Architectural Details – Conveying Clarity

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CONTINUING EDUCATION
AIA

Learning Objectives

- Understand the importance of architectural details
- Understand the consequences of not including sufficient details as part of construction documents
- Know what code requires architects to provide for details
- Building Science effects to the architectural design
- Understanding how materials can play into the constructability of a design

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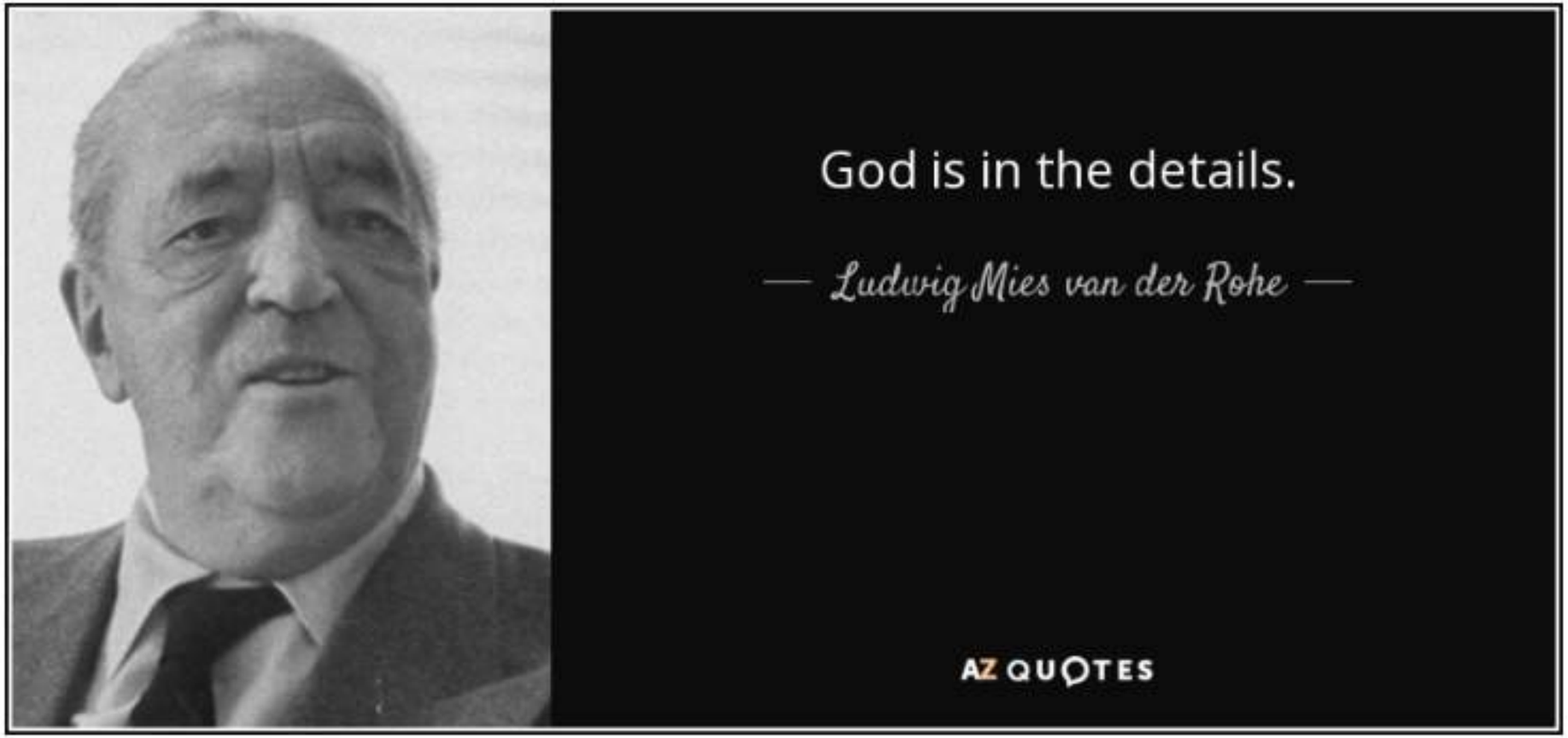

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~~The Devil~~ God is in the Details

Designers should illustrate details to bring clarity to the construction of the building.

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Building Enclosure Defined

The system or assembly of components that provides environmental separation between the conditioned space and the exterior environment.

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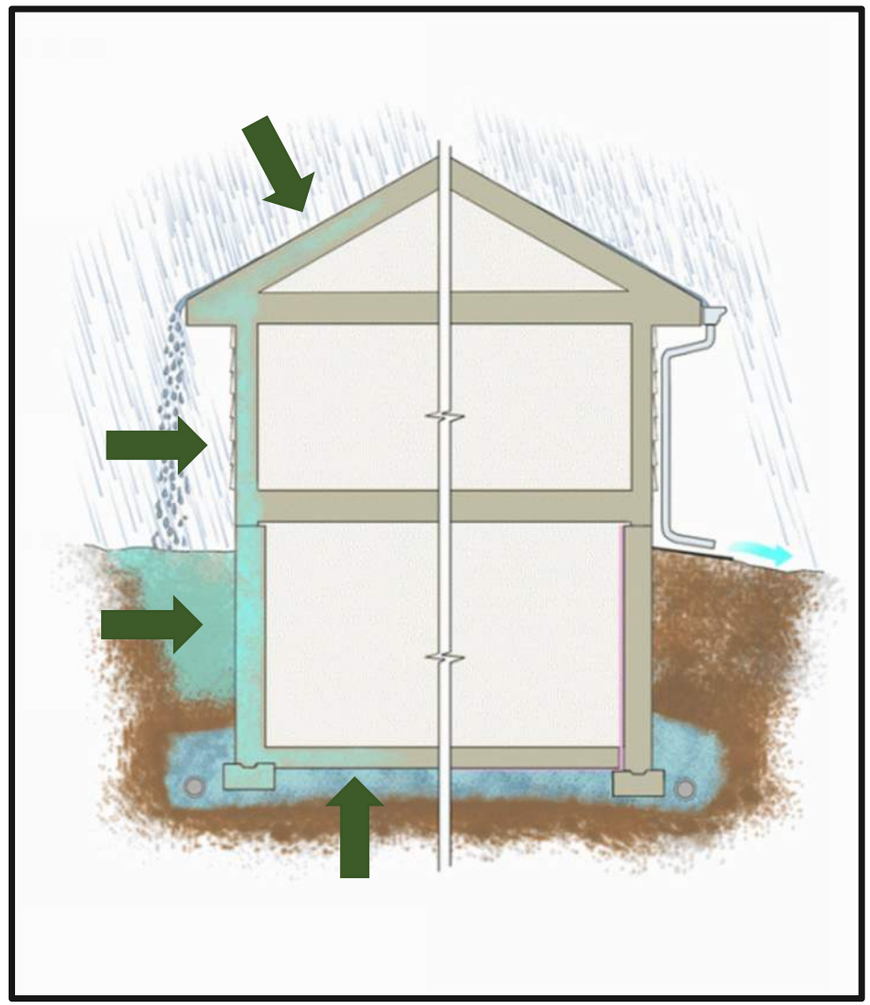
Four Primary Components – Six Sided Cube

- Roof
- Walls
- Foundation
- Slab



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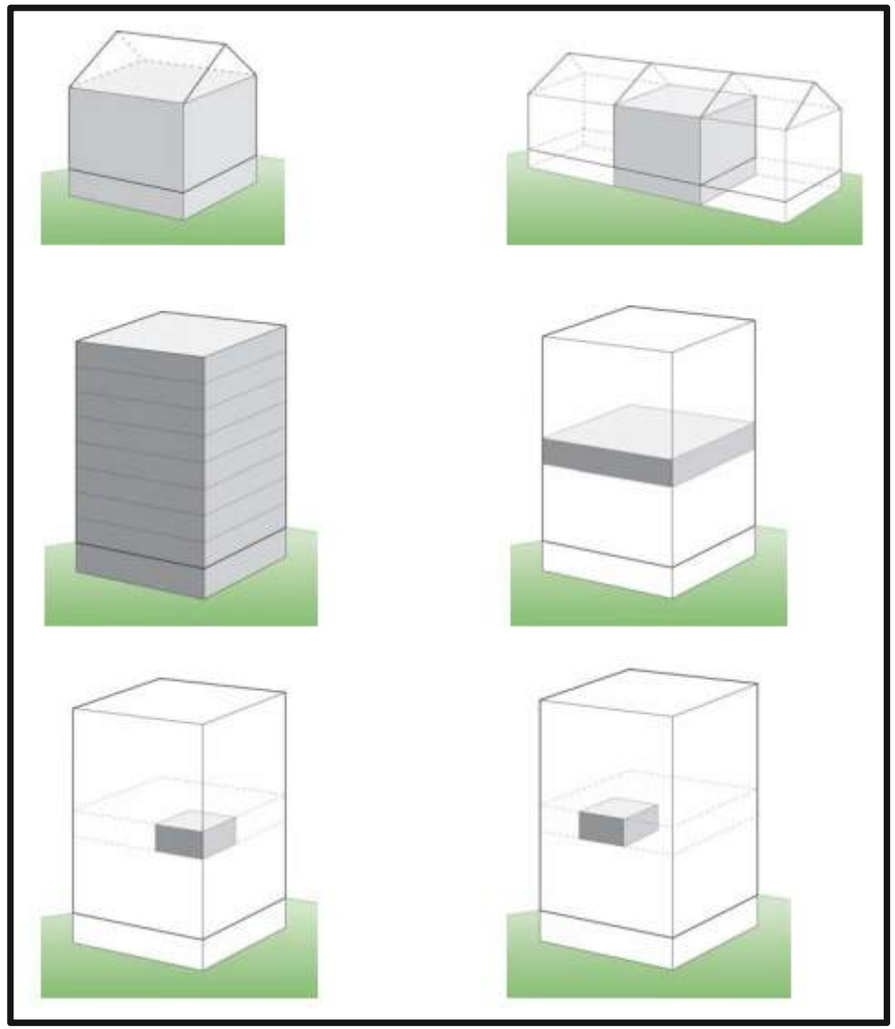
Secondary Components of the Six Sided Cube

- Environmental Separators
  - Townhouses
  - Office Spaces
  - Apartment Units
  - Server Rooms
  - Indoor Pool/Spas (Chemical)
  - Science Labs/Medical Labs
  - Operating Rooms
  - Attached Garage
  - Etc…



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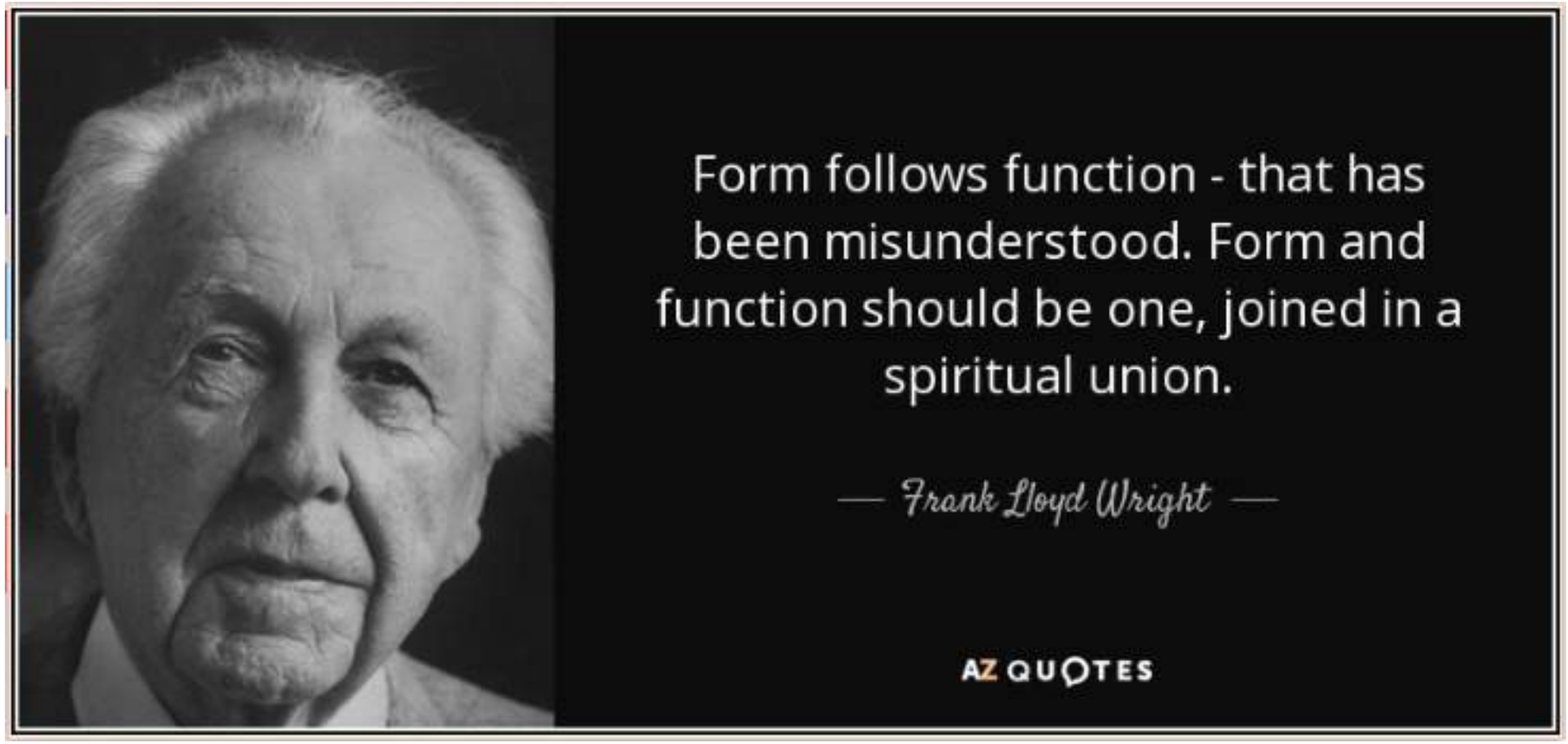

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Building Science

Basic Principles

Moisture	Air	Heat	Vapor
Liquid Water	High to Low	Hot to Cold	High to Low Pressure
Control and Disposal	Control Passage of air into and out of the building enclosure	Control Heat Transfer	Diffusion – Permeability Drying Capacity
#1	**#2**	#3	#4

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Building Science

Moisture

Control of Water Vapor Flow and Rain is very critical

Uncontrolled moisture could lead to fungal growth (mold), corrosion, decay, damage to moisture sensitive interior finishes, and structural failure

Bulk water from rain and

Water Vapor from air currents and diffusion

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Building Science

Air

For air flow to occur, there must be both:

- ✓ Pressure difference between two points – Remember air flows from high pressure to low pressure
- ✓ Continuous flow path or opening connecting the points

Uncontrolled air leakage through the enclosure is a major cause of performance problems

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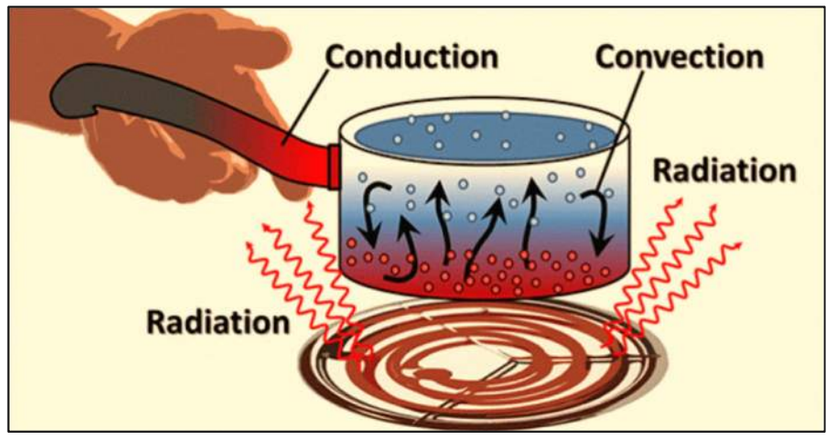
Building Science



Heat

Conduction: Flow of heat through a material by direct molecular contact (solids)

Convection: Transfer of heat by the movement or flow of molecules with a change in the heat content (fluids and solids)

Radiation: Transfer of heat from electromagnetic waves through a gas (solids) Solar Heat and Night Sky Cooling

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Building Science

Vapor

Water Vapor Transport occurs by “diffusion” and “convection”

- It is driven by vapor pressure differences (more to less)
- Solar driven inward vapor is a source of condensation (typically only for a small amount of time)
- Cold weather diffusion condensation is normally only a problem in very cold weather particularly for poorly insulated walls and very high interior humidity levels

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Why the Building Science Tangent?

We need to understand and identify the control layers in order to attain continuity.

- Moisture Control (Outside)
- **Air Control** (Both sides of the enclosure)
- Thermal Control (Continuous outside preferred)
- Vapor Control (Warm side of wall?)

CONTINUITY = CONTROL

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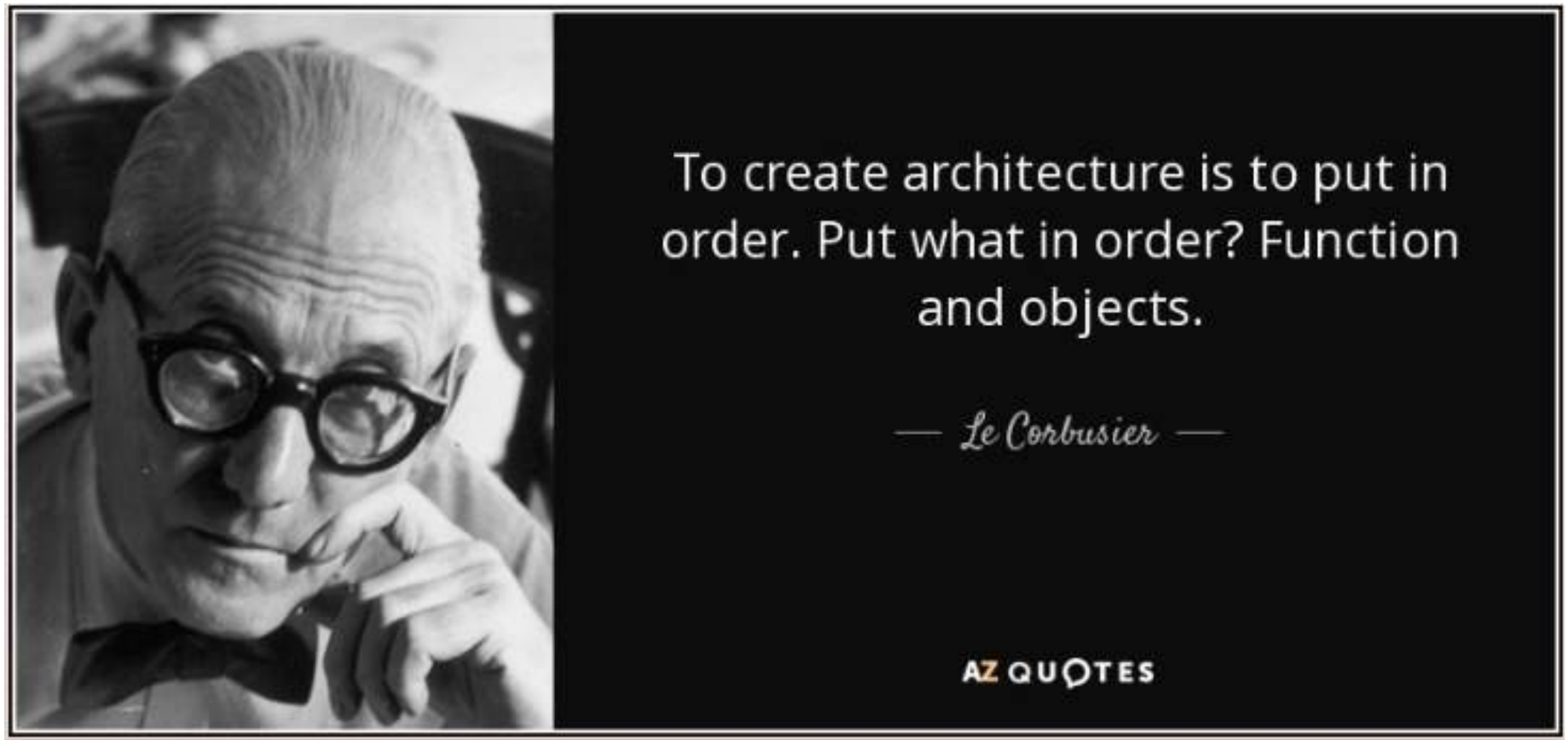

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Design Requirements

Conveying details through adequate understanding/ identification of the control layers to attain continuity.

- Specify Materials
- Identify details on construction documents
- Identify boundary limits
- Allow the building to dry
- Allow the building to move

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Design Desires

Well represented design intent is desired in order to give contractors the chance to succeed and the building to be installed per the architect’s design.

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What is the Architect's Role?

- To educate Clients during the Owner's Project Requirement Phase on the benefits of a High Performance Building Envelope
- Create or participate in a Design Team who understands building science
- Empowerment and opportunity for improvements and savings early on when changes can be made on paper rather than through the change order process
- **Provide complete Specifications for building envelope installation to ensure that the owner truly gets the building performance he or she expects and paid for**
- **Ultimately provide the Owner with a functional, durable, efficient building which is constructible and sustainable**

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What does 2009 IBC Say?

[A] 107.2.4 Exterior wall envelope. *Construction documents* for all building shall describe the *exterior wall envelope* in sufficient detail to determine compliance with this code… ***shall provide details of the exterior wall envelope as required, including flashing, intersections with dissimilar materials, corners, end details, control joints, intersections at roof, eaves or parapets, means of drainage, water-resistive membrane and details around openings.***

The construction documents shall include manufacturer's installation instructions that provide supporting documentation that the proposed penetration and opening details described in the construction documents maintain the weather resistance of the exterior wall envelope. The supporting documentation shall fully describe the exterior wall system which was tested, where applicable, as well as the test procedure used.

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Designer Deliverables

The documents should include narrative description and details of individual items that support the design intents.

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What does the Building Scientist Say?

Least safe…
Least Strong…
Least energy efficient…
…. building allowed by law

-Chris Mathis

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Who should be looking out for the Owner?

In all simplicity and reality….

You Should!

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How to minimize risks?

- Abundance of Architects
- Owners wanting more for less
- Abundance of building enclosure products and systems
- Tight design schedules
- Use of resources
- Train/empower staff

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Building Enclosure Performance

Building Envelopes are complex systems…

Inter-related with the interior conditions, subject to numerous influences and risk.

- Roof Design
- Wall Design
- Slab Design

CONTINUITY = CONTROL

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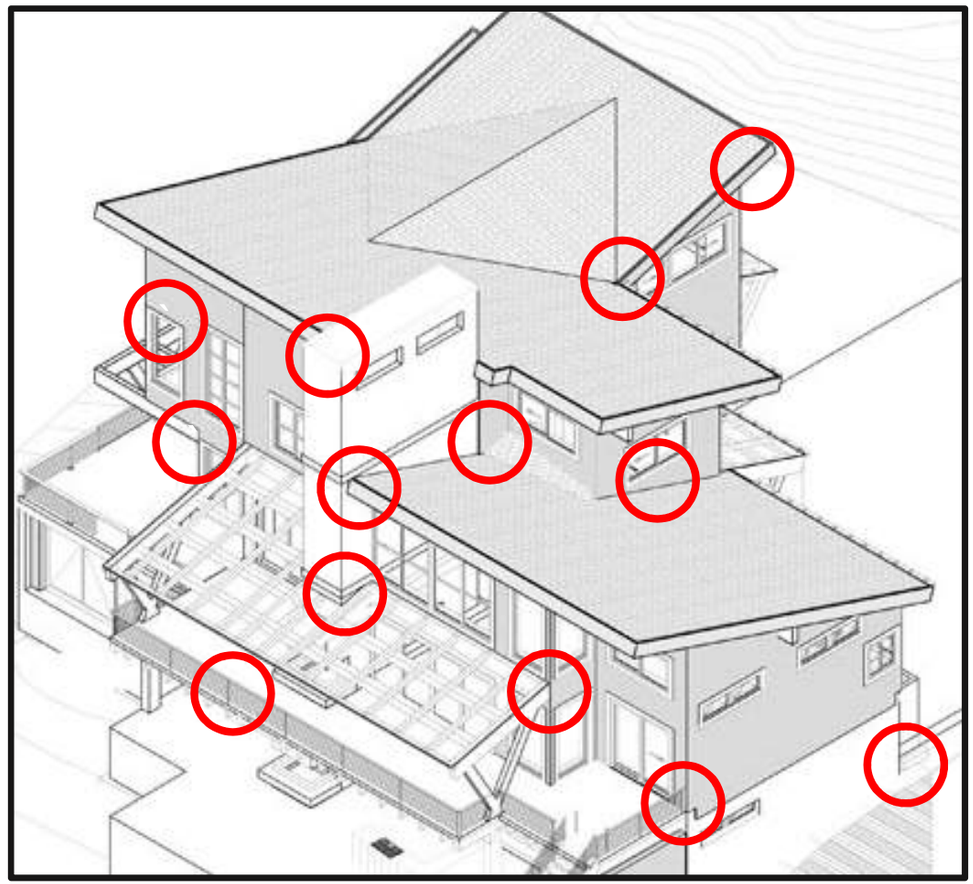
Building Enclosure Performance

What to detail?

ALL Transitions!!!

“Complexity is the biggest challenge designers have to deal with when it comes to design.”

-Dr. John Straube



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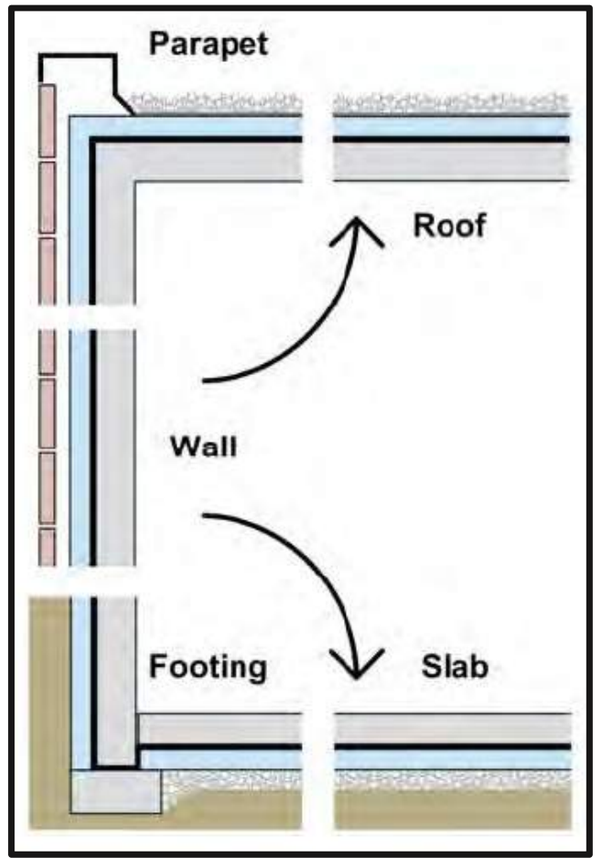
RDH BUILDING SCIENCE LABORATORIES

Don’t Sell Yourself Short

CONTINUITY = CONTROL

- Roof-to-Parapet Design
- Wall-to-Window/Door Design
- Footing-to-Wall Design



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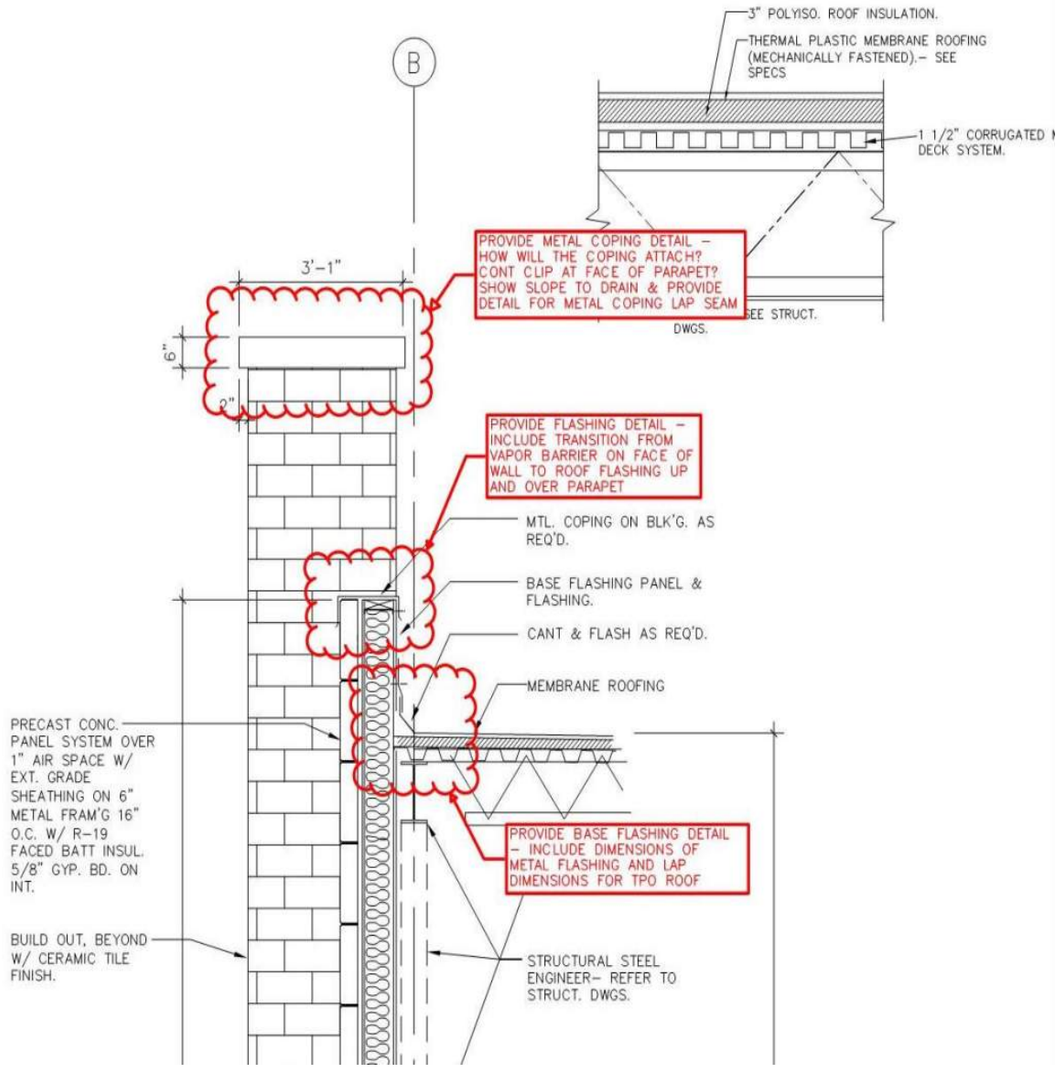
Critical Detailing

- Integrity and Continuity of:
  - ✓ Air Barrier
  - ✓ Vapor Retarder
  - ✓ Thermal Resistance Plane
  - ✓ Moisture Resistance Plane
- Constructability
- Ensuring All Trades Understand the Design
- Reduced RFI's and Change Orders



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If you do not show a way to construct/build in a plausible means on the drawings, contractors will just make up the crap in the field!

Why?

If you do not show a way to construct/build in a plausible means on the drawings, contractors will just make up the crap in the field!

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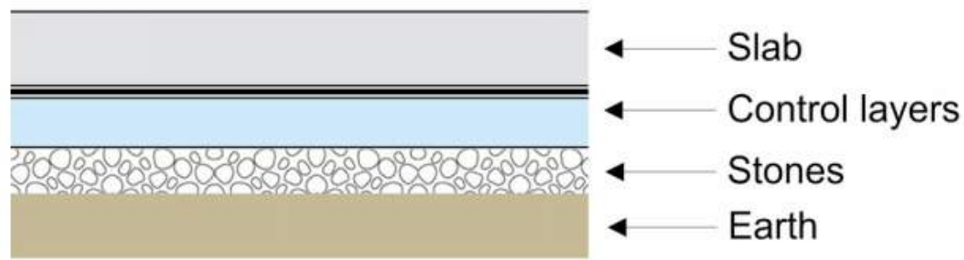
Slab Design



Slab/Footing Detailing:

- Substrate preparation
- De-watering (Well points/sump pits)
- Under slab barrier (Vapor, water, ground contaminants)
- Drainage Systems (Perimeter or under slab)
- Compatible transition substrate
- Expansion, control and cold joints
- Grade (Sidewalks, landscaping, etc.)
- Seals and penetrations

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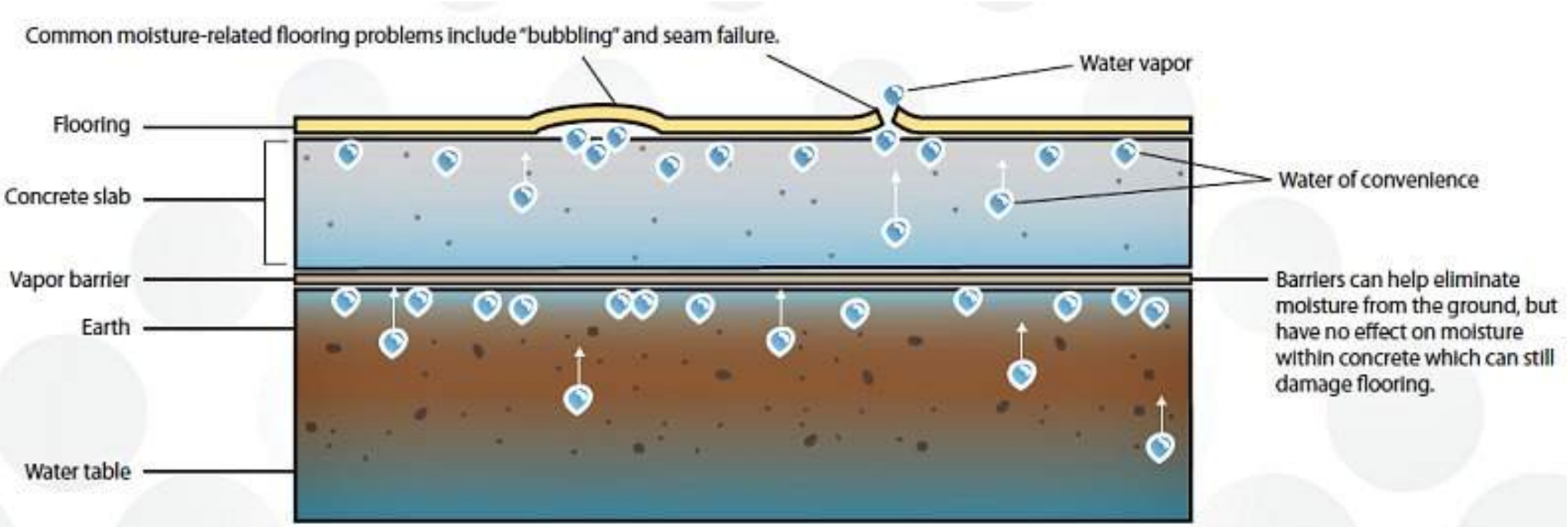
Slab Issues



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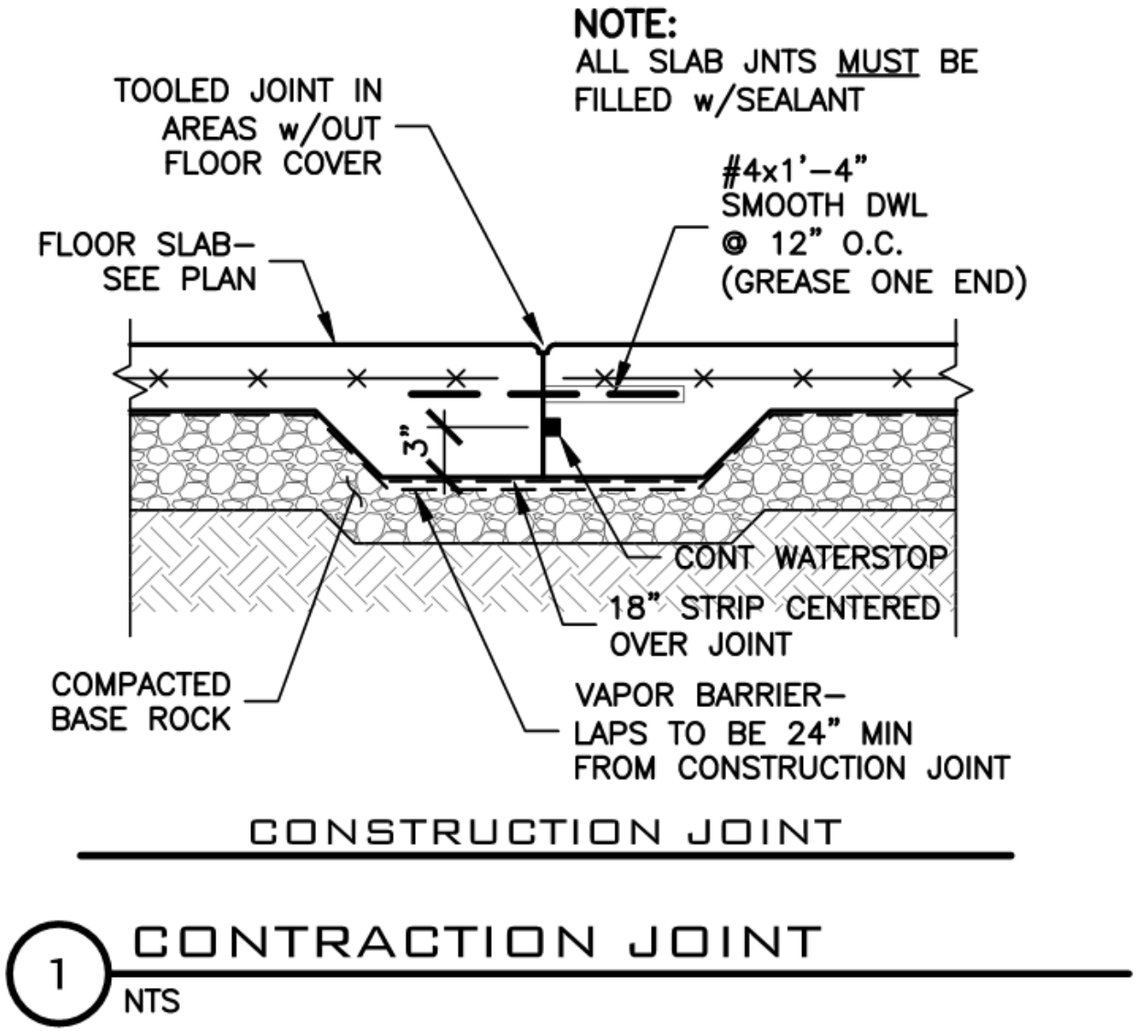
Under Slab Design



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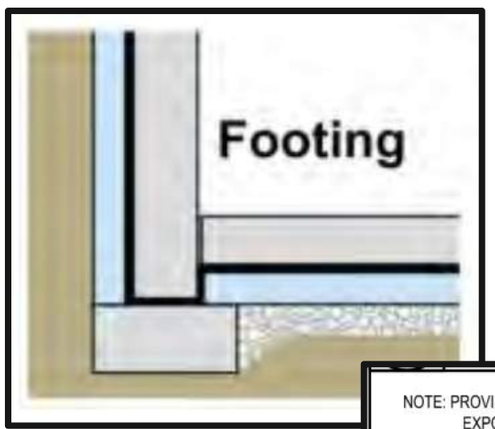
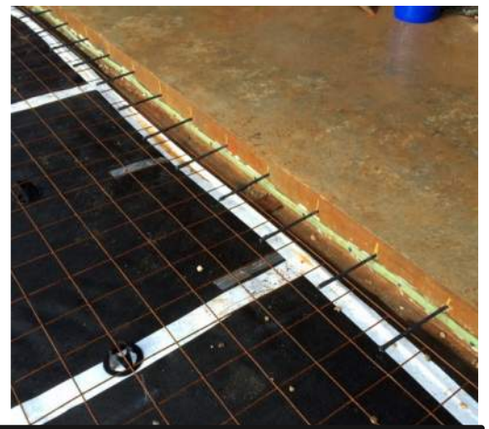
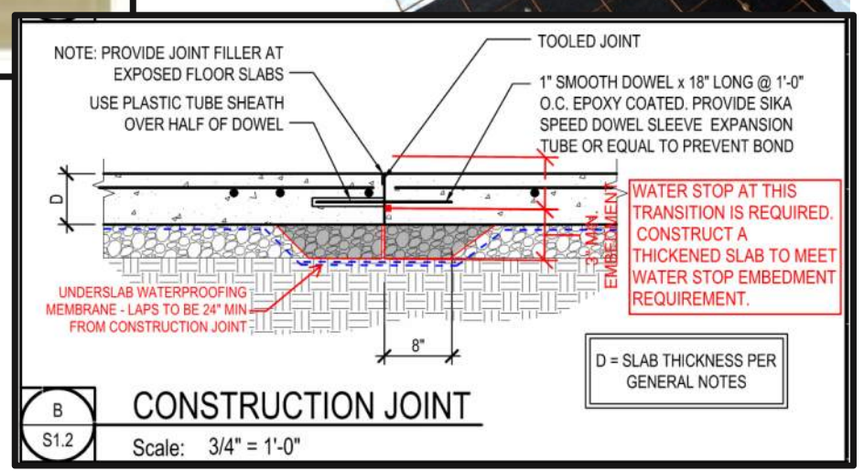
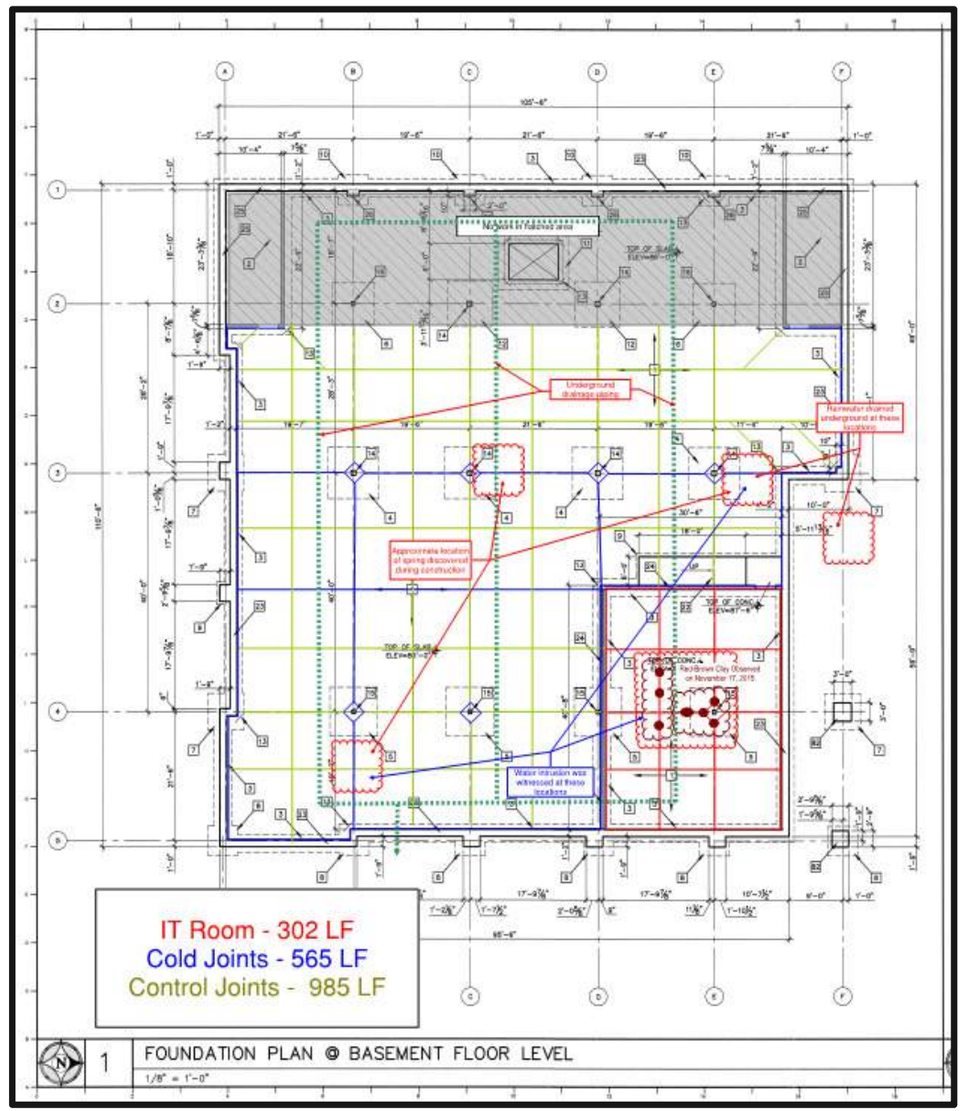
Slab Design









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Under Slab Design

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Under Slab Conduit Bank

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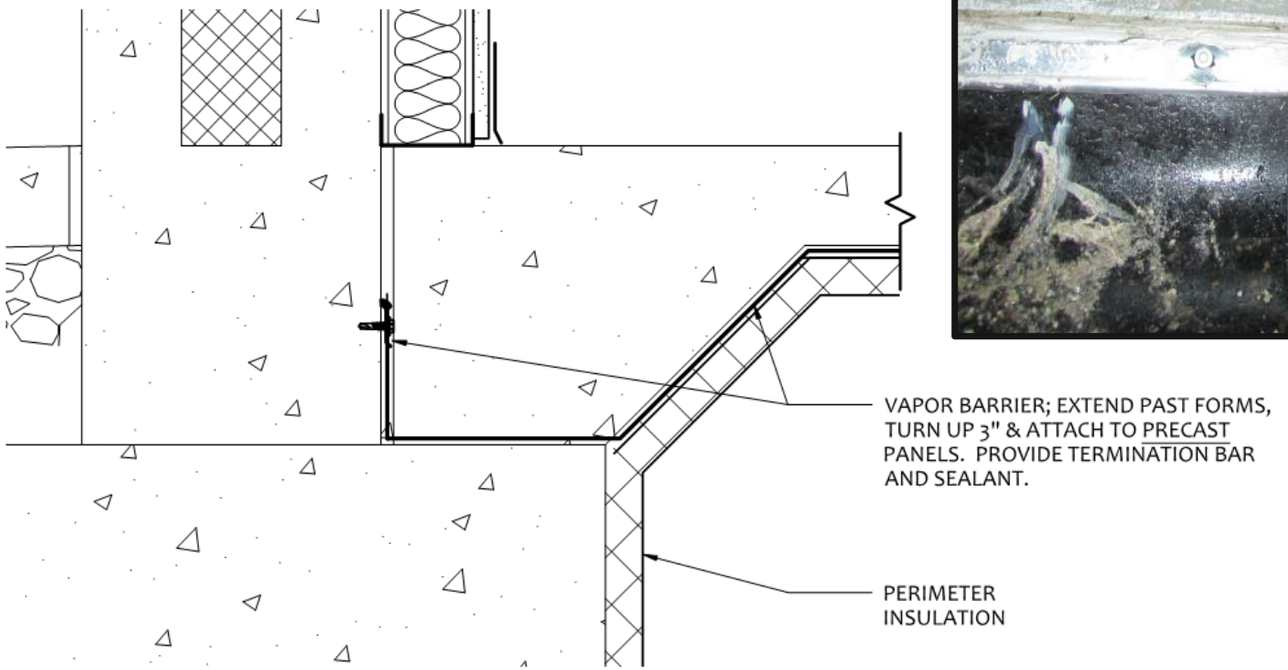

7 VAPER BARRIER AT SLAB - ENDWALL

NOT TO SCALE

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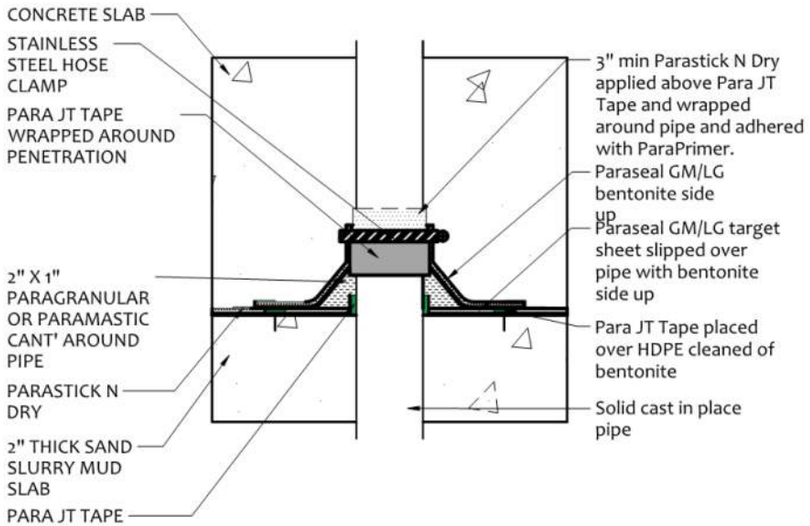

4 VERTICAL PIPE PENETRATION DETAIL

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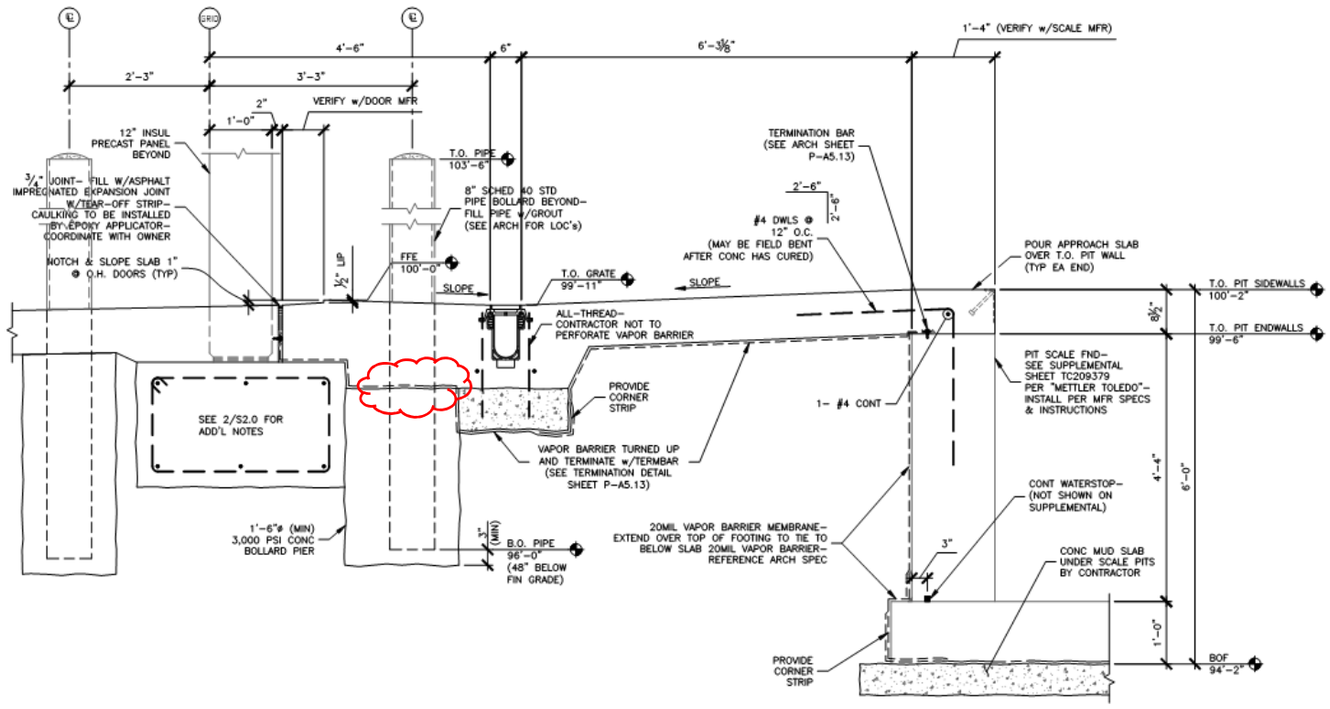

6 SECTION

¾"= 1'-0"

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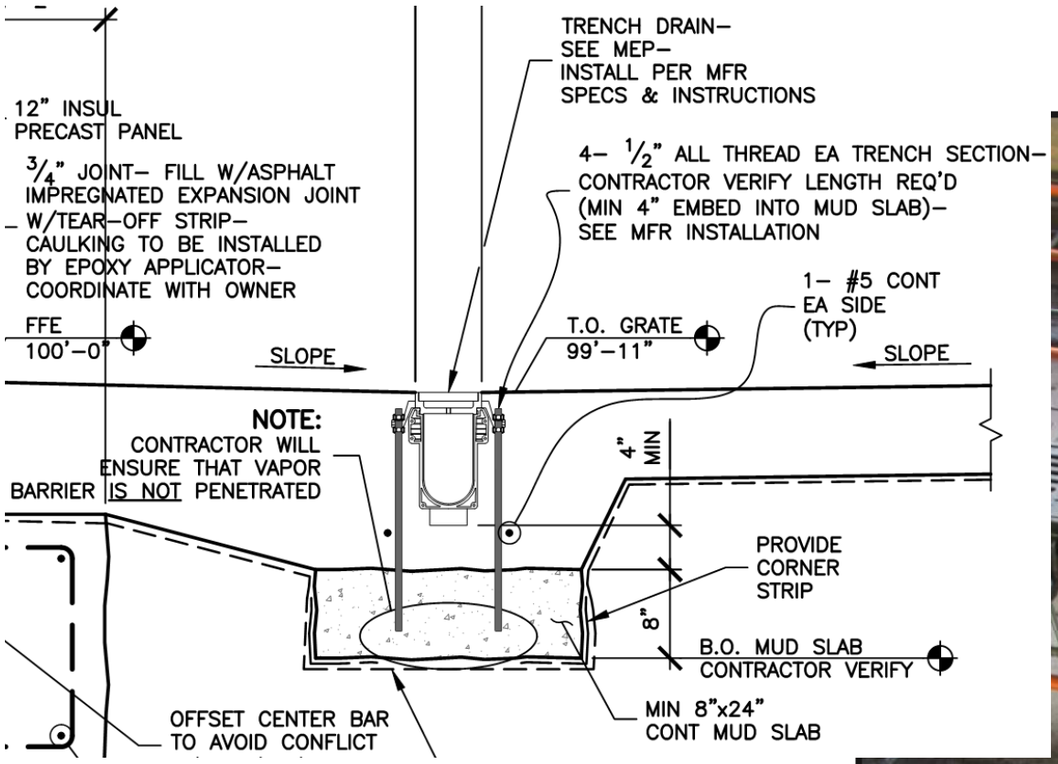

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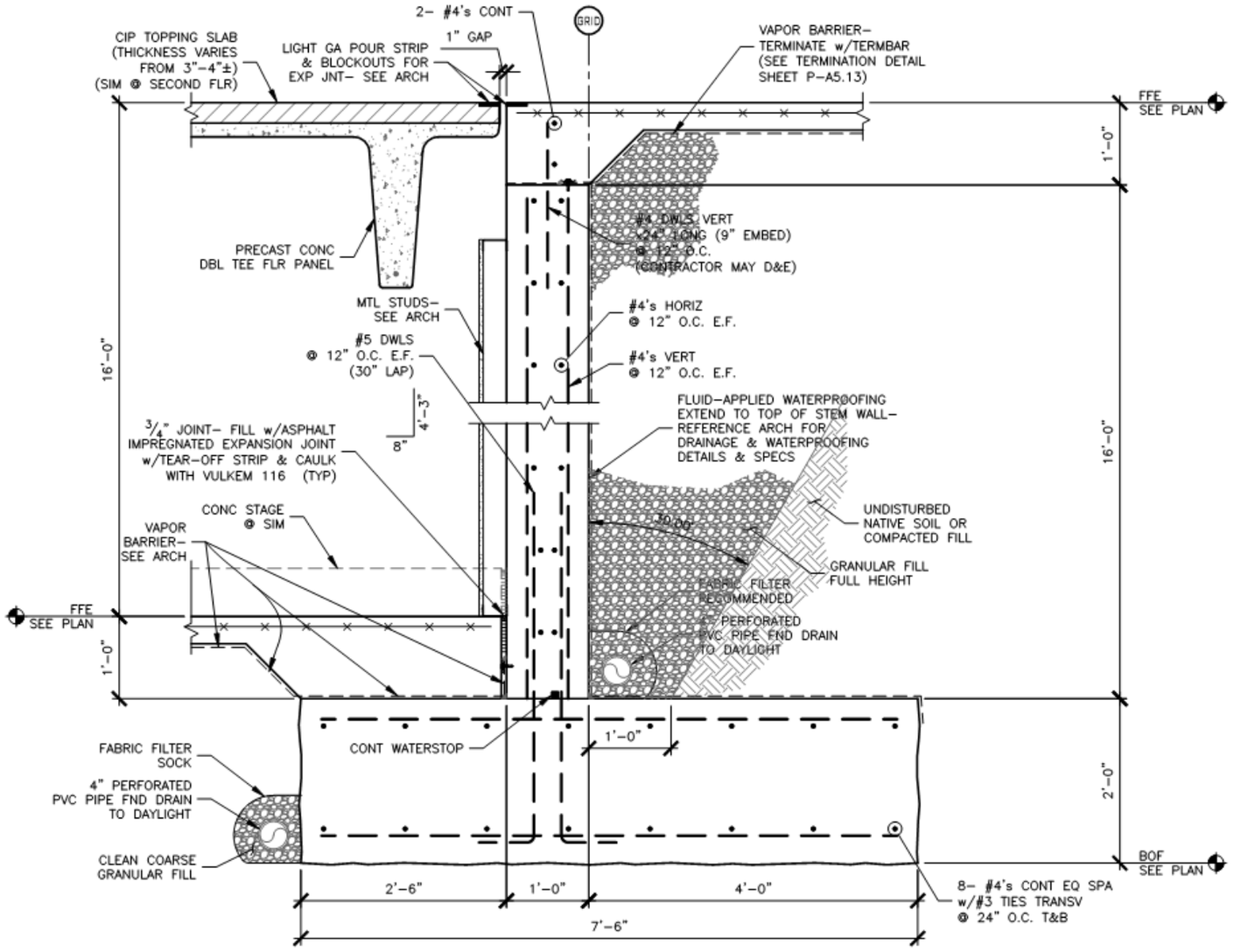

1 SECTION
3/4"= 1'–0"

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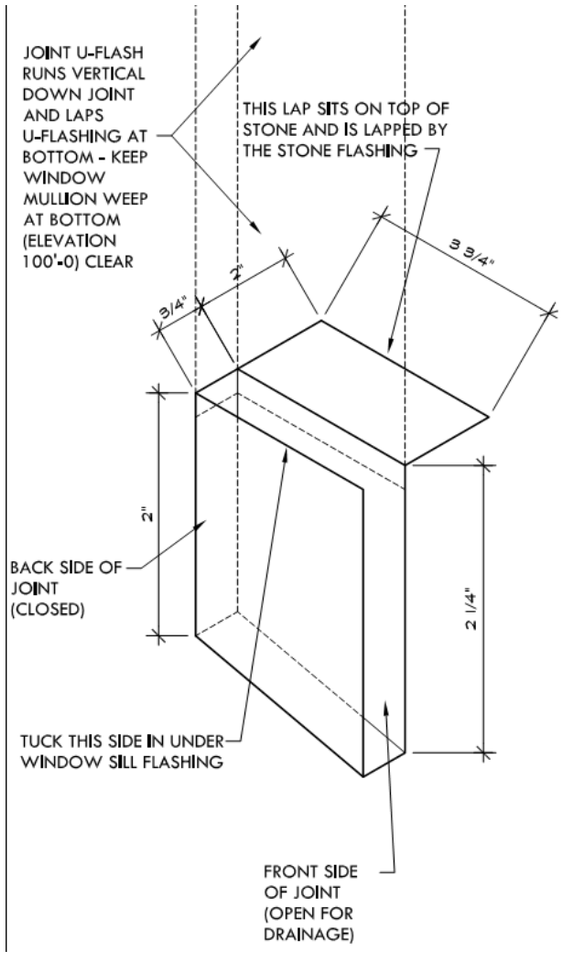

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Wall Types

System Options:

- Mass Wall (or Storage) Assemblies
  - ✓ Rubble
  - ✓ Solid Masonry Composite/Layered
- Screened and Drained
  - ✓ Lap Siding
  - ✓ Panel Cladding System
  - ✓ Masonry Veneer
- Perfect Barrier (Face Sealed)
  - ✓ Architectural Precast Concrete
  - ✓ Steel-Clad Foam Panels
  - ✓ Glazing

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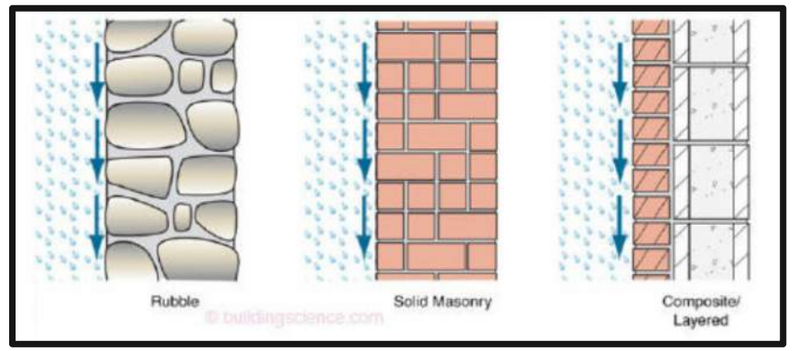
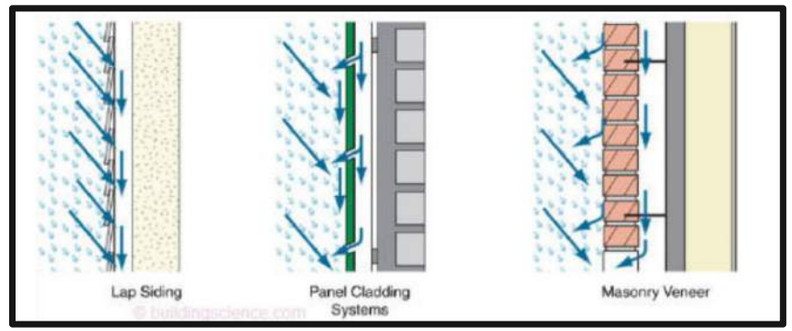
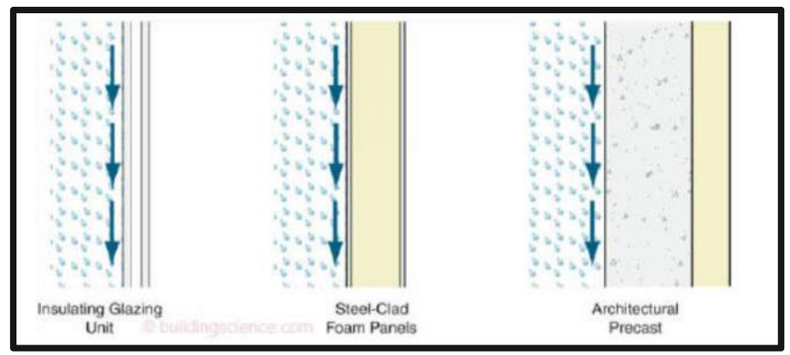


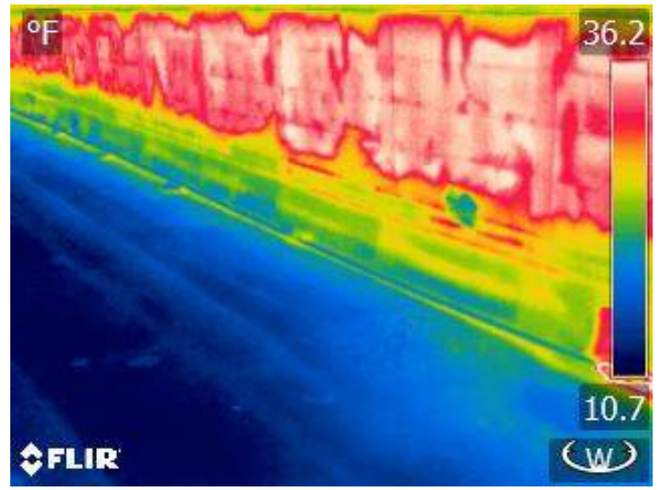


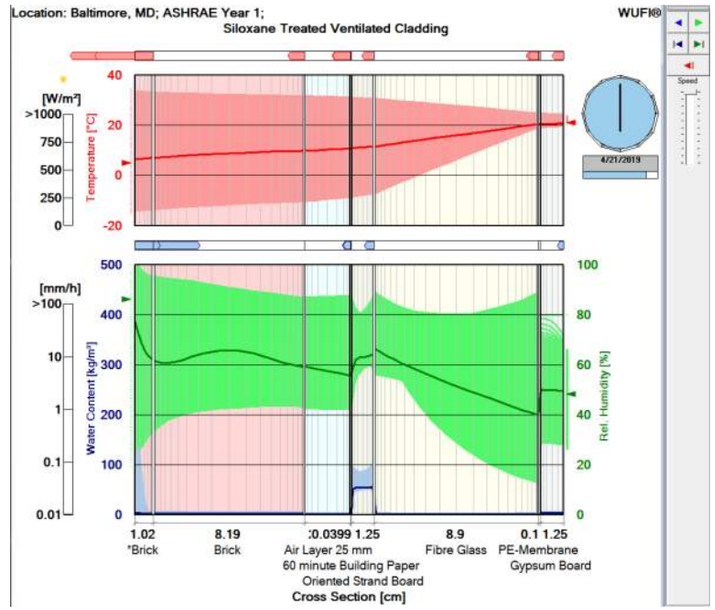


Wall Design

Drying of Assembly:

- Orientation
- Exposure
- Saturation
- Temperature/RH%
- Thermal Bridging
- Vapor Permeance
- Air Movement
- Fire Resistance
- Wind Load





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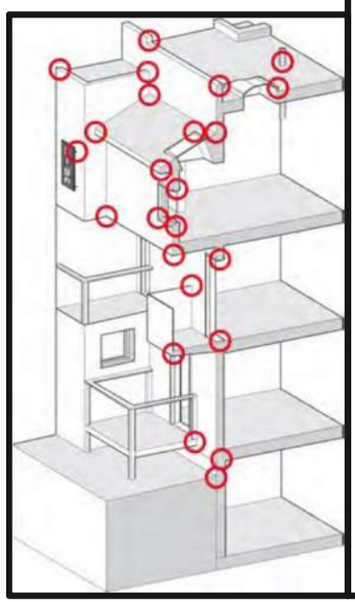
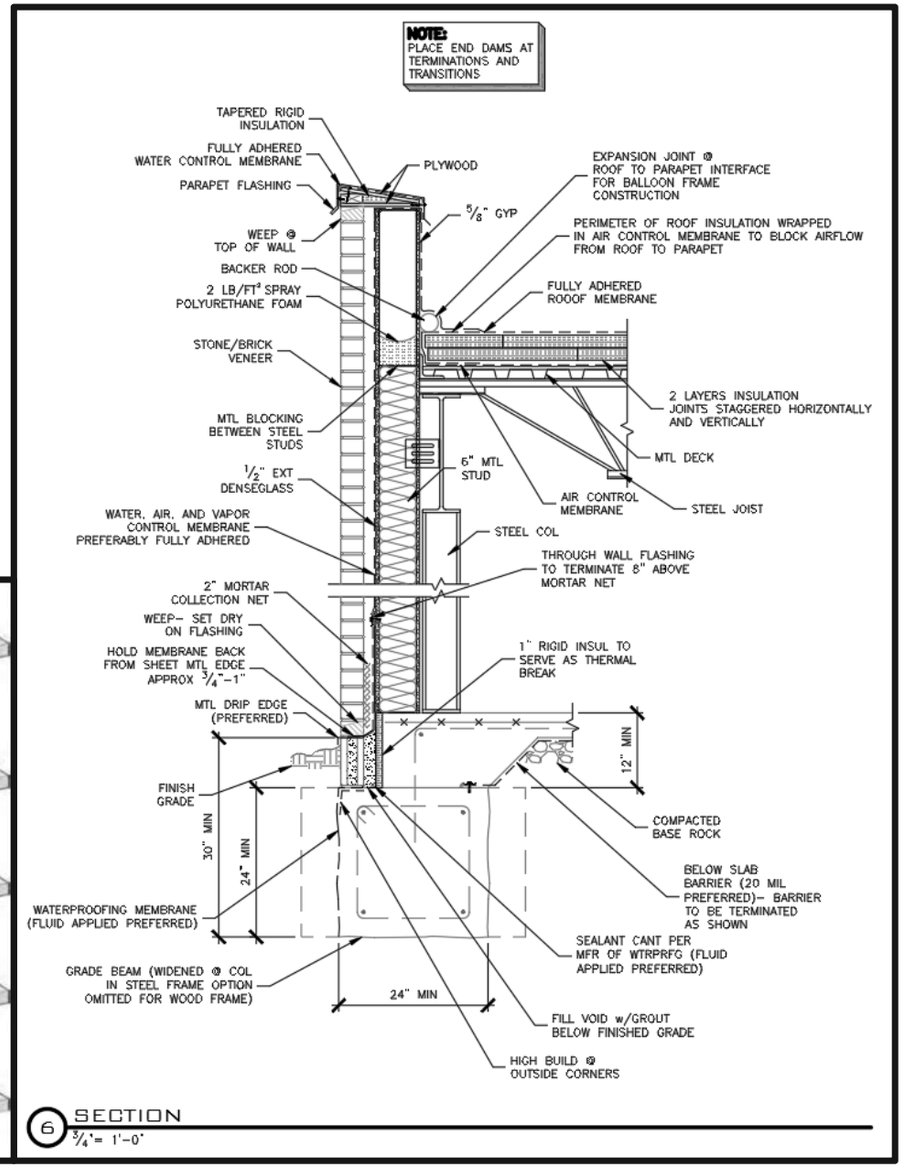
Wall assemblies must be allowed to dry to the interior in warm climates and primarily to the exterior in cold climates. Why?

Principles of Detailing

Wall Detailing:

- Through wall flashing/drip edge
- Corners (Inner and outer)
- End dams
- Three sided end dam
- Head flashing
- Jamb flashing
- Sill pan flashing
- Receptors and Windows
- Vertical cavity closure
- Seals between dissimilar materials
- Expansion and control joints
- Expansion Joints between building
- Continuity of air/moisture barrier
- Insulation
- Vapor retarder
- Cap flashing





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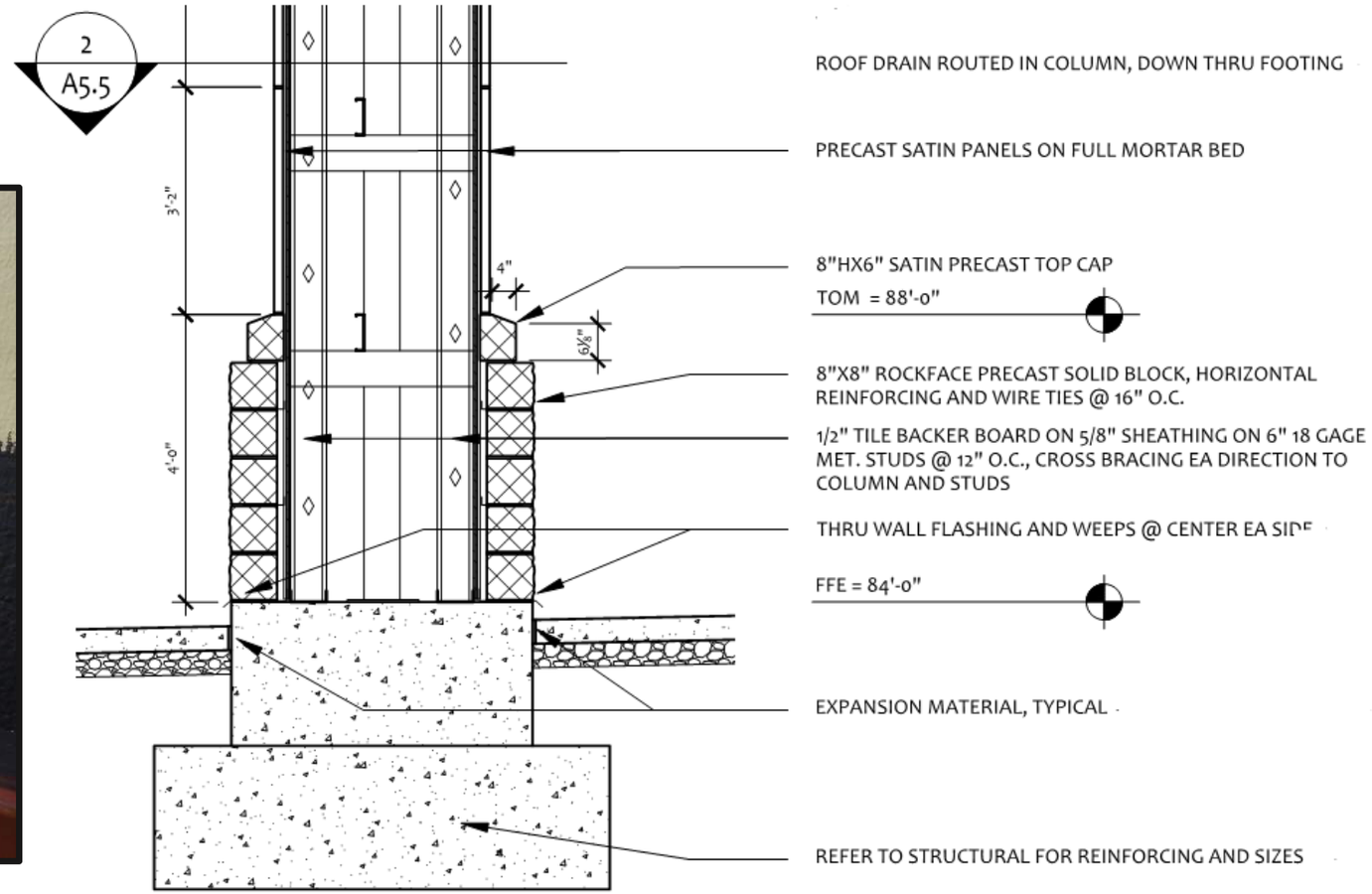
Wall Design



3 WALL SECTION

0 1' 2' 4'

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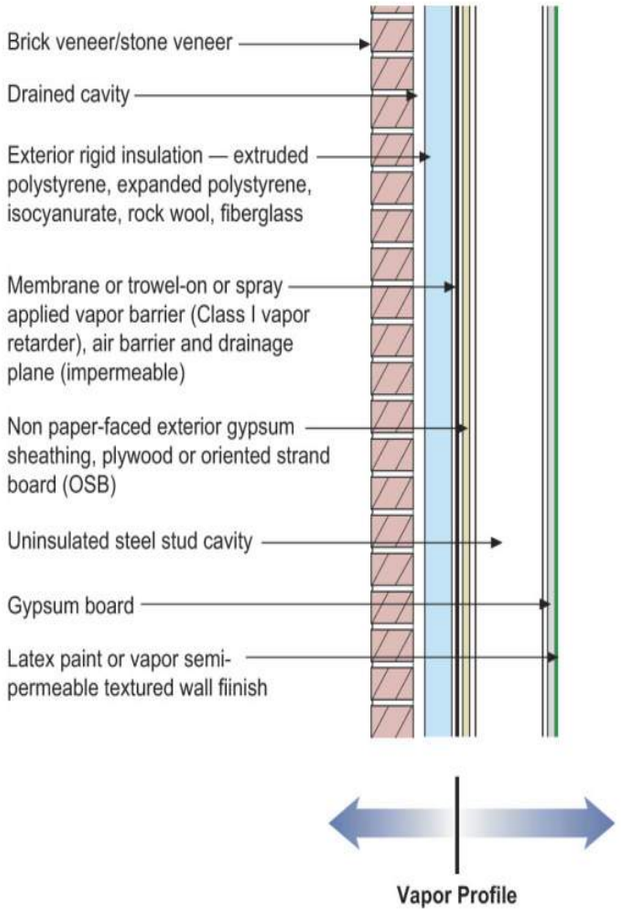
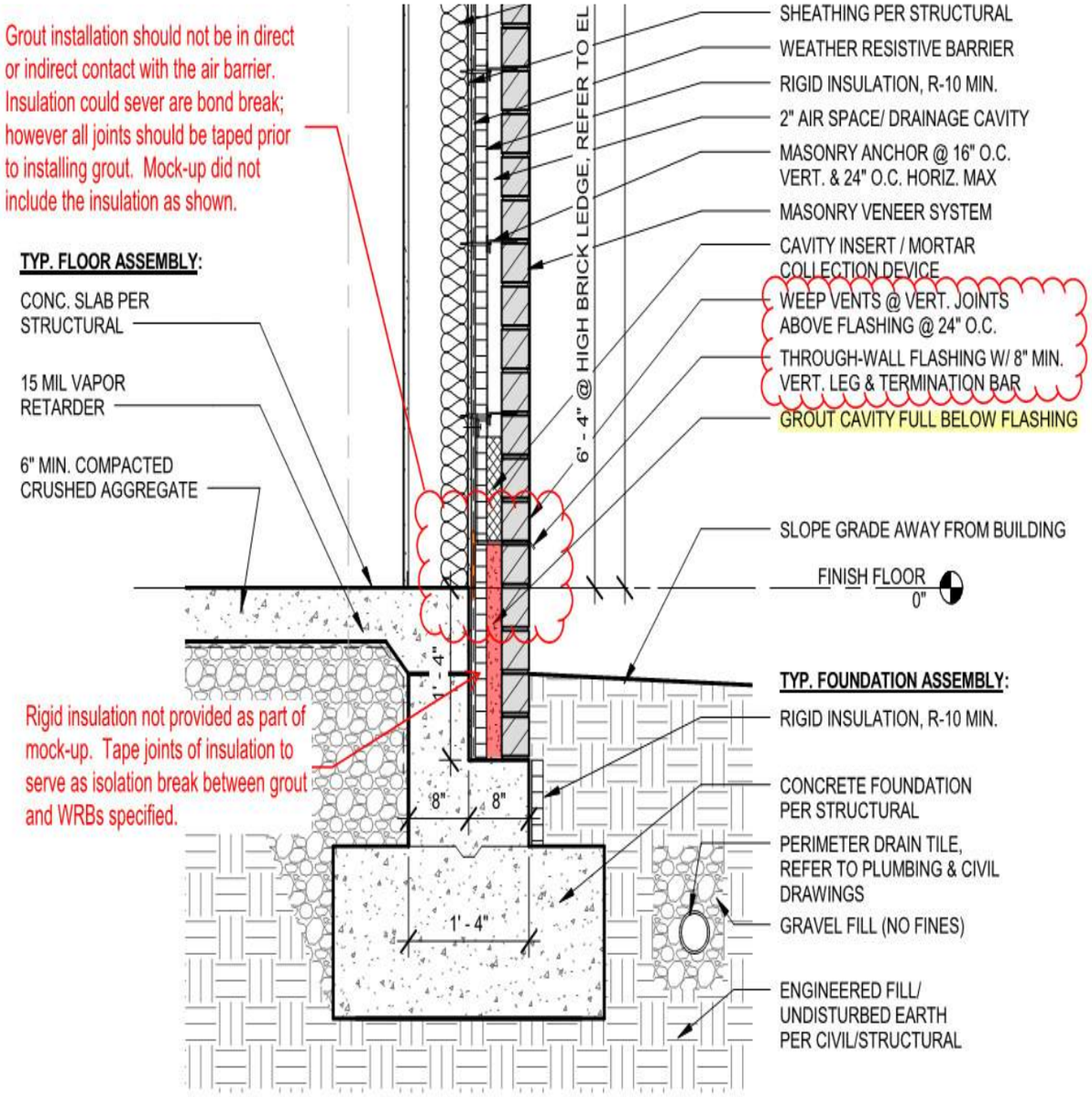
Wall Design



Frame Wall With Exterior Insulation and Brick or Stone Veneer



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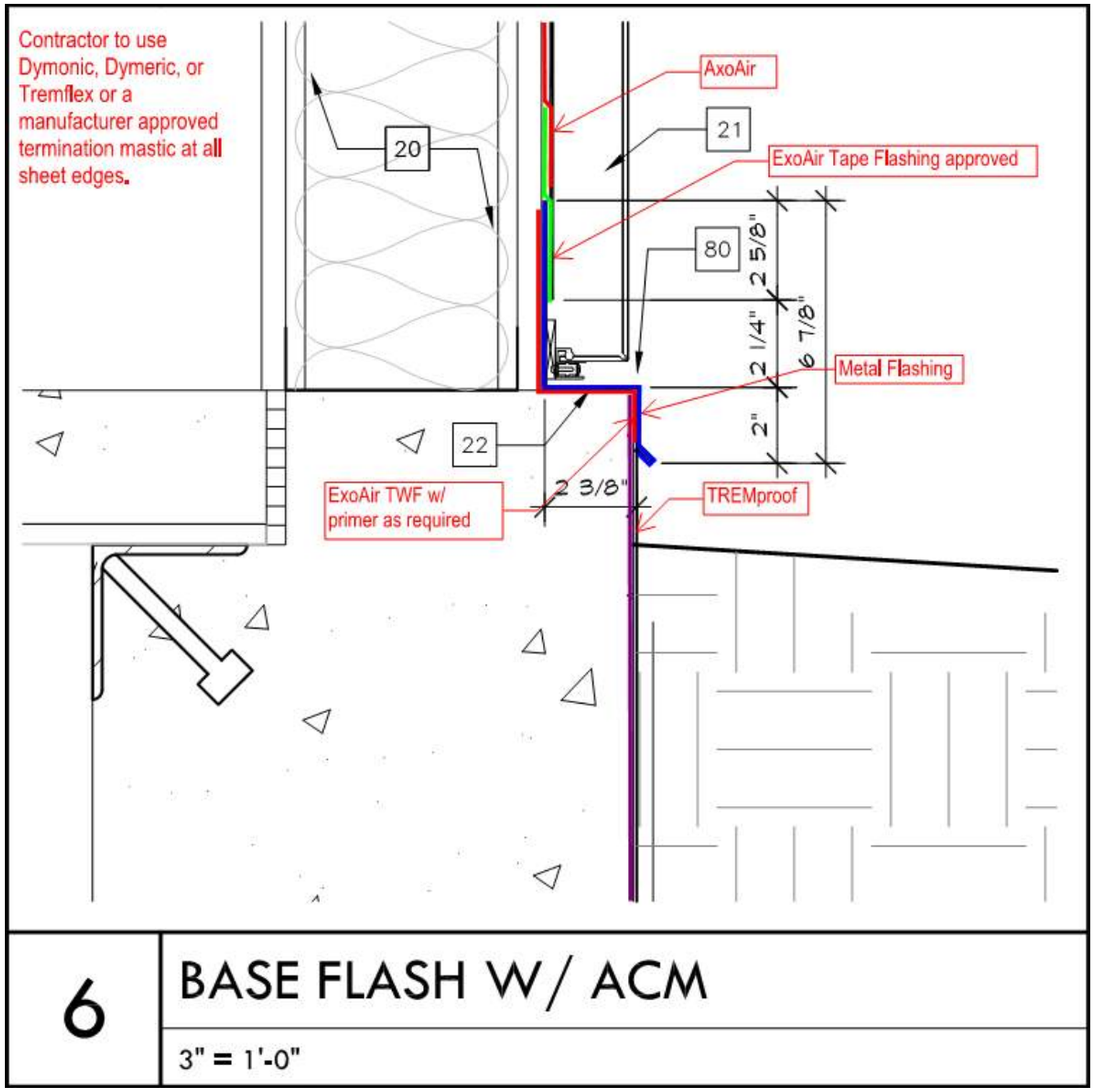

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Base Flashing:
Flashing Sequencing coordination with various trades

Transition Details

Understanding the systems when detailing will help the contractor understand sequencing of installation.

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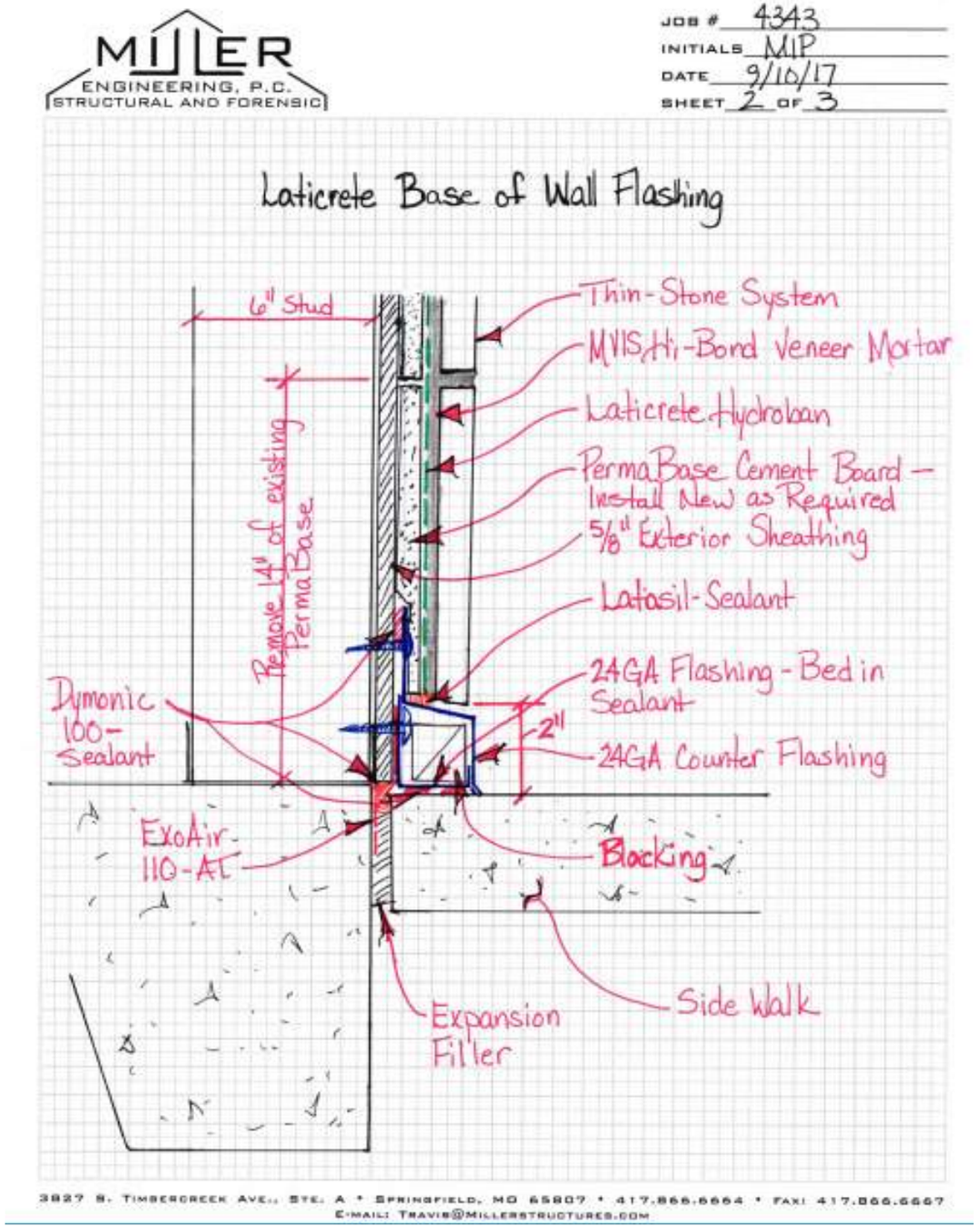
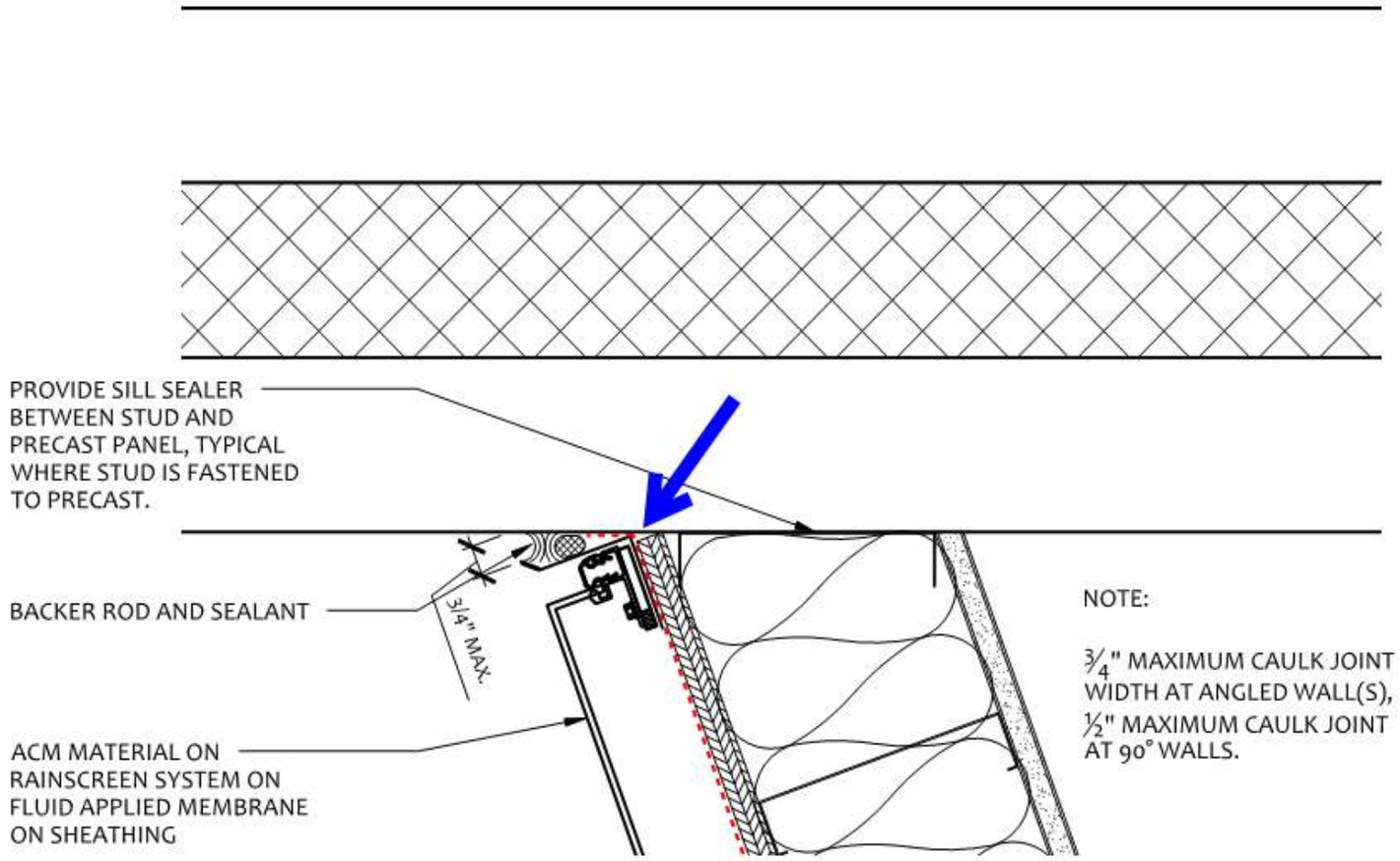


Wall Design

Transition to pre-cast panel with air control



7 EXT. STUD TO PRECAST DETAIL

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Curtain Wall Sill Design

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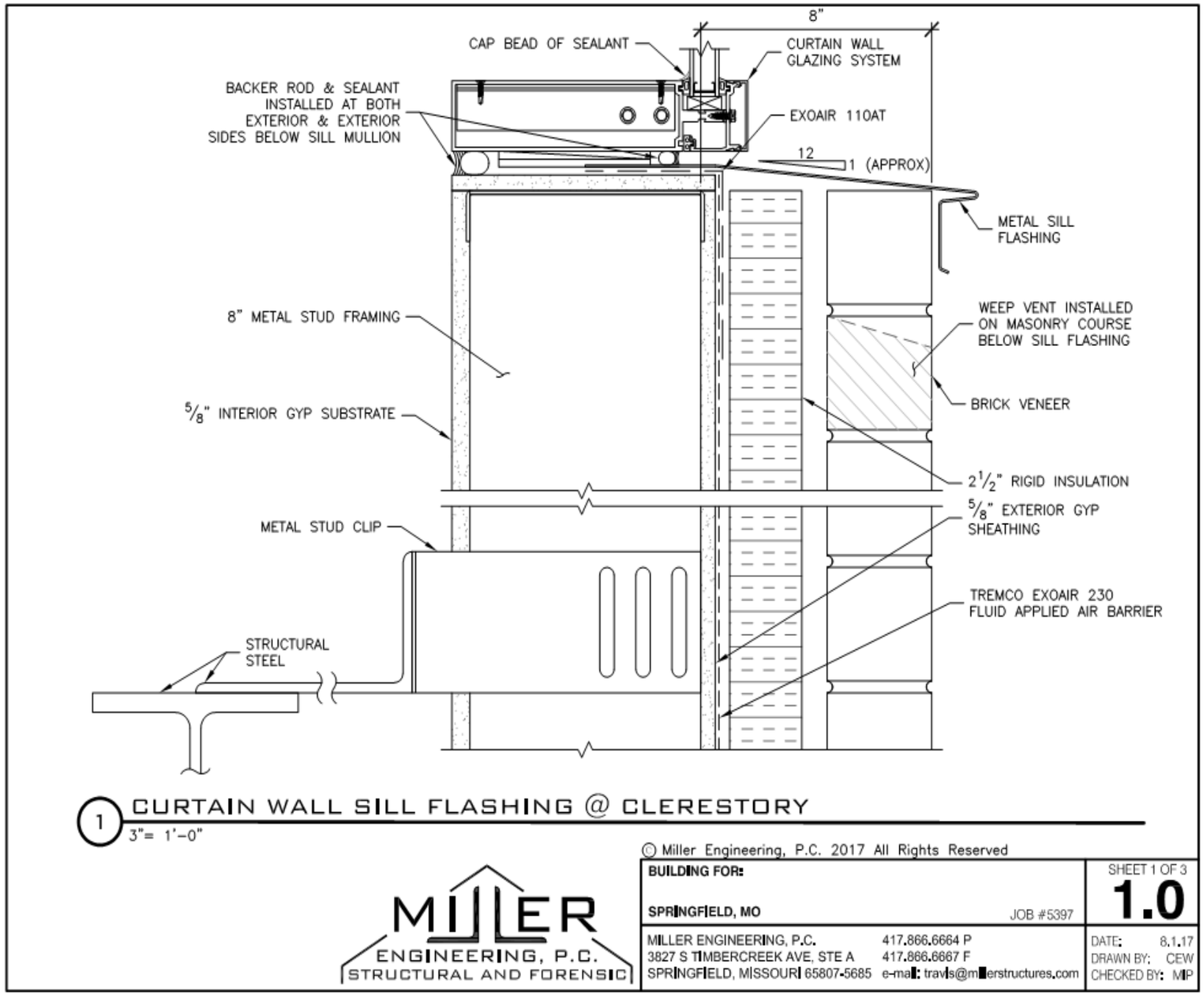

MILLER ENGINEERING, P.C.
STRUCTURAL AND FORENSIC

BUILDING FOR:
SPRINGFIELD, MO JOB #5397

SHEET 1 OF 3
1.0

MILLER ENGINEERING, P.C.
3827 S TIMBERCREEK AVE, STE A
SPRINGFIELD, MISSOURI 65807-5685
417.866.6664 P
417.866.6667 F
e-mail: travis@millerstructures.com

DATE: 8.1.17
DRAWN BY: CEW
CHECKED BY: MP

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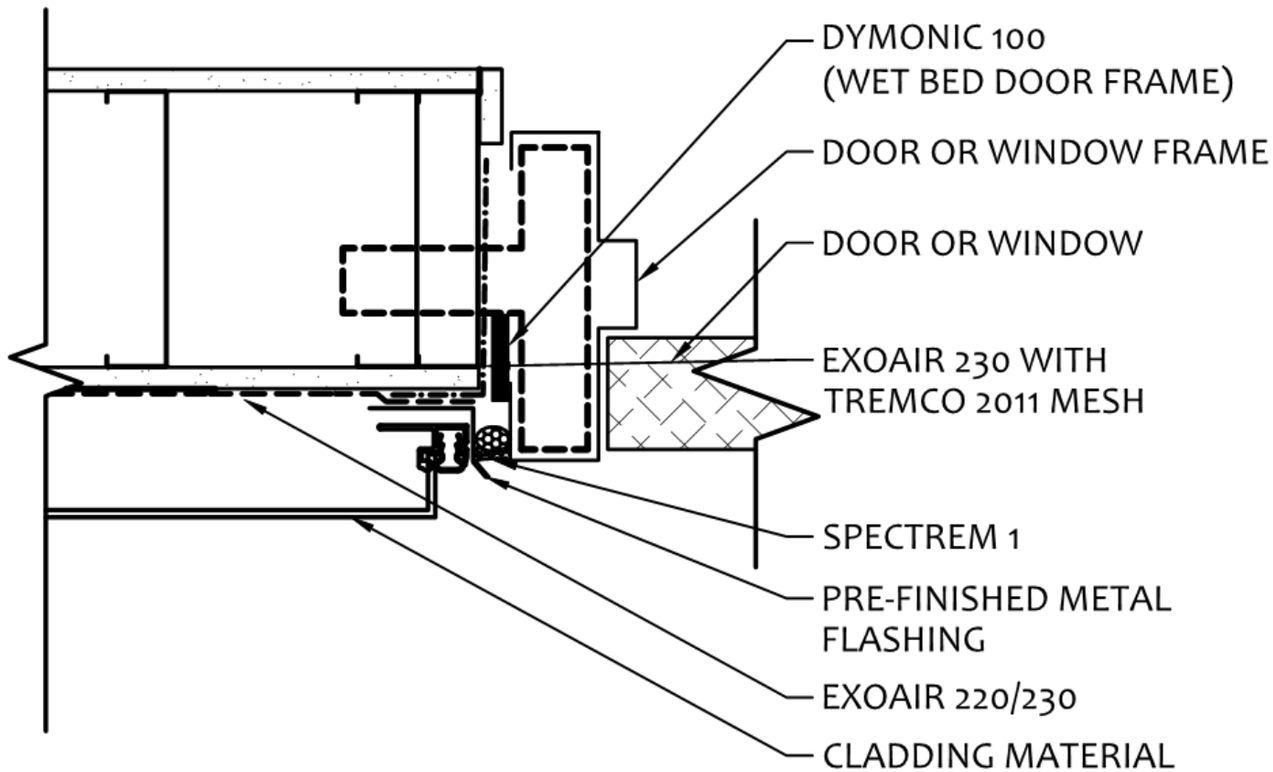
Sample of Sill Flashing Install –
The obvious sometimes does not
get done!

Wall Design
Door Jamb



1 HEAD/JAMB DETAIL

NOT TO SCALE

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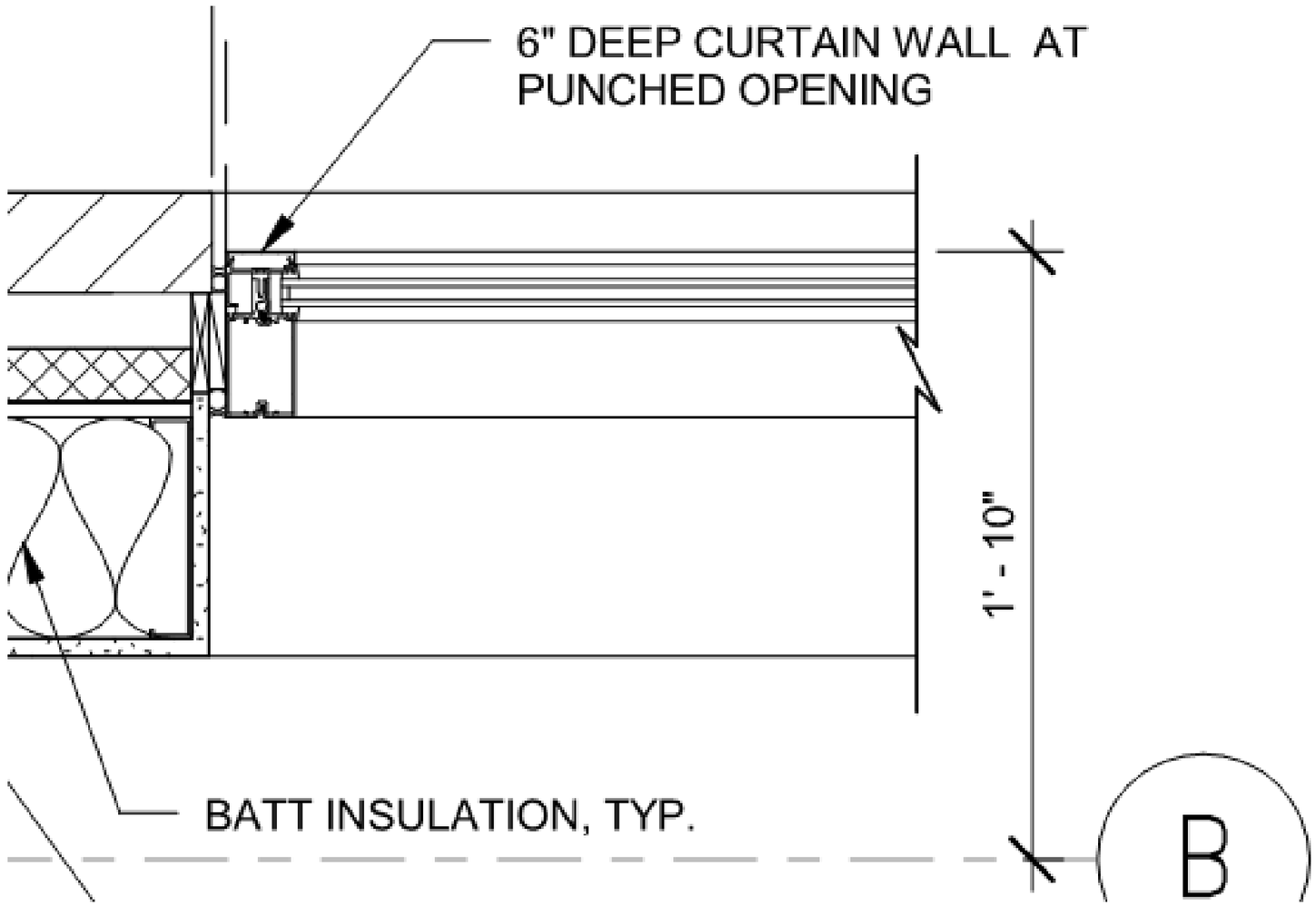

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Original Jamb Detail

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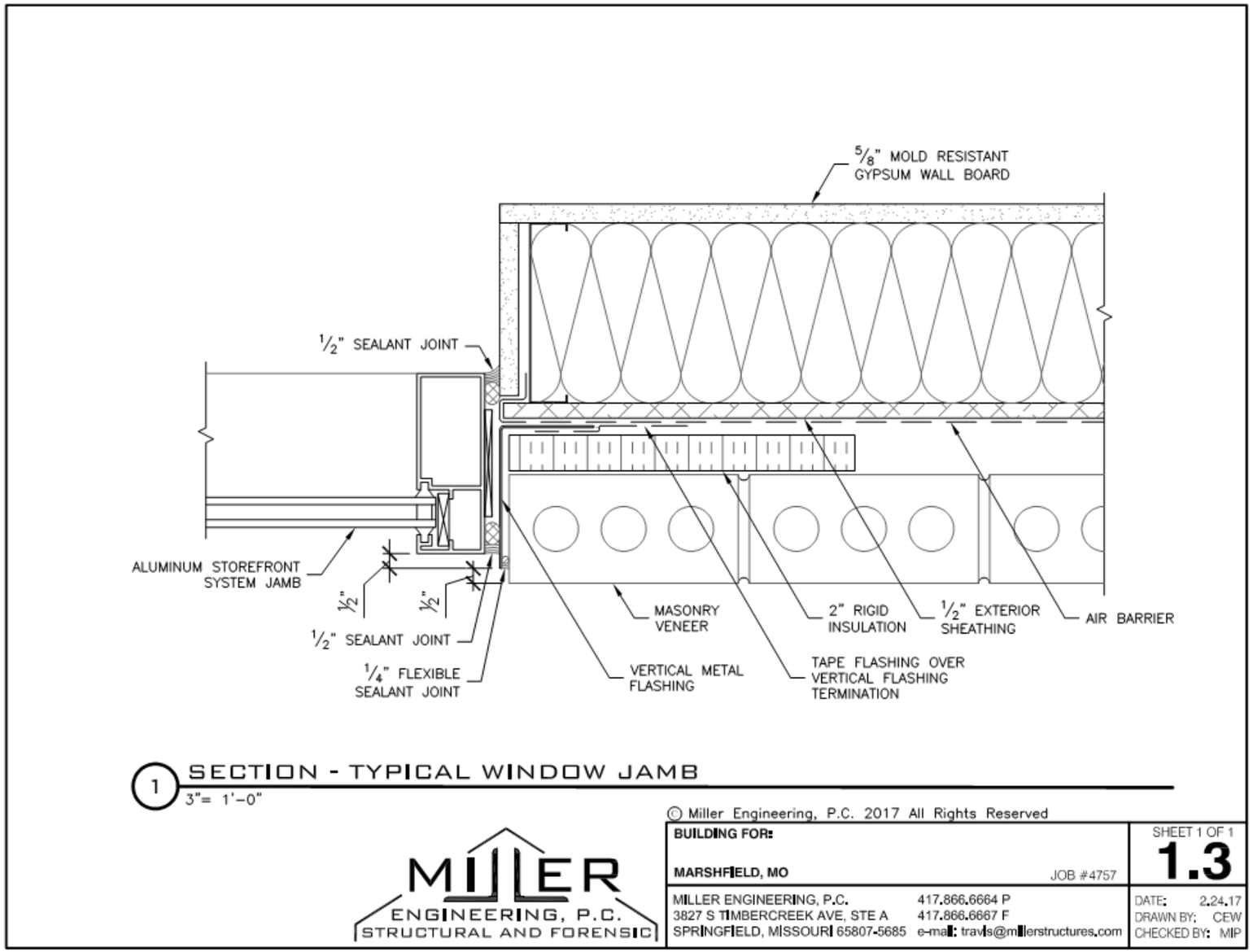

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Revised Jamb Flashing Detail

If you don't detail it, it will not happen in the field.

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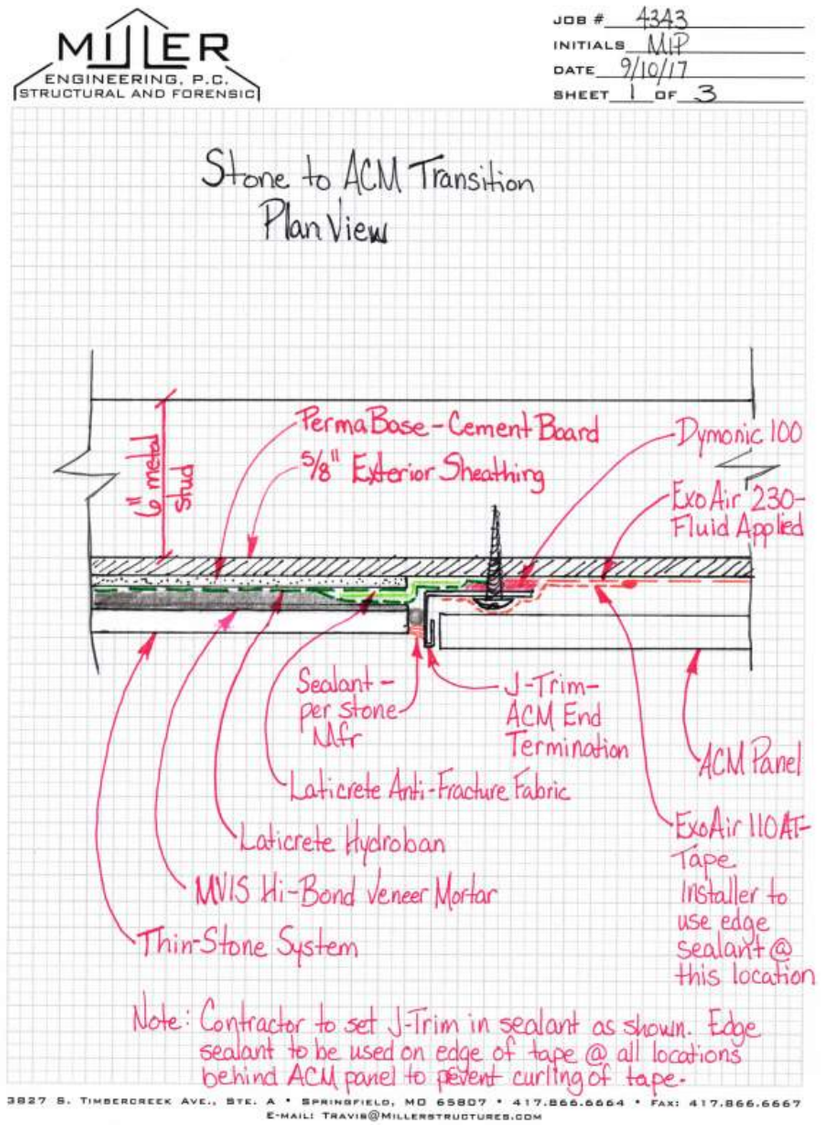
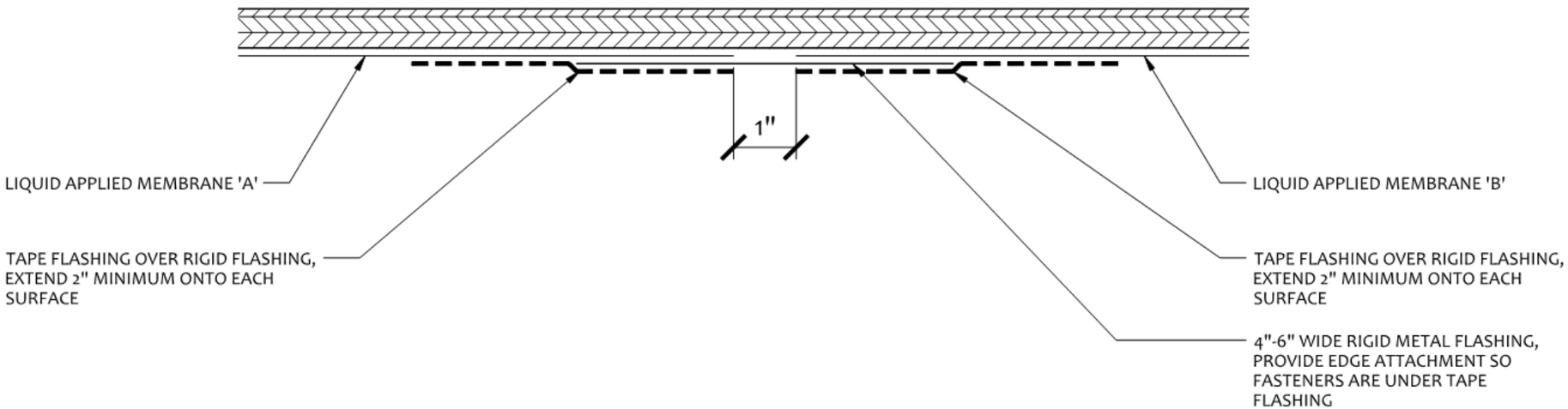


Sample of Transition Detail

Dissimilar Fluid-Applied Transition



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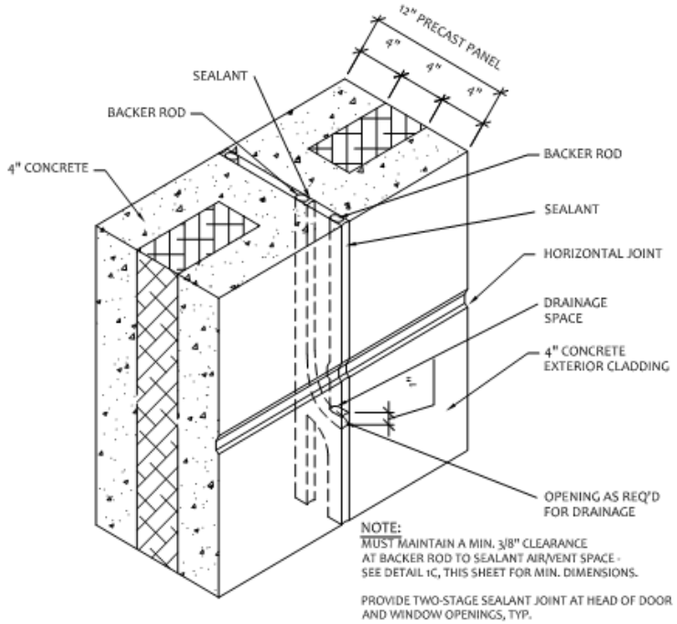
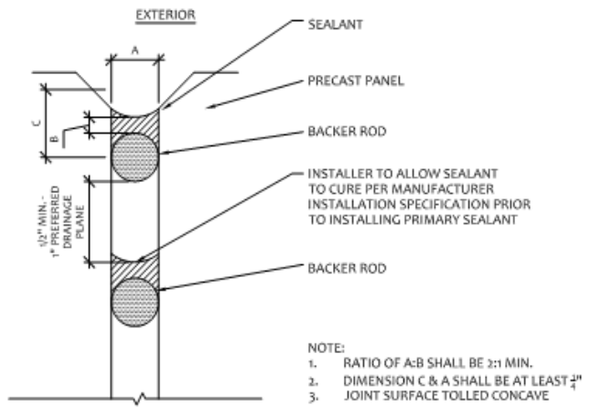
11 TRANSITION OF DISSIMILAR LIQUID APPLIED AIR BARRIERS

NOT TO SCALE

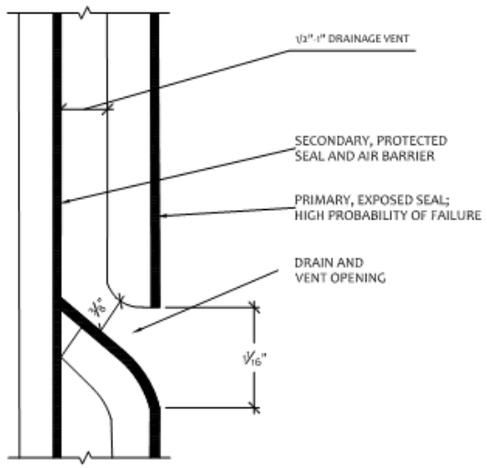
Pre-Cast Wall Design



1A TWO-STAGE SEALANT JOINT
NOT TO SCALE



1B SEALANT JOINT - TWO-STAGE OPTION
NOT TO SCALE



1C DRAINAGE PLANE DETAIL
NOT TO SCALE

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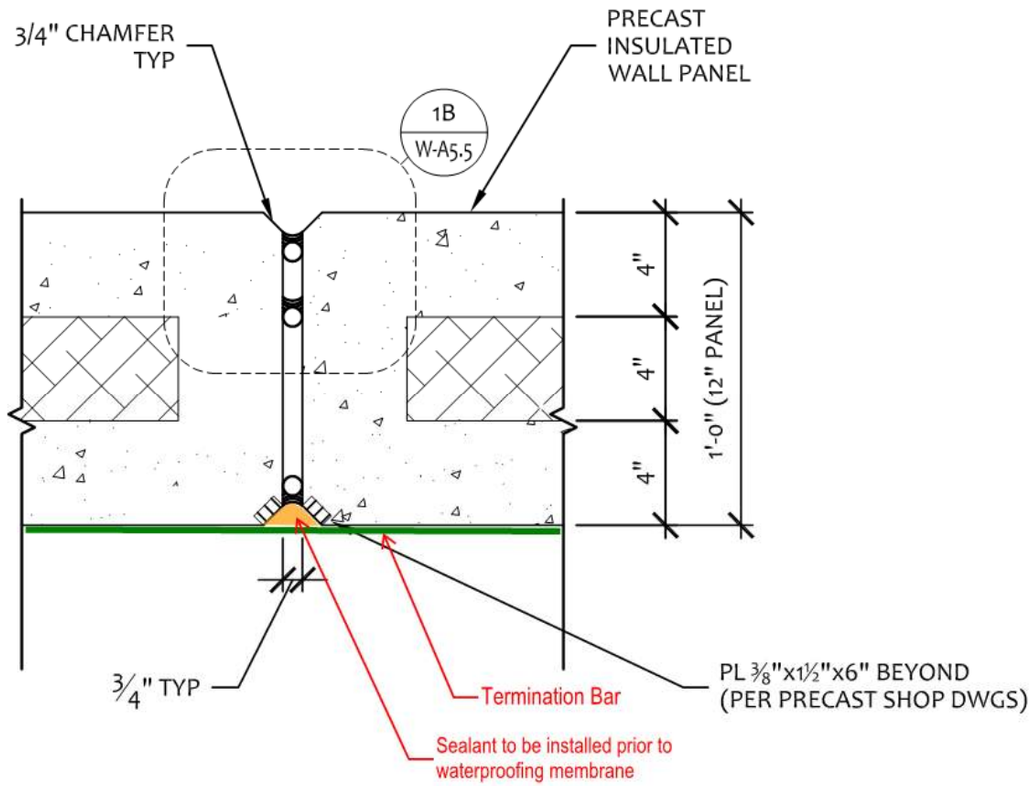
Pre-Cast Wall Design



2 TYP PANEL JOINT DETAIL (12" THK. INSUL PANEL)
NOT TO SCALE

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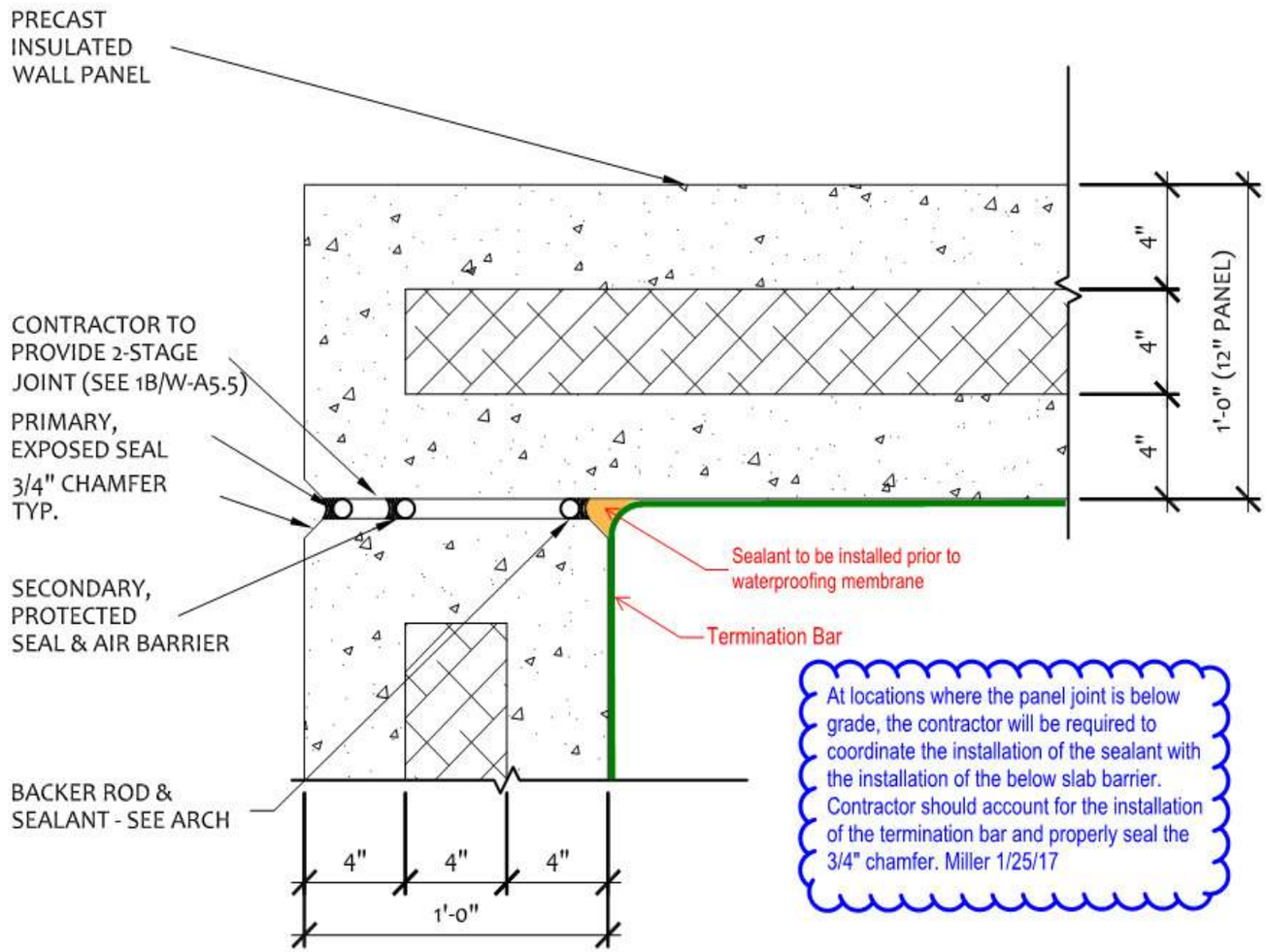
Pre-Cast Wall Design



3 SEALANT JOINT - TWO-STAGE OPTION

NOT TO SCALE

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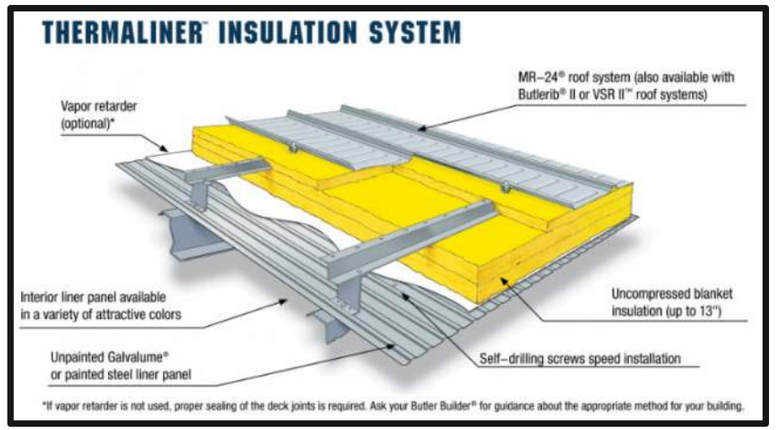
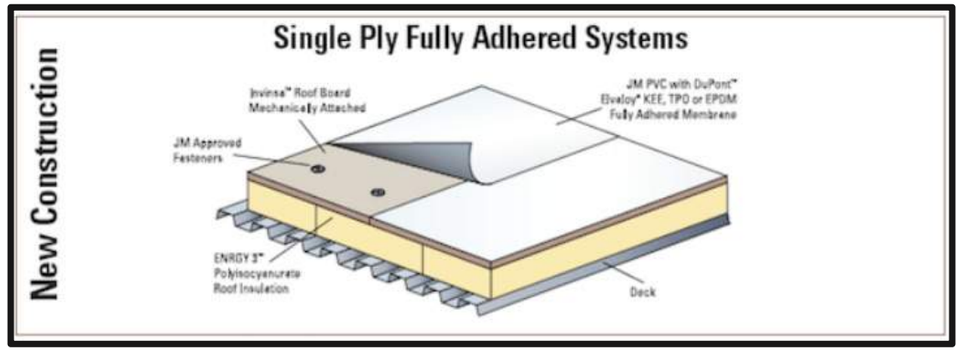
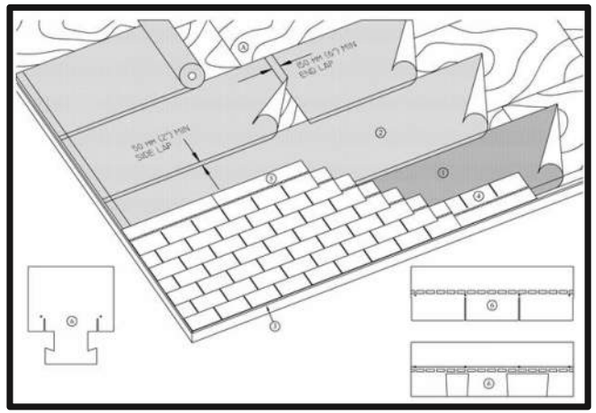
Roof Types

System Options:

- Metal Roof Panel
- Single-Ply Roof Systems
  - ✓ TPO (Thermoplastic Polyolefin)
  - ✓ PVC (Polyvinyl Chloride)
  - ✓ EPDM (Ethylene Propylene Diene Monomer)
- Multilayer Roof Systems
  - ✓ APP (Atactic Polypropylene)
  - ✓ SBS (Styrene Butadiene Styrene)
  - ✓ SBR (Styrene Butadiene Rubber)
- Pitched Roof Systems
  - ✓ Asphalt Shingle
  - ✓ Slate Shingles
  - ✓ Tile Shingles
  - ✓ Wood Shake







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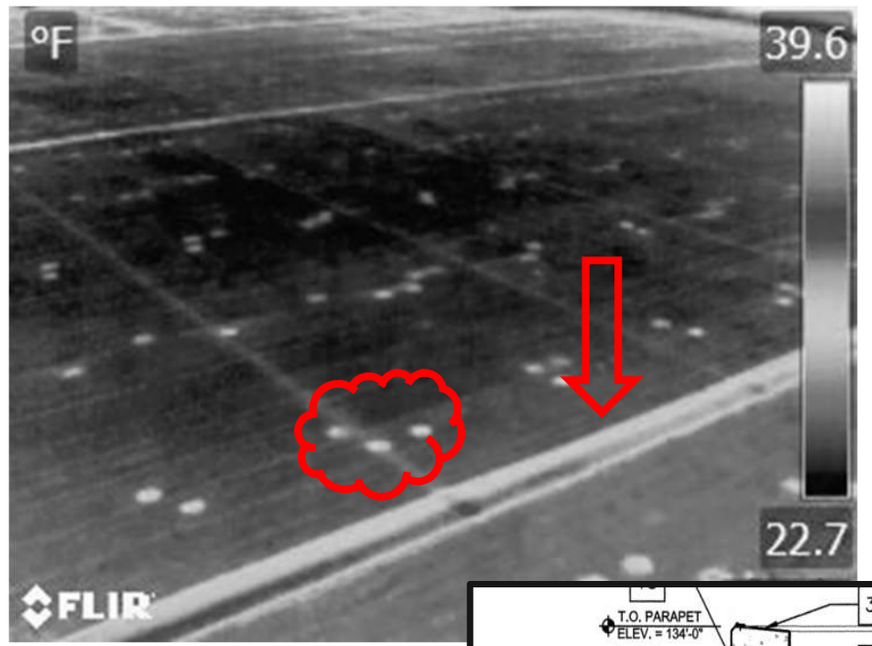
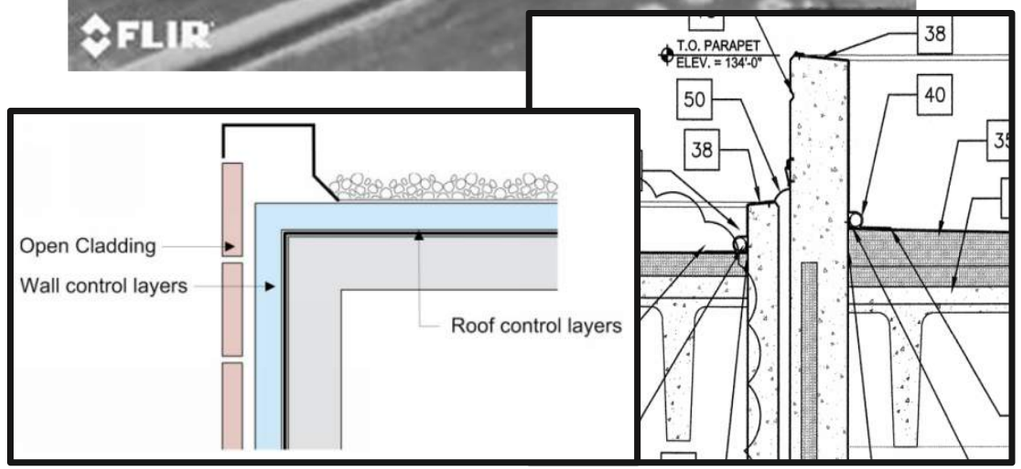
Roof Design

Roof Detailing:

- Eaves, Diverter Flashing and Scuppers
- Penetrations and Edges
- Pads and Curbs
- Exterior Walls Design and continuity of air/moisture barrier
- Wall to coping coordination
- Expansion Joint
- Roof Supporting the Parapet
- Wall Supporting the Parapet





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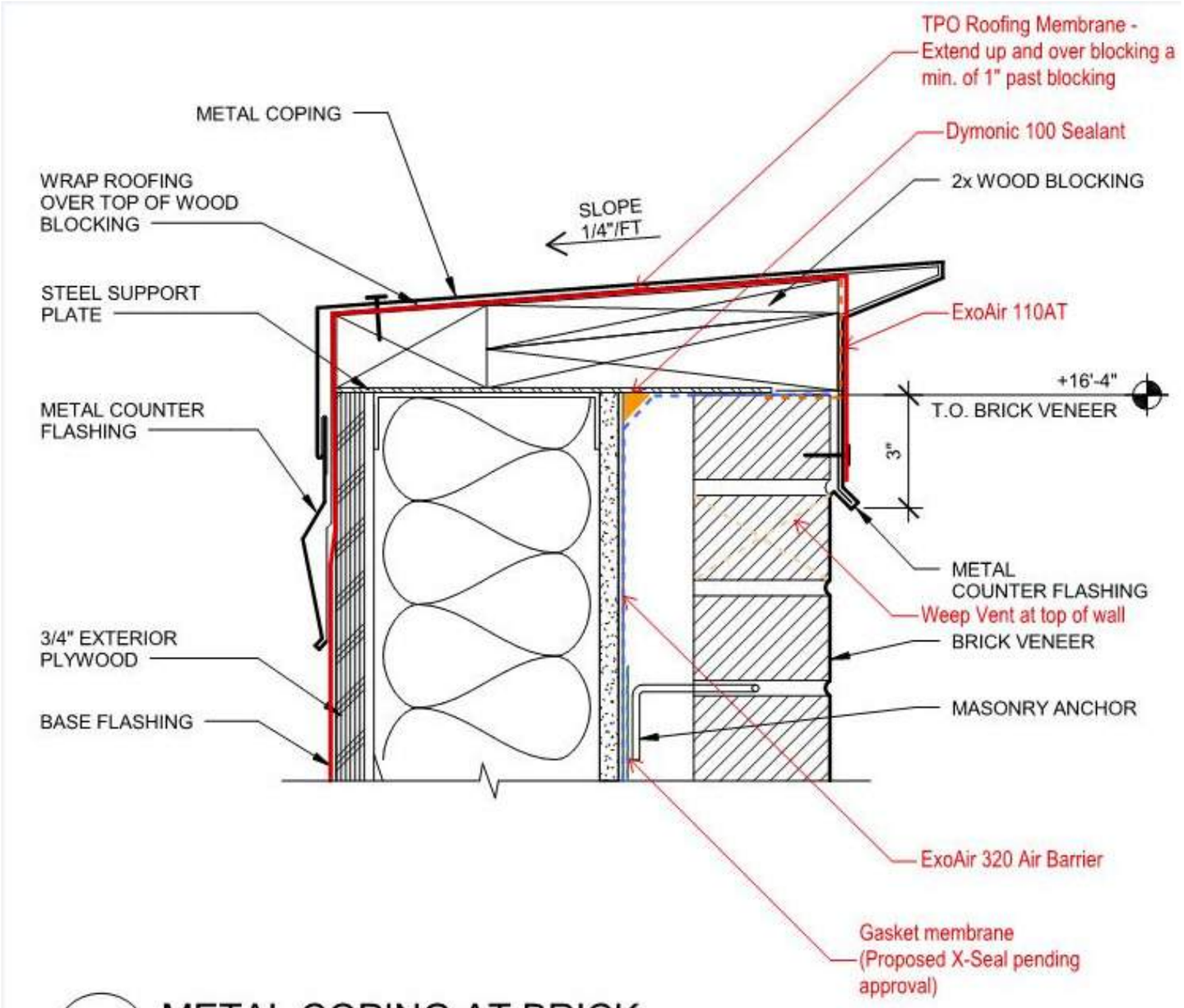

3 METAL COPING AT BRICK

3" = 1'-0"

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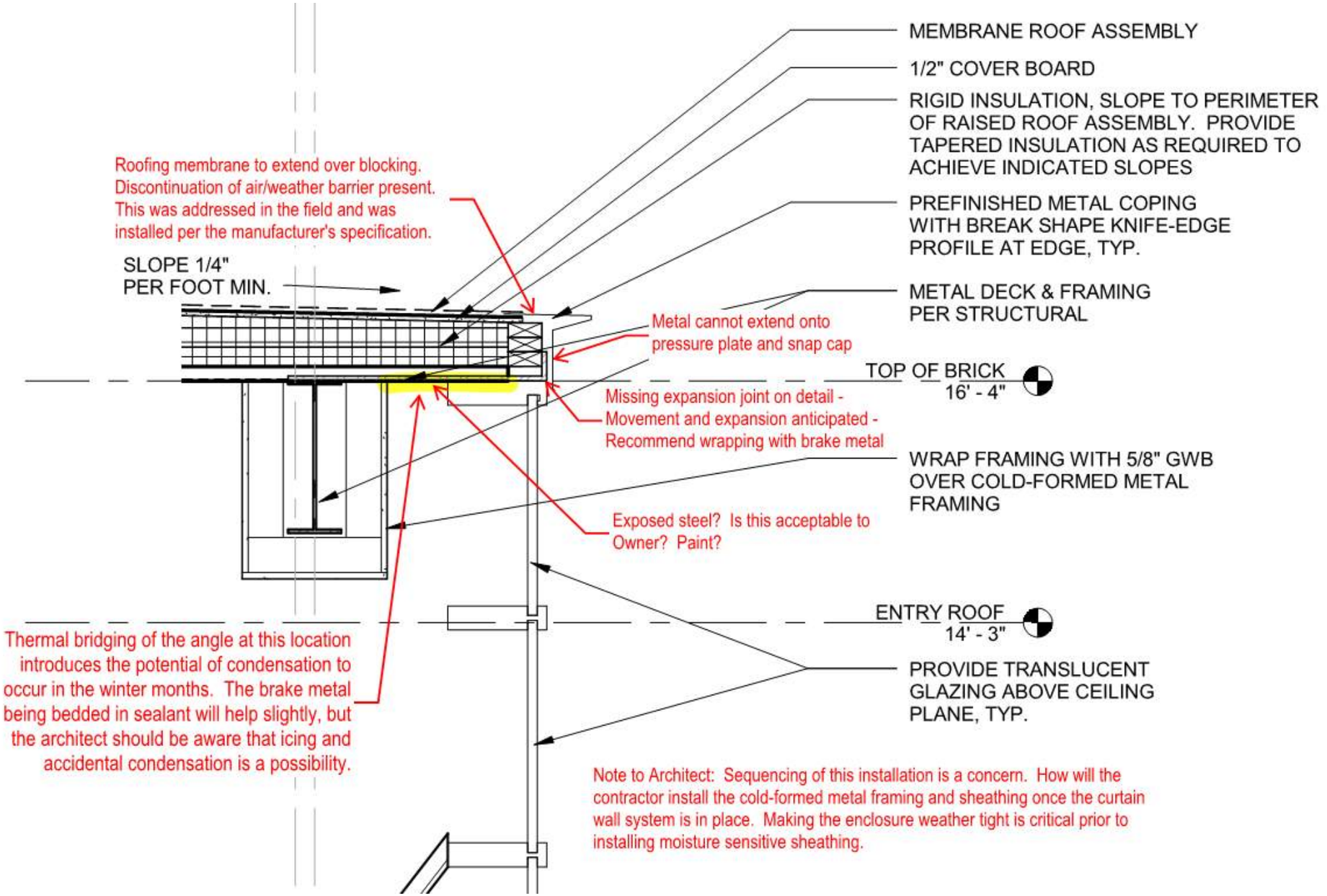

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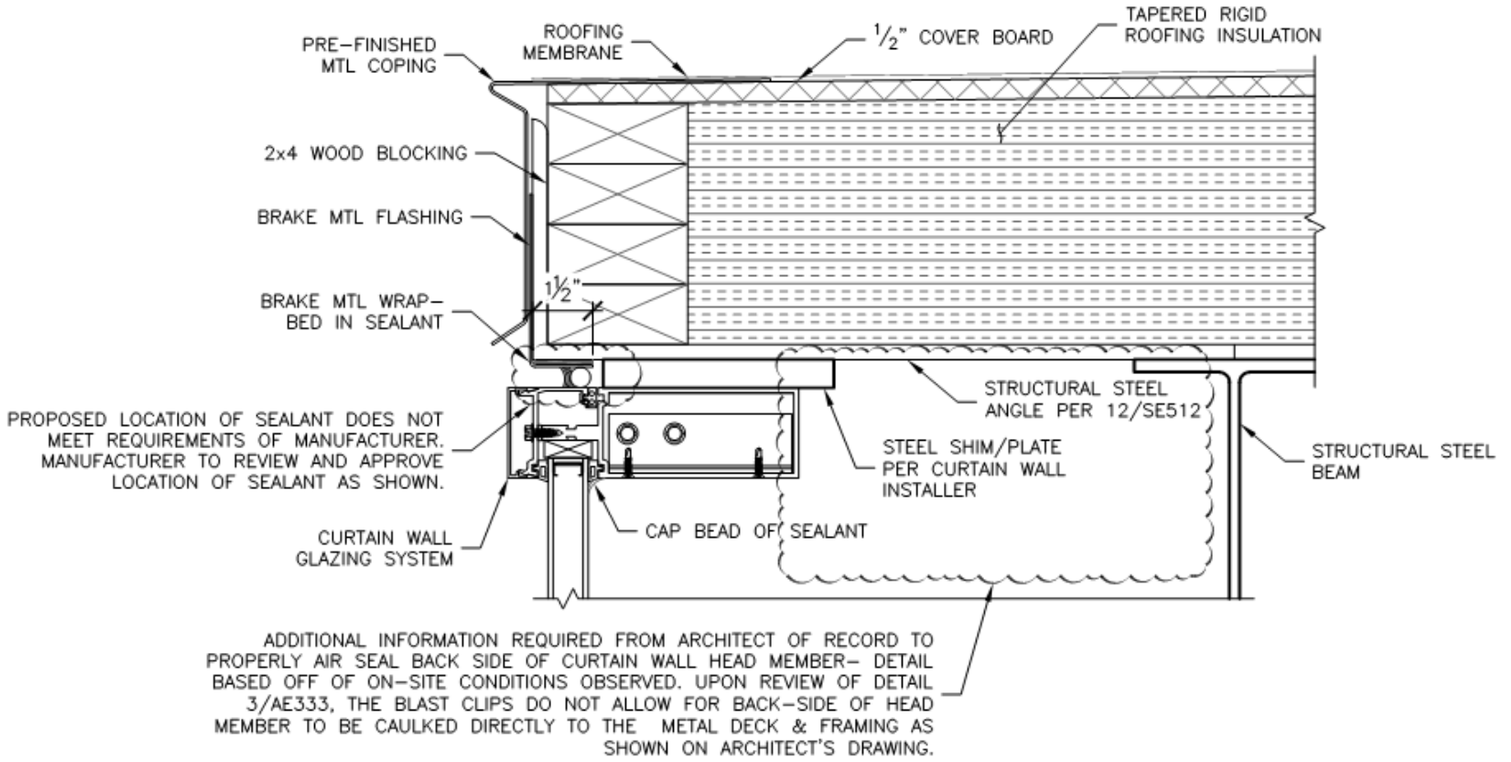

1 CURTAIN WALL HEADER

3"= 1'–0"

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BUILDING FOR:
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SPRINGFIELD, MO
JOB #5397

SHEET 1 OF 1
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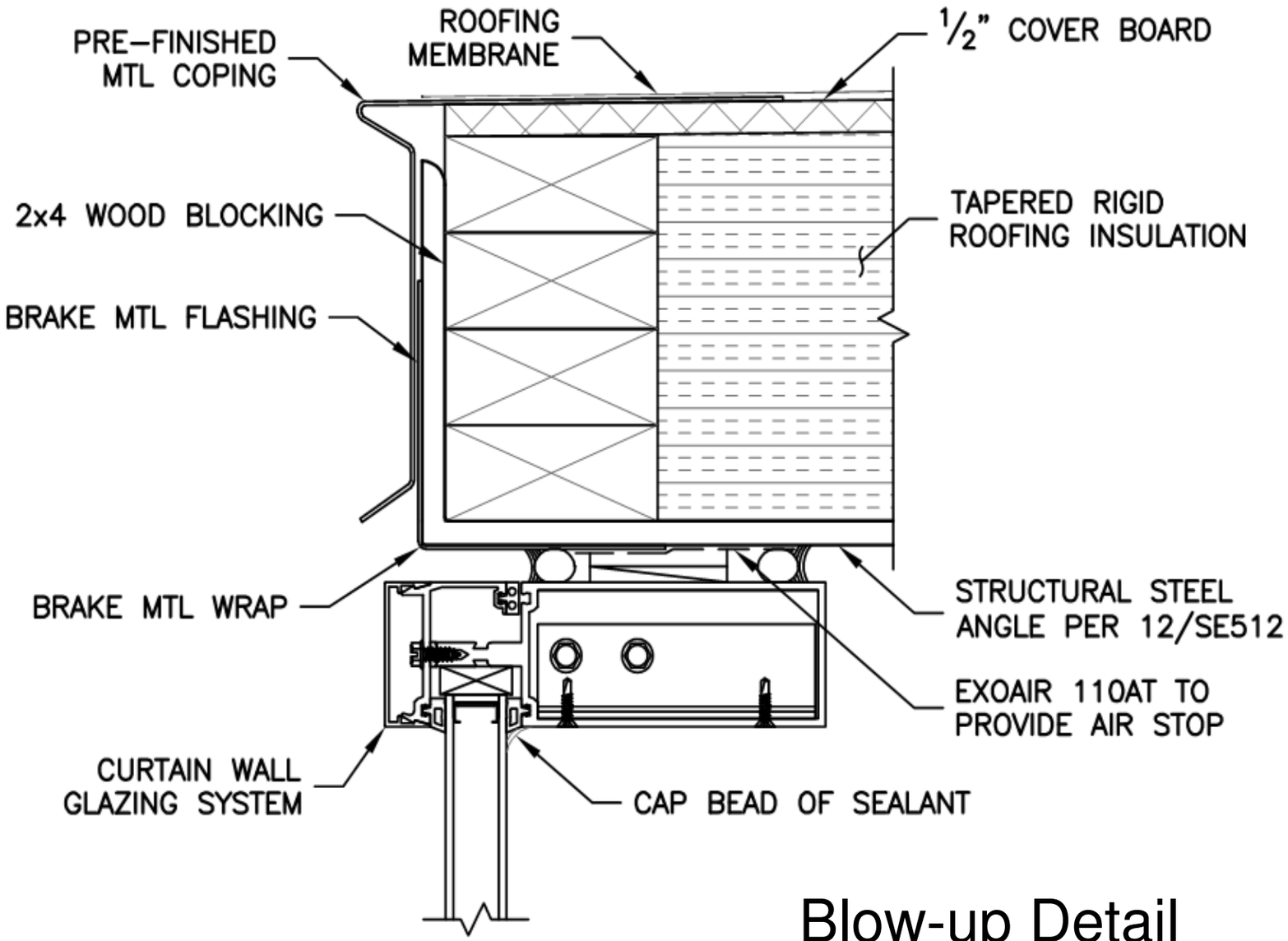

Blow-up Detail

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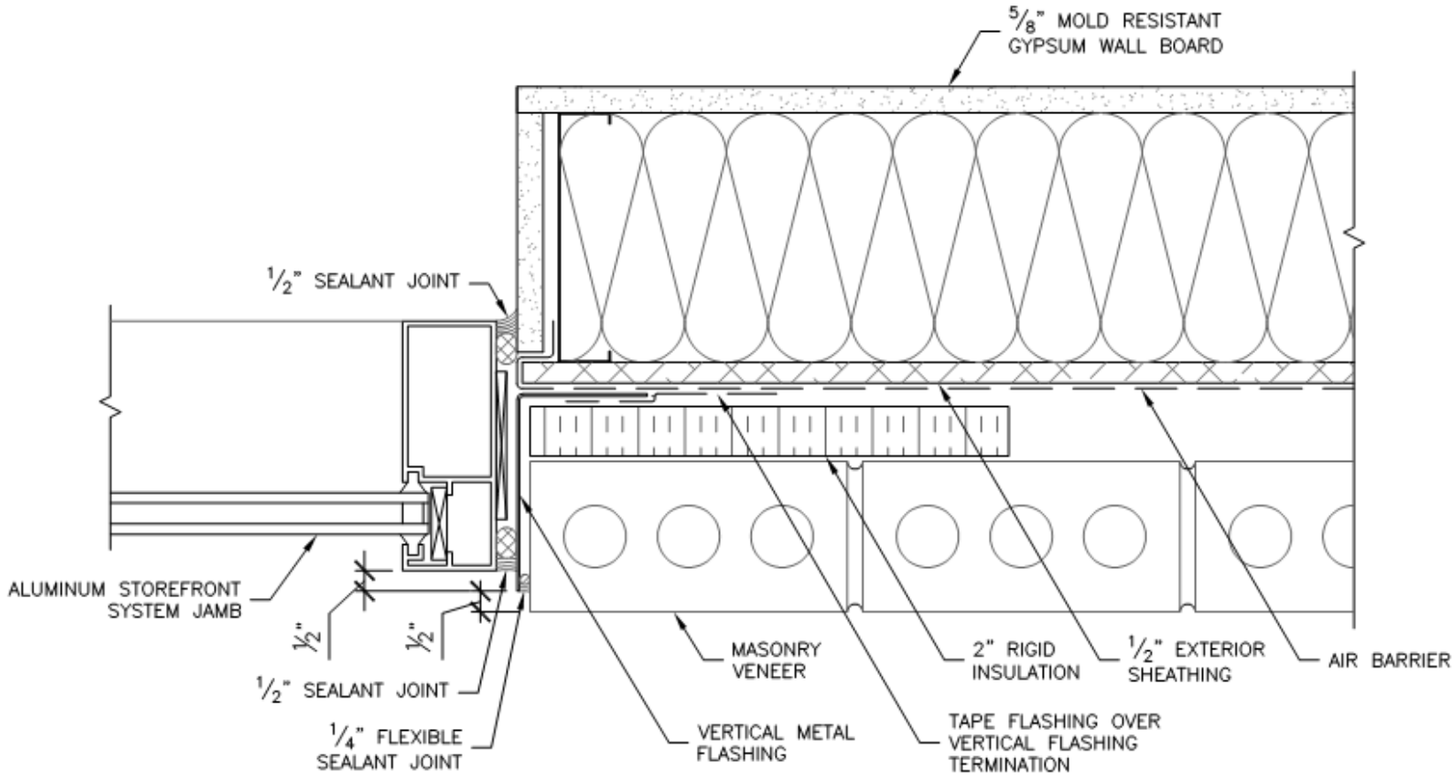

1 SECTION - TYPICAL WINDOW JAMB

3"= 1'-0"

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BUILDING FOR:
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MARSHFIELD, MO JOB #4757

SHEET 1 OF 1
1.3

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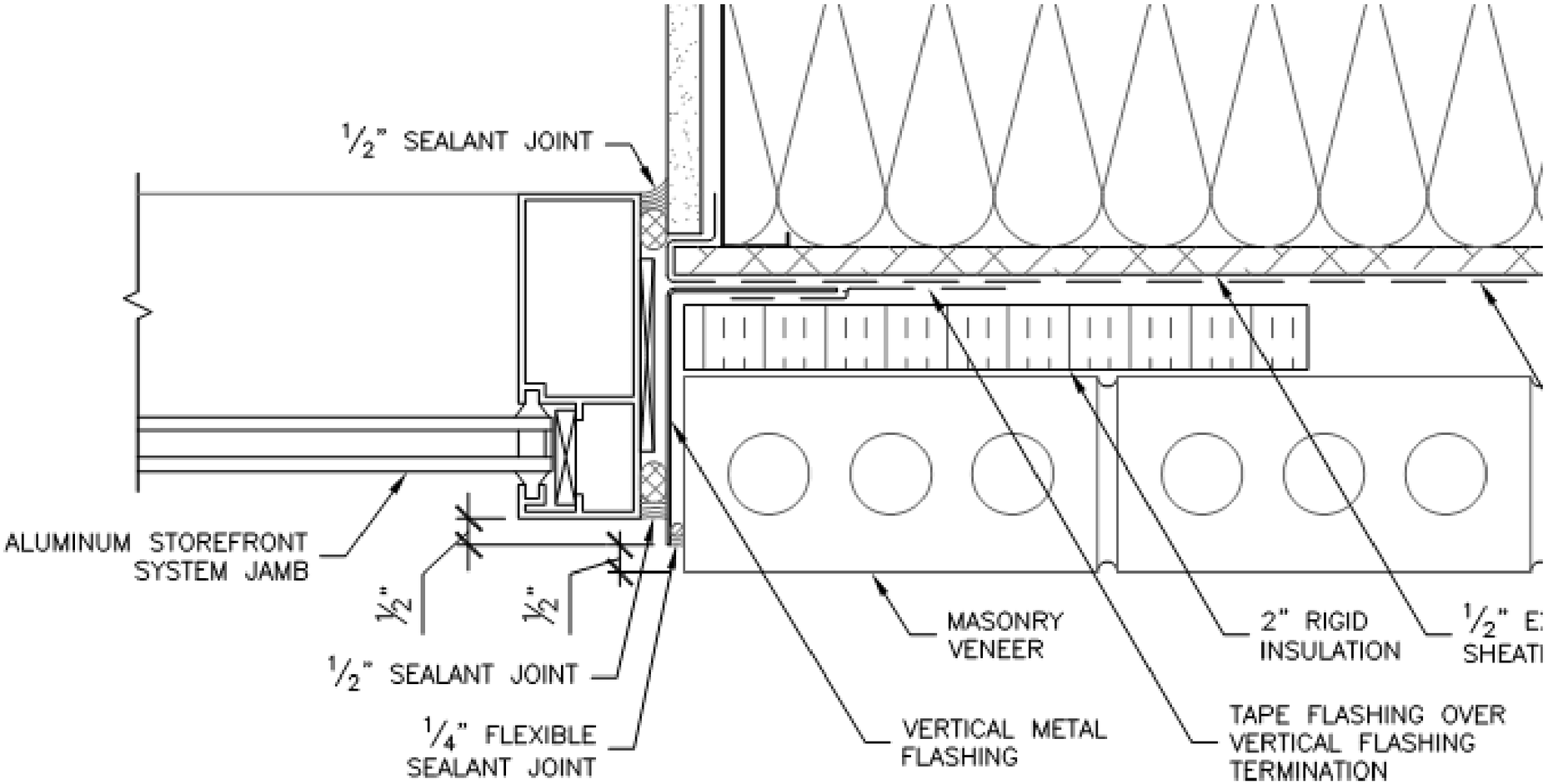

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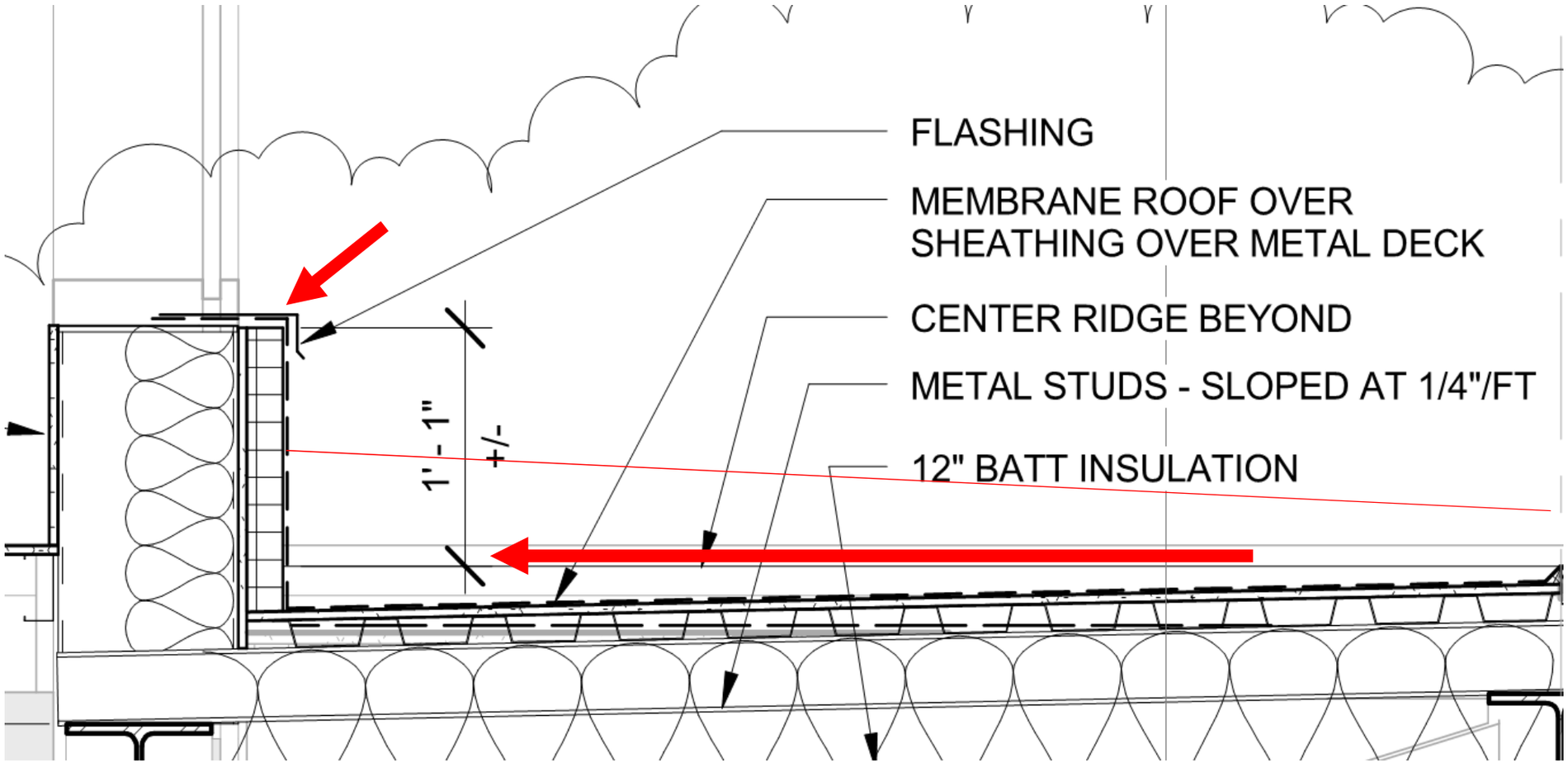
Blow-up Detail



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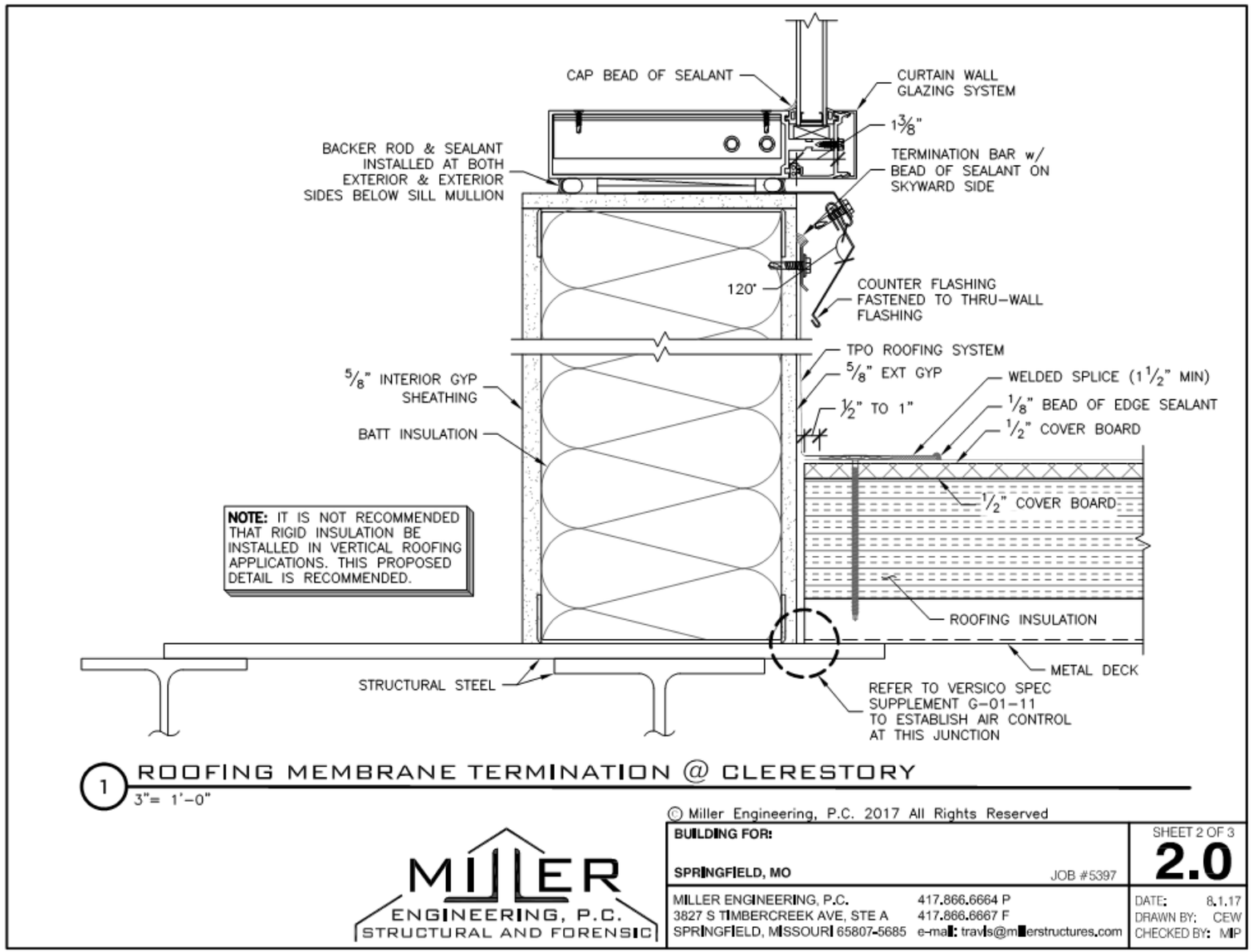
Original Roof Termination Flashing Detail



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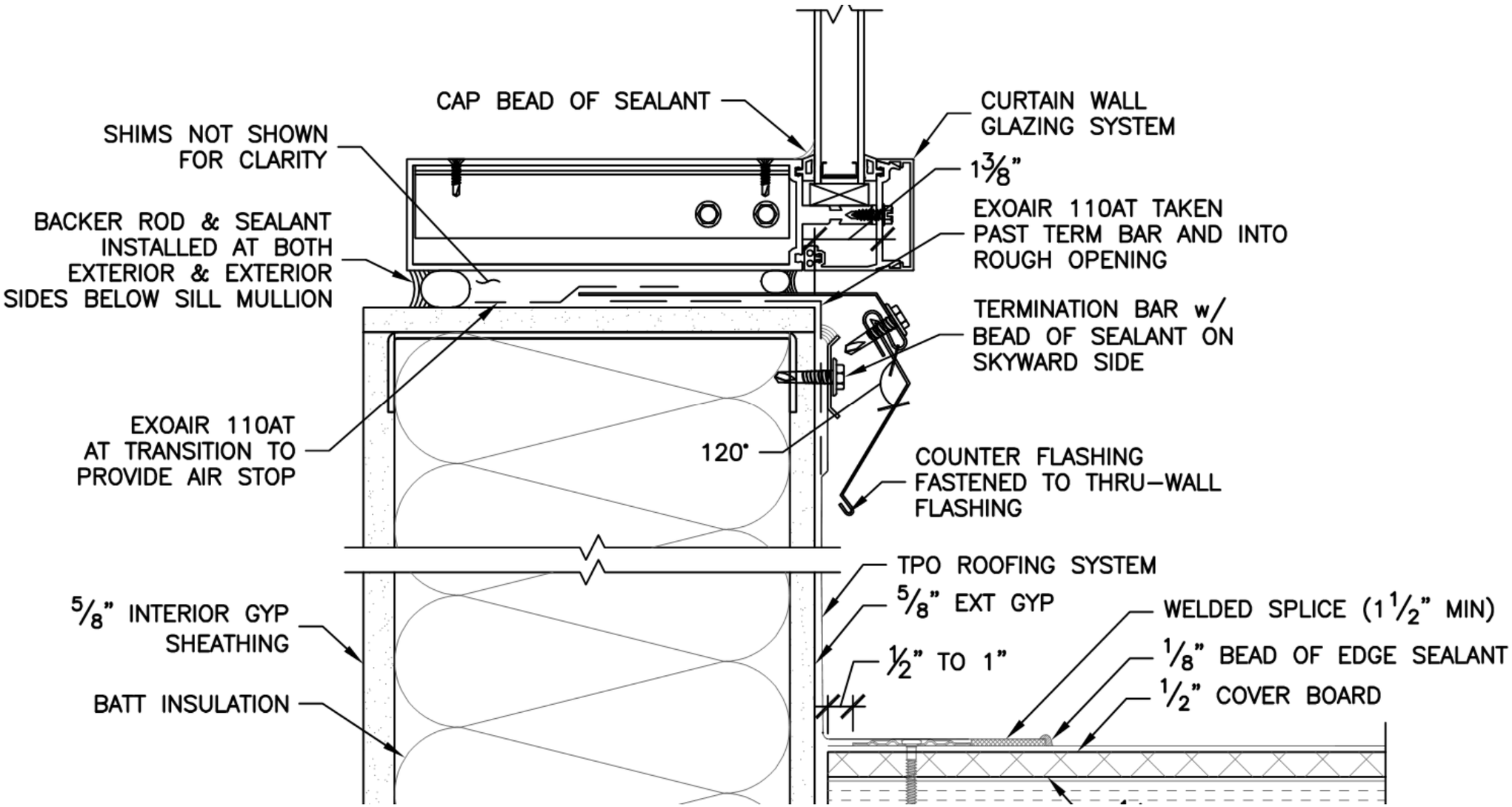
Revised Roof Termination Flashing Detail



Blow-up Roof Termination Flashing Detail

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Roof Termination Flashing Failures

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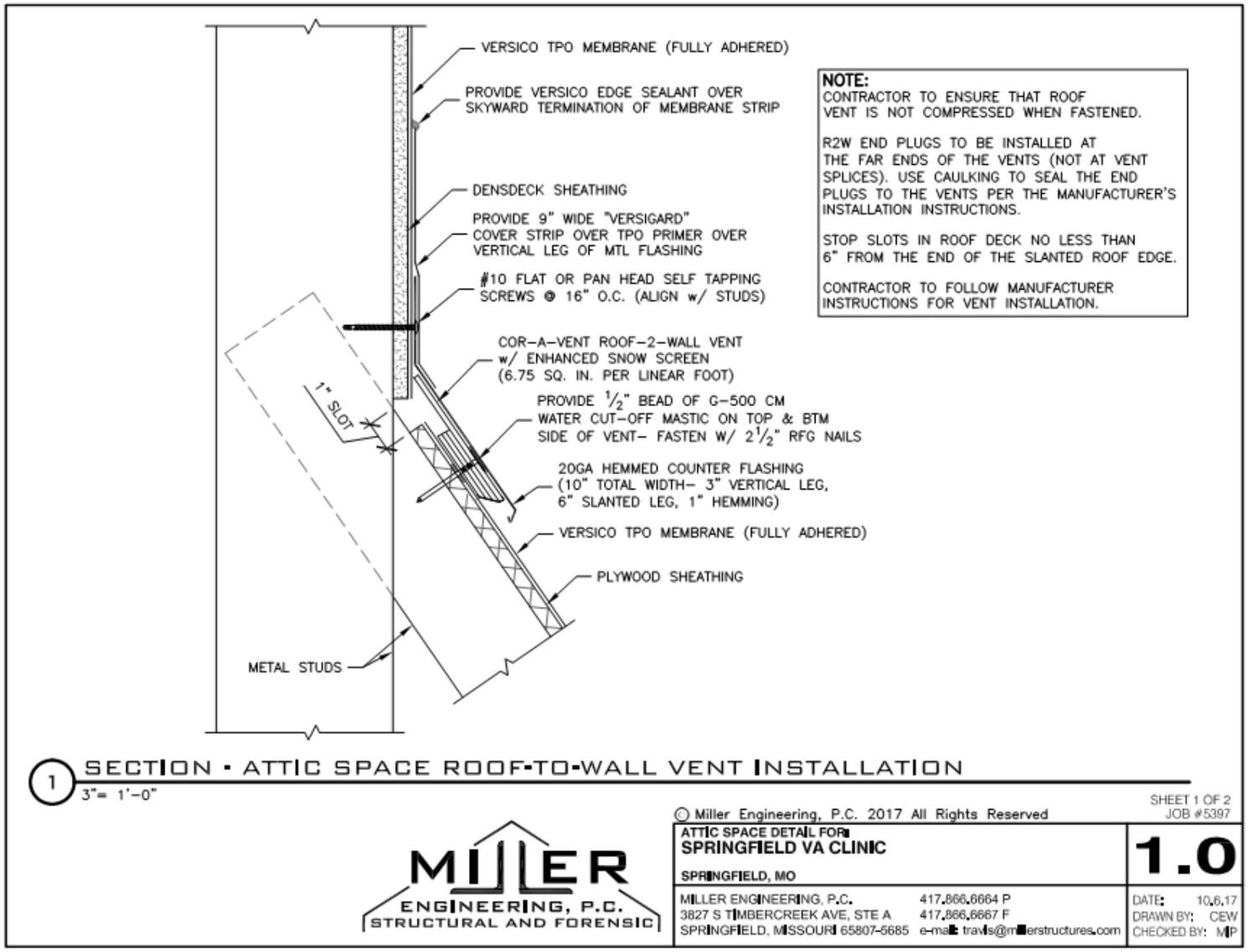

1 SECTION - ATTIC SPACE ROOF-TO-WALL VENT INSTALLATION
3"= 1'-0"

SHEET 1 OF 2
JOB #5397

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STRUCTURAL AND FORENSIC

ATTIC SPACE DETAIL FOR:
SPRINGFIELD VA CLINIC
SPRINGFIELD, MO

1.0

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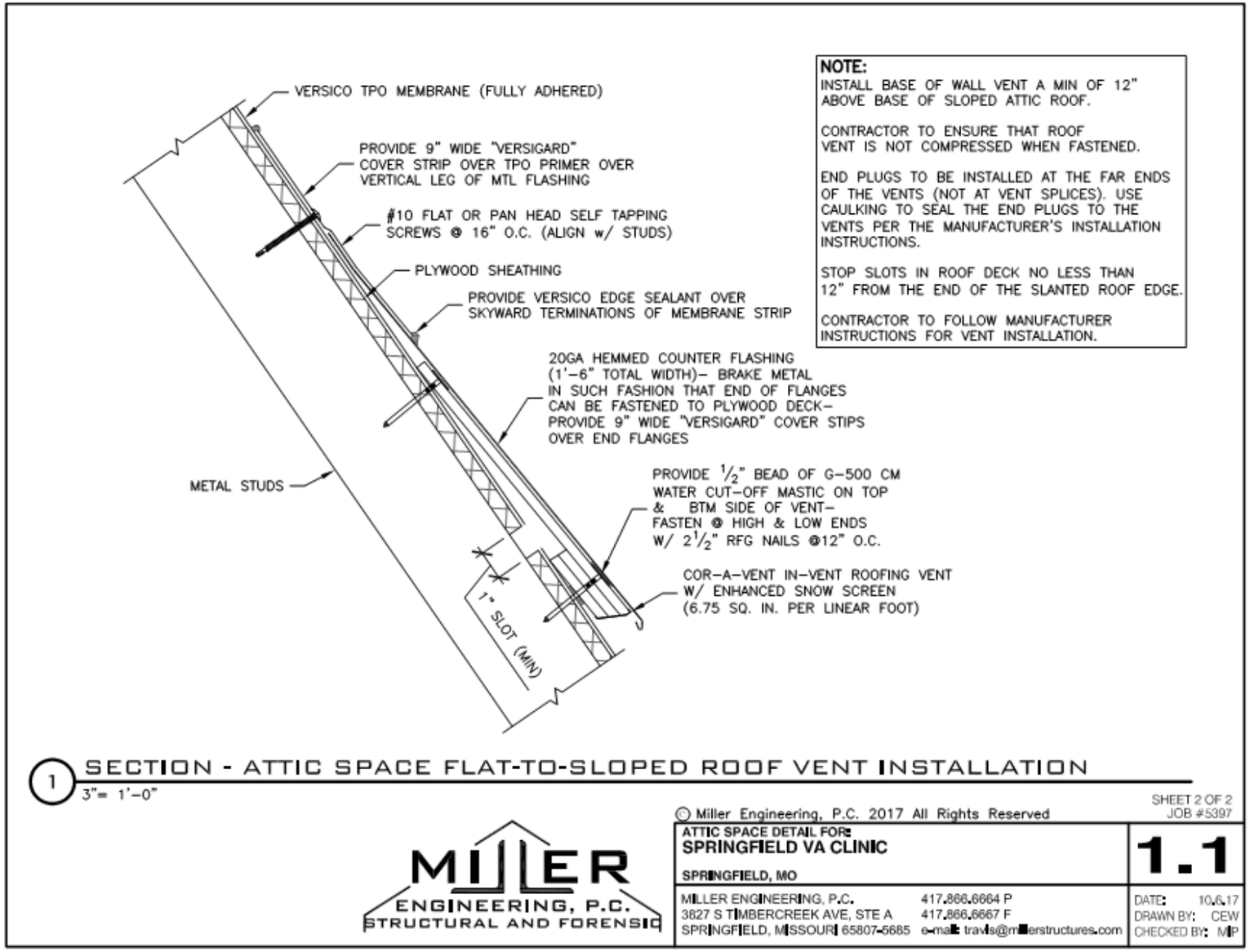

NOTE:
INSTALL BASE OF WALL VENT A MIN OF 12" ABOVE BASE OF SLOPED ATTIC ROOF.

CONTRACTOR TO ENSURE THAT ROOF VENT IS NOT COMPRESSED WHEN FASTENED.

END PLUGS TO BE INSTALLED AT THE FAR ENDS OF THE VENTS (NOT AT VENT SPLICES). USE CAULKING TO SEAL THE END PLUGS TO THE VENTS PER THE MANUFACTURER'S INSTALLATION INSTRUCTIONS.

STOP SLOTS IN ROOF DECK NO LESS THAN 12" FROM THE END OF THE SLANTED ROOF EDGE.

CONTRACTOR TO FOLLOW MANUFACTURER INSTRUCTIONS FOR VENT INSTALLATION.

1 SECTION - ATTIC SPACE FLAT-TO-SLOPED ROOF VENT INSTALLATION
3"= 1'-0"

SHEET 2 OF 2
JOB #5397

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STRUCTURAL AND FORENSIC

ATTIC SPACE DETAIL FOR:
SPRINGFIELD VA CLINIC
SPRINGFIELD, MO

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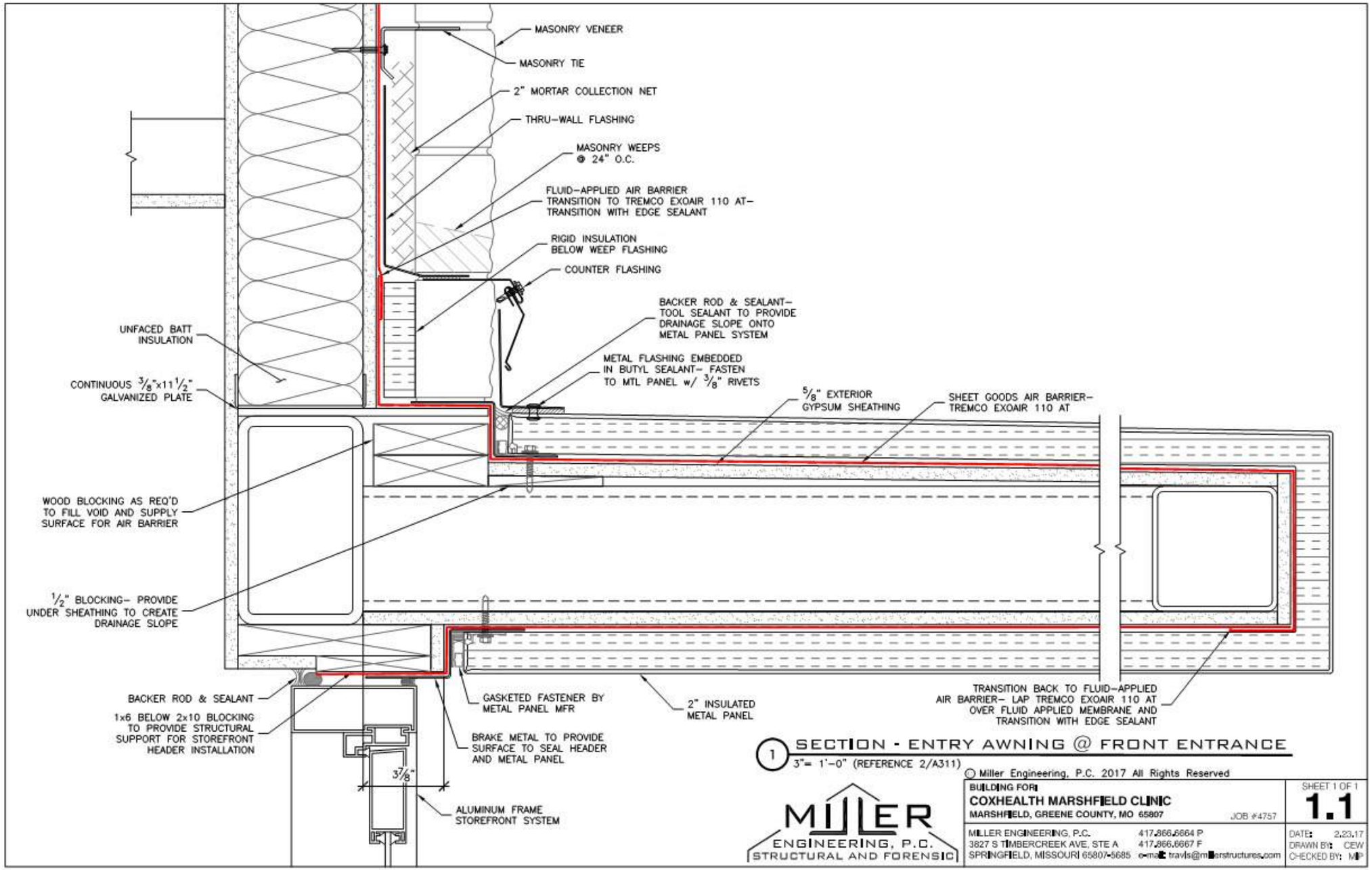

1 SECTION - ENTRY AWNING @ FRONT ENTRANCE
3"= 1'-0" (REFERENCE 2/A311)

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BUILDING FOR:
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MARSHFIELD, GREENE COUNTY, MO 65807
JOB #4757

SHEET 1 OF 1
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Transition Details

Understanding the materials when detailing is critical to the sequencing of installation and warranty of the system.

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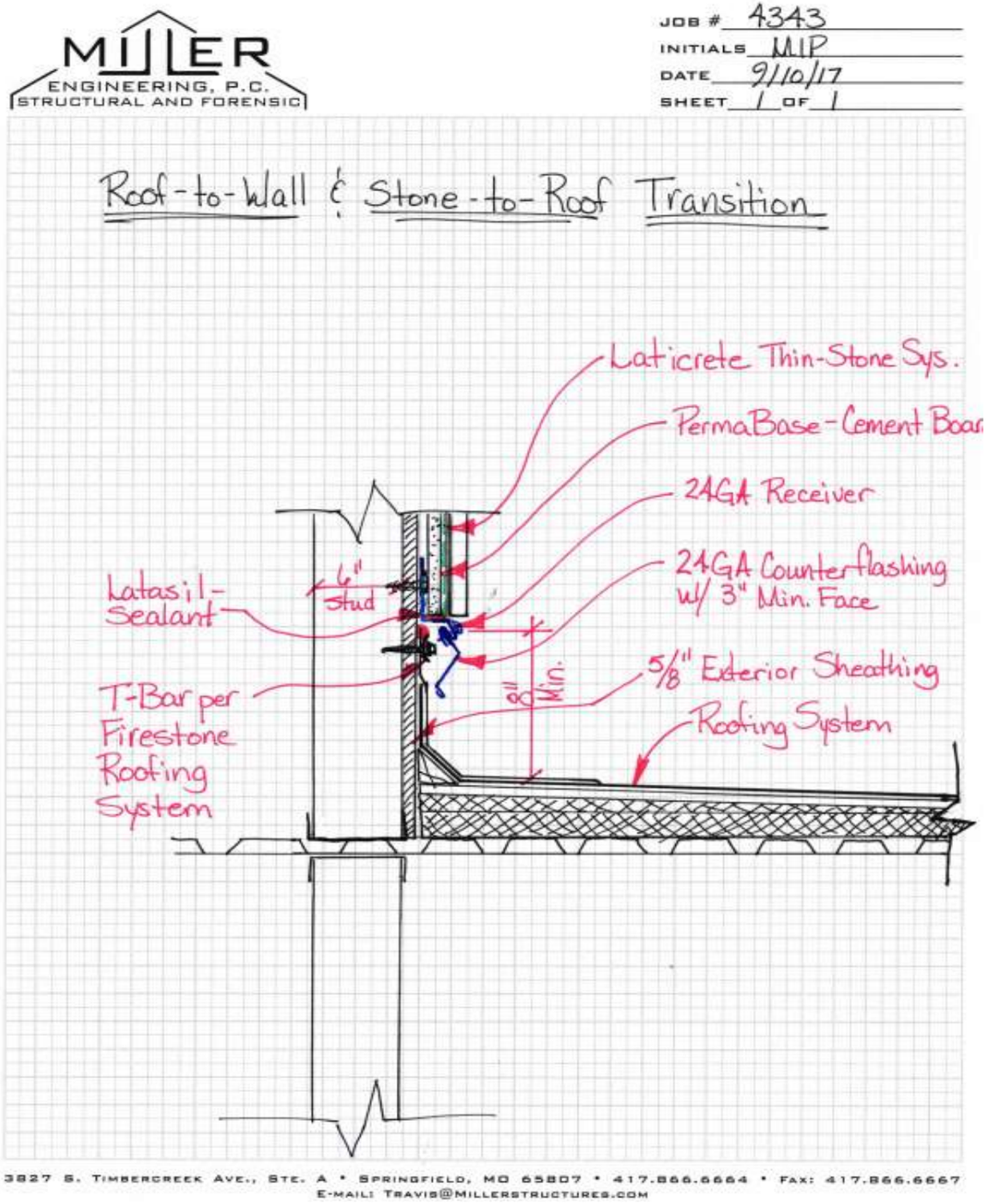

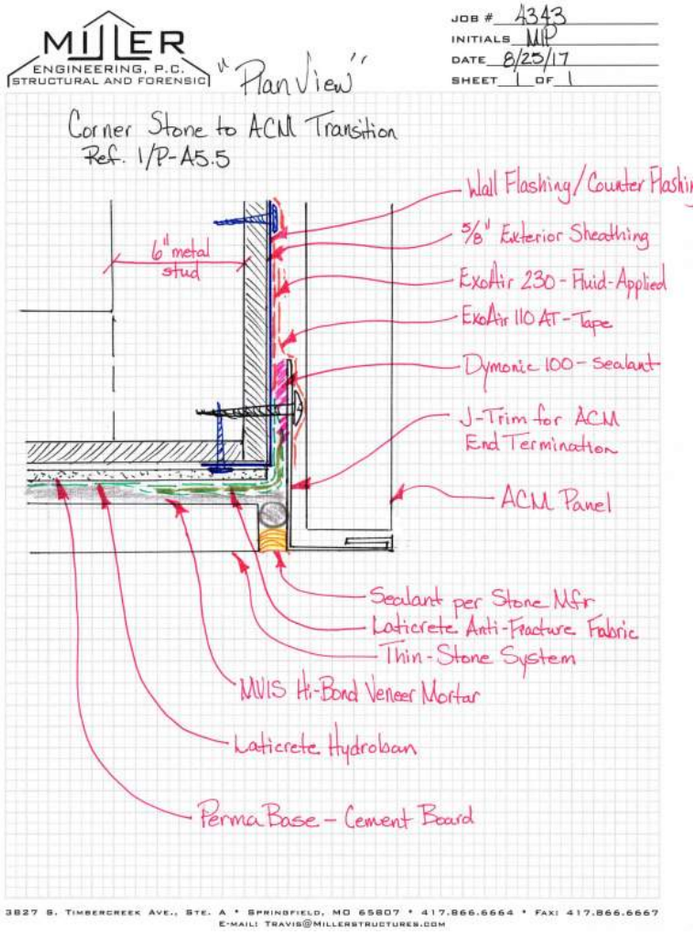

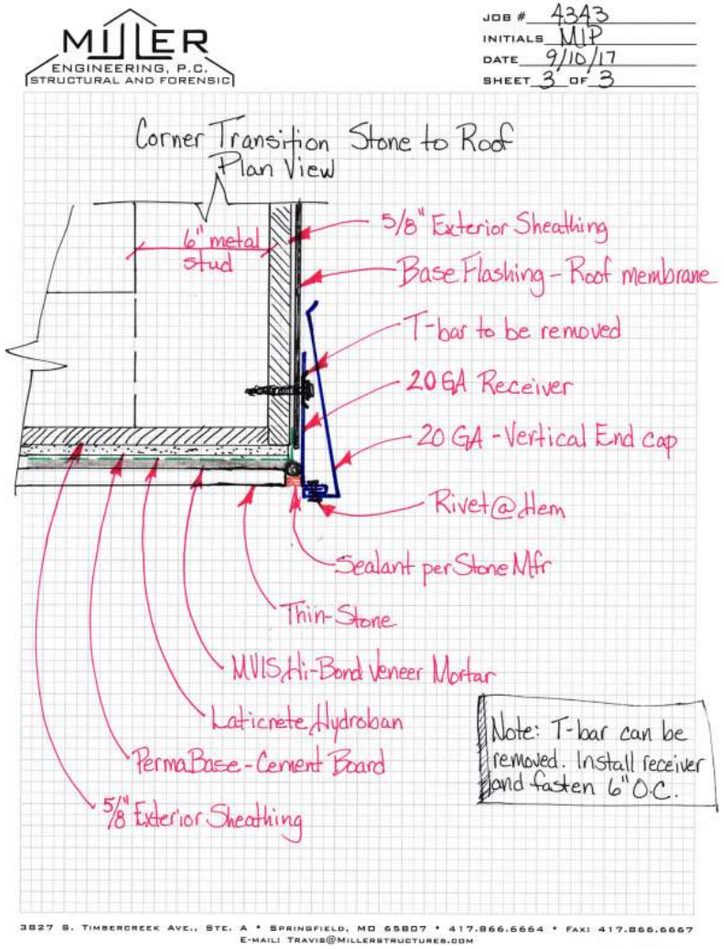

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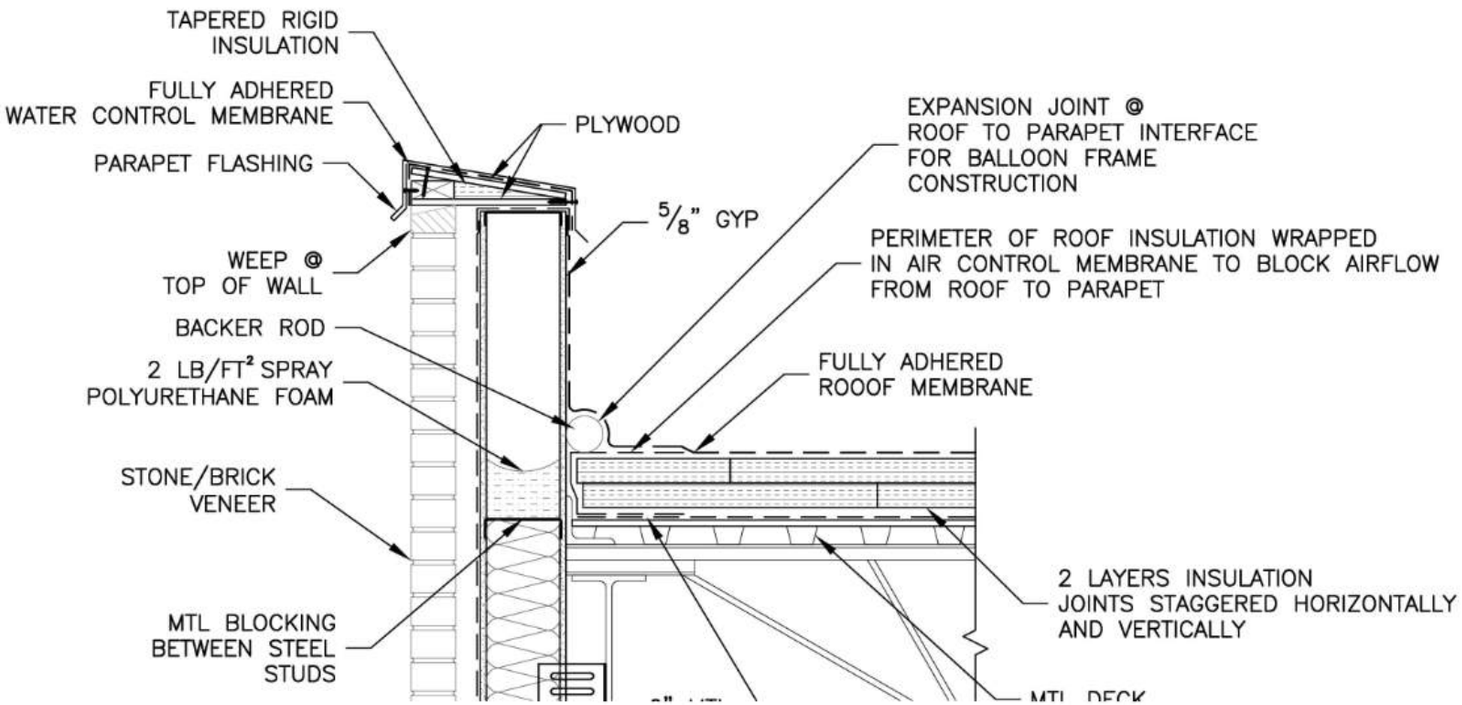
Sample of Transition Details

Interior Air Control Is a Must!



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Note Owner Coordination!

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Lack of Understanding:
Location of weep rope and stone veneer flashing is below finish grade, mulch, and plantings to be irrigated

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Complexity Needs Clarification

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Transition flashing for multiple style claddings and various dissimilar materials need to be detailed.

The Consequences

According to AIA Best Practices, there are two compelling reasons:

1. The number of problematic issues of enclosures which manifest themselves during construction and the quality reflecting on the services provided by the design team, and
2. the increased complexity coupled with the drive for improved performance of building enclosures with regard to sustainability considerations.

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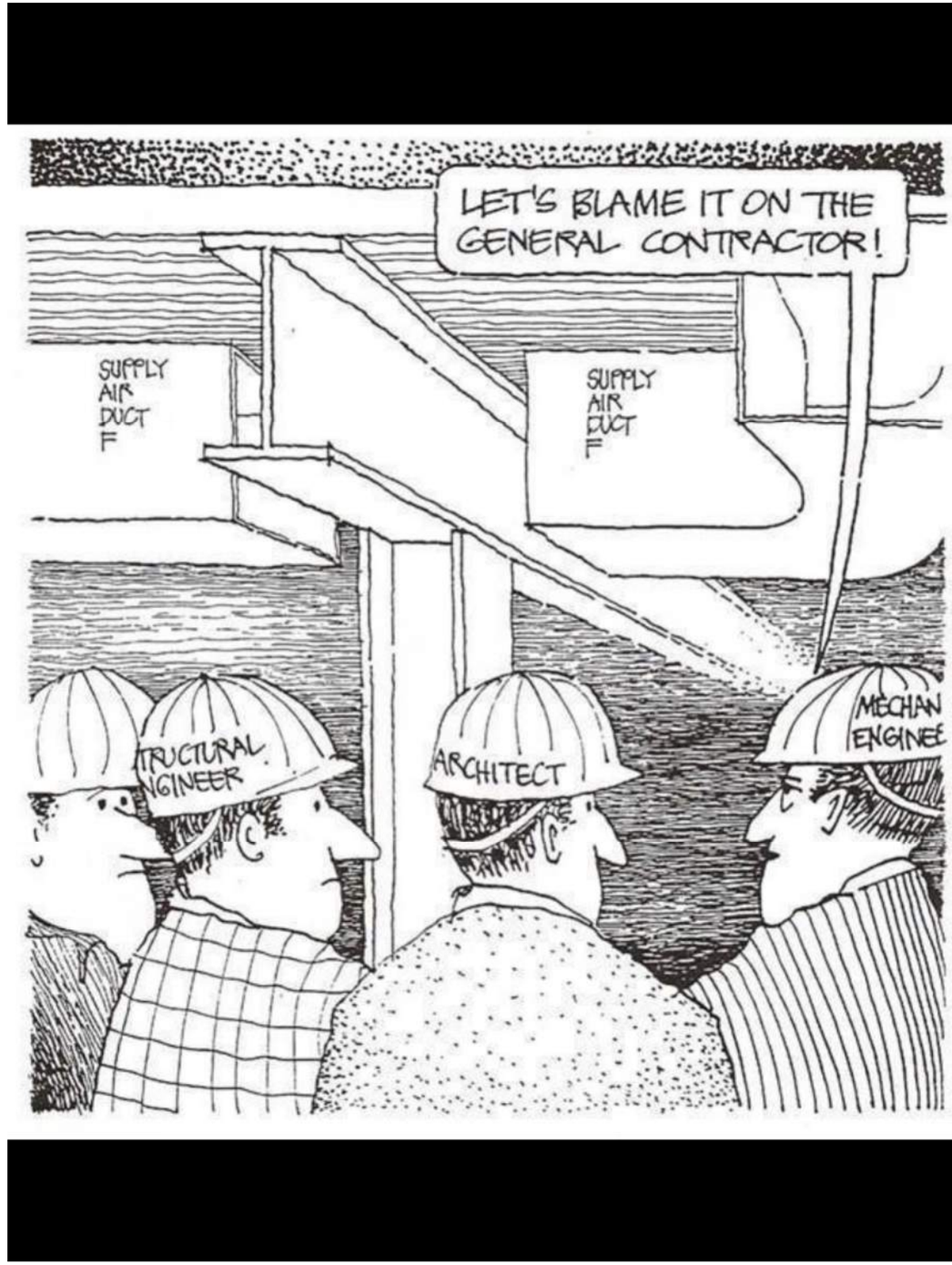
Minimizing the Risks



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Why is it Critical?

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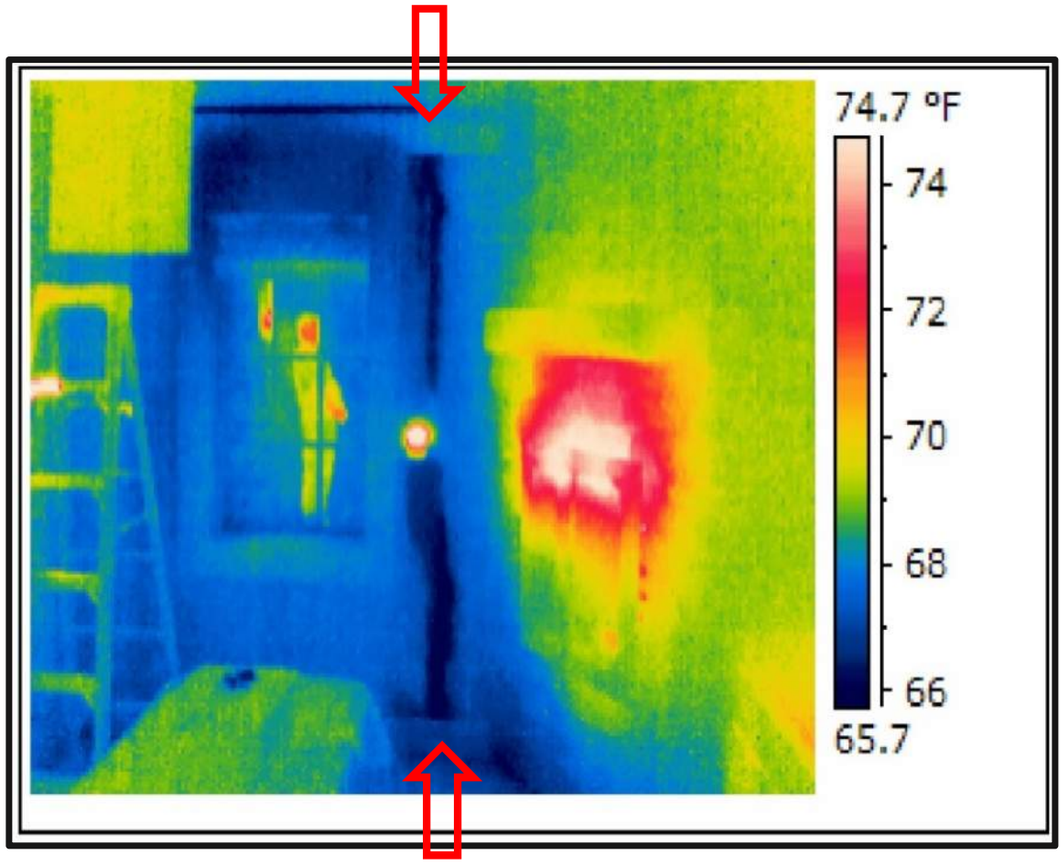
It is the Little Things…



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Penetrations in the air/moisture barrier must be sealed to provide continuity. Provide detailing for sealing the penetrations.

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Flashing Issue:
Laps are less than 3” and mastic is missing – bed and lap mastic missing on brick ledge

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Flashing Issue:
Unsupported flashing membrane – grout below flashing missing, mastic missing, improper lap

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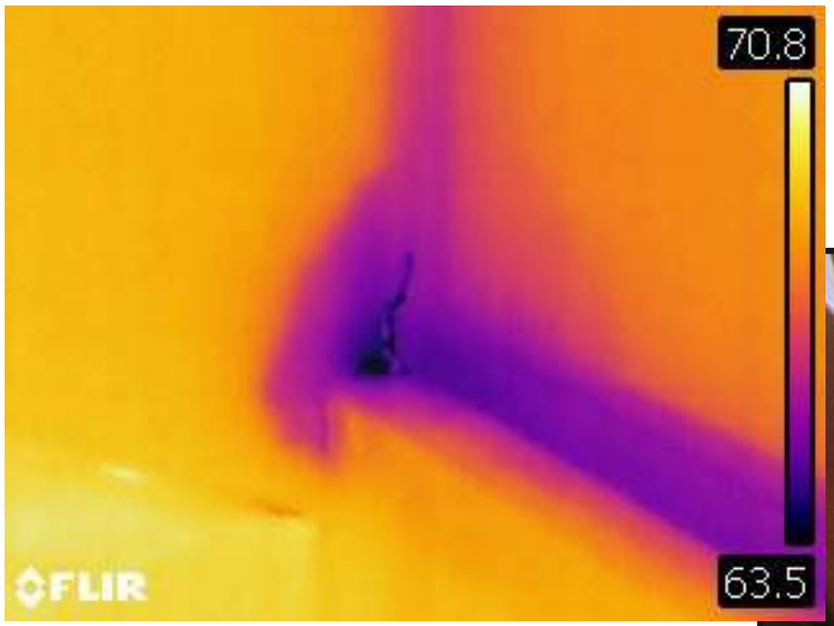
Flashing Issue:
Incorrectly installed flashing at head of window – Improper end-dam, flashing tape improperly installed



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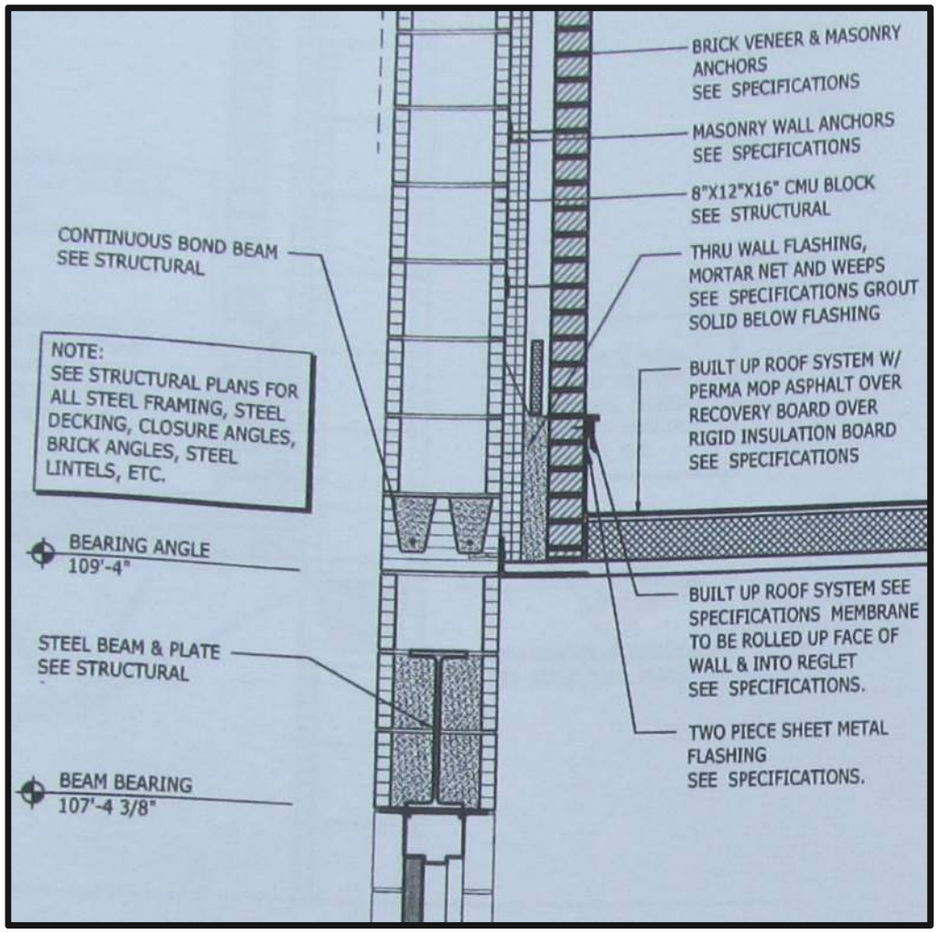

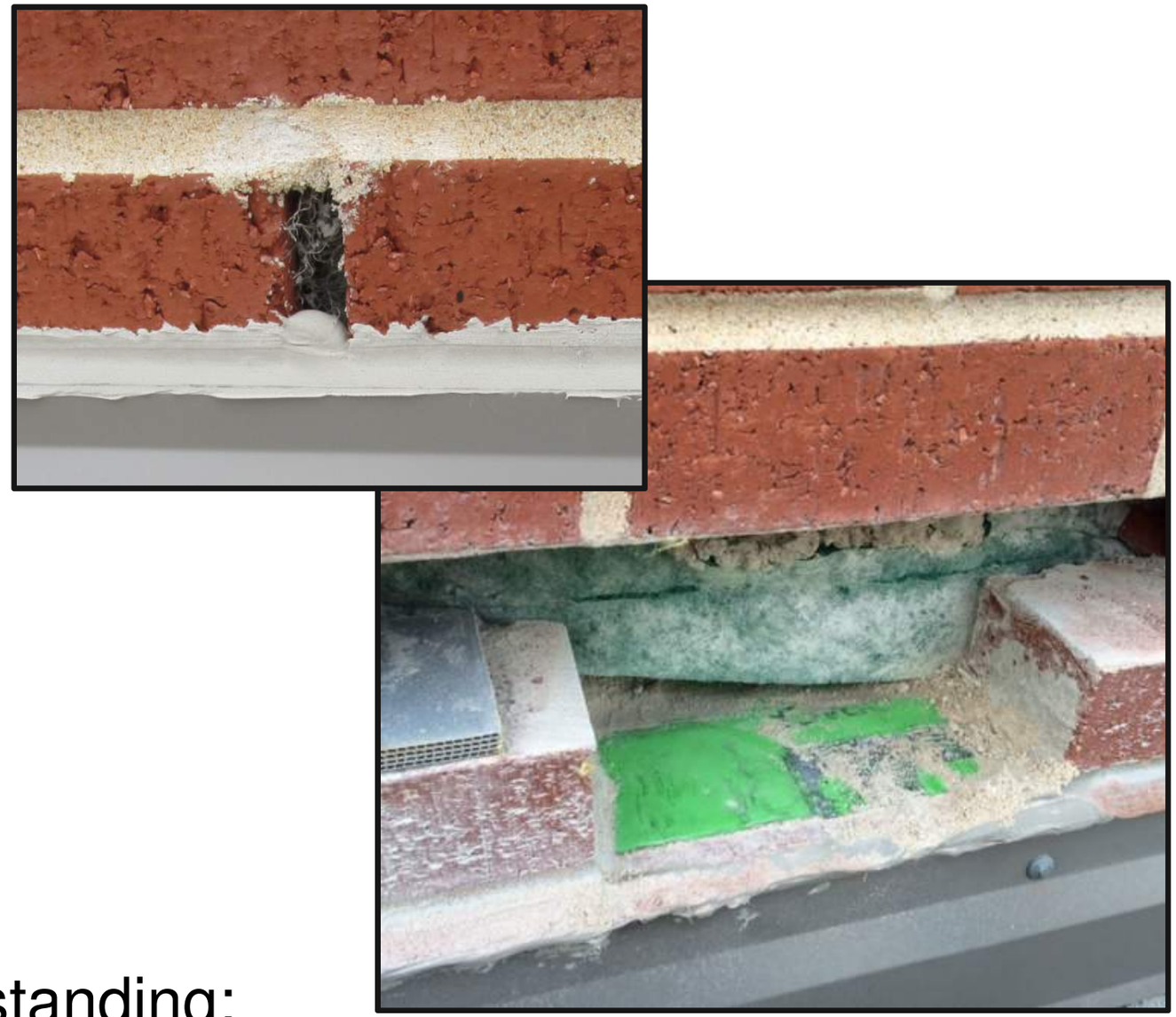

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Lack of Understanding:
What you design is not what the trades always do.

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Lack of Understanding:
Roofing contractor did not understand that thru-wall flashing was concealed and covered it with surface mounted flashing.

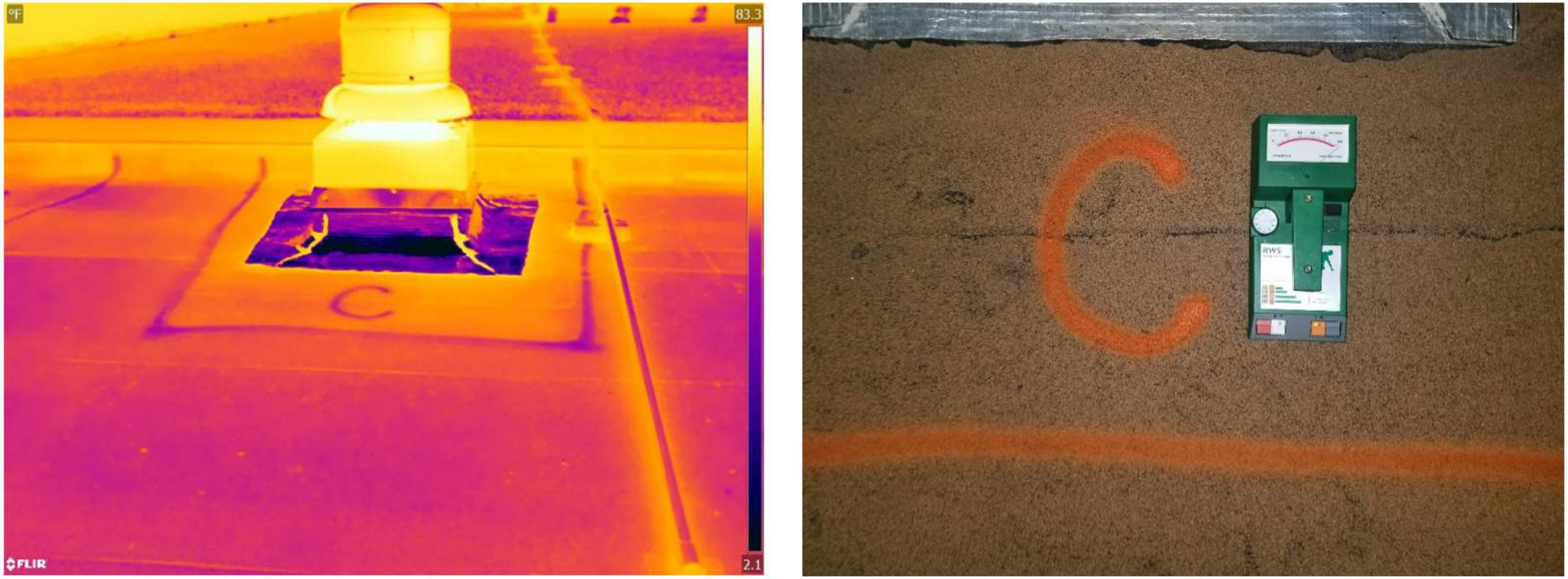

Image Set 3: Infrared image (left) displaying a thermal anomaly indicative of moisture infiltration surrounding the exhaust vent (Spot C). Non-invasive moisture readings at this location were elevated. The right image is a digital that displays the elevated moisture reading in the center of Spot C.

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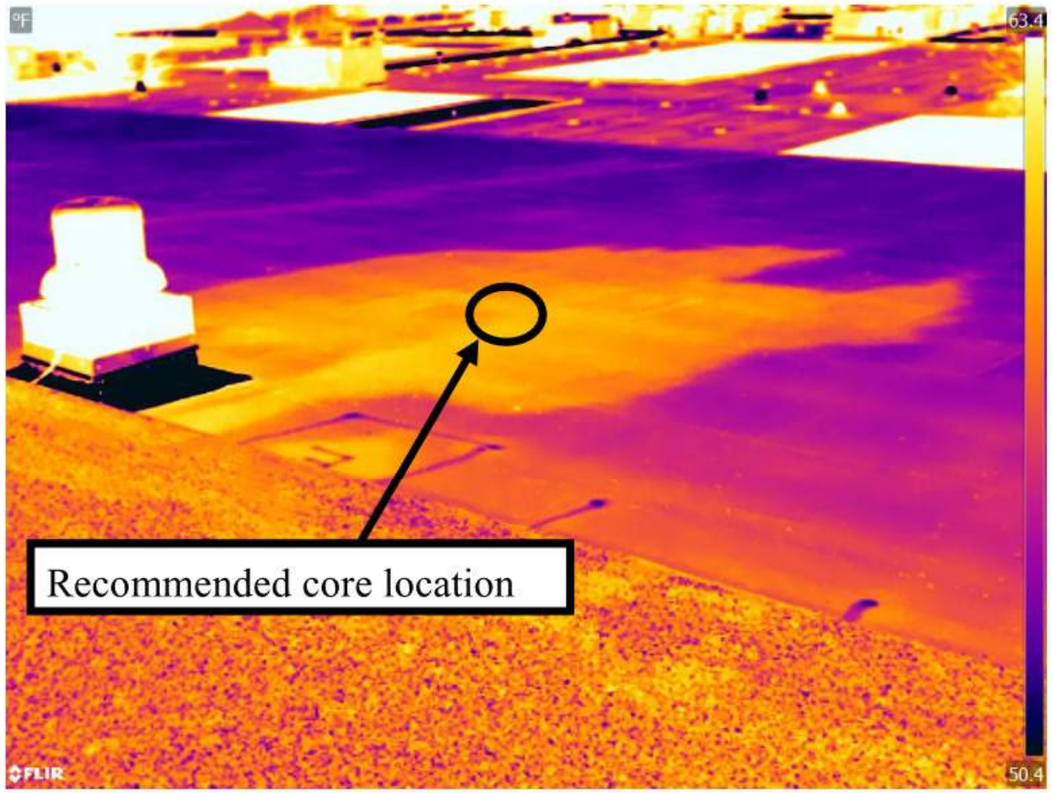

Image Set 4: Infrared image (left) displaying a large thermal anomaly extending down-slope (Spot F). Another anomaly can also be viewed in this image to the right of the exhaust vent (Spot E) The right image is a digital that displays the elevated moisture reading in the center of Spot F.

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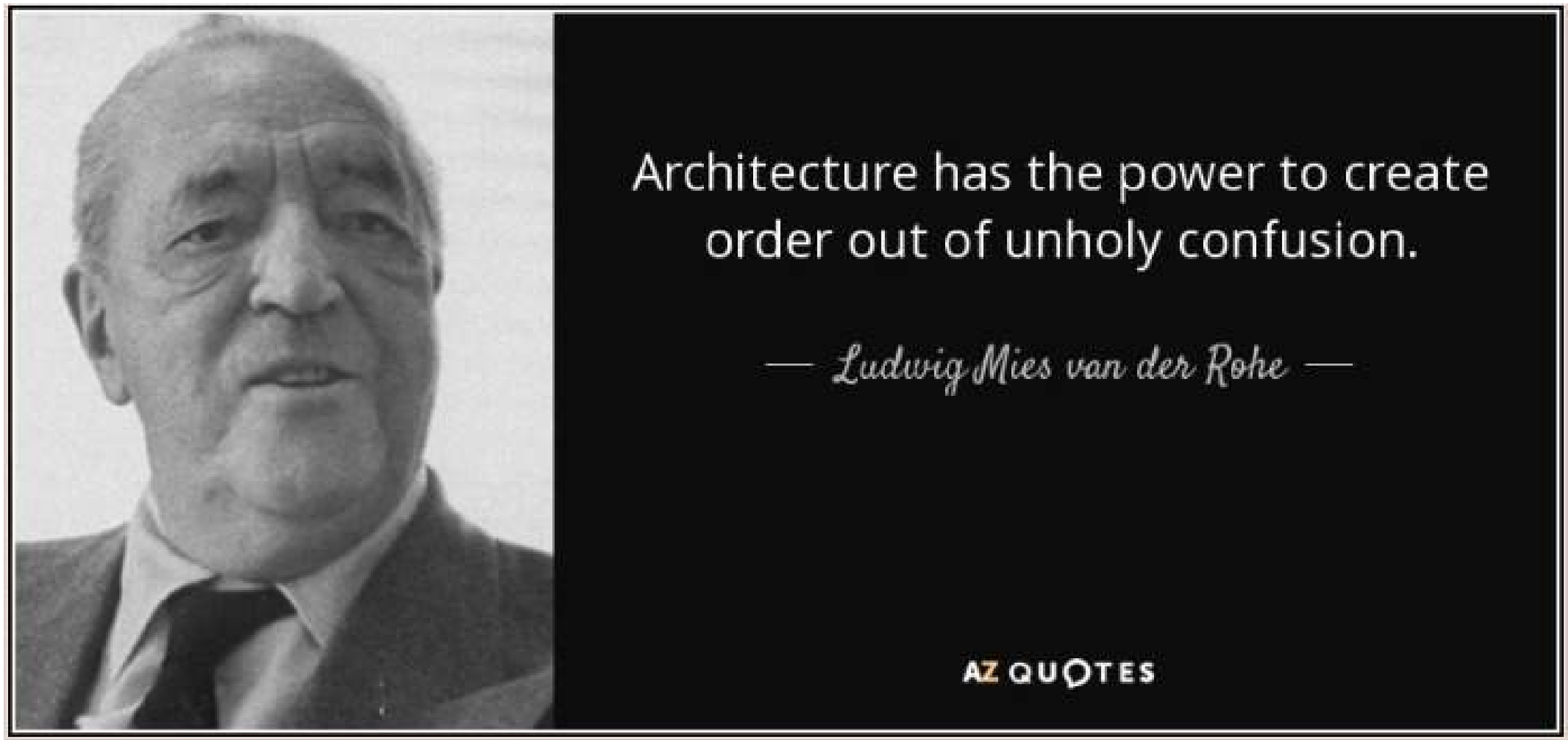
Final Thought



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Tribute to Bill Nash

May Zelda's Fortune
always be in your favor!

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Melissa I. Payne

Building Enclosure Consultant – Forensic Investigator

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