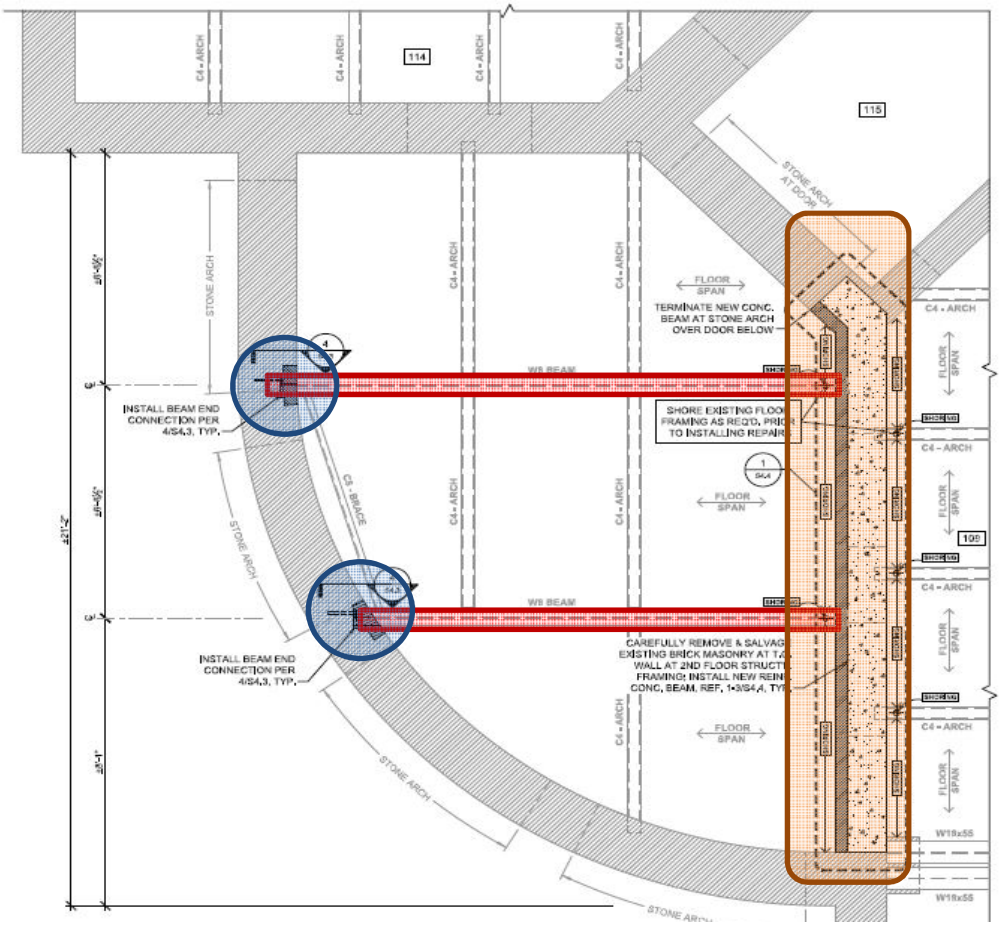
Portico Second Level





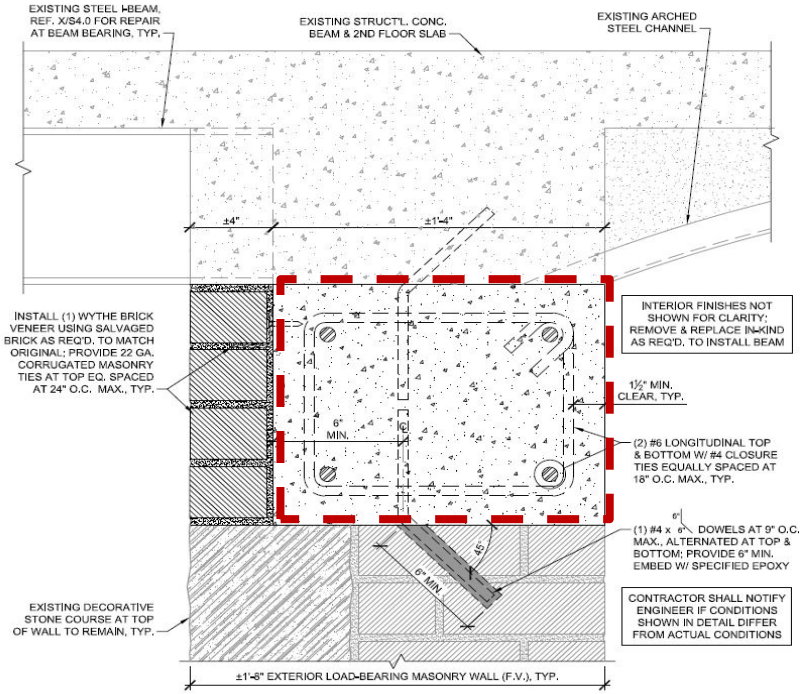
Background | Assessment | **Repair Approach** | Conclusions

Portico Roof Level

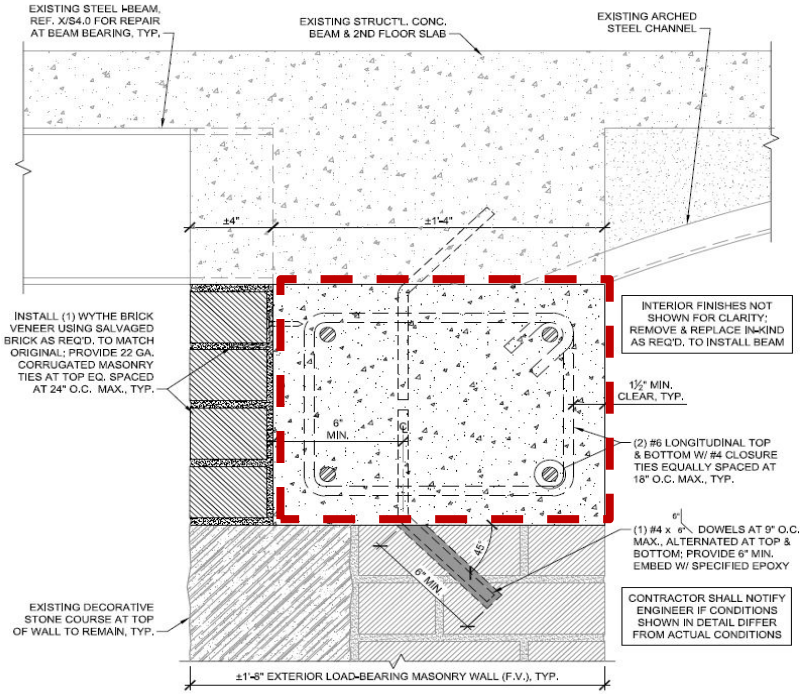


- **Use Existing Steel I-Shapes as Tension Ties**
- **Anchor to Exterior Wall**
- **Use Concrete Beam at Interior Wall**

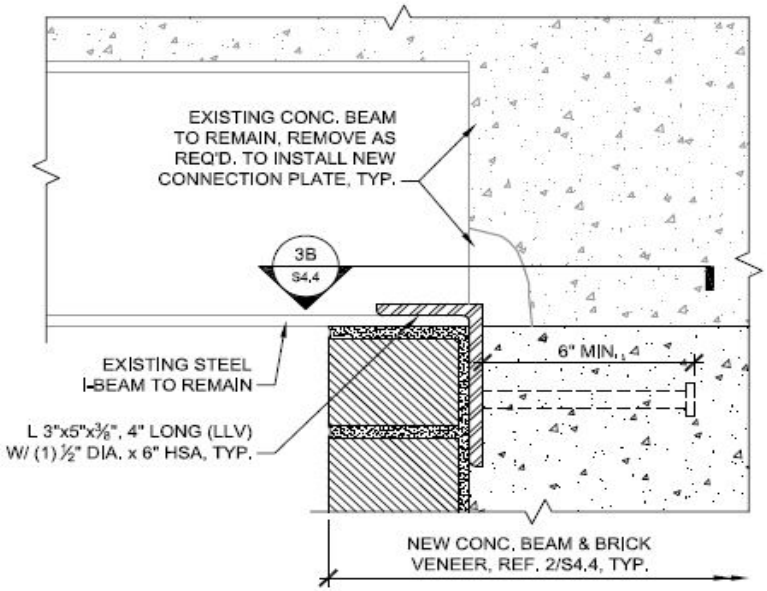
Concrete Beam at Interior Wall



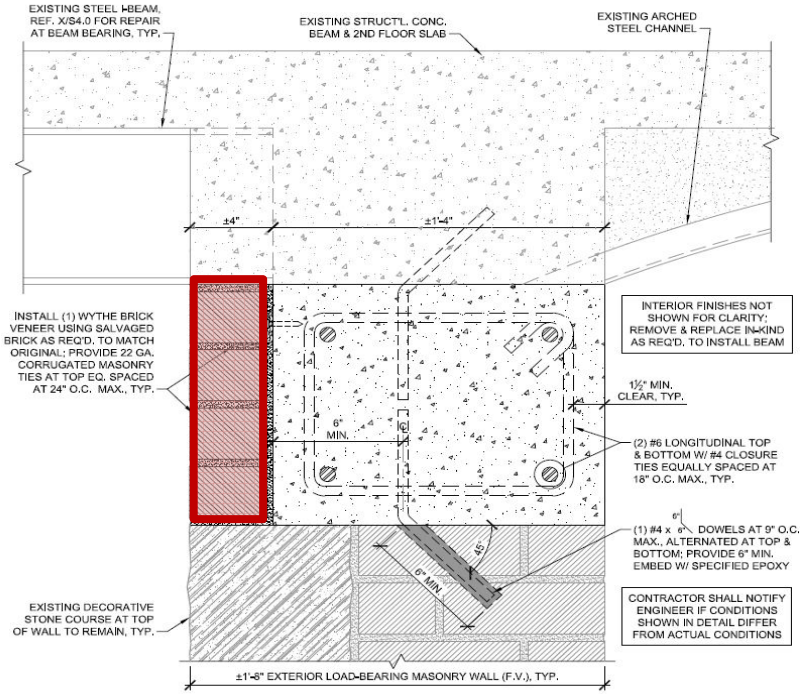
Concrete Beam at Interior Wall

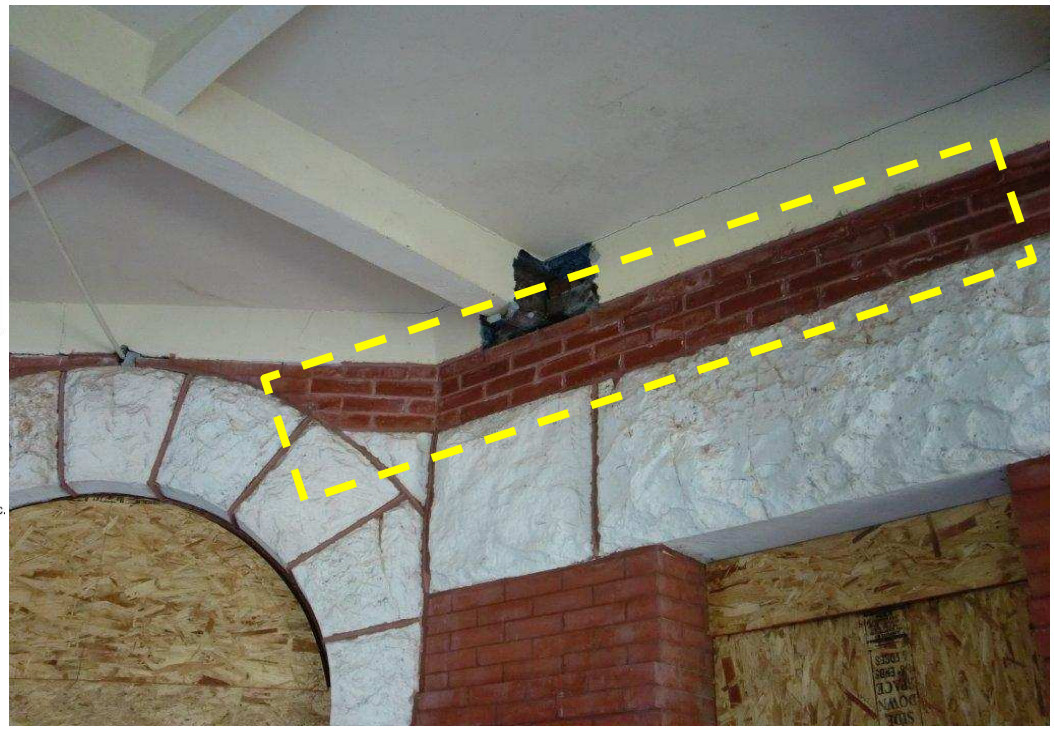


Portico Roof Level

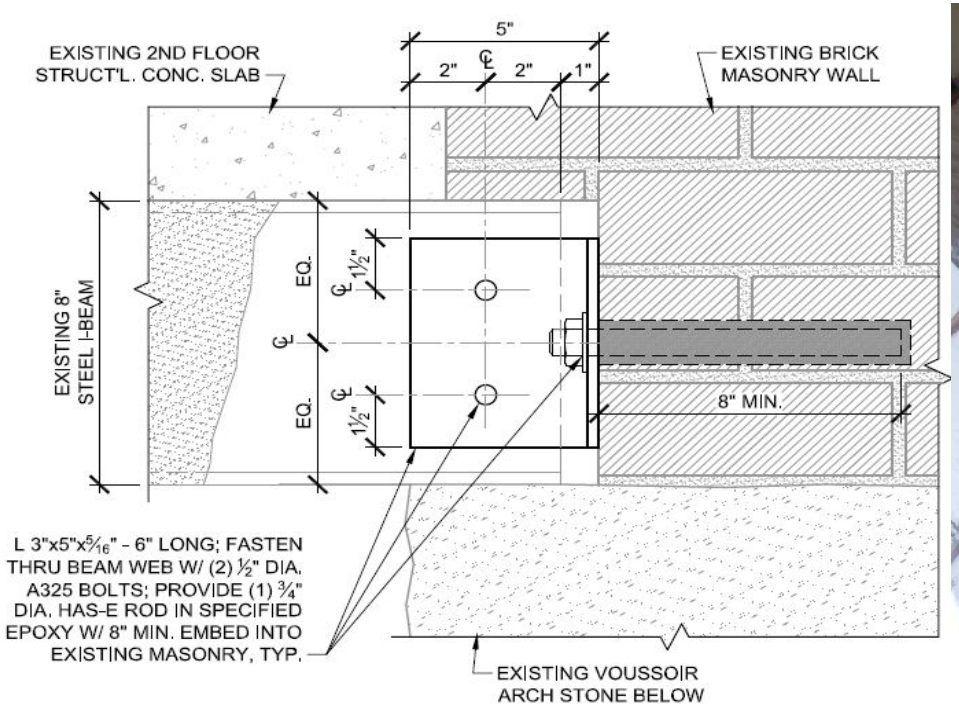


Portico Roof Level

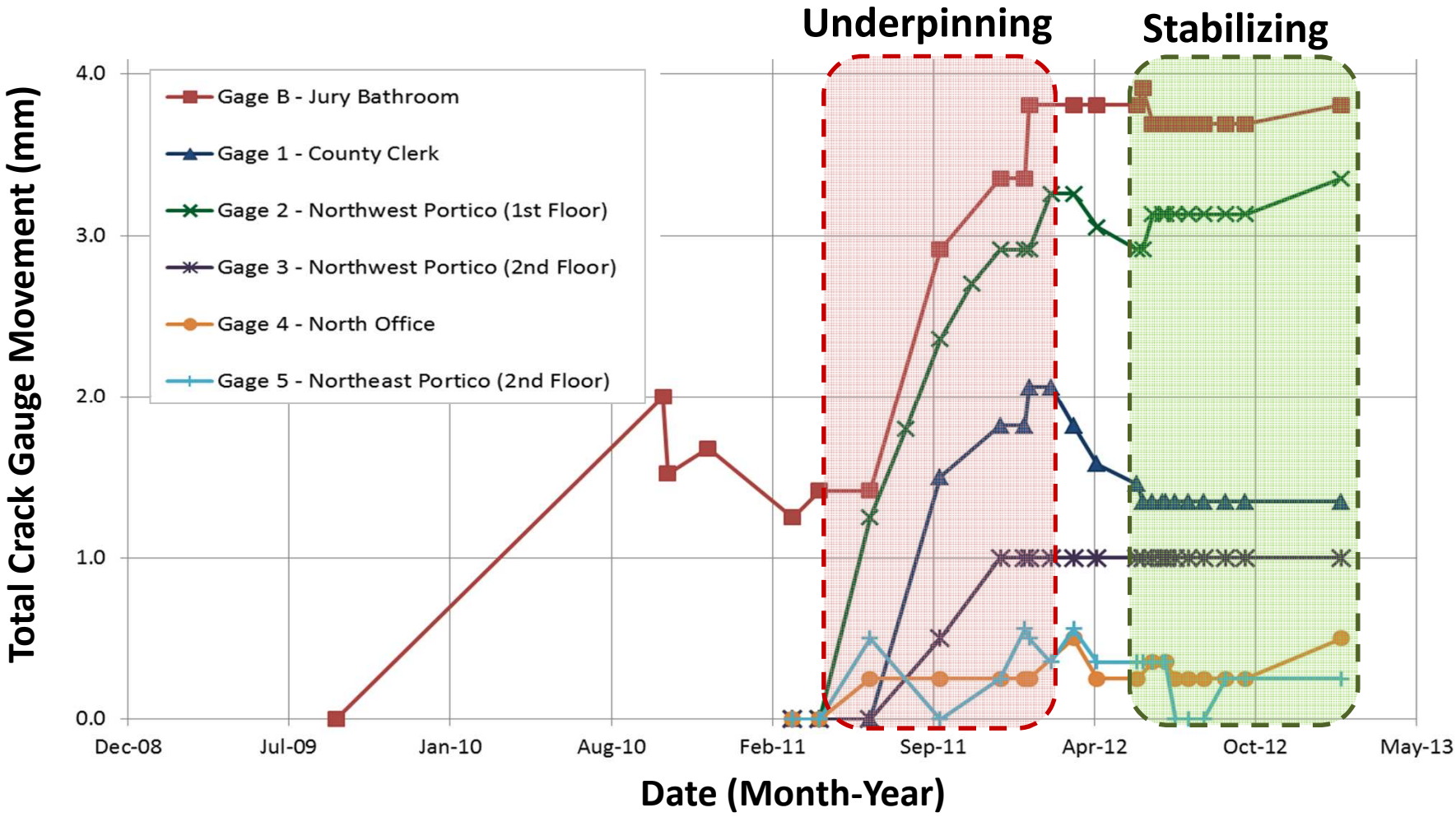




Portico Roof Level



Successful Stabilization?



Conclusions

- Concrete Provided Unique Benefits for Repair
- 1911 vs. 2011 Concrete Underpinning
- Integral Concrete Beam to Stabilize Wall