abaa 2025 building enclosure conference

Meeting Today's Construction Challenges with Prefabrication

Rob Zdenek
Mortenson

David S. Young
BPL Enclosure

AIA Continuing Education Provider

abaa EDUCATION

Meeting Today's Construction Challenges with Prefabrication

Learning Objectives

1. Identify the advantages and disadvantages of prefabrication as it compares to conventional construction.
2. Identify the key building enclosure elements and how they can be detailed and designed for panelized construction.
3. Apply potential strategies for overcoming construction challenges of prefabricated panelization using a completed Denver project to demonstrate how solutions were implemented throughout the project.
4. Implement pathways for compliance with IECC 2021/Denver Energy Code 2022 air barrier performance verification requirements for prefabricated enclosure construction.

Speakers:

Rob Zdenek
Enclosure Executive
M. A. Morentson Company
Minneapolis, Minnesota
rob.zdenek@mortenson.com

David S. Young, AIA, NCARB
Principal, Senior Consultant
BPL Enclosure
Denver, Colorado
dyoung@BPL-Enclosure.com

abaa building enclosure conference

abaa EDUCATION

Background

The Early Days of “Prefabrication” in the United States

Post WW I Housing

- Sears, Roebuck & Company sold kit houses through catalogues from 1908 thru 1942.
- Technically not a prefabricated house, but rather a kit containing all building supplies
- Many other producers, including:
  - Van Gorden Tine
  - Aladdin Homes
  - Bennett Homes

Background

The Early Days of Prefabrication in the United States

Post WW I Housing

- Sears, Roebuck & Company sold kit houses through catalogues from 1908 thru 1942.
- Technically not a prefabricated house, but rather a kit of building supplies.
- Many other producers, including:
  - Van Gorden Tine
  - Aladdin Homes
  - Bennett Homes

Post WW II Housing

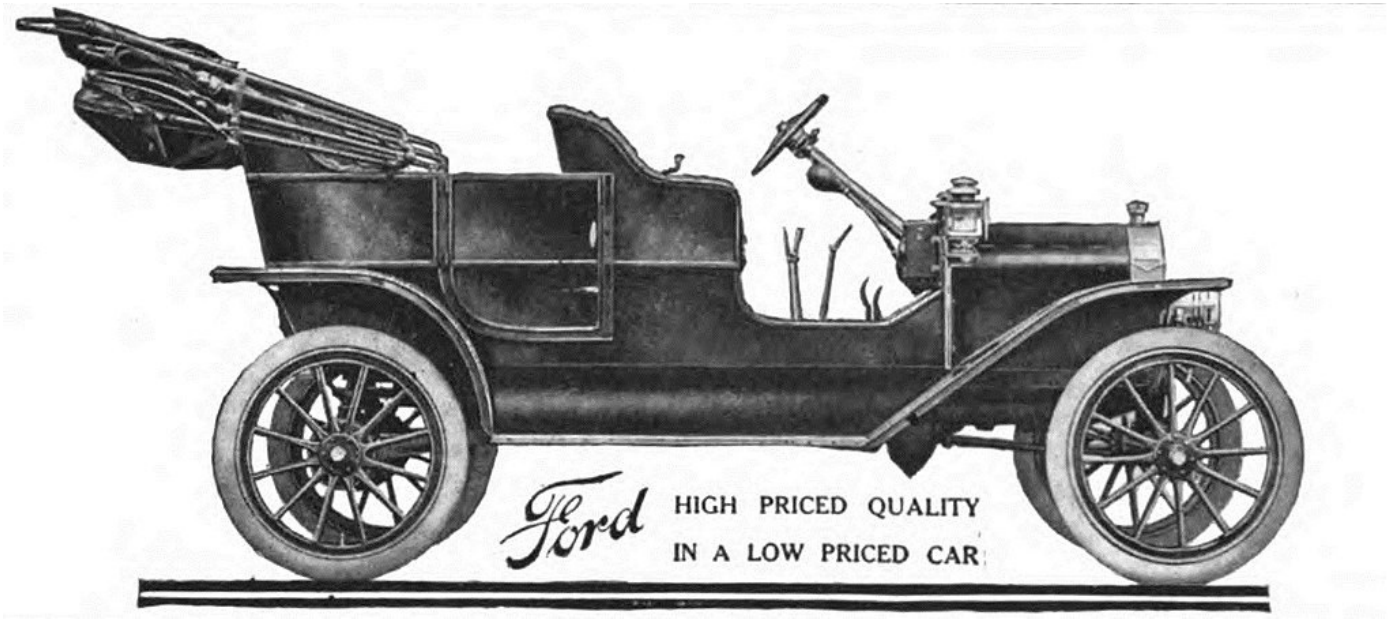
- Massive housing shortage led to large scale prefabrication of homes.
  - Lustron Homes

Background

Recent Developments in Prefabrication in the United States

1970s to 1990s Automation and Standardization

- Focused on cost efficiency and standardization:
  - Consistent
  - Efficient
  - Interchangeable
  - Specialized Equipment
  - Division of Labor



Background

Recent Developments in Prefabrication in the United States

1970s to 1990s Automation and Standardization

- Focused on cost efficiency and standardization:
  - Consistent
  - Efficient
  - Interchangeable
  - Specialized Equipment
  - Division of Labor

Today: Digital Prefabrication and Sustainability

- BIM and 3D and 4D modeling
- Off-site, Panelization and Modular Construction
- 3D Printing and Robotics

The Construction Industry Today

Issues currently plaguing the industry

Shortage of Skilled Labor

- …any questions

Material Costs and Availability

- Volatility

Regulatory Compliance

- Frequently Changing Codes
- Colorado – Home Rule State
- Long lead times for permits

Technology Adoption

- Uneven adoption of technology and project management techniques to improve efficiency

Safety

- The construction industry is a dangerous industry

The Primary Types of Prefabrication

Component and System

- Off site construction of components has been a part of construction for a long time
- System prefabrication refers primarily to prefabrication of MEP system

The Primary Types of Prefabrication

Component and System

- Off site construction of components has been a part of construction for a long time
- System prefabrication refers primarily to prefabrication of MEP system

Panelized

- Construction of 2D assemblies – varying levels of completeness
- Precast concrete and unitized curtain wall are common examples

The Primary Types of Prefabrication

Component and System

- Off site construction of components has been a part of construction for a long time
- System prefabrication refers primarily to prefabrication of MEP system

Panelized

- Construction of 2D assemblies – varying levels of completeness
- Precast concrete and unitized curtain wall are common examples

Modular

- 3D units
- Beneficial for projects with repetition such as hotels, classrooms, etc.

The Primary Types of Prefabrication

Component and System

- Off site construction of components has been a part of construction for a long time
- System prefabrication refers primarily to prefabrication of MEP system

Panelized

- Construction of 2D assemblies – varying levels of completeness
- Precast concrete and unitized curtain wall are common examples

Modular

- 3D units
- Beneficial for projects with repetition such as hotels, classrooms, etc.

Semi-Volumetric (Hybrid)

- Some elements are panelized while others are modular

Drivers to Prefabrication

Reduced Construction Time/Increased Efficiency

- Controlled Environment / Not Weather Dependent
- Specialized Workforce
- Daily Mobilization / Demobilization Time
- Simultaneous Workflows / Speed

Reduced Waste

- Precise Cutting
- Efficient use of material

Cost Savings

- Increased Efficiency + Reduced Waste = Money in the Bank!

Drivers to Prefabrication

Reduced Construction Time/Increased Efficiency

- Controlled Environment / Not Weather Dependent
- Specialized Workforce
- Daily Mobilization / Demobilization Time
- Simultaneous Workflows / Speed

Reduced Waste

- Precise Cutting
- Efficient use of material

Cost Savings

- Increased Efficiency + Reduced Waste = Money in the Bank!

Quality Control

- Allows for better quality oversight
- Fewer variables results in more consistent output

Site Logistics

- Fewer deliveries to the site
- Less storage area needed at the site

Safety

- More control (designed safety) reduces potentially dangerous activities and increases safety

Disadvantages of Prefabrication

Limited Design Flexibility / Paradigm Shift

- Architect's Concerns (?)
- Lack of Understanding of Means, Methods and Techniques

Transportation and Handling

- Special Transportation and Handling
- Damage During Transit and Handling

Precise Planning

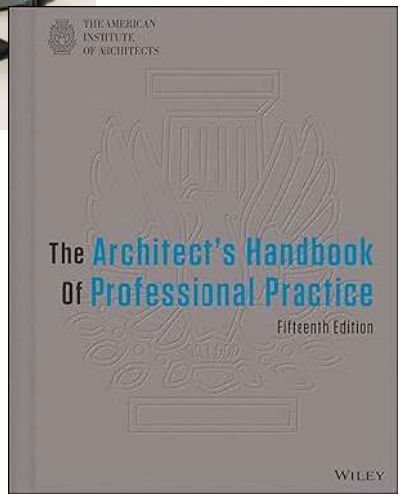
- Detailed planning (BIM and 4D models)
- Changes are harder and more costly

On-site Integration

- Misalignment of existing conditions/site built with prefabricated components

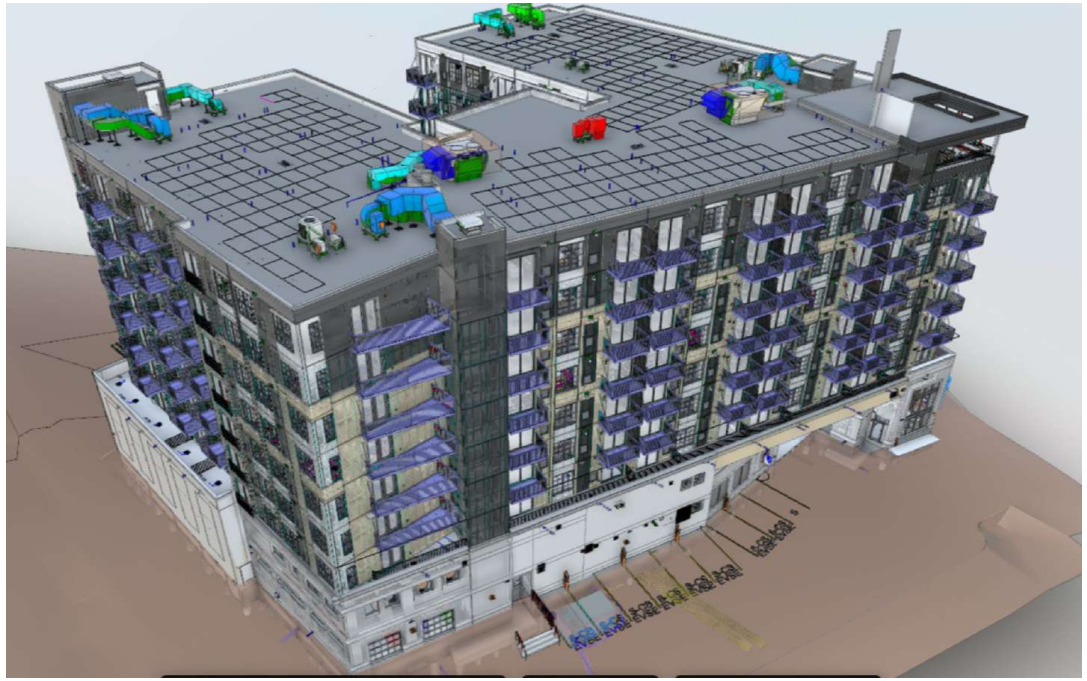
Capital Investment / Flexibly

- High Levels of Automation / High Initial Capital / Reduced Flexibility
- Low Levels of Automation / Low Initial Capital / Greater Flexibility



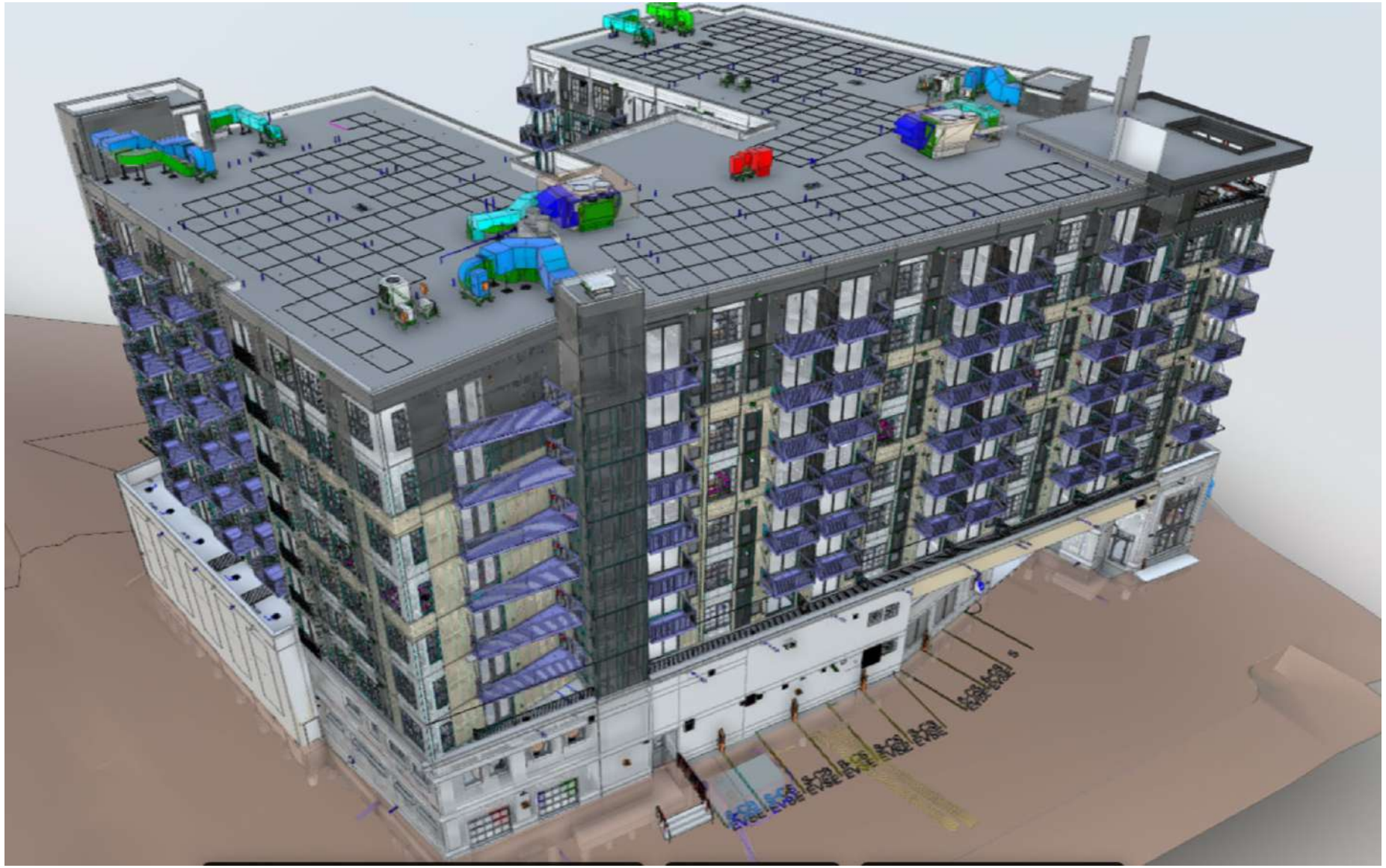
Introduction to the Project

Revival on Platte



Project Facts:

- 234,000 Square Feet of Multi-Family Living
- 200 Units
- 2,500 Structural Wall, Floor, and Roof Panels
- Seven Floors of Light Gauge Structure over Two Levels of Concrete Structure
- 367,518 Square Feet of Vertical Walls and Floors Exterior Fully Finished Walls with Windows, Doors, Mechanical, Plumbing



Revival On Platte – Prefabrication Case Study

Introduction

Revival on Platte: Vertical Integration in Construction | Mortenson

Revival on Platte

Compliance – Denver Energy Code Air Barrier Requirements

Relevant Code: 2019 Denver Amendments to the 2018 IECC - Section 402.5 Air Leakage

Section C402.5.1.2 Air Barrier Compliance Options

- …verified by a registered design professional or approved agency in accordance with the following:
  - Review of the construction documents with a Report documenting compliance with Section 402.5.1
  - Inspection of air barrier components and assemblies during construction while they are accessible for inspection and repair (10% of air barrier can be unverified if the measured air leakage is 0/40 CFM/SF)
  - Final Commissioning Report

Section C402.5.1.3 Building Thermal Envelope Testing

- …shall be tested in accordance with ASTM E779 or equivalent
  - **Exception:** For buildings not required to be tested, full air barrier verification is required.

City of Denver

- Exterior wall panels will be regarded as a manufactured component, and therefore, it is not necessary to observe 100% of the air barrier in the factory
- Design Professional or approved agency does not need to be third party

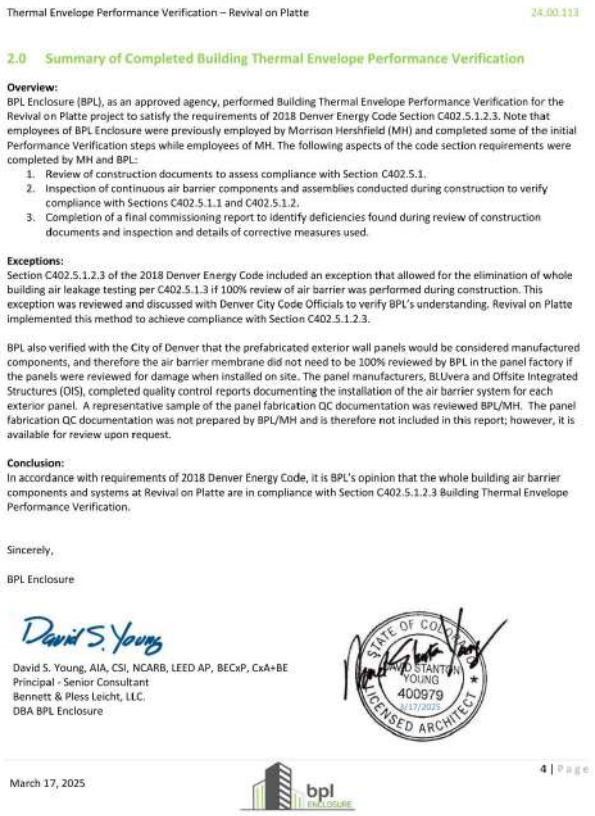
Revival on Platte

Compliance – Denver Energy Code Air Barrier Requirements

Relevant Code: 2019 Denver Amendments to the 2018 IECC - Section 402.5 Air Leakage

Services Provided for Compliance:

- Review of the construction documents with a Report documenting compliance with Section 402.5.1
- ASTM E1105 testing of a sample of wall panels at fabrication facility
- Inspection of 100% of the air barrier components and assemblies during construction while they are accessible for inspection
- ASTM E1105 testing of a sample of wall panels
- AAMA 501.2 testing of panel-to-panel joints – both vertical dual stage joints and horizontal “smash” joints
- Final Commissioning Report



Thermal Envelope Performance Verification – Revival on Platte 24.00.113

2.0 Summary of Completed Building Thermal Envelope Performance Verification

Overview:
BPL Enclosure (BPL), as an approved agency, performed Building Thermal Envelope Performance Verification for the Revival on Platte project to satisfy the requirements of 2018 Denver Energy Code Section C402.5.1.2.3. Note that employees of BPL Enclosure were previously employed by Morrison Hershfield (MH) and completed some of the initial Performance Verification steps while employees of MH. The following aspects of the code section requirements were completed by MH and BPL:

1. Review of construction documents to assess compliance with Section C402.5.1.
2. Inspection of continuous air barrier components and assemblies conducted during construction to verify compliance with Sections C402.5.1.1 and C402.5.1.2.
3. Completion of a final commissioning report to identify deficiencies found during review of construction documents and inspection and details of corrective measures used.

Exceptions:
Section C402.5.1.2.3 of the 2018 Denver Energy Code included an exception that allowed for the elimination of whole building air leakage testing per C402.5.1.3 if 100% review of air barrier was performed during construction. This exception was reviewed and discussed with Denver City Code Officials to verify BPL's understanding. Revival on Platte implemented this method to achieve compliance with Section C402.5.1.2.3.

BPL also verified with the City of Denver that the prefabricated exterior wall panels would be considered manufactured components, and therefore the air barrier membrane did not need to be 100% reviewed by BPL in the panel factory if the panels were reviewed for damage when installed on site. The panel manufacturers, BLUvera and Offsite Integrated Structures (OIS), completed quality control reports documenting the installation of the air barrier system for each exterior panel. A representative sample of the panel fabrication QC documentation was reviewed BPL/MH. The panel fabrication QC documentation was not prepared by BPL/MH and is therefore not included in this report; however, it is available for review upon request.

Conclusion:
In accordance with requirements of 2018 Denver Energy Code, it is BPL's opinion that the whole building air barrier components and systems at Revival on Platte are in compliance with Section C402.5.1.2.3 Building Thermal Envelope Performance Verification.

Sincerely,

BPL Enclosure

David S. Young

David S. Young, AIA, CSI, NCARB, LEED AP, BECxP, CxA+BE
Principal - Senior Consultant
Bennett & Pless Leicht, LLC.
DBA BPL Enclosure

STATE OF COLORADO DAVID STANTON YOUNG 400979 LICENSED ARCHITECT

March 17, 2025

bpl ENCLOSURE

4 | Page

Revival on Platte

Current Denver Energy Code Air Barrier Requirements

Relevant Code: 2022 Denver Amendments to the 2021 IECC - Section 402.5 Air Leakage

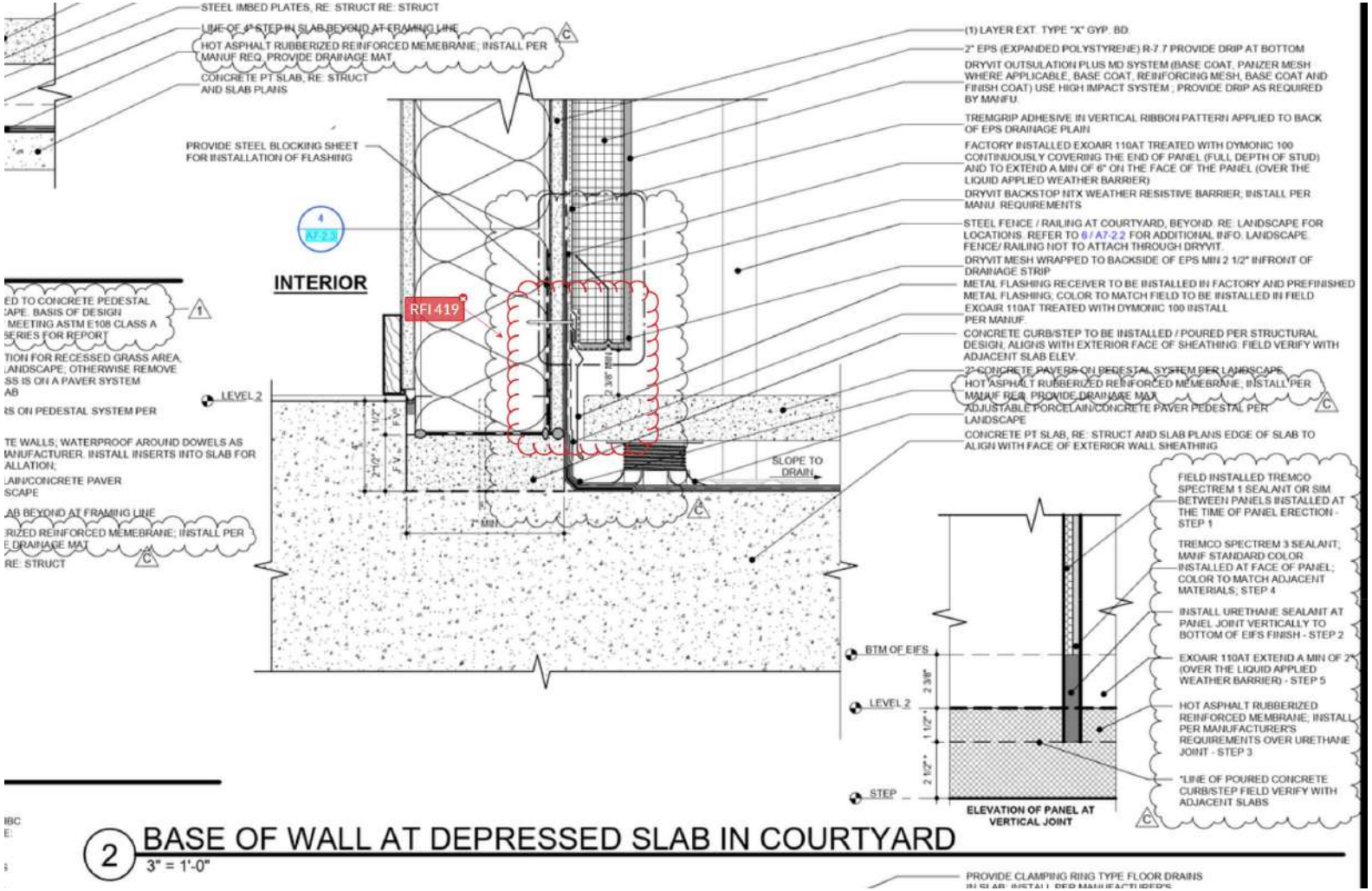
Section C402.5.1.5 Building envelope Performance Verification

- …verified by a registered design professional or approved agency (3rd party not req'd) in accordance with the following:
  - Review of the construction documents with a Report documenting compliance with Section 402.5.1
  - Inspection of air barrier components and assemblies during construction while they are accessible for inspection and repair
  - Final Commissioning Report

Section C402.5.3 Building Thermal Envelope Testing

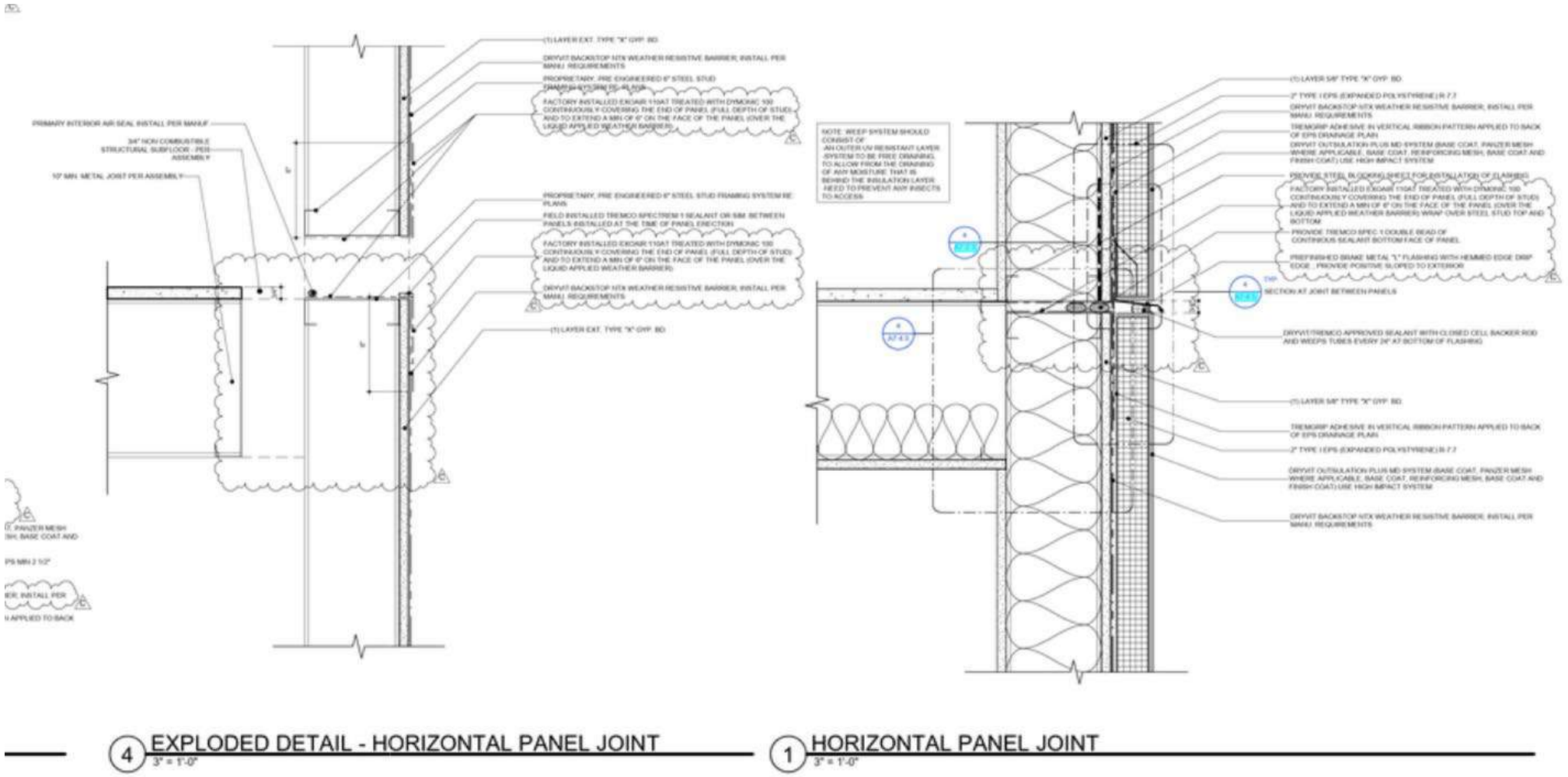
- For occupancy types other than R and I, …shall be tested in accordance with ASTM E779 or equivalent
  - Measured air leakage shall not exceed 0.40 CFM/SF at 75 Pa

Review of Construction Documents



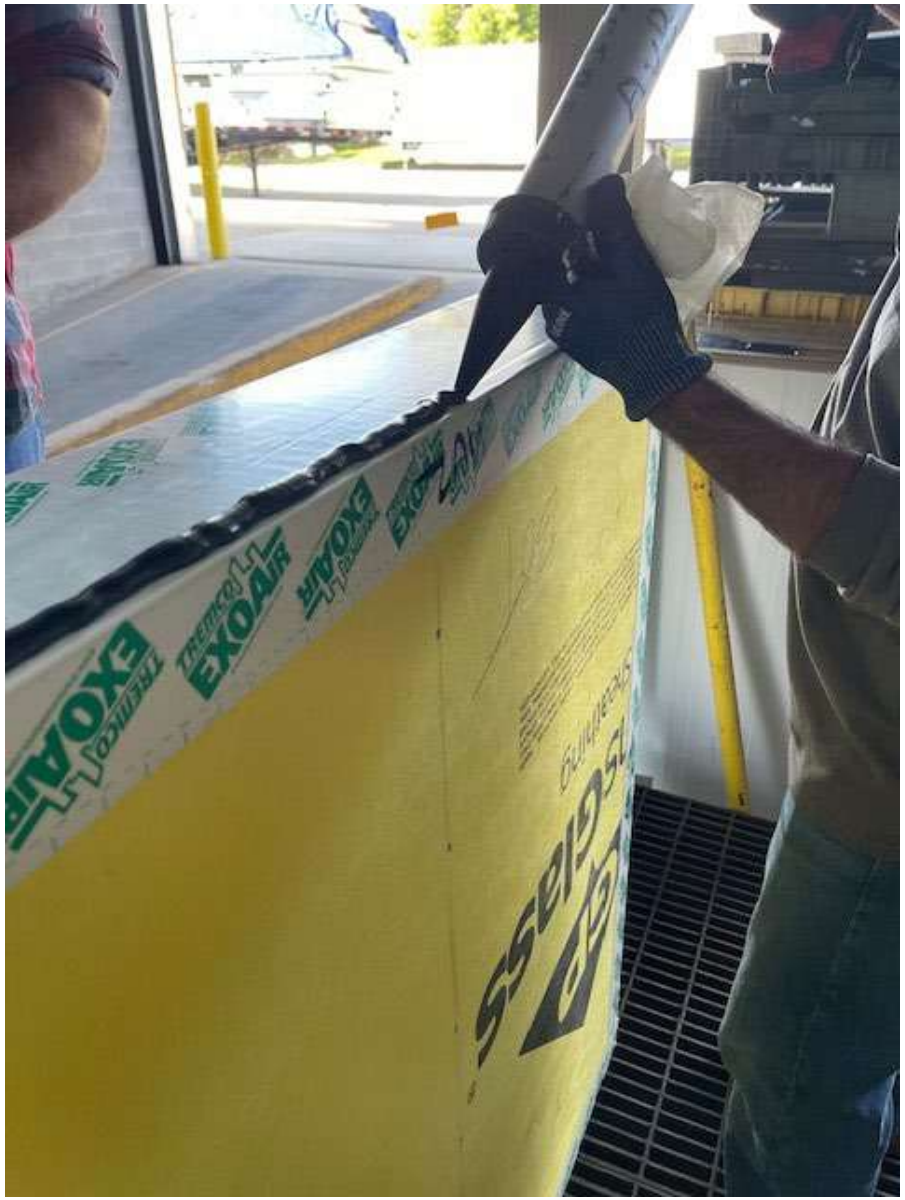
2 BASE OF WALL AT DEPRESSED SLAB IN COURTYARD
3" = 1'-0"

Review of Construction Documents



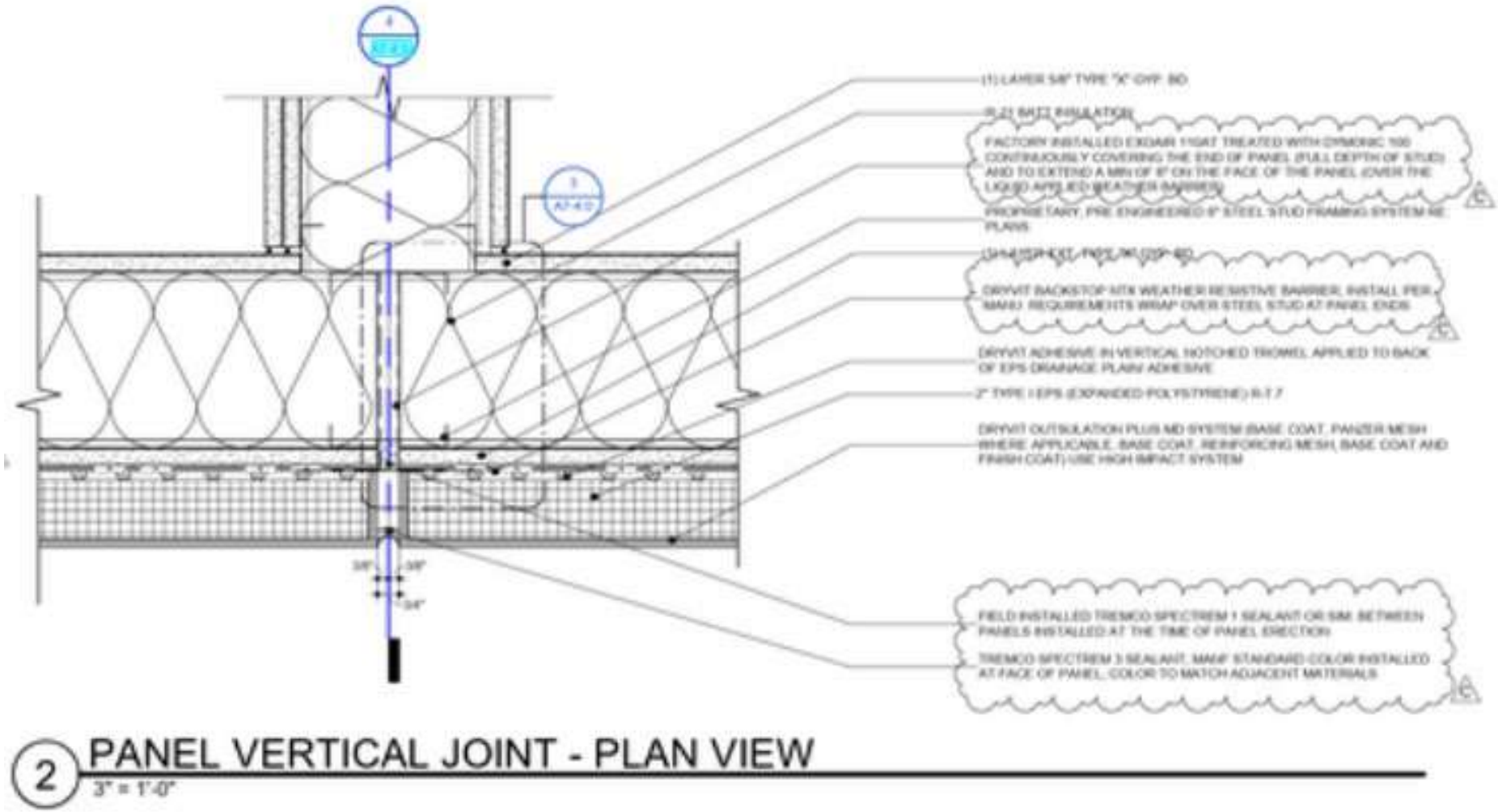
4 EXPLODED DETAIL - HORIZONTAL PANEL JOINT
3" = 1'-0"

1 HORIZONTAL PANEL JOINT
3" = 1'-0"


TREMCO
EXOAIR

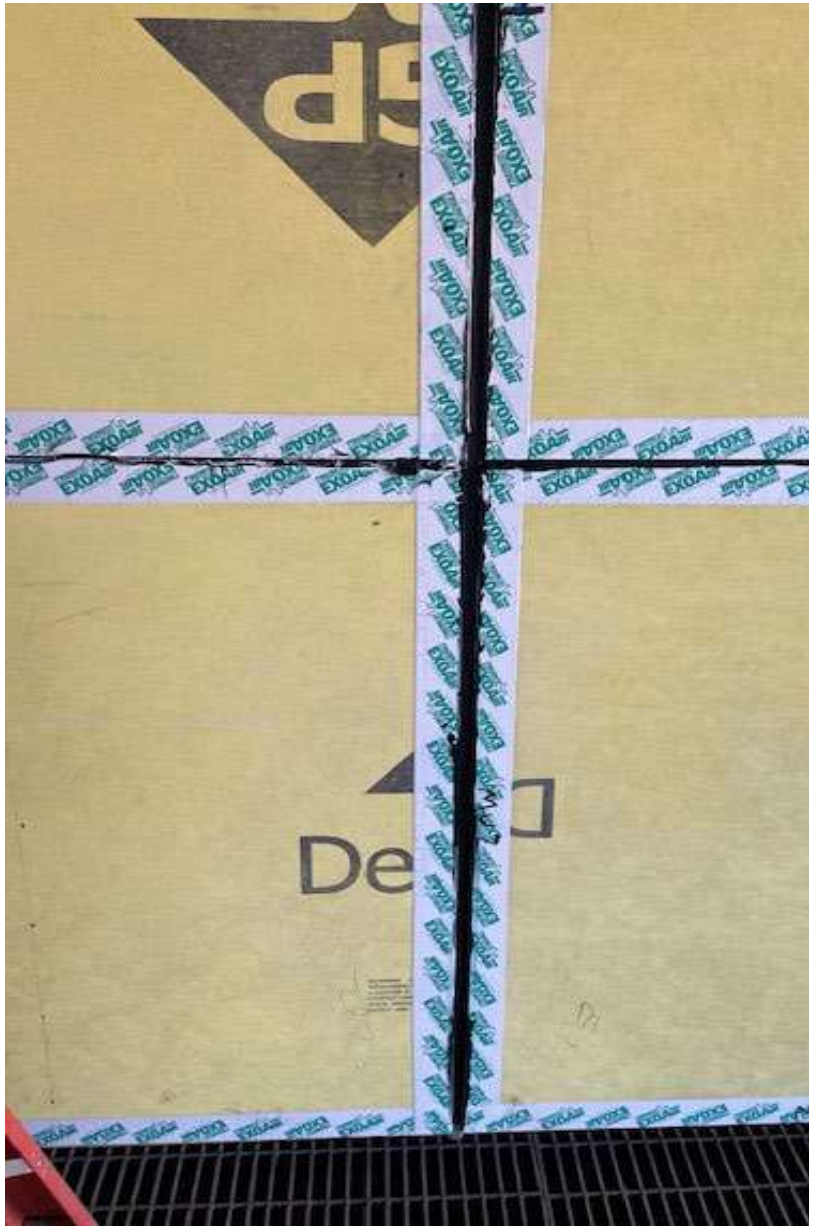

TREMCO
EXOAIR

Review of Construction Documents



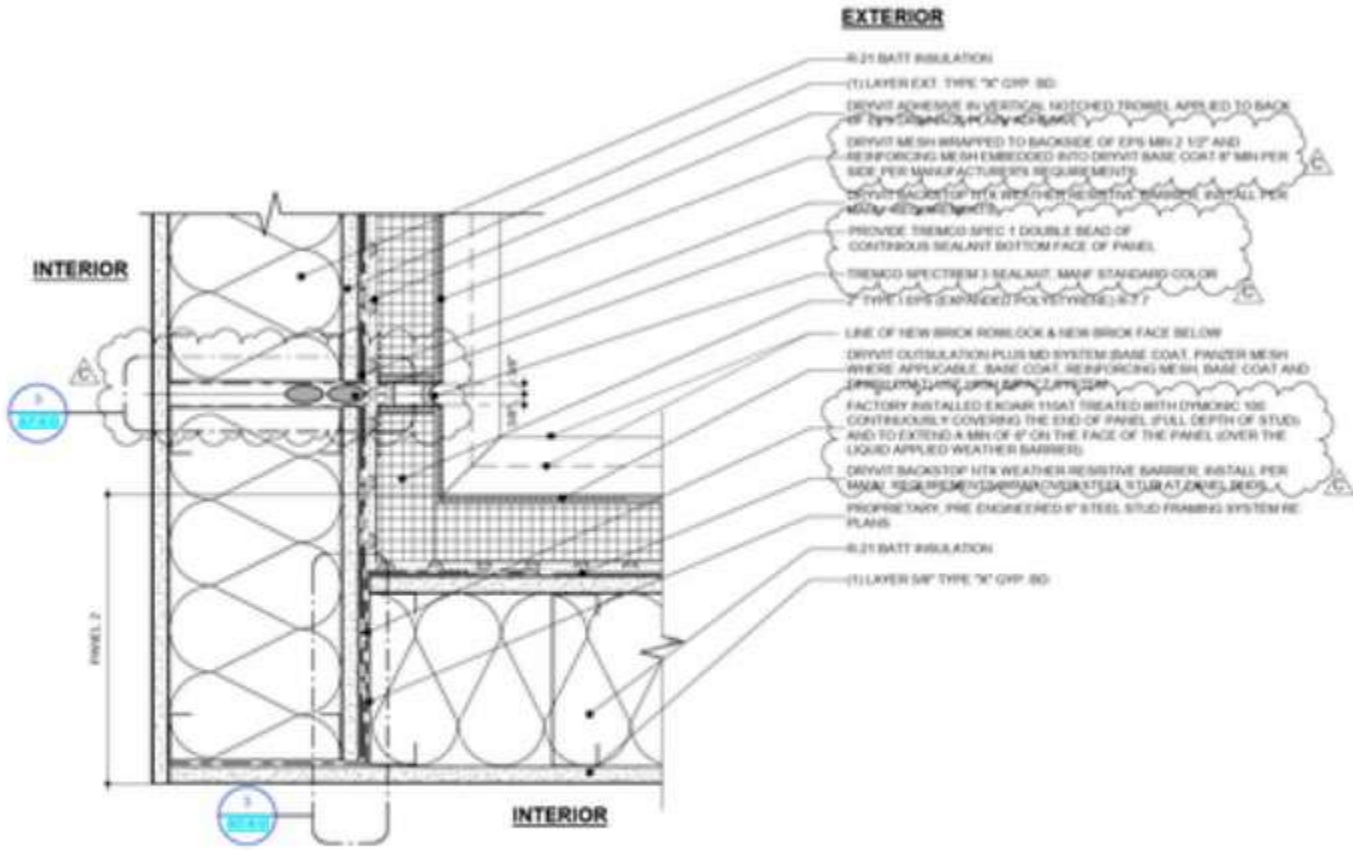
2 PANEL VERTICAL JOINT - PLAN VIEW
3" = 1'-0"


TREMCO
EXOAIR


EXOAIR


TREMCO
EXOAIR

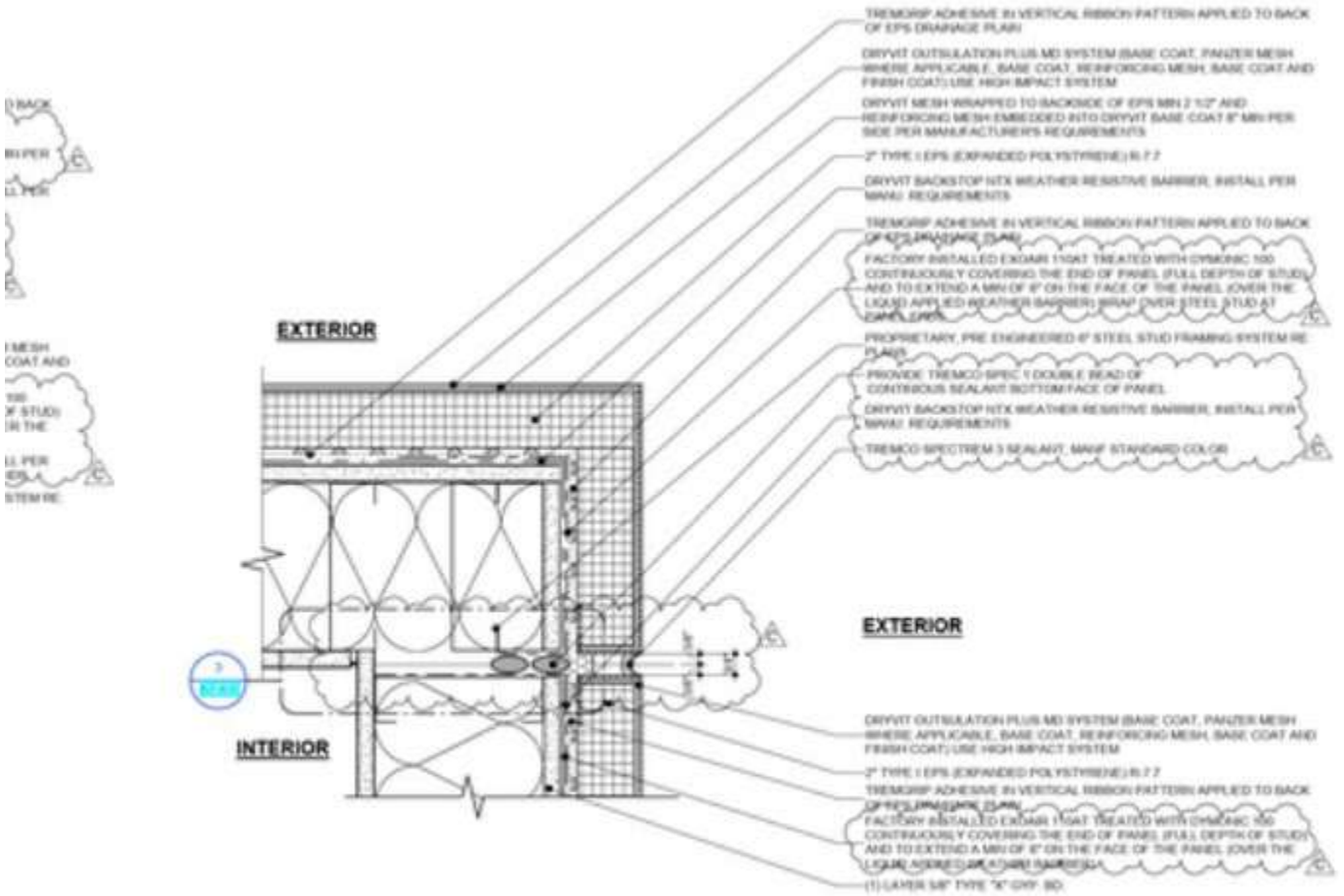
Review of Construction Documents



6 INSIDE CORNER AT EIFS
3" = 1'-0"

3

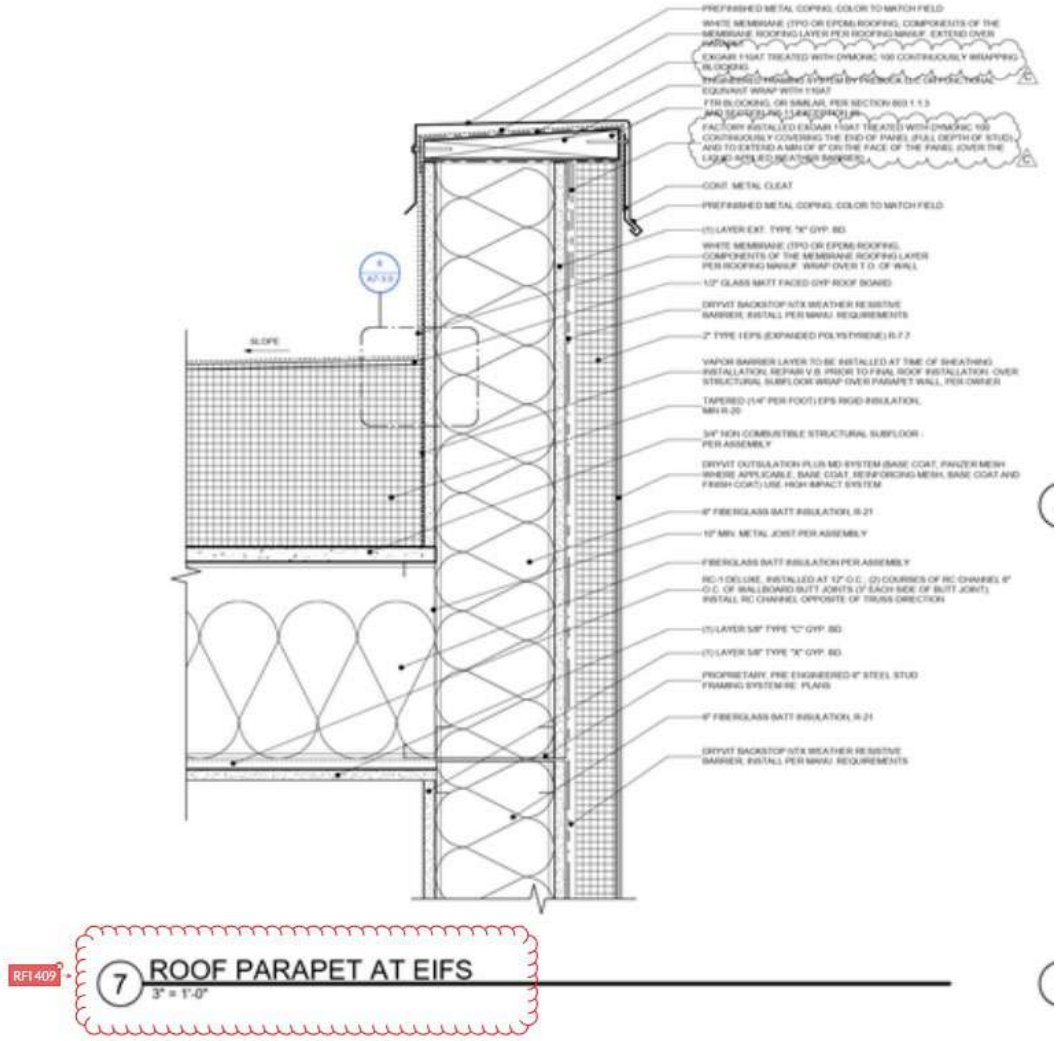
Review of Construction Documents



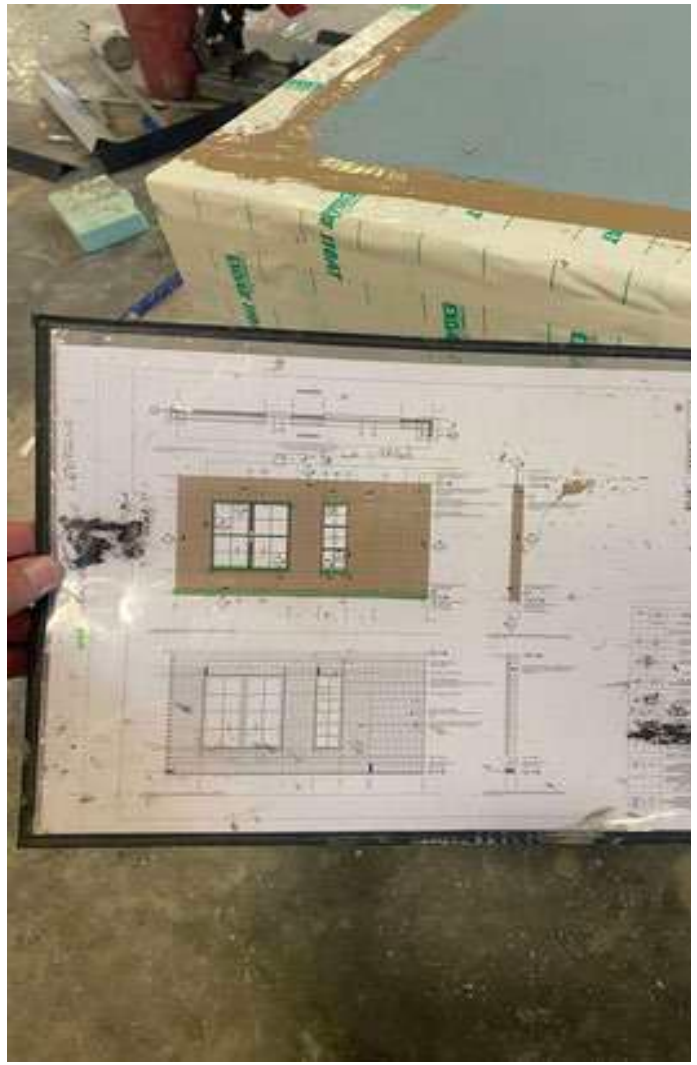
3 OUTSIDE CORNER AT EIFS
3" = 1'-0"


EXOAIR 110AT
USG

Review of Construction Documents

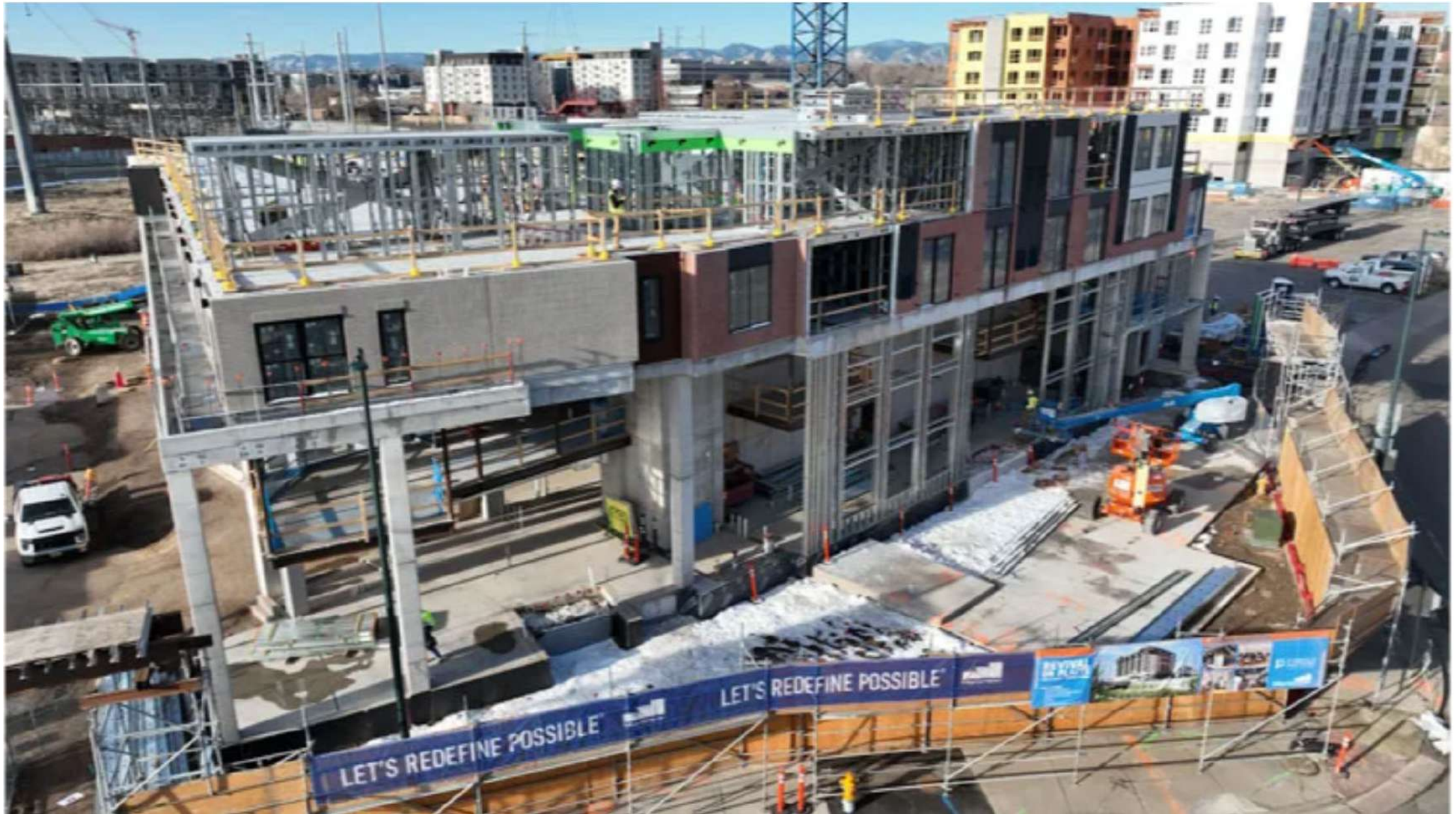


Tracking of Panels



Factory Testing of Panels

Field Testing of Panels


LET'S REDEFINE POSSIBLE
LET'S REDEFINE POSSIBLE


abaa2025
building
enclosure
conference