



Unique Solutions for Building Envelope Repair

Rachel Michelin, AIA, LEED AP BD+C

Thornton Tomasetti

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Unique Solutions for Building Envelope Repair

Agenda

- Speaker Introduction
- Review of envelope improvement concepts
- Case Study #1 – Rhodes Tower
- Case Study #2 – OSF Healthcare Administration Building
- Audience Q&A

Learning Objectives

At the end of the presentation, you will be able to:

- Identify real-life examples of various improvement strategies and will understand each strategy's potential energy impact
- Explain the benefits of performing advanced analytic modeling (such as hygro-thermal analysis)
- Recognize when building materials testing/sampling is necessary during envelope improvement projects.
- Understand alteration of the vapor drive within an exterior wall assembly, including the long-term repercussions of changes.

Speaker Introduction

Our Locations

5 Continents

1500 Engineers,
Architects, Scientists
and Professionals

+50 Offices

Projects in
54
Countries

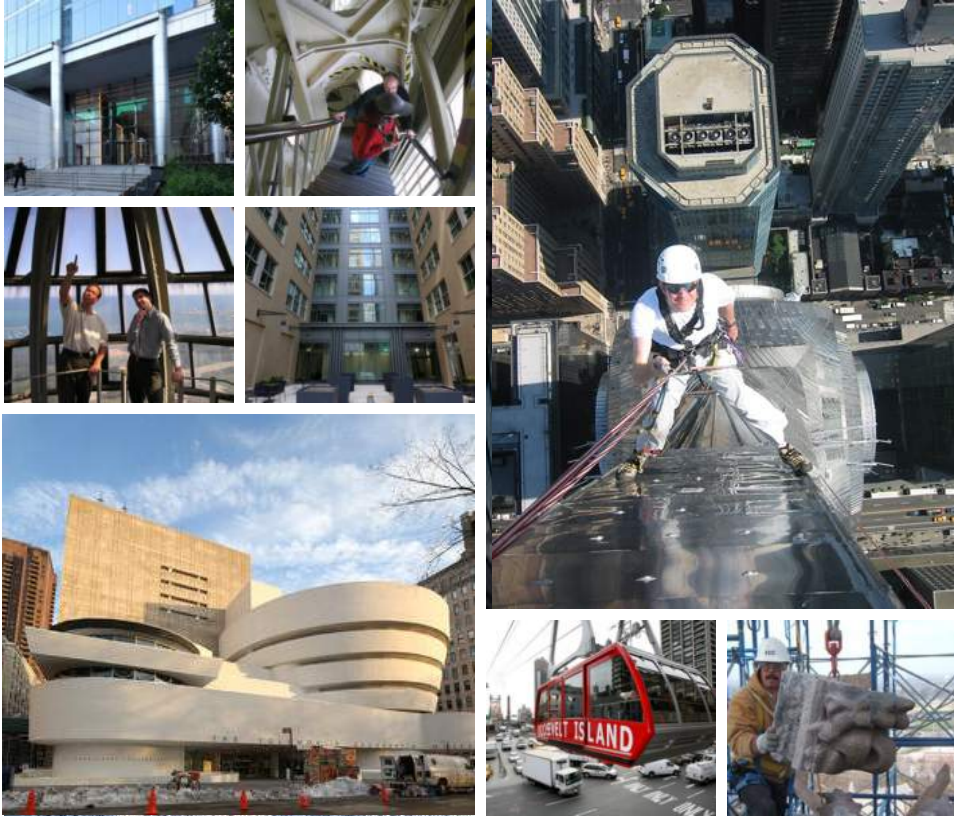
Albuquerque, New Mexico
Austin, Texas
Boston, Massachusetts
Chicago, Illinois
Cupertino, California
Dallas, Texas
Denver, Colorado
Ft. Lauderdale, Florida
Houston, Texas
Kansas City, Missouri
Los Angeles, California
Miami, Florida
Milwaukee, Wisconsin
Mississauga, CA
New York, Madison Ave /
Wall Street
Newark, New Jersey
Ottawa, CA
Phoenix, AZ
Philadelphia, Pennsylvania
Portland, Maine
San Diego, California
San Francisco, California
Seattle, Washington
São Paulo, Brazil
Tampa, Florida
Toronto, CA
Washington, D.C.
West Hartford, Connecticut



Aberdeen, UK
Ballymena, UK
Bristol, UK
Edinburgh, UK
London, UK (Head Office)
London, UK (PLC City Office)
London (Victoria), UK
Romsey, UK
Warrington, UK
York, UK
Moscow, Russia
Beijing, China
Hong Kong, China
Shanghai, China
Mumbai, India
UAE
Ho Chi Minh City, Vietnam
Perth, Australia
Wellington, New Zealand

Our Practices





Renewal Practice

Envelope Renewal
Structural Renewal
Advanced Analytics

Passionate About What We Do

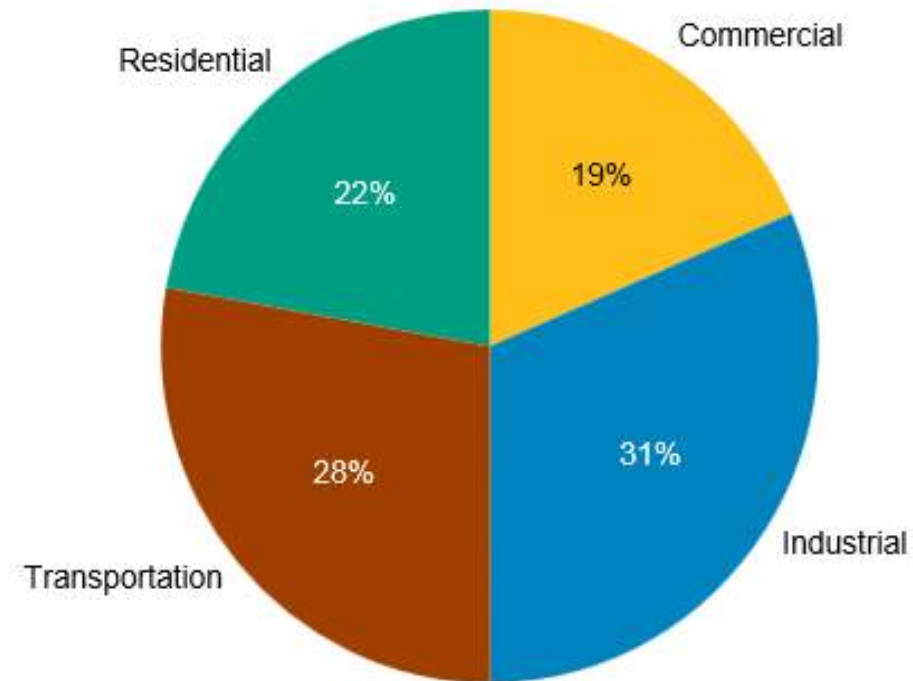
Hands-on professional technical staff throughout the life of the project



Building Envelope Concepts

Building Envelope Concepts

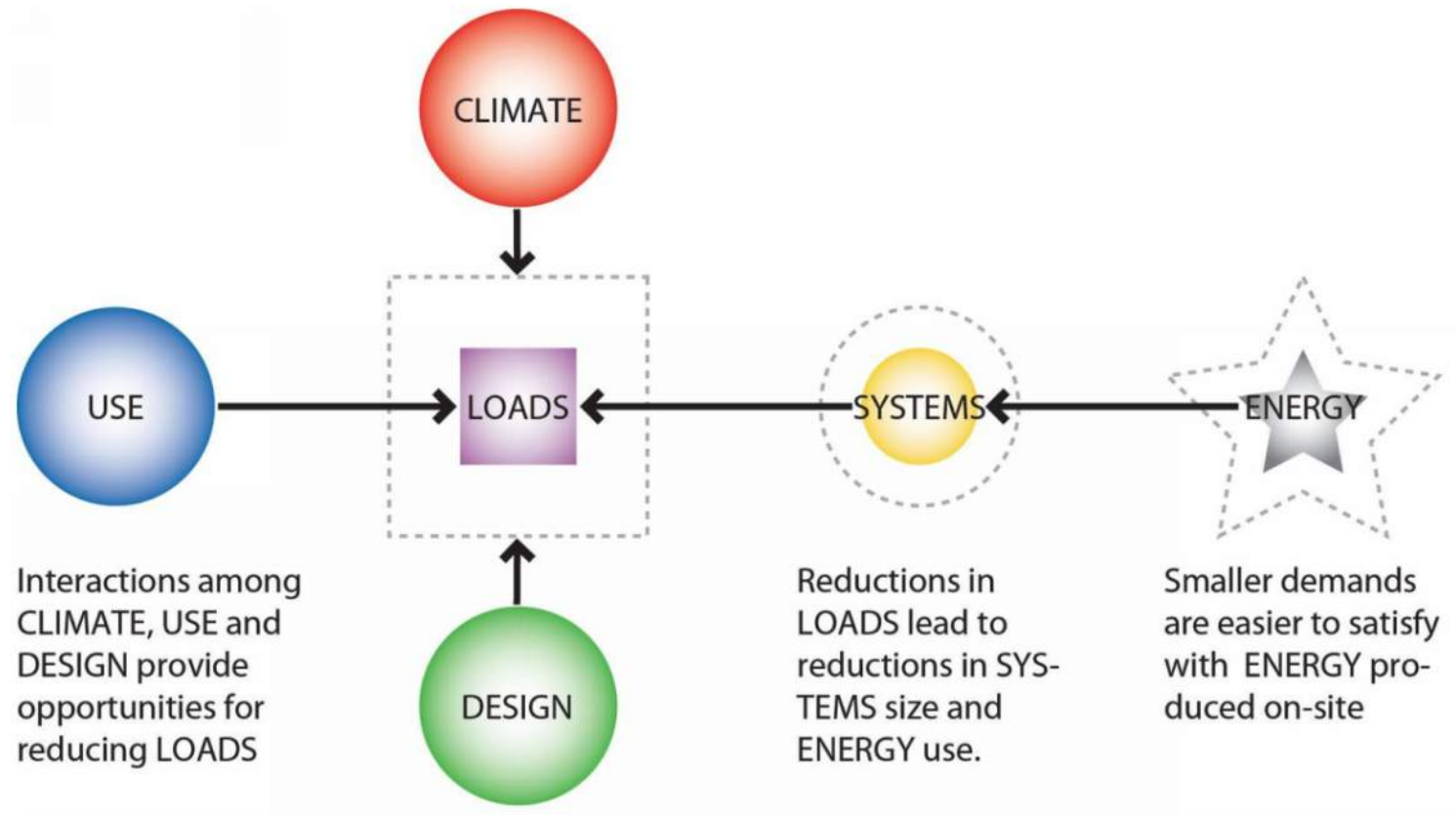
End-Use Sector Shares of Total Consumption, 2011



Source: U.S. Energy Information Administration: Annual Energy Review 2011 & State Energy Data System

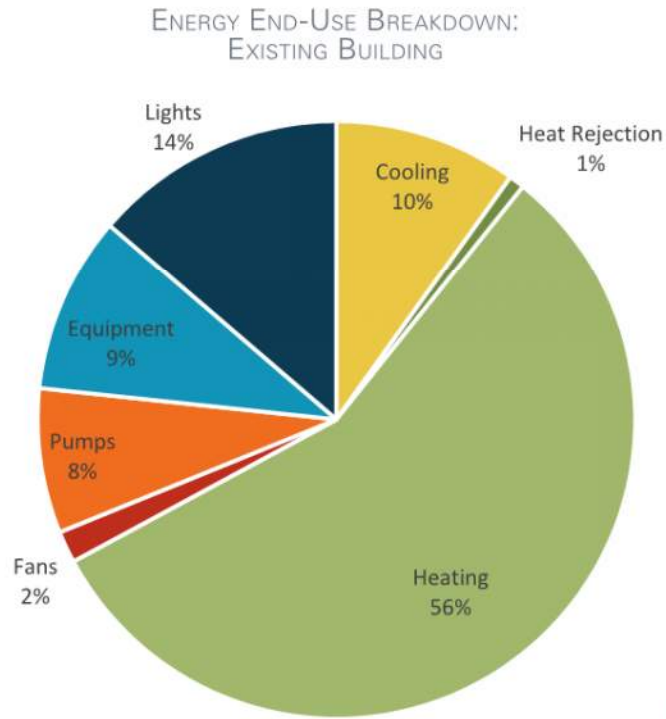
Building Envelope Concepts

COMPOUNDING ENERGY USE REDUCTION BY RIGHT-SIZING HVAC TO REDUCED HEATING AND COOLING LOAD

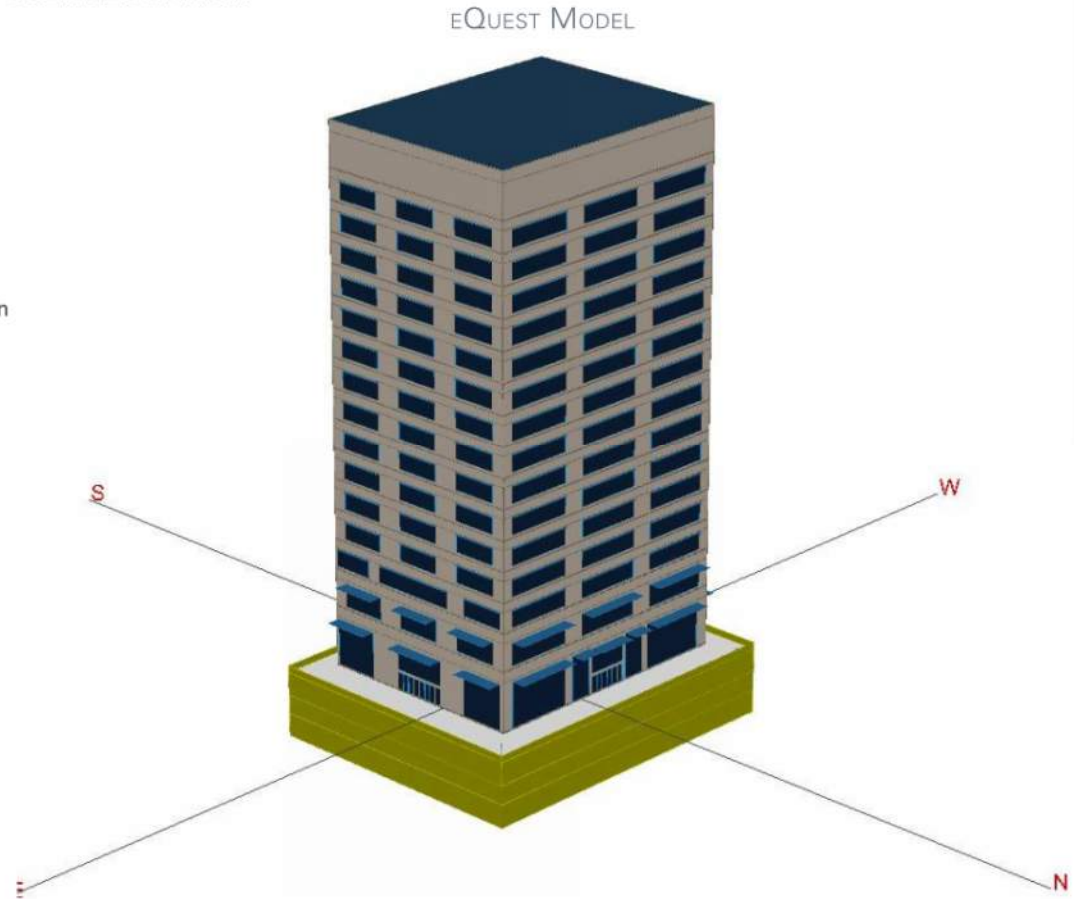


Building Envelope Concepts

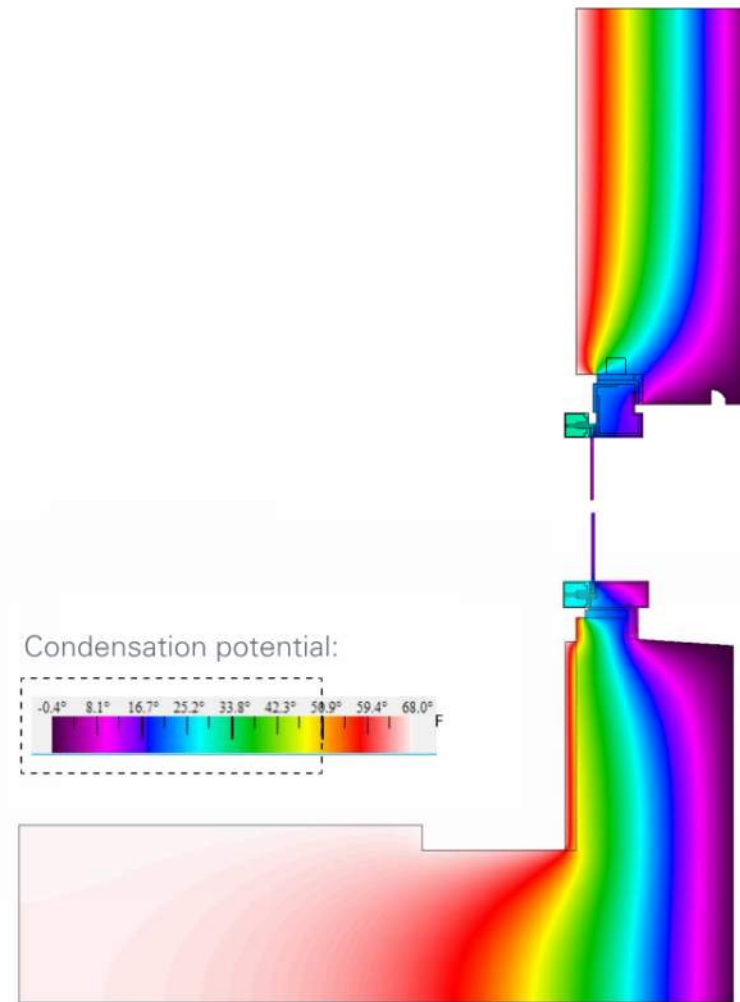
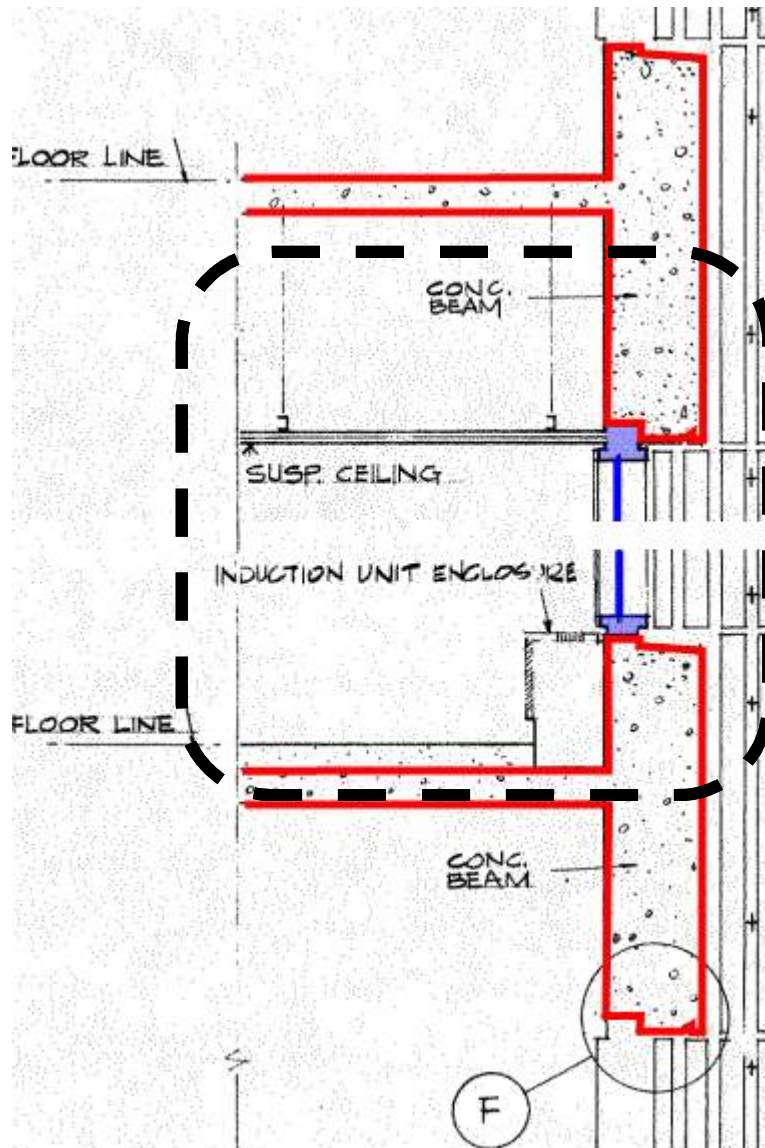
- EXISTING MODEL DEMONSTRATES ENERGY USE ALLOCATION



Note: These results are subject to change, as assumptions are based on limited knowledge of the existing design.



Building Envelope Concepts

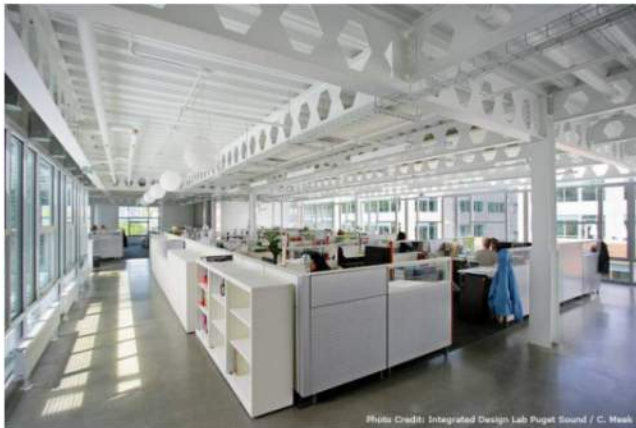


Building Envelope Concepts



EUI: 86 KBTU/SF-YR
EUI SAVINGS: 2%

Natural light has many benefits, including better occupant productivity and well-being. Incorporating daylight into office spaces has these positive impacts as well as decreased energy usage in both lighting and cooling. By implementing a lighting control system with daylighting sensors that dim or turn off electric lighting when illuminance levels are met with daylight alone can result in significant energy savings.



EUI: 75 KBTU/SF-YR
EUI SAVINGS: 15%

Typical office buildings from the mid-century era tend to have poor performing glass. By upgrading to high performance double or triple pane glass with low-E coatings, significant energy savings can be seen. In conjunction with the remainder of the envelope, high performance glass can greatly contribute to reducing loads on the building, leading to smaller mechanical equipment requirements. In addition, high performance glass can have a positive impact on thermal comfort and acoustics.



Building Envelope Concepts



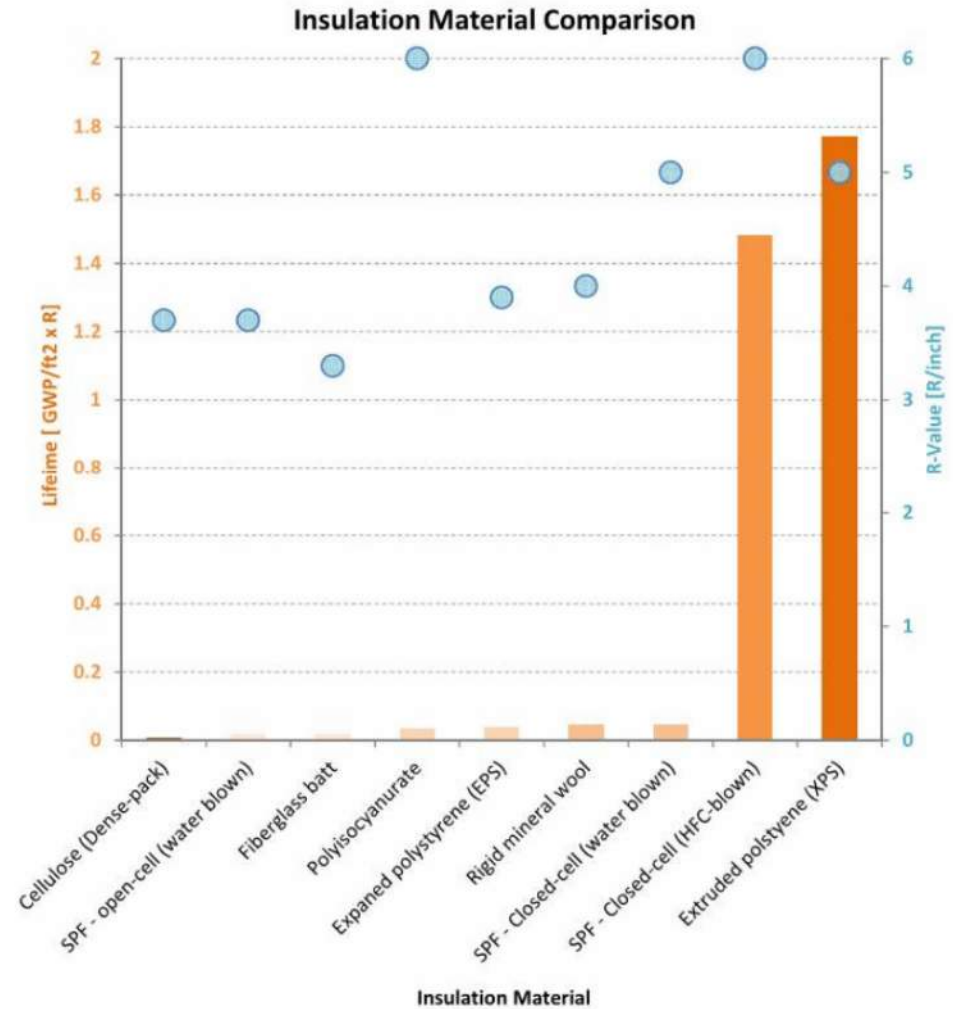
EUI: 75-80 KBTU/SF-YR

EUI SAVINGS: 10-15%

The addition of interior insulation can have large impacts on the performance of the envelope, leading to significant energy savings. TT generally recommends insulation with good environmental performance and low Global Warming Potential (GWP). A range of options could be considered and evaluated with hygrothermal and thermal analysis to determine the point of diminishing returns for the project.



Vi at Aventura, Aventura, FL



Building Envelope Concepts



EUI: 65 KBTU/SF-YR
EUI SAVINGS: 25%

Along with re-cladding, this option is the most extreme. A whole building approach could be taken, adding a second skin to provide a high performance insulative envelope. This option can be useful if normal operating hours are required during the renovation.



EUI: 65 KBTU/SF-YR
EUI SAVINGS: 25%

Along with overcladding, this option is the most extreme, requiring removal of the current envelope and providing a full facade replacement. However, with big risk comes big reward and this option can result in deep energy savings.



AJ Celebrezze Center Federal Building, Cleveland, OH

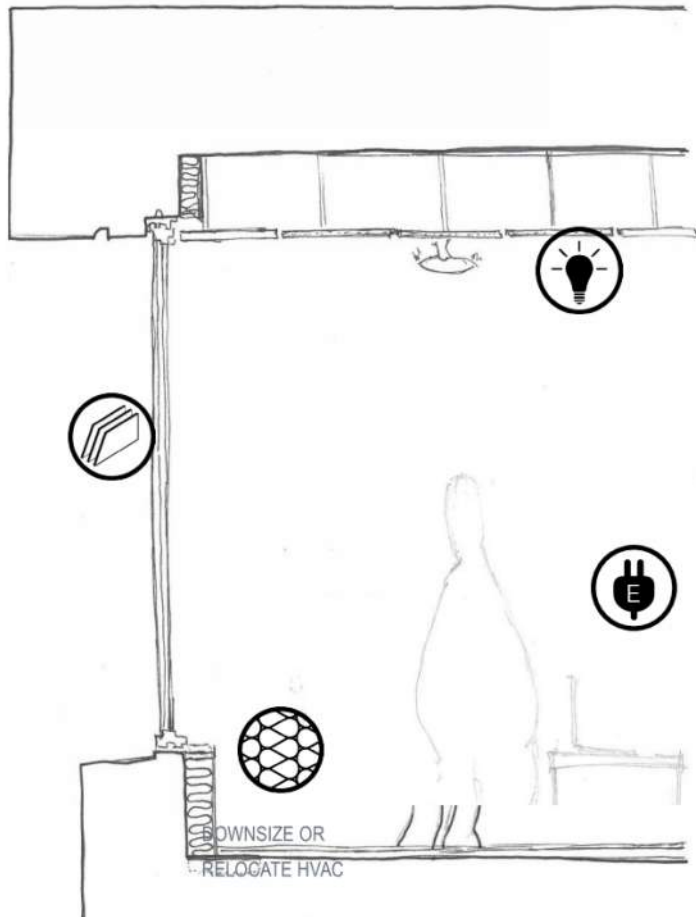


Hemingway House Condominiums, Chicago, IL

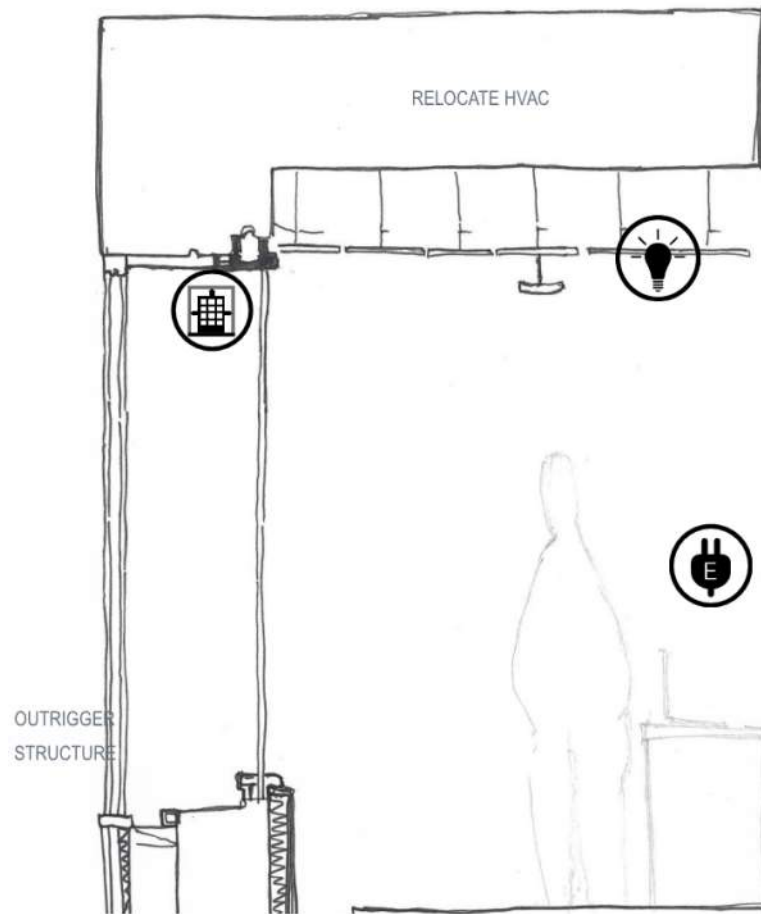


Building Envelope Concepts

- Option 1: Retrofit

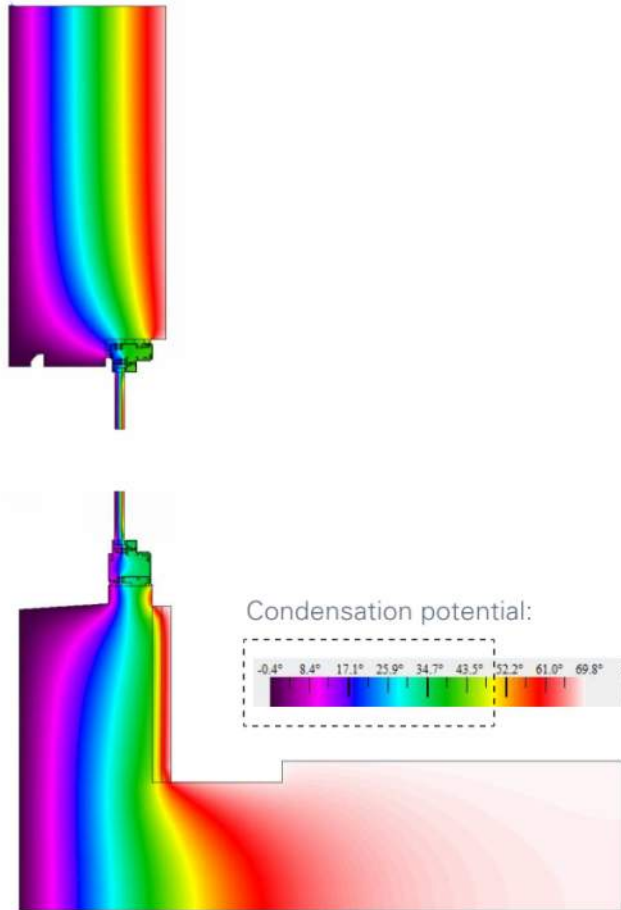


- Option 2: Overclad

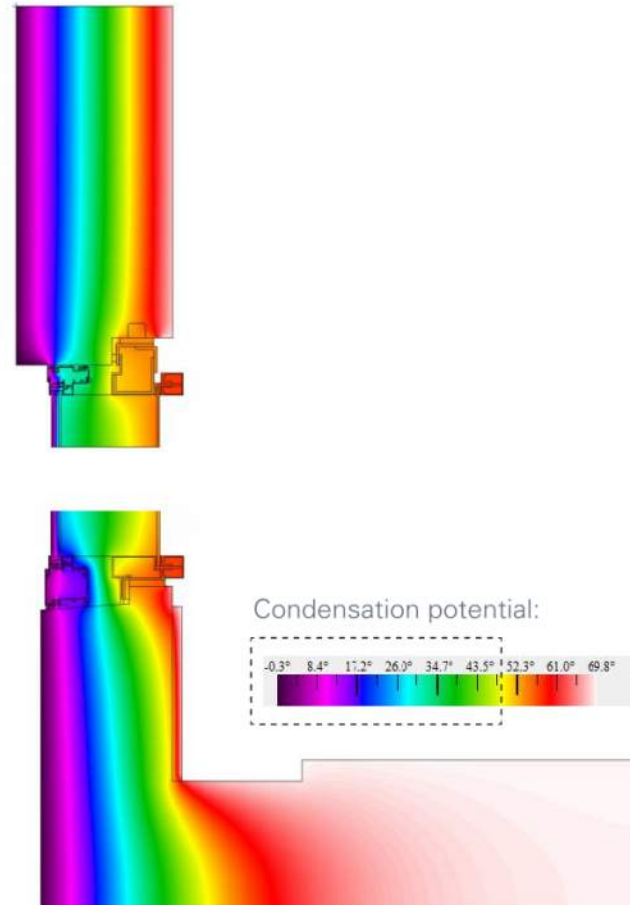


Building Envelope Concepts

- Option 1: Retrofit



- Option 2: Overclad



Case Study #1

Rhodes Tower

Rhodes Tower

Columbus, Ohio

- 44 Floors
- 1 Million Square Feet
- 2,400 State Employees
- Clad with granite and window wall system



Rhodes Tower

Columbus, Ohio

Two Primary Distresses



Granite Spalls



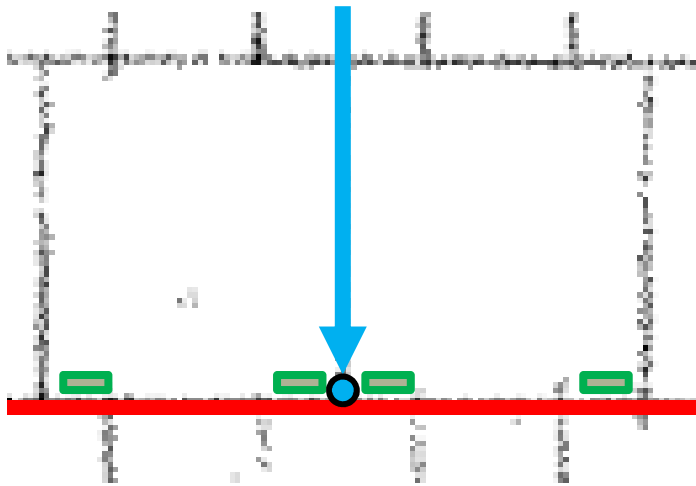
Water Infiltration at Windows

Rhodes Tower

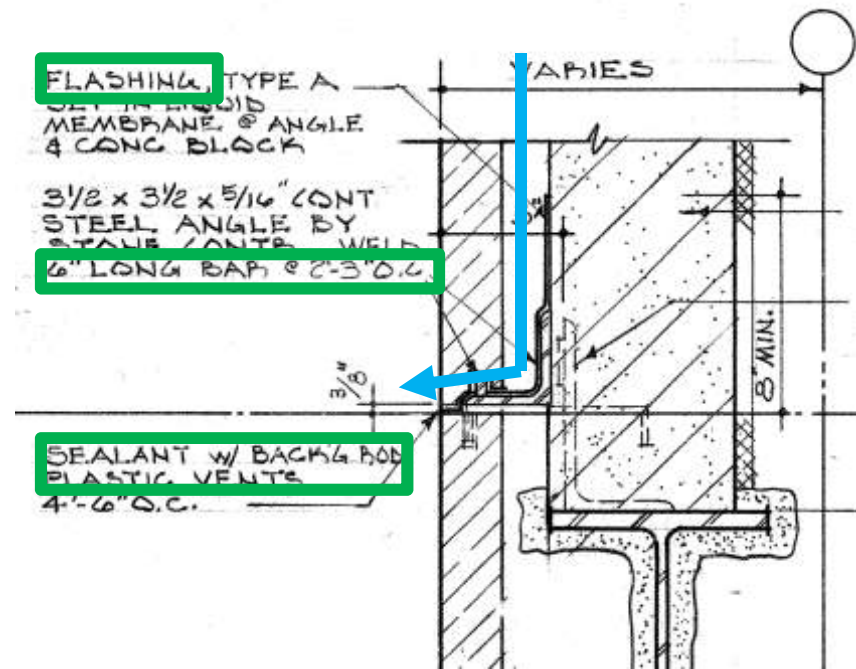
Columbus, Ohio

GRANITE

Analysis Investigation Restoration



Enlarged Elevation

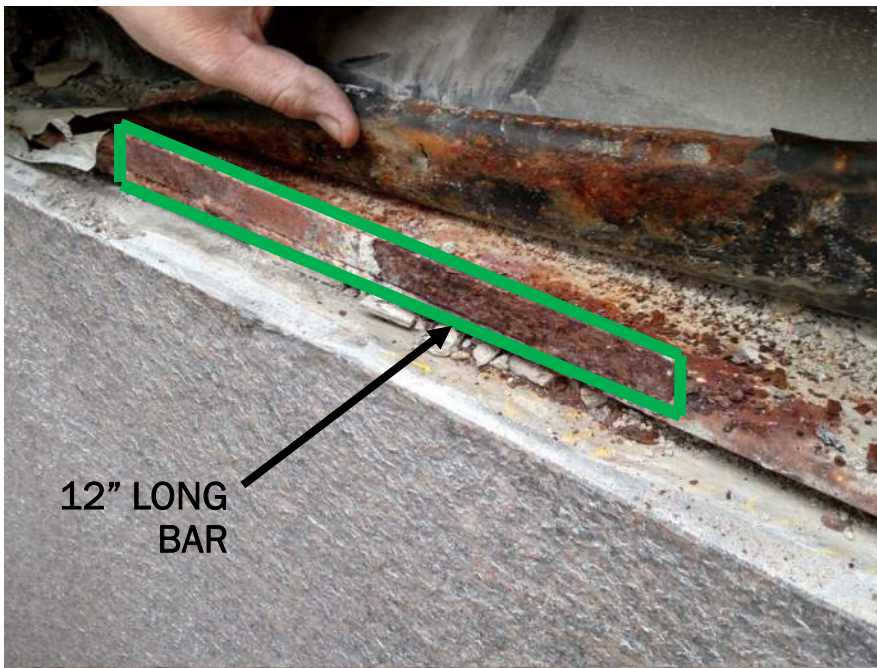


Section Detail

Rhodes Tower

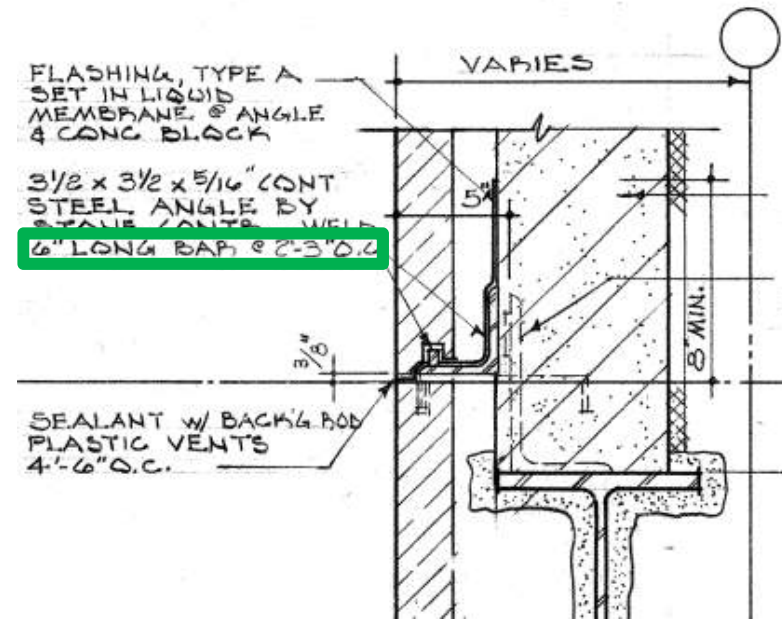
Columbus, Ohio

GRANITE



12" LONG
BAR

Analysis Investigation Restoration



Section Detail

Rhodes Tower

Columbus, Ohio

GRANITE

Analysis Investigation Restoration



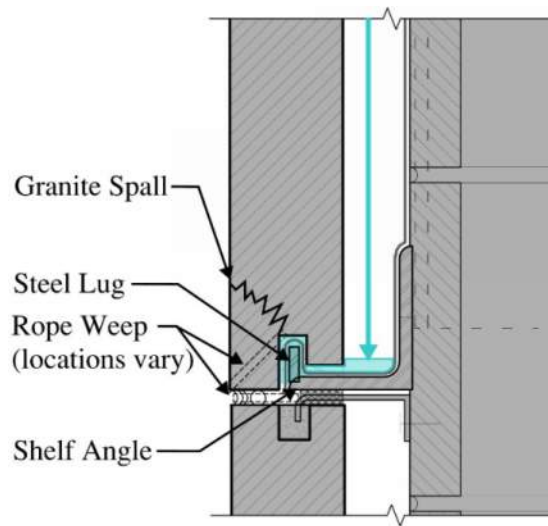
Design Assist - Mockup

Rhodes Tower

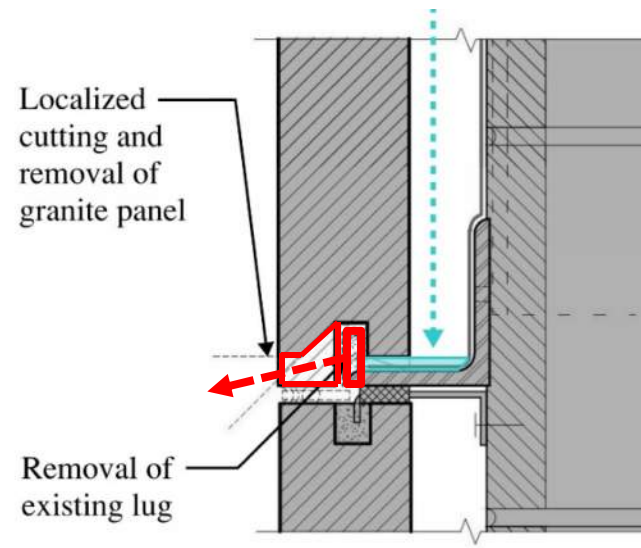
Columbus, Ohio

GRANITE

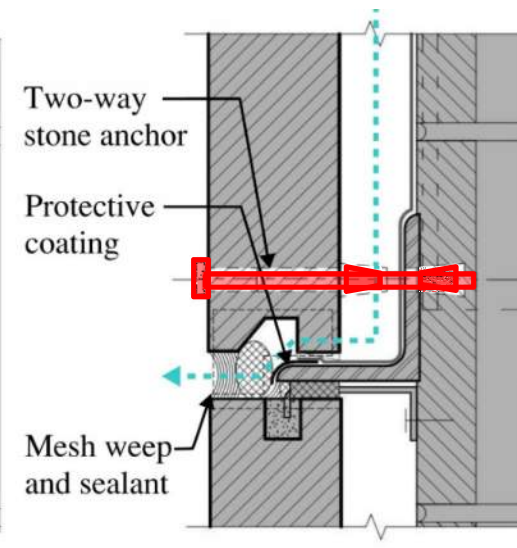
Analysis Investigation Restoration



Existing



Demolition



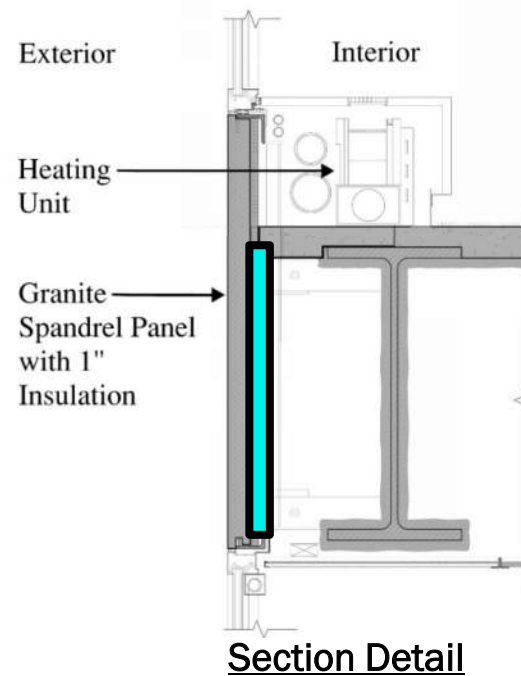
Repair

Repair Scheme

Rhodes Tower

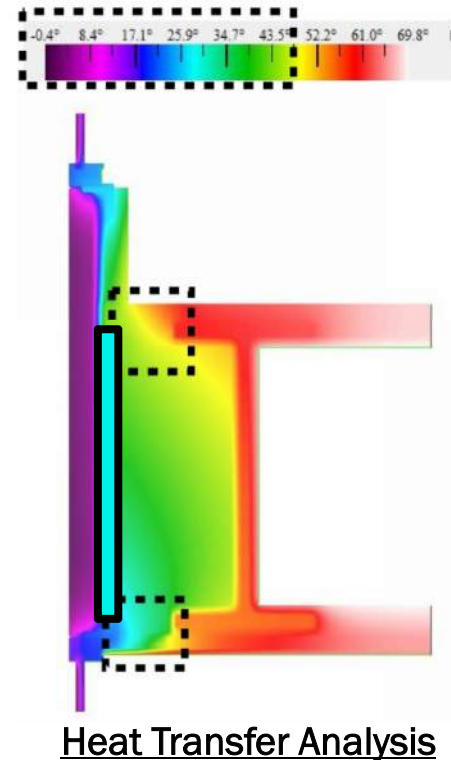
Columbus, Ohio

WINDOWS AND INSULATION



Analysis Investigation Restoration

Approximate area of possible condensation

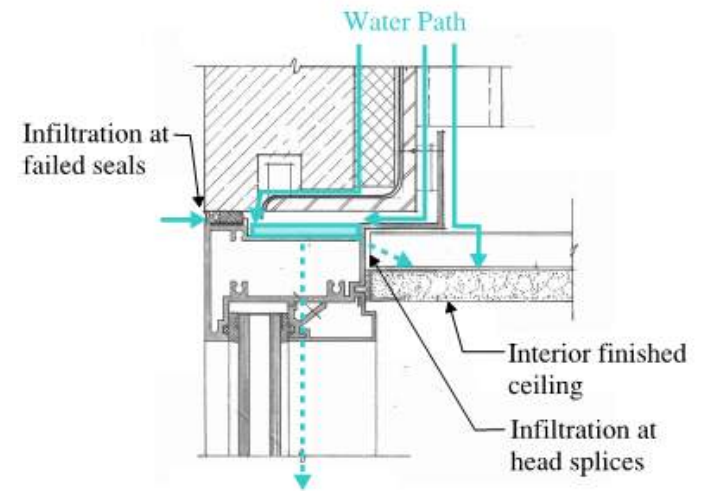


Rhodes Tower

Columbus, Ohio

WINDOWS AND INSULATION

Analysis Investigation Restoration



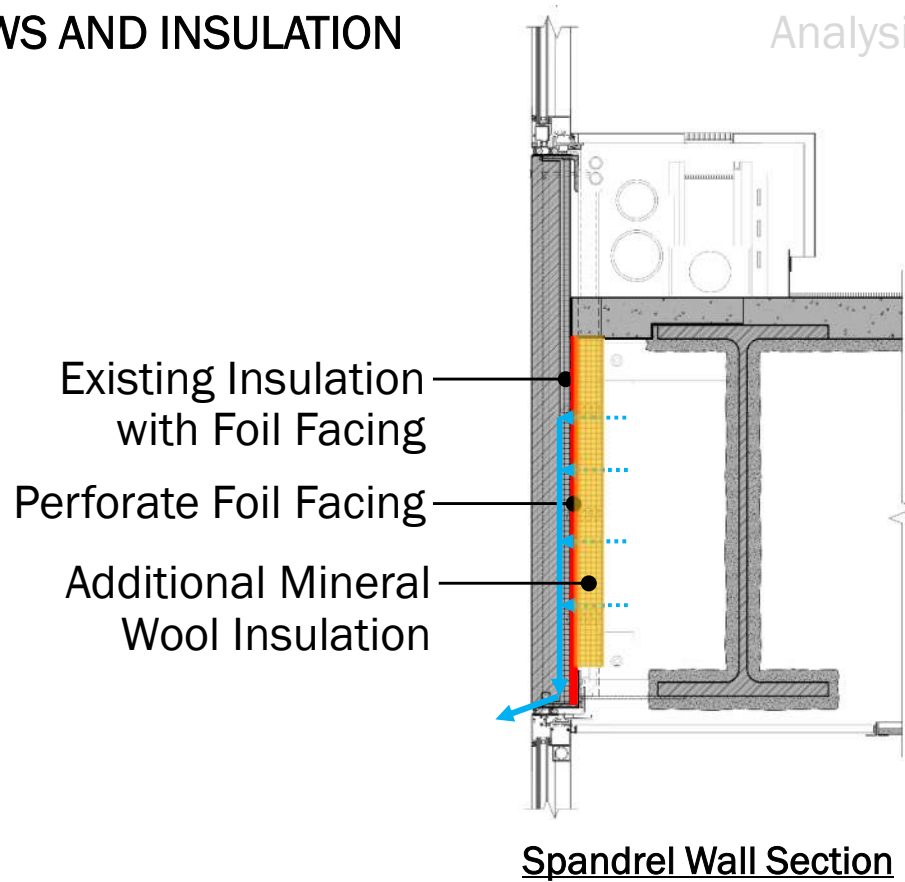
Head Detail

Rhodes Tower

Columbus, Ohio

WINDOWS AND INSULATION

Analysis Investigation Restoration

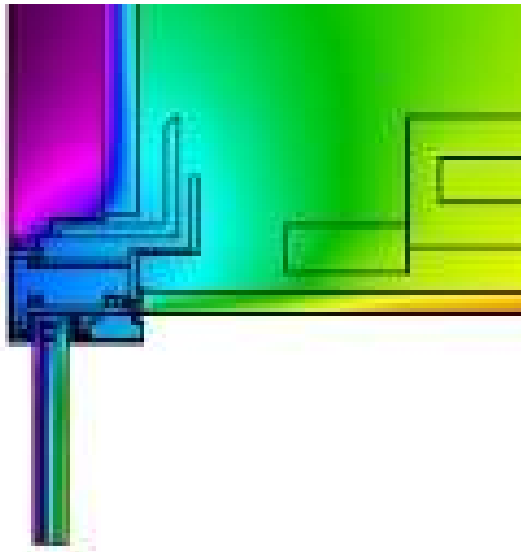
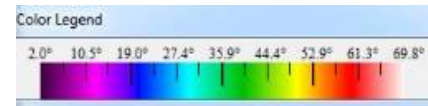


Rhodes Tower

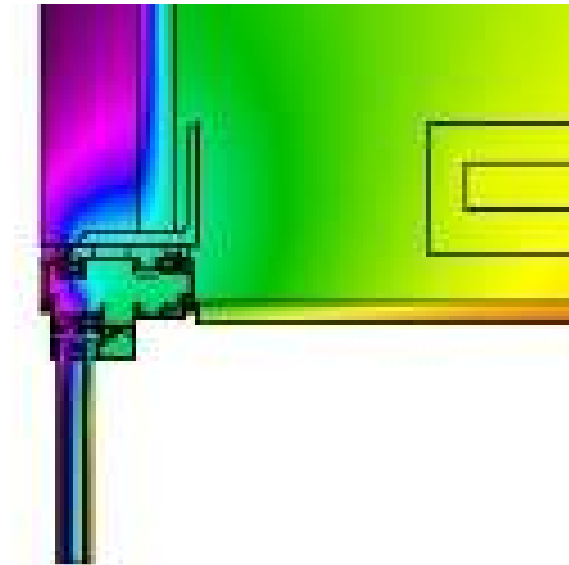
Columbus, Ohio

WINDOWS AND INSULATION

Analysis Investigation Restoration



Existing Windows



New Windows

Case Study #2

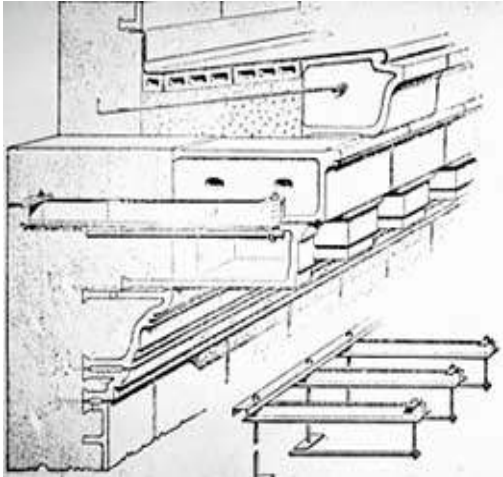
OSF Healthcare Administration Building

OSF Healthcare Administration Building

Peoria, Illinois



Circa 1914. Image courtesy of Peoria Public Library, Peoria, Illinois



OSF Healthcare Administration Building

Peoria, Illinois



OSF Healthcare Administration Building

Peoria, Illinois

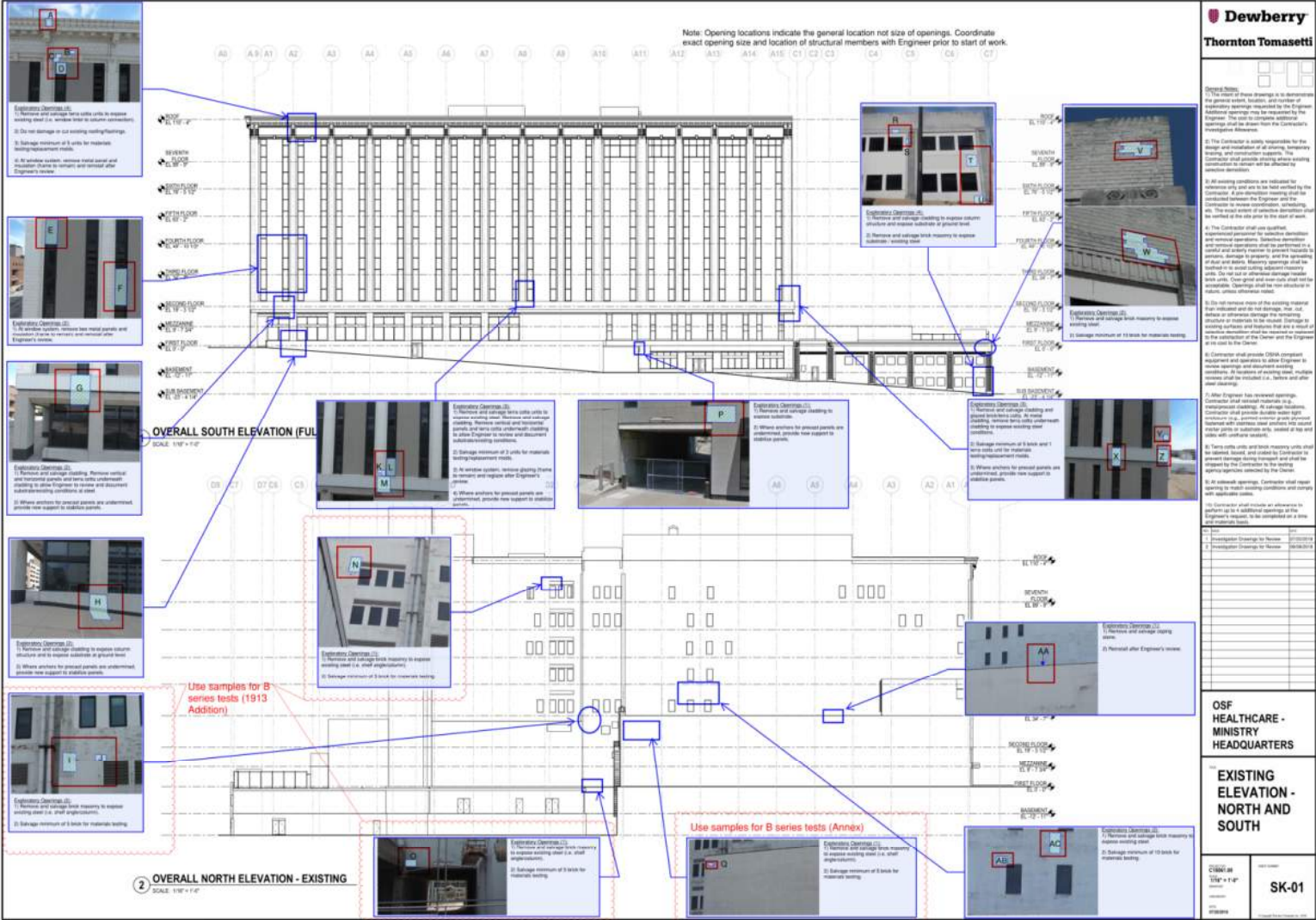
PROCESS

- Investigation (Drone, Laser scan, hands-on review)
- Research/Testing
- Assessment/Analysis
- Repair documents



OSF Healthcare Administration Building

Peoria, Illinois



Dewberry
Thornton Tomasetti

Open Notes:
 1) The intent of these drawings is to determine the general extent, location, and quantity of existing openings in the building. Additional openings may be requested by the Engineer. The size of complete additional openings shall be shown from the Contractor's knowledge of the building.

2) The Contractor is solely responsible for the design and installation of all openings, including framing, and construction supports. The Contractor shall provide framing where existing construction is removed or affected by opening installation.

3) All existing conditions are indicated for reference only and are to be field verified by the Contractor. A pre-demolition meeting shall be conducted between the Engineer and the Contractor. The intent of pre-demolition meeting shall be to coordinate the work to be done.

4) The Contractor shall use qualified, experienced personnel for selective demolition and removal operations. Selective demolition is a careful and orderly removal to prevent hazards to persons, damage to property, and the spreading of dust and debris. Mastery openings shall be finished to meet existing appearance requirements. Do not use an alternative damage made brick units. Clean up and over haul shall not be allowed. Changes shall be noted on the structure in nature, unless otherwise noted.

5) Do not remove tops of the existing exterior floor joist and do not damage the roof, gutters or other exterior finish. The existing structure of exterior finish shall be removed and replaced with new exterior finish. The Contractor shall provide exterior finish to match existing conditions. As locations of existing steel, multiple openings shall be indicated on, before and after opening.

6) After Engineer has received opening-enclosure drawings, if a change is required, the Contractor shall provide drawings to the Engineer for review. The Contractor shall provide drawings to the Engineer for review. The Contractor shall provide drawings to the Engineer for review. The Contractor shall provide drawings to the Engineer for review.

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OSF Healthcare Administration Building

Peoria, Illinois



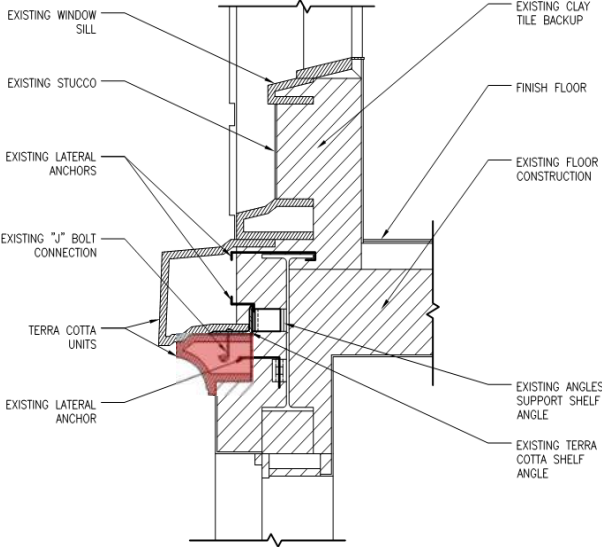
Examples of Terra Cotta Repairs

Unit repair/coating

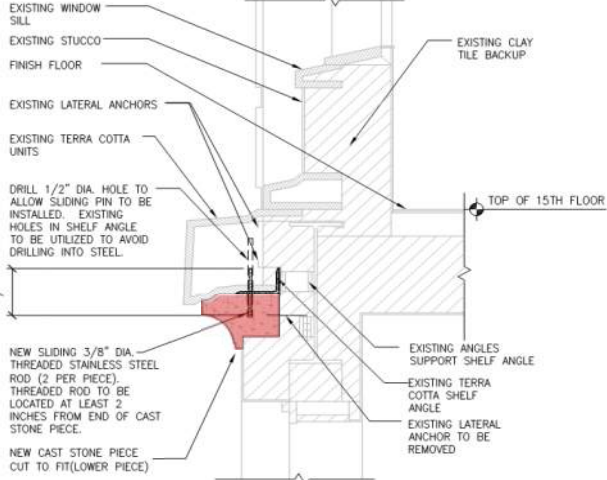


Example of Terra Cotta Replacement

Replacement with Alternate Material (Cast Stone)



1 EXISTING WALL SECTION
 SCALE: 1" = 1'-0"

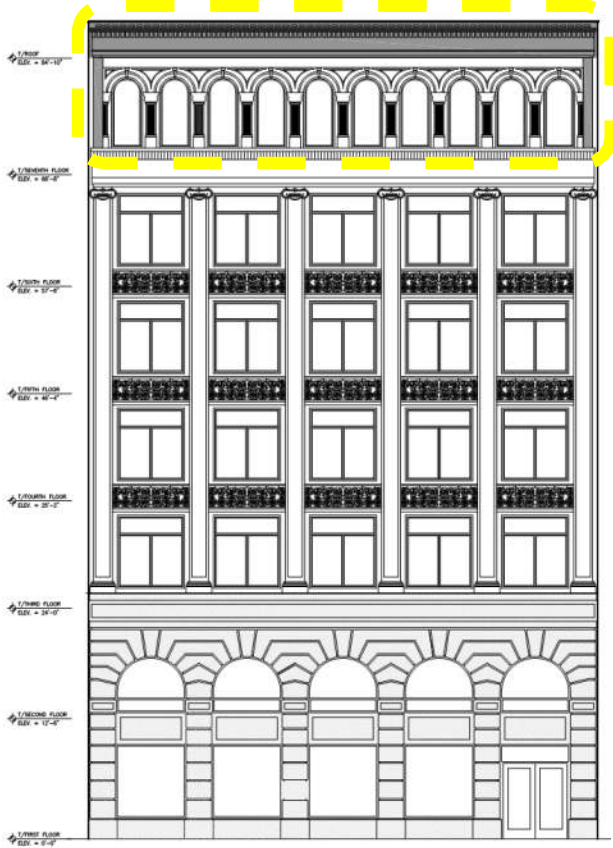
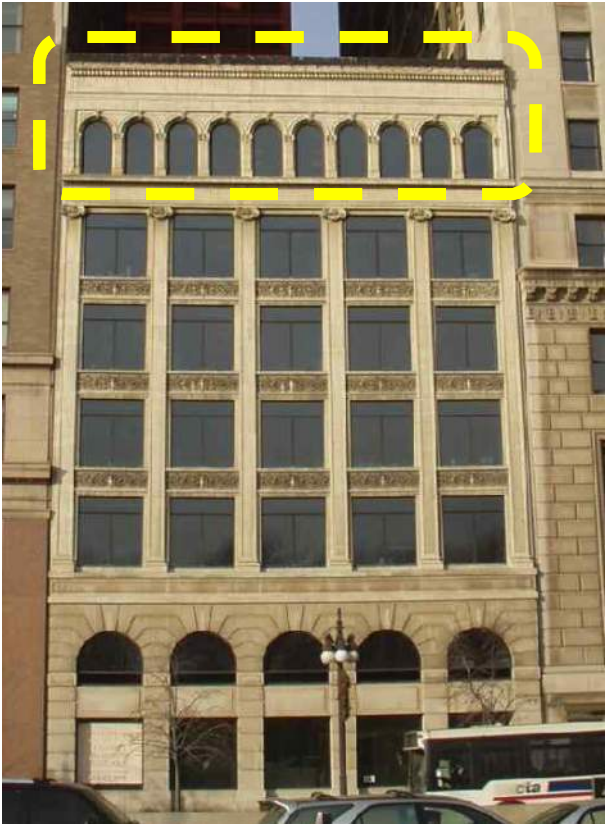


NOTE: THE 1/2" DIAMETER HOLE SHALL BE DRILLED INTO THE CAVITY OF THE ABOVE TERRA COTTA UNIT. DURING THE DRILLING, THIS SHOULD BE EVIDENT IF TERRA COTTA DEBRIS IS NOT BE NOTED AFTER THE DRILL BIT HAS PENETRATED 3-4 INCHES. IF THE HOLE EXTENDS BEYOND 3-4 INCHES, THE DRILL BIT HAS MOST LIKELY HIT THE RIB OF THE TERRA COTTA UNIT. IF THE HOLE IS LOCATED AT A RIB OF A TERRA COTTA UNIT, A NEW LOCATION SHALL BE SELECTED.

1 ATTACHMENT FOR LOWER CAST STONE PIECE
 SCALE: 1" = 1'-0"

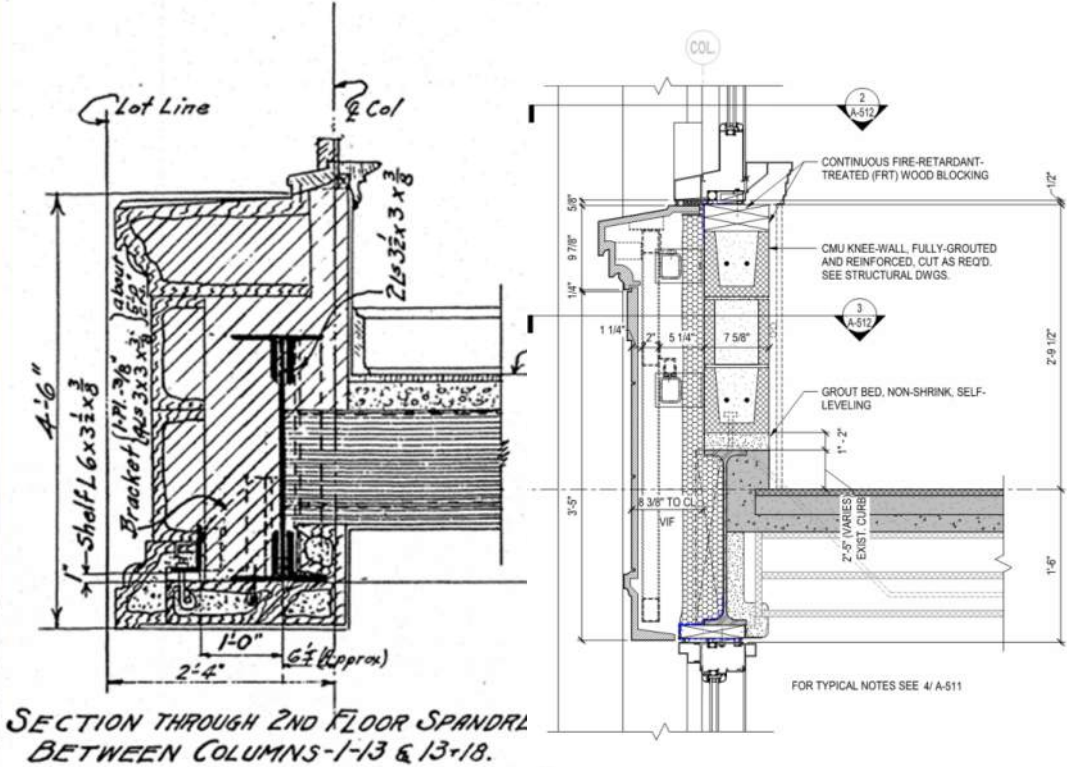
Example of Terra Cotta Replacement

Replacement with Glass Fiber Reinforced Concrete Panels



OSF Healthcare Administration Building

Peoria, Illinois



GFRC Replacement Spandrels

OSF Healthcare Administration Building

Peoria, Illinois



GFRP Replacement Spandrels

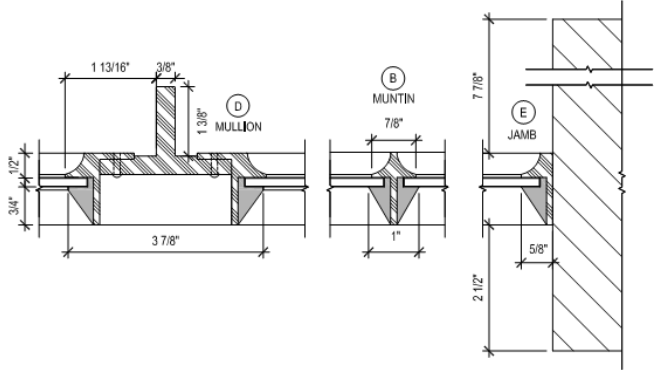
OSF Healthcare Administration Building

Peoria, Illinois



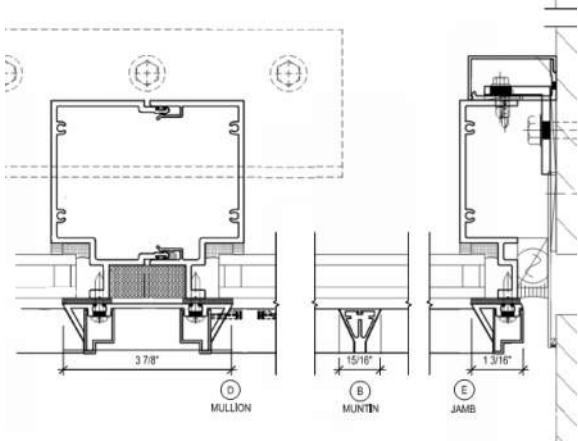
Example of Historic Window Replacement

Replacing windows in a National Historic Landmark



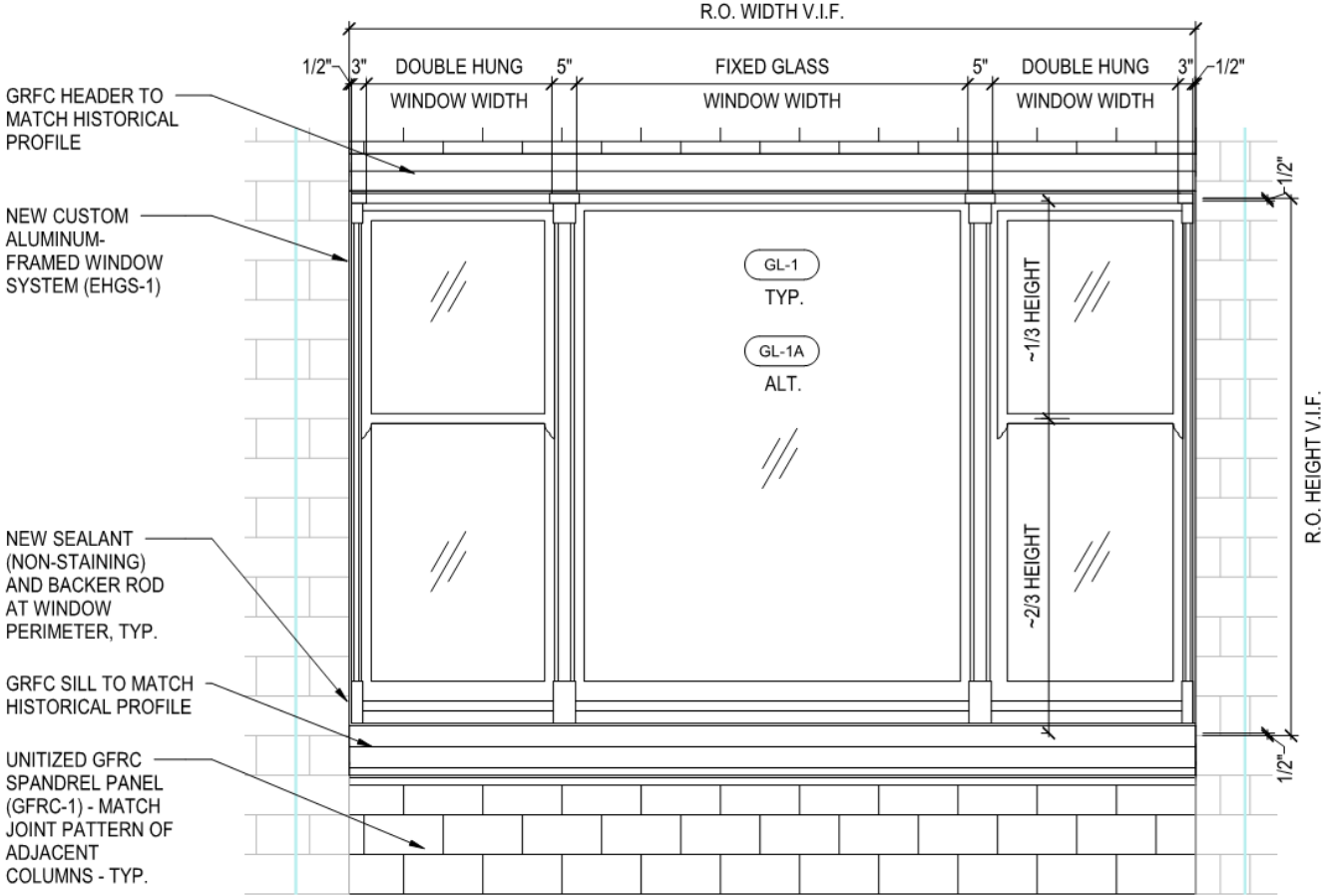
Example of Historic Window Replacement

Replacing windows in a National Historic Landmark



OSF Healthcare Administration Building

Peoria, Illinois

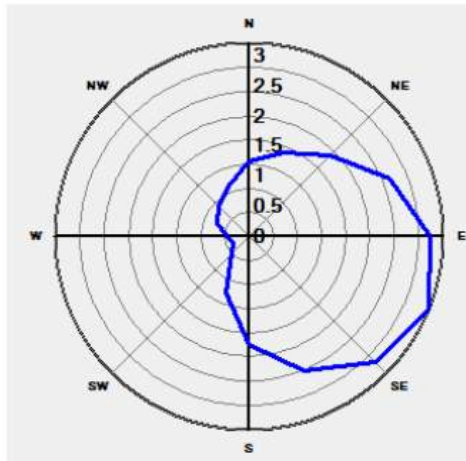
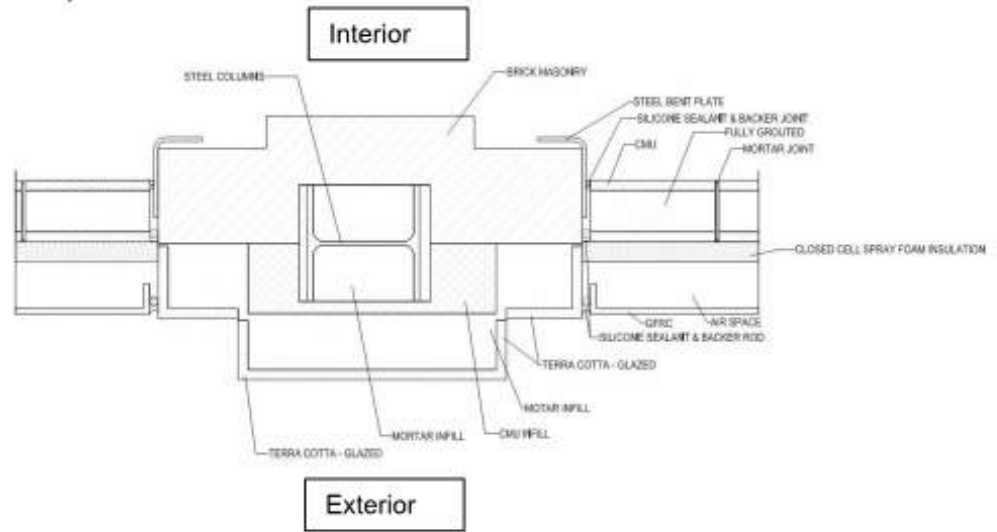


FOR ADDITIONAL DETAIL, SEE 2/ A-511

Replacement Windows Systems

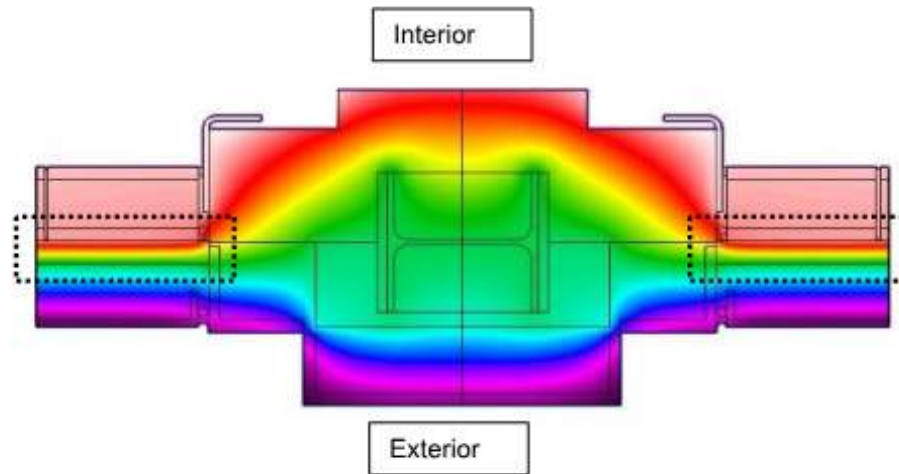
OSF Healthcare Administration Building

Peoria, Illinois



Outside Air Temperature 0°F
 Inside Air Temperature 70°F
 Inside Relative Humidity 50%
 Inside Dew Point Temp 51°F

1.9° 8.7° 15.5° 22.4° 29.2° 36.0° 42.8° 49.6° 56.5° F



Hygrothermal and Heat Transfer Analysis

Conclusions

- Various improvement strategies can improve building enclosure performance with (or without, if desired) affecting the building's appearance.
- The long-term durability of the enclosure is recommended to be assessed by performing advanced analytic modeling (such as hygro-thermal analysis).
- Building materials testing/sampling is often necessary during envelope improvement projects, especially for historic buildings.
- The addition of insulation and vapor barriers will alter the vapor drive within an exterior wall assembly, and there may be long-term repercussions of changes.

Questions?

Contact me!

Rachel Michelin

Thornton Tomasetti
330 N. Wabash Avenue
Suite 1500
Chicago, IL 60611
T +1.312.596.2000

