Quality Management Best Practices for Installing Self-Adhering Sheet Air Barriers

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Mortenson Construction

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Quality Management Best Practices for Installing Self-Adhering Sheet Air Barriers

Learning Objectives:

1. Identify best practices and lessons learned during the installation of air barrier system on a large commercial building
2. Demonstrate how a QA/QC process can reduce the inherent risk in to control water, air, and vapor
3. Describe the methods used to control and assure the quality of the barrier system from design through construction
4. Explore how the testing of adjacent enclosure systems can impact inspection of the air barrier

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Agenda

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Introduce Quality Management Program

- Quality Core and the Project Quality Plan
- Definable Feature of Work Log
- Compare with Building Enclosure Commissioning and Assurance Program

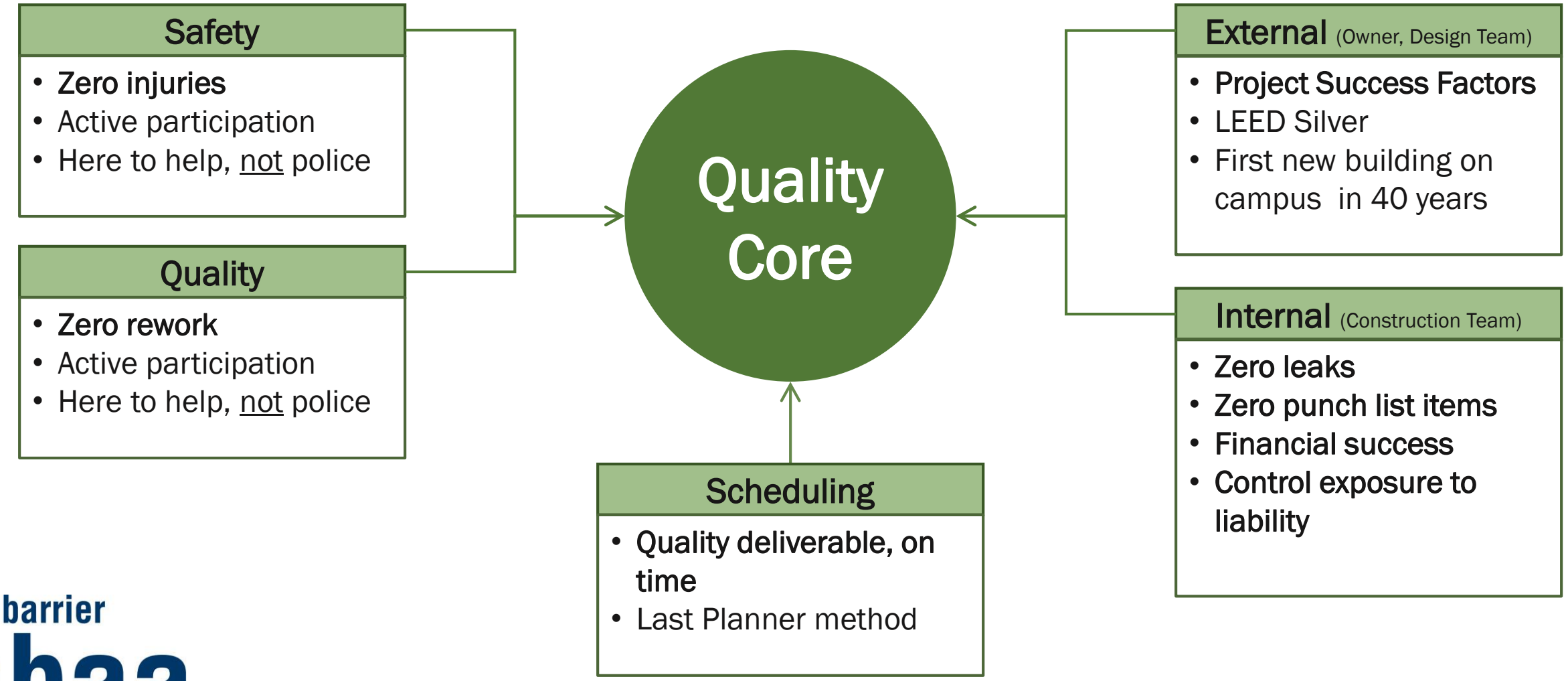
Case Study Project

- Wall Construction
- NFPA 285
- Design Review
- Enclosure Review

Inspections and Testing

Summary

Goals for Quality Management Program



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Strategies: Project Quality Plan (PQP)

Personnel

- Third Party Reviewer
- On-site Quality Manager
- Testing Agency
  - Scope Managers
    - GC Craft
    - Sub-contractors

Product

Process

- Lean Construction
  - Last Planner Method
- Change Management
- Definable Feature of Work
  - Integrated Work Plans
  - Inspections
  - Testing

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Definable Feature of Work (DFW)

Phase Level

BUILDING ENCLOSURE

Design Review

- Drawing and Specification Review
- Coordination
- Mockups
- Change Management

Constructability Review

- Enclosure Coordination Meetings

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Task Level (Work Feature)

WRB

Preparatory Meeting

- Change Management

Integrated Work Plan

Initial Inspection

- Quality Management

Final Inspection

Definable Feature of Work (DFW)

Phase Level

Task Level

Title	IWP Required (blank = No)	Prep Meeting/ IWP Review	Anticipated Start Date	Initial Inspection	Mock-Up Required (blank = No)	Quality Control Notes (Mock-up Description, Performance Testing, 3rd Party Inspections, etc.)
General Conditions						
Special Inspections & Testing - Structural & Technical		11/8/15	11/15/15	N/A		
Tower Cranes Erection	Y	2/1/16	2/8/16	2/9/16		3rd Party Inspection
Personel/Material Hoist		Scheduled 7/29	8/1/16	8/2/16		3rd Party Inspection
Earth Retention Systems	Y	DONE	1/20/16	1/21/16		3rd Party Design Review and Inspection Mort Inspection
Existing Conditions						
Hazardous Material Abatement	Y	DONE	1/20/16	NA		IWP received 1/20
Demolition	Y	11/6/15	11/13/15	NA		
Erosion Control		11/23/15	11/30/15	12/1/15		Subcontractor weekly (or 1/2" of rainfall within 24 hrs)
Sitework						
Utilities	Y	NOT DONE	4/29/16	4/30/16		
Landscaping and Hardscaping, Irrigation, Site Furnishings		6/7/17	6/14/17	6/15/17		
Storm water infilitration system		5/8/17	5/15/17	5/16/17		
Foundation						
Footings and Grade Beams	Y	1/25/16	2/1/16	2/2/16		Prepour (Soil, Formwork, Rebar, Embeds/Sleeves, Mix, Design, Install Method/rate)
Backfill and compaction		DONE	4/1/16	4/2/16	Y	In Place Mock-up, collect and save 3rd party soils inspection/tests
Structure						
CMU		DONE 7/25/16	8/8/16	8/9/16		
Mortenson Self-Perform Concrete (footings, foundation walls, columns)	Y	DONE	2/3/16	2/4/16		Includes Tunnel, Winter Conditions, Columns, Interaction with WP membrane,
Mortenson / CECO Self-Perform Concrete decks	Y	3/21/16	3/28/16	3/29/16		Includes Winter Conditions, PT, Shoring
Structural Steel Erection	Y	9/6/16	9/13/16	9/14/16		Date is for start of skyway erection. Includes metal decking installation, as-built specific points after erection
Mortenson Self-Perform Slab on Metal Deck	Y	9/13/16	9/20/16	9/21/16		Date is for skyway floor. Includes floor flatness discussion, as-built specific points after pours
Precast Architectural Concrete	Y	DONE 7/25/16	8/8/16	8/9/16	Y	
Enclosure						
Foundation Waterproofing	Y	DONE	3/15/16	3/16/16	Y	Includes flexble flashings, sheet metal flashings, water-resistive barriers (WRBs), preformed joint seals,
Exterior wall framing, sheathing and waterproofing above grade (WRB)		DONE 6/6/16	8/1/16	8/2/16		Includes mineral wool insulation (on exterior walls)
Roofing, Deck Insulation, and roof accessories		9/22/16	9/29/16	9/30/16		
Metal Wall Panels		9/8/16	9/15/16	9/16/16	Y	Includes Louvers
Openings (Doors and Windows)						
Hollow metal doors and frames, wood doors, door hardware, sliding interior doors, etc.		10/11/16	10/18/16	10/19/16		Be sure to cover security / access control.
Curtainwall and Glazed Assemblies, Entrances and Storefronts	Y	8/30/16	9/6/16	9/7/16	Y	Include firestopping at slab edge

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BECx	Case Study	ABAA QAP	
Owner's Project Requirements (OPR)	Design Narrative	No	Design Narrative includes some of this information, but OPR document has more specific information like Owner directives, restrictions or limitations, durability expectations and building enclosure life to have more detail relating directly to enclosure systems.
Drawing and Specification Review	Yes	No	In BECx, checking for inclusion of Commissioning Process requirements In Case Study, checking coordination and constructibility
Building Enclosure Specialist	On-Site Quality Manager	ABAA Accredited Contractor Certified Installer	On-site QM is building enclosure SME, but is employee of GC
Commissioning Authority	No	No	
Third Party Reviewer, Inspectors	Yes	Yes	
Commissioning Plan	Project Quality Plan	Specifications with ABAA QAP	
BECx Progress Reports	Inspectors reports Third Party Reviewer reports	Inspectors reports Third Party Reviewer reports	
Basis of Design reviews at design phase	No	No	Some other projects (usually Design Building delivery method) include periodic design review by GC
Technical Peer Review of enclosure	Enclosure Review by GC and Third Party	No	
Thermal Analysis	By Consultant and by GC's in-house Performance	No	
Review and advise lab and field mockups	By Third Party Reviewer	Yes	
BECx reviews submittals	GC reviews submittals	No	
Issues/non-conformance log	Yes		
Construction observation	By Third Party Reviewer and Architect	By Third Party Reviewer	
Pre-construction meeting	Yes	Yes	
BECx activities in project schedule	No	No	
Site Specific Building Enclosure Verification Program	Per Specifications	Specific to WRB: Three alternatives for compliance with QAP	Case Study Project: Specifications did not include performance testing of WRB
QC Checklists	Yes	No	
No	No	Specific testing required for WRB	
Building Enclosure maintenance manual, preventative maintenance program	No	No	
Schedule of service during waranty phase, call-back and warranty Enforcement	Yes	No	

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Hennepin County Medical Center

HCMC by the Numbers

- $950 million annual budget
- 620,781 clinic visits
- 486 staffed hospital beds
- 23,051 inpatients treated
- 112,626 emergency department & urgent care visits
- 2,243 births per year
- Paramedics serve residents in 14 cities in Hennepin County
- Approximately 50% of Minnesota's physicians have trained at HCMC
- Minnesota's only 24/7 Hyperbaric Chamber

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Case Study: HCMC Clinic and Specialty Center

Houses 37 clinics previously in 9 buildings

337,000 SF clinic space

200 space underground parking

Skyway and tunnel connection to HCMC Campus

Primary Care and Specialty Clinics

- Same day surgery and procedure
- Comprehensive Cancer Center with radiation therapy
- Physical Therapy and Rehabilitation
- Outpatient Imaging and Women's Imaging
- Traumatic Brain Injury Center
- Integrative Health

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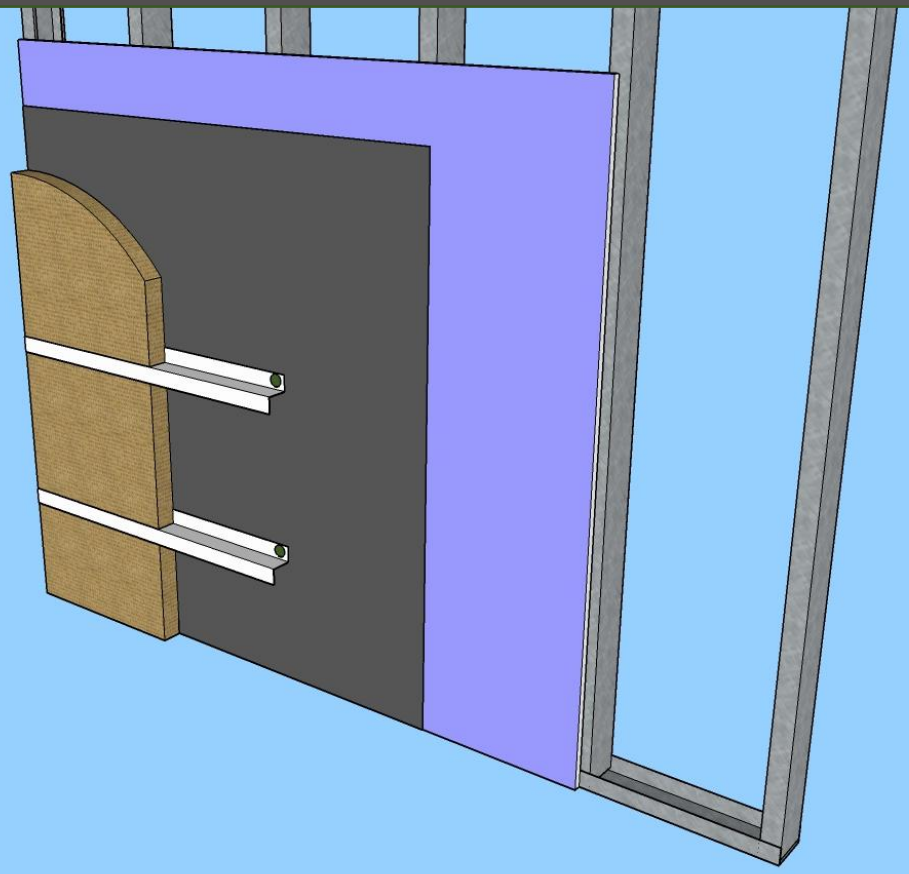
Case Study: HCMC Clinic and Specialty Center



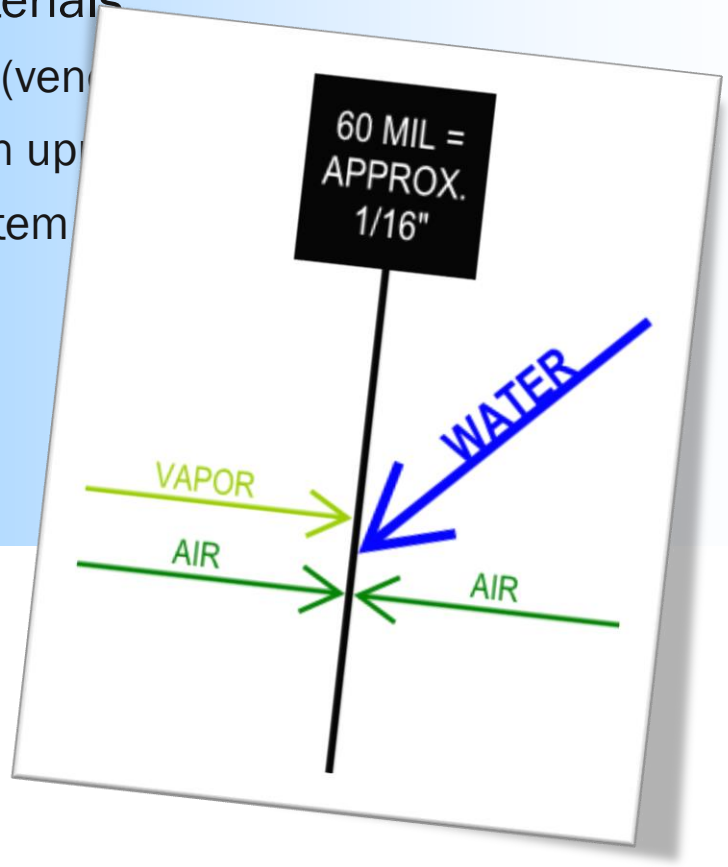
Building Construction:

Cast-in-place concrete structure

Light gauge framing exterior wall construction

Exterior finish materials:

- Precast panels (ven
- Metal panels on up
- Curtainwall system



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Design Review: The Building Membrane

Prescriptive Specification

- Multiple manufacturers plus “others as approved”
- ASTM E2178 (max. 0.004 CF/minute/SF at 1.57 PSF differential pressure)
- < 0.1 Perm (vapor impermeable)
- Either self-adhering sheet or liquid-applied membrane

Coordination with Other Trades

- Foundation waterproofing material: Use same manufacturer
- Sealant compatibility at curtainwall
- Construction Sequencing

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Walls Containing Mineral Wool Insulation

Wall Component	Materials
Base wall system – Use either 1, 2, 3, 4 or 5	1 – Concrete wall 2 – Concrete Masonry wall 3 – Standard Clay Brick Wall 4 – Adobe Block Wall 5 – 1 layer – ⅝-inch thick, Type X, Gypsum wallboard on interior, installed over steel studs: minimum 3 ⅝-inch depth, minimum 20-gauge at a maximum of 16-inch OC with lateral bracing every 4 ft. vertically
Cavity Insulation – Use either 1, 2 or 3	1 – None 2 – Fiberglass batt insulation (faced or unfaced) 3 – Any noncombustible insulation
Exterior sheathing – Use either 1, 2 or 3	1 – None 2 – ½-inch thick, exterior type gypsum sheathing 3 – ⅝-inch thick, Type X, exterior type gypsum sheathing
Air and water barrier applied to gypsum sheathing – Use either 1, 2, 3, 4 ,5, 6, 7, 8 or 9	1 – Perm-A-Barrier® Liquid 2 – Perm-A-Barrier® NPL 3 – Perm-A-Barrier® NPL 10 4 – Perm-A-Barrier® VPO 5 – Perm-A-Barrier® VPL 6 – Perm-A-Barrier® VPL LT 7 – Perm-A-Barrier® Wall Membrane 8 – Perm-A-Barrier® Aluminum Wall Membrane 9 – Perm-A-Barrier® VPS
Exterior insulation	Mineral wool (2" min. thick, unfaced, mechanically attached and meets ASTM C612). 1 – The mineral wool shall not have any type of facer on either side. 2 – The mineral wool shall be noncombustible via ASTM E 136 testing. The density of the mineral wool shall range from 4.0 to 9.0 lbs/ft3. The R-value/inch of the mineral wool shall range from 3.5 to 4.5. 3 – The mineral wool insulation must be mechanically attached. 4 – The mineral wool must completely cover the air barrier.
Exterior Veneer – Use either 1 or 2	1 – Any noncombustible exterior veneer with or without air gap between exterior insulation and exterior veneer 2 – Any combustible exterior veneer, that has been successfully tested by the panel manufacturer via NFPA 285 test method, with or without air gap between exterior insulation and exterior veneer. Installed using standard installation techniques. Evidence of testing in accordance with NFPA 285 and/or an ICC-ES report must be submitted to the code official.

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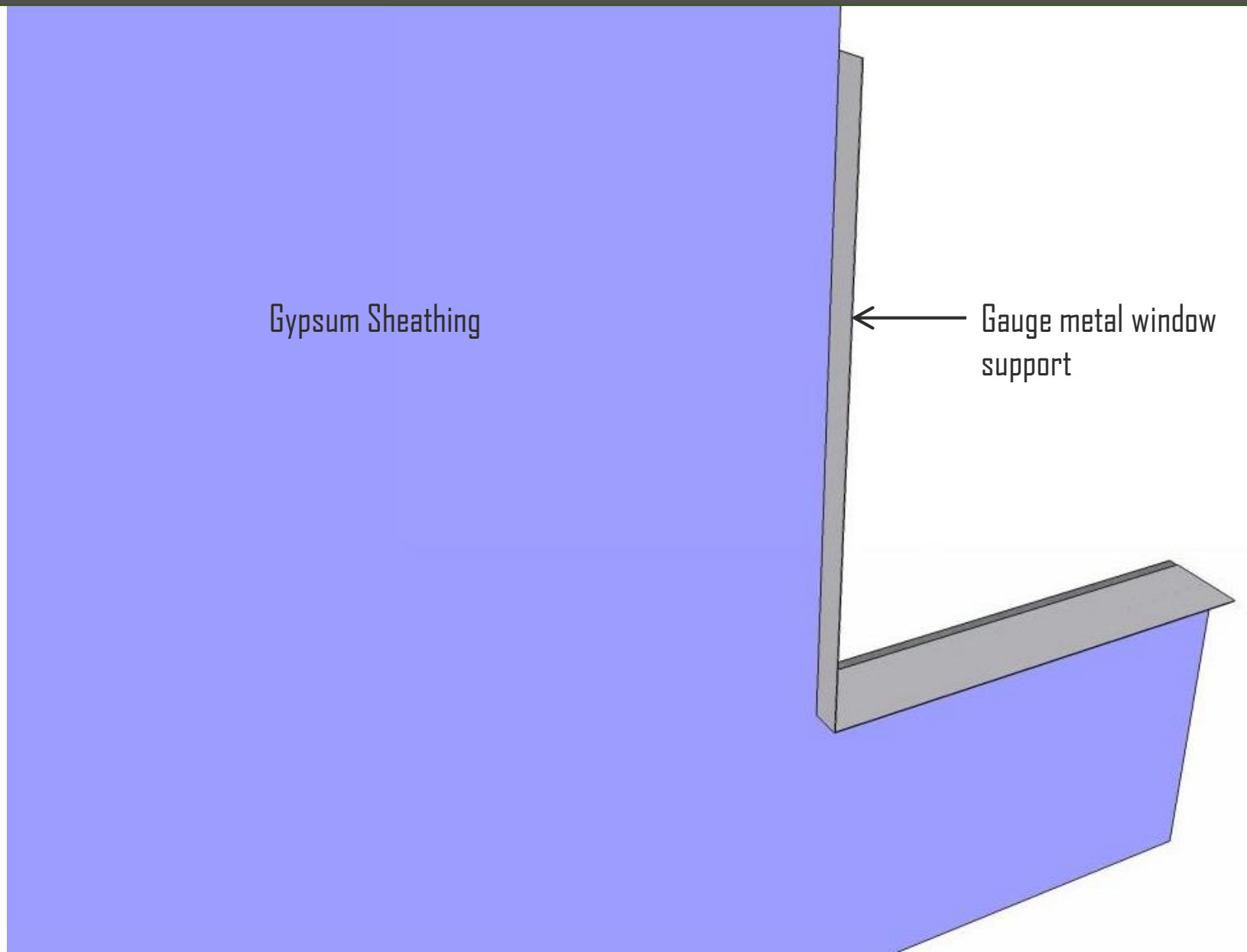
Design Review: The Building Membrane



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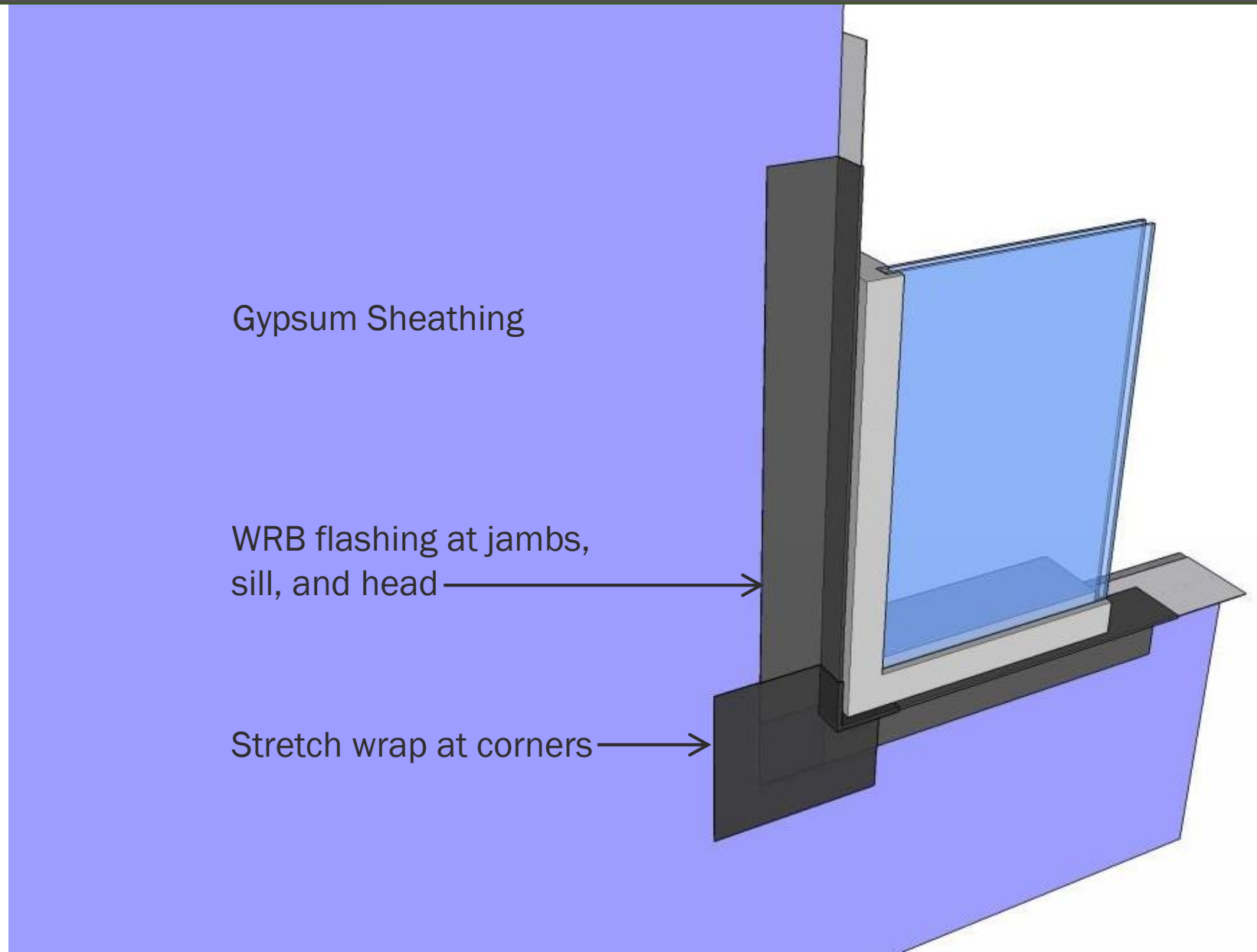

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Design Review: The Building Membrane

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Design Review: The Building Membrane

Compatibility with other materials

- Must still meet specification requirements
- Must also meet project documentation requirements
  - Submittal
  - Substitution request
- Needs to address legitimate concern
- Compatibility letter both ways

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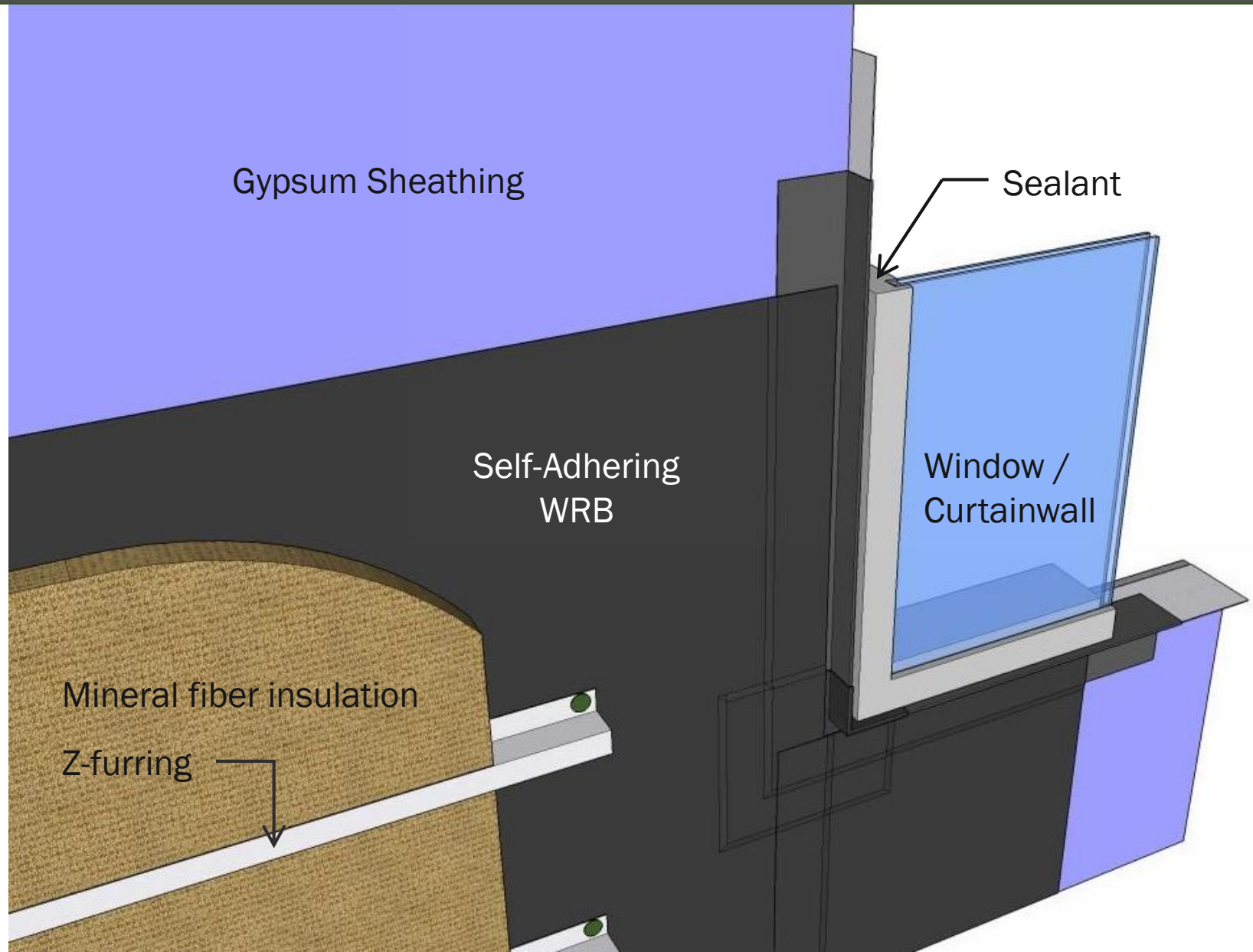
Design Review: The Building Membrane



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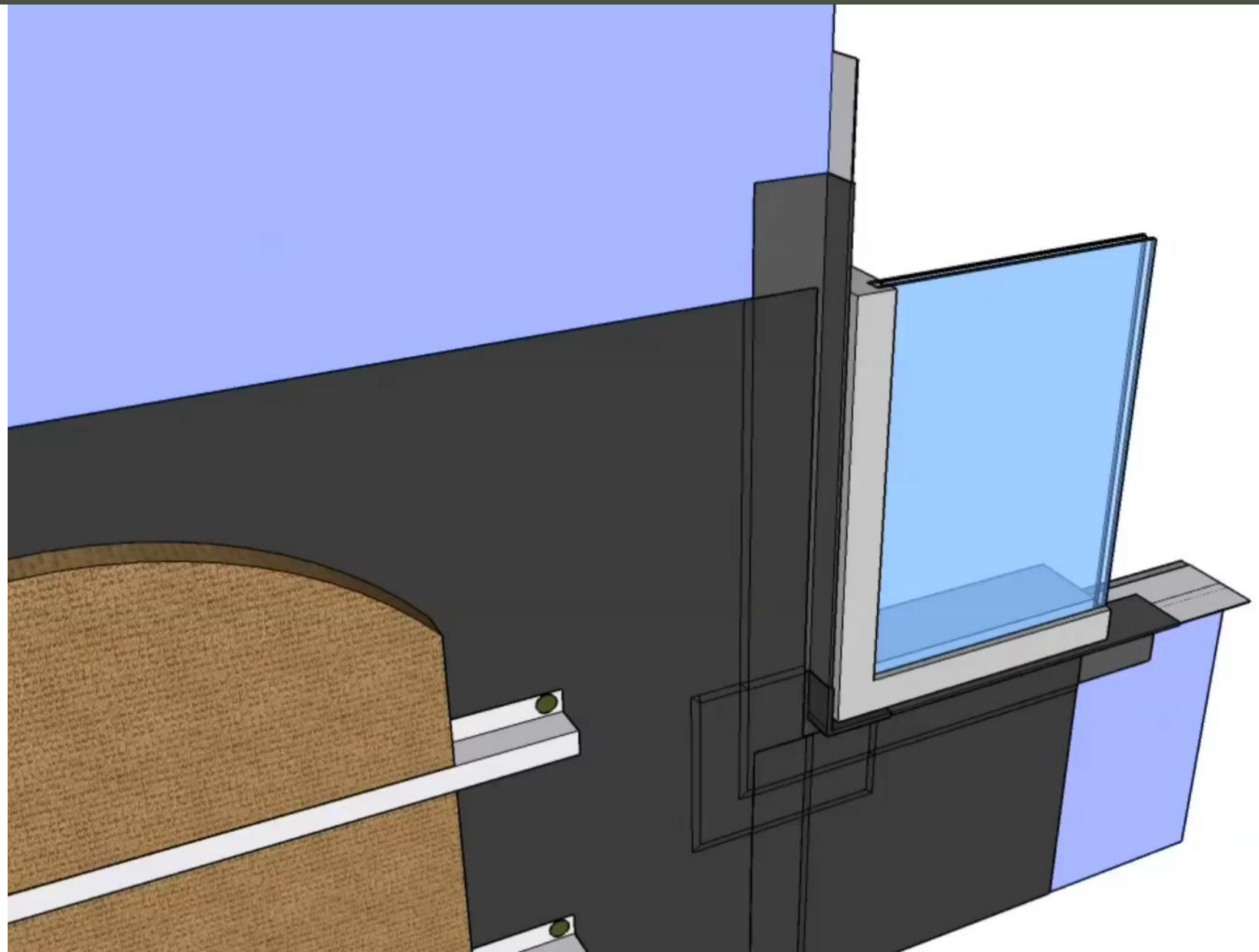

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- Design Review
- Modeling
- Construct-ability Review
  - Physical Mockups
  - Virtual Mockups

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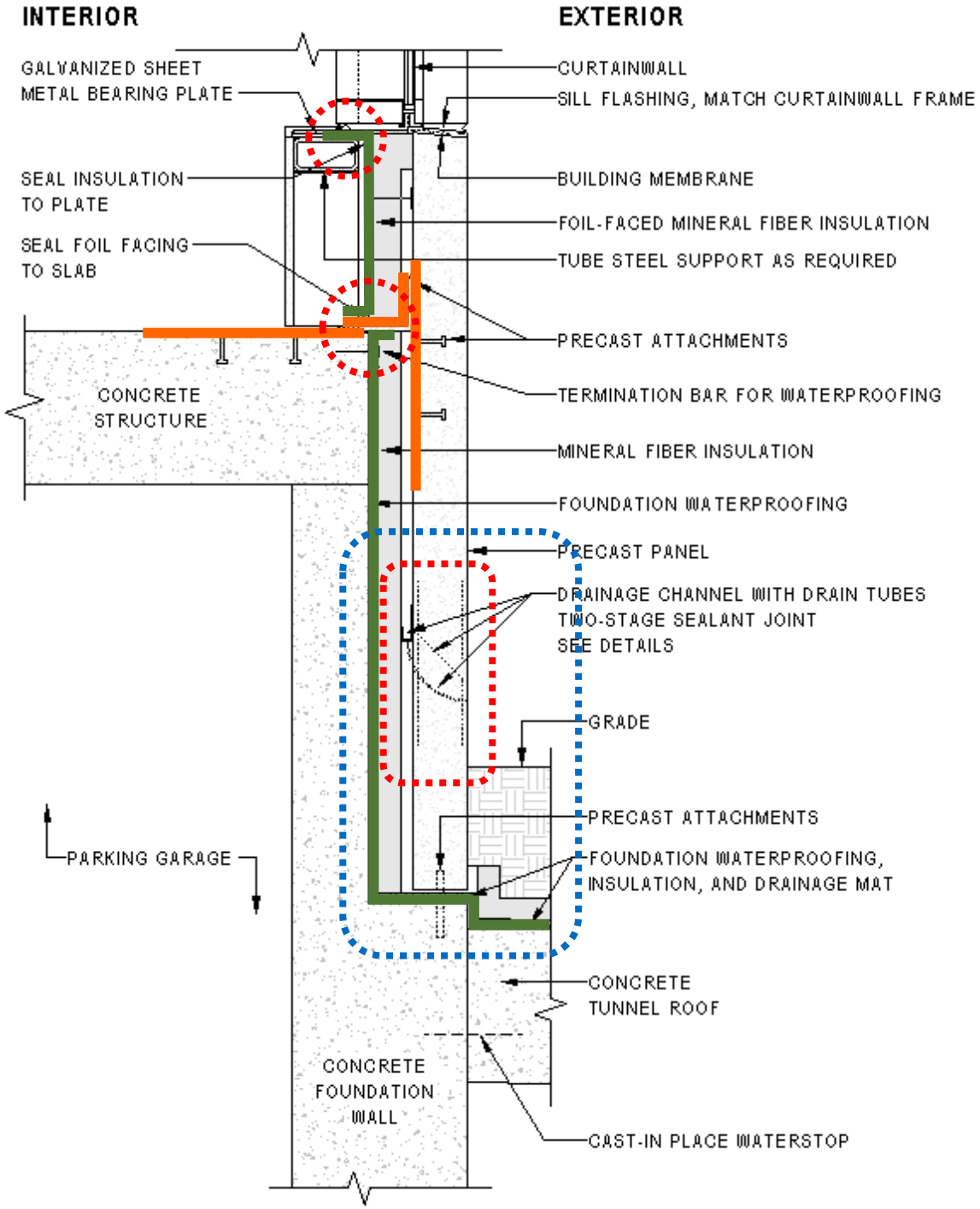

Enclosure Review Findings

- Discontinuous air barrier
- Drainage at precast
- Thermal bridge
- Construction Sequence:
  - Sealing Air Barrier
  - Drainage Channel / Tubes

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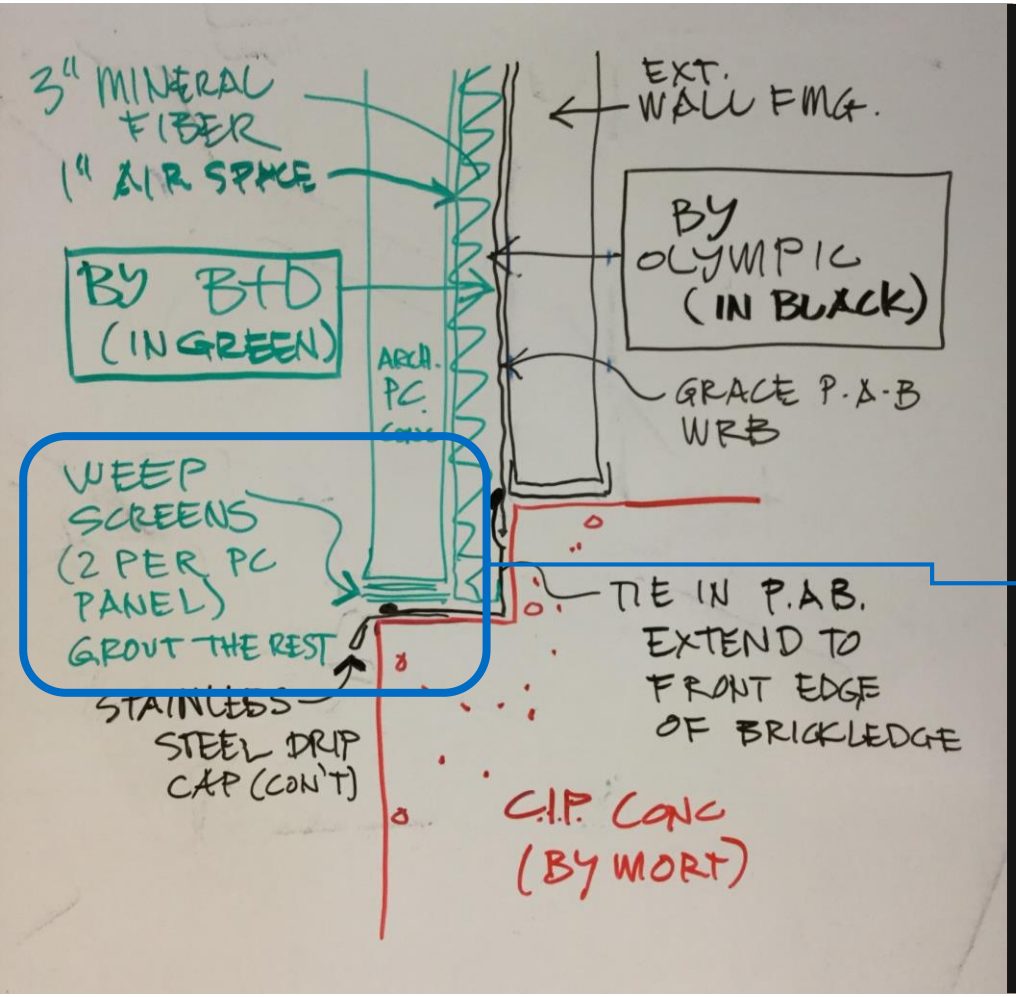

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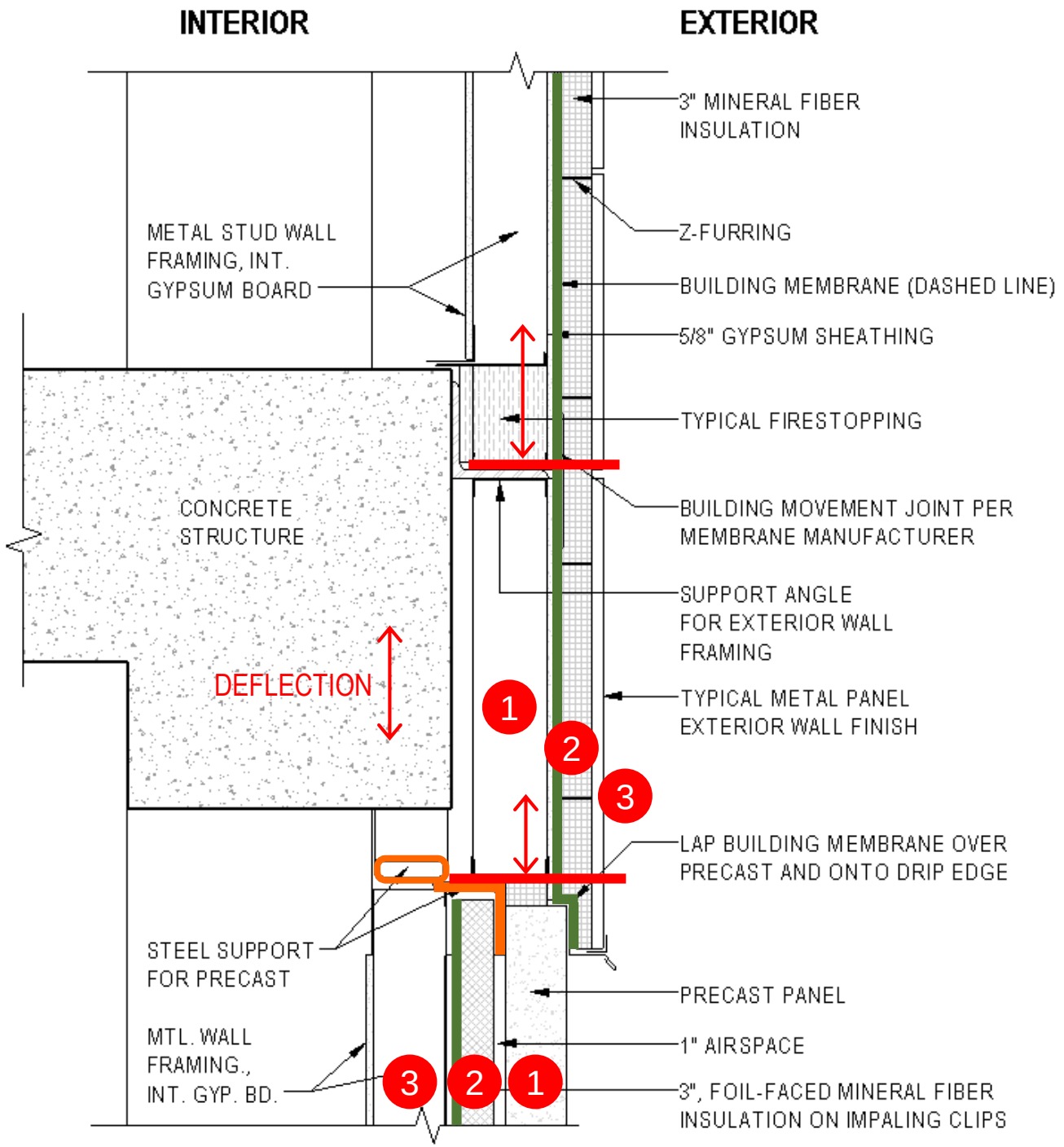

Enclosure Review Findings

- Discontinuous air barrier
- Thermal bridge
- Movement joint locations
- Construction sequence

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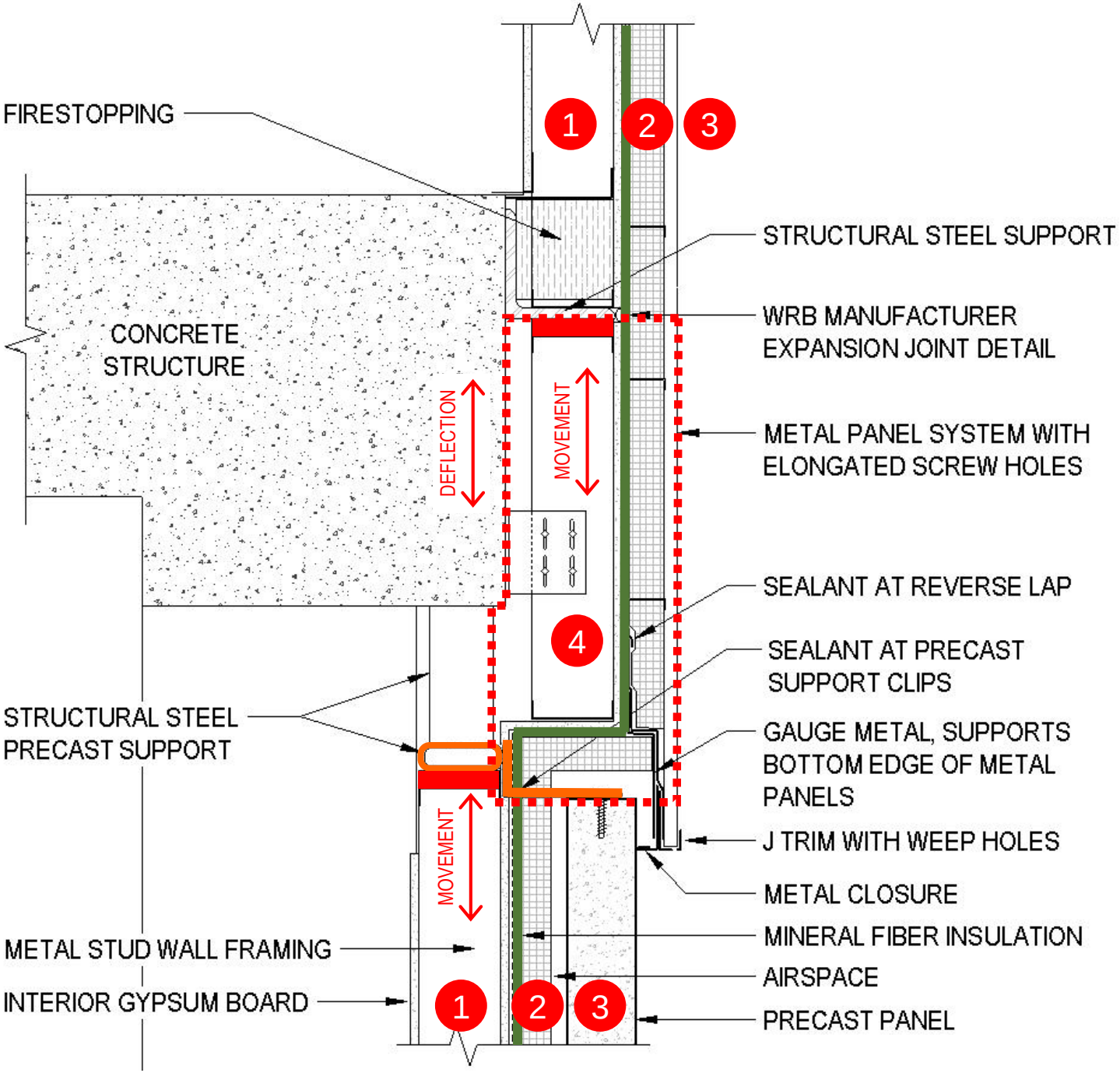

Modified Detail

- Continuous air barrier
- Thermal bridge
- Movement joint locations
- Construction sequence

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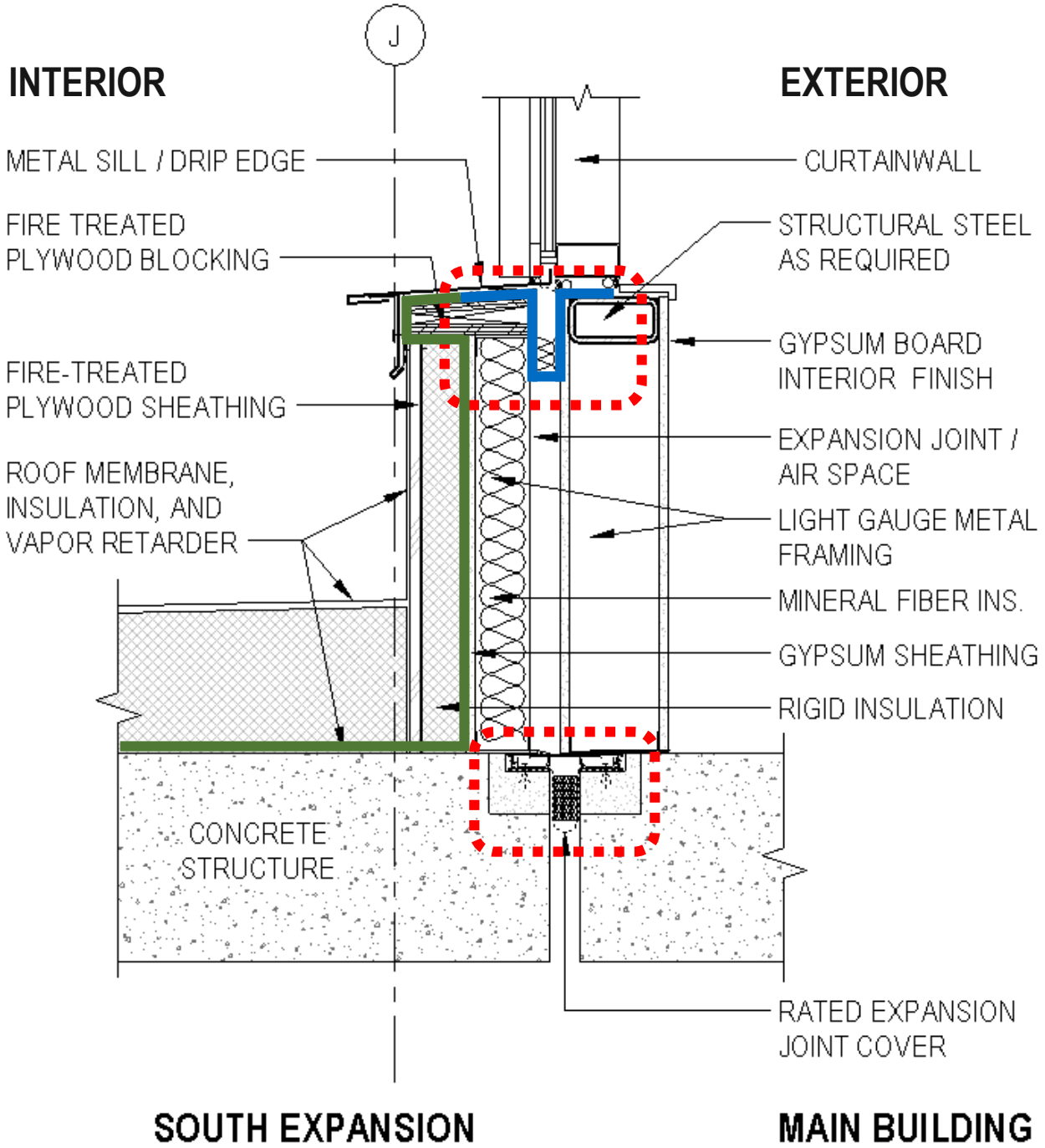

Enclosure Review Findings

- Potential collection area / leak
- Construction Sequence

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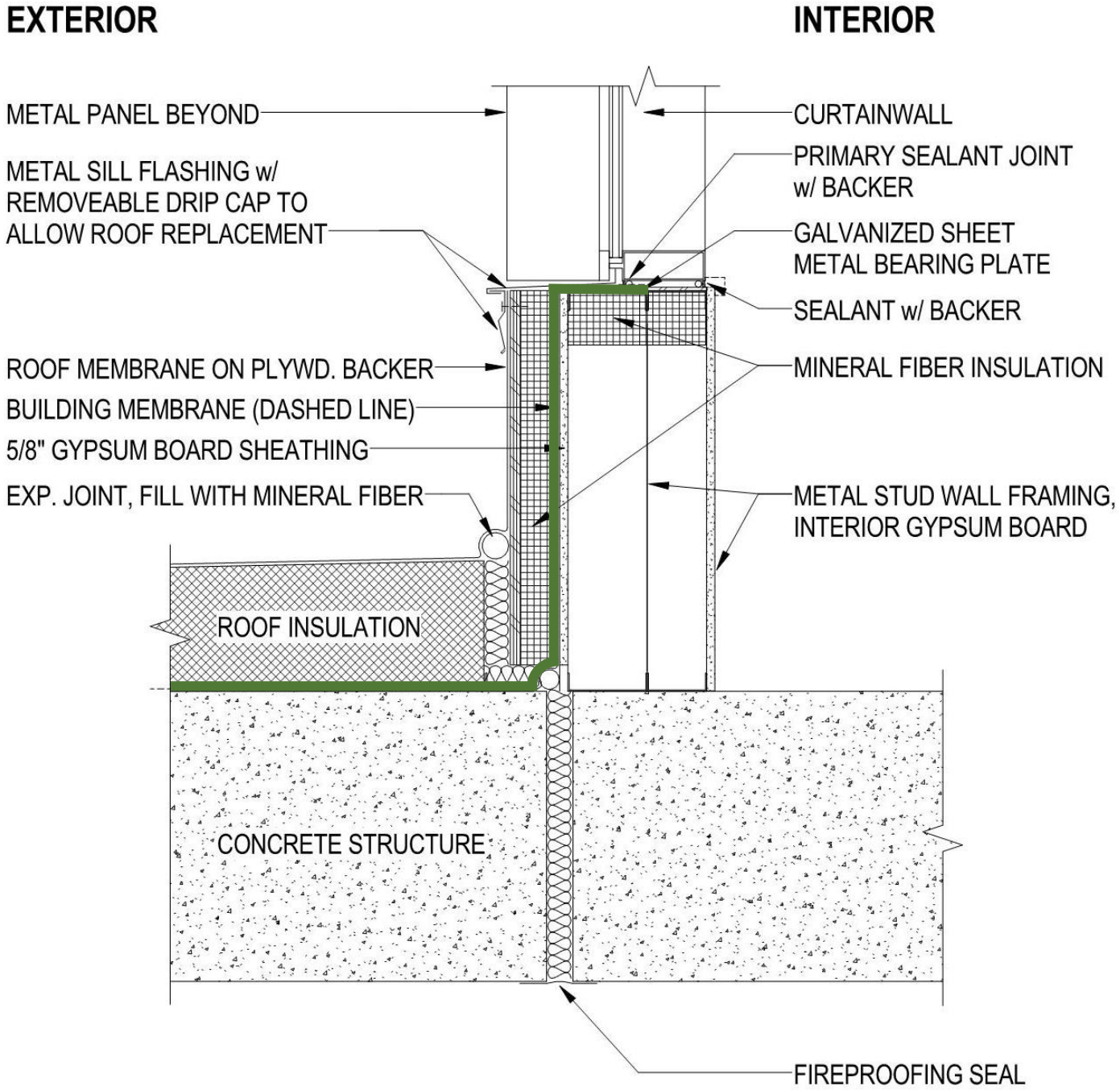

Modified Detail

- Simplified air barrier, same as the rest of the building

- Simplified expansion joint
- Construction sequence

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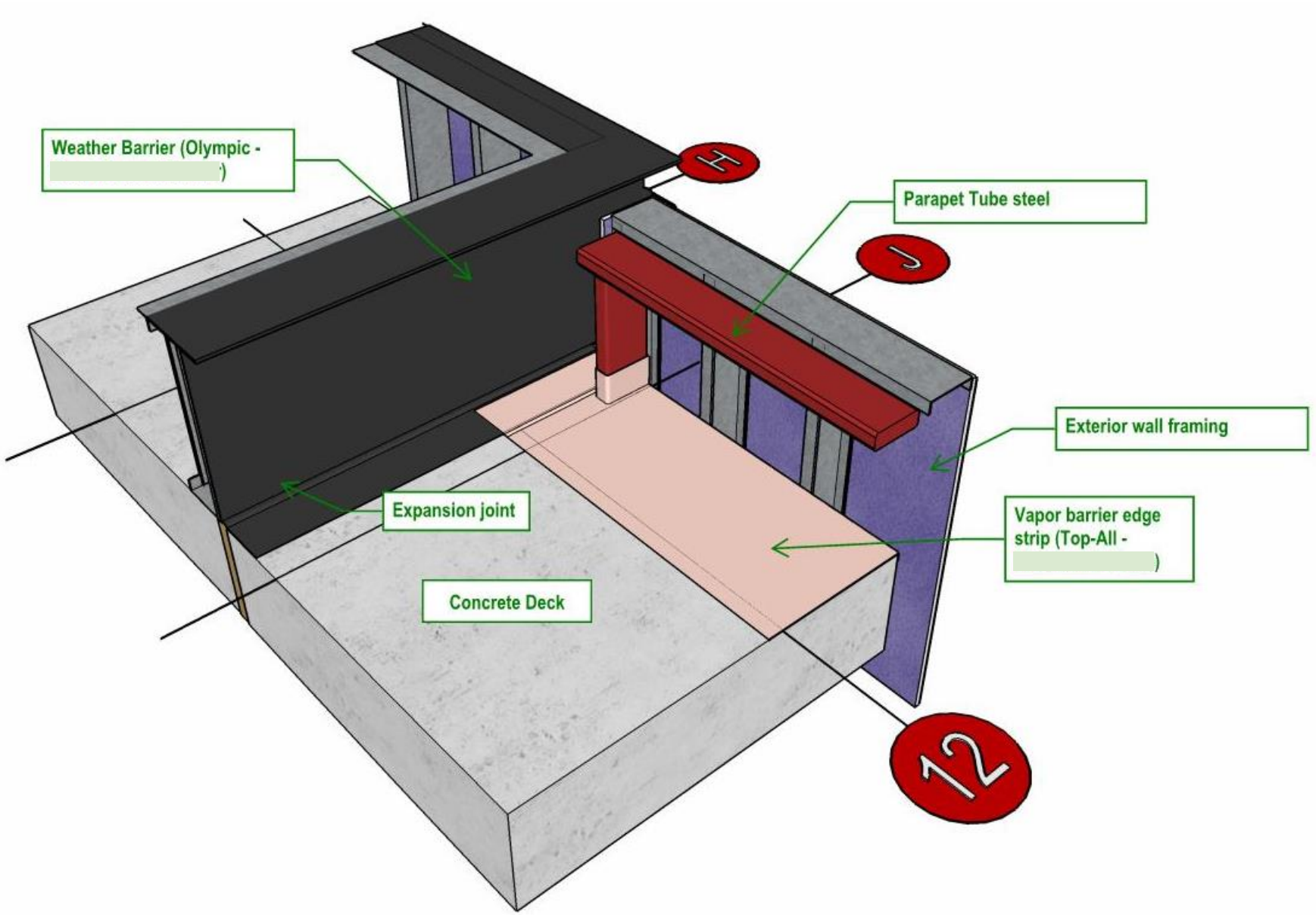
STEP 1



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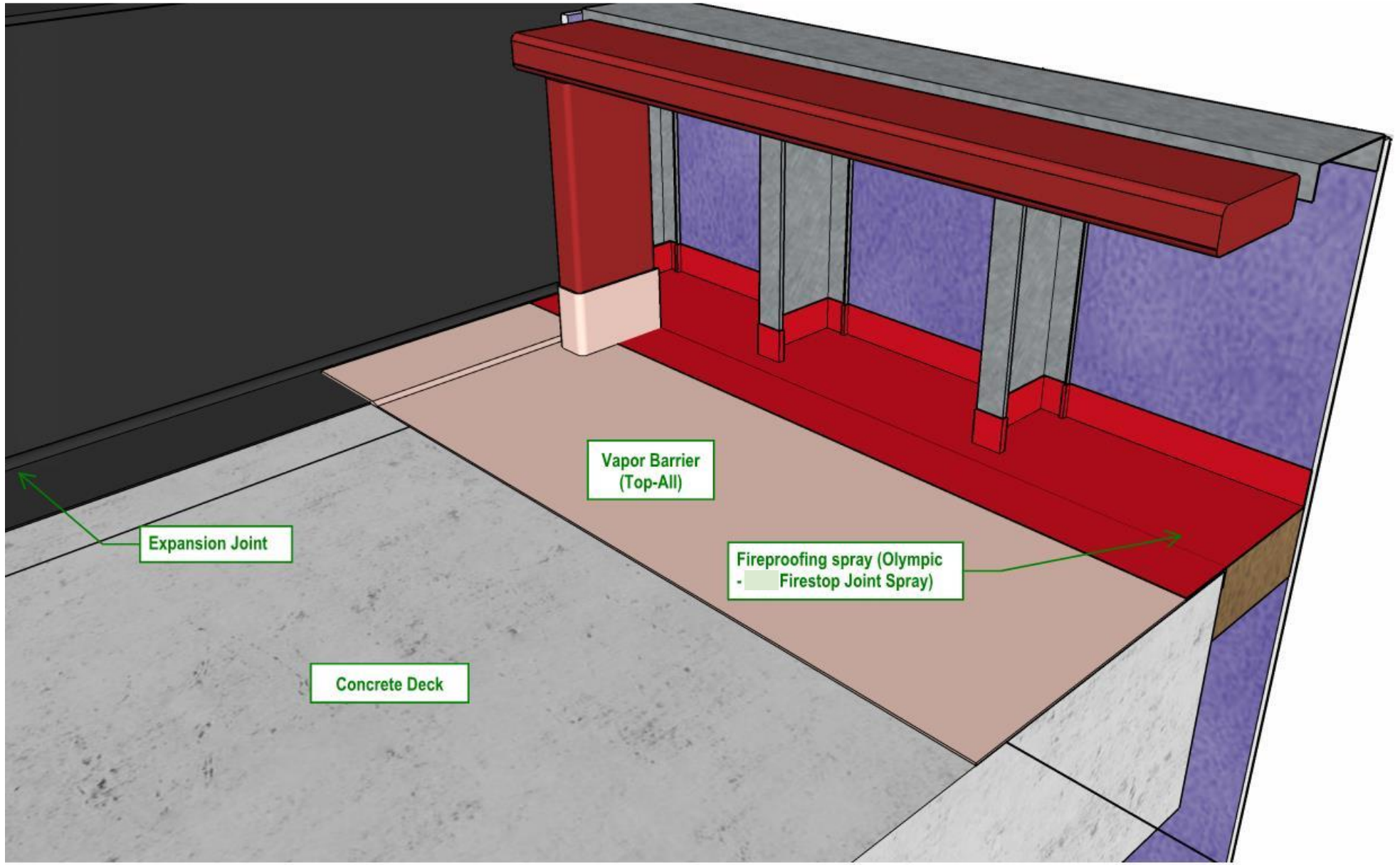
STEP 2



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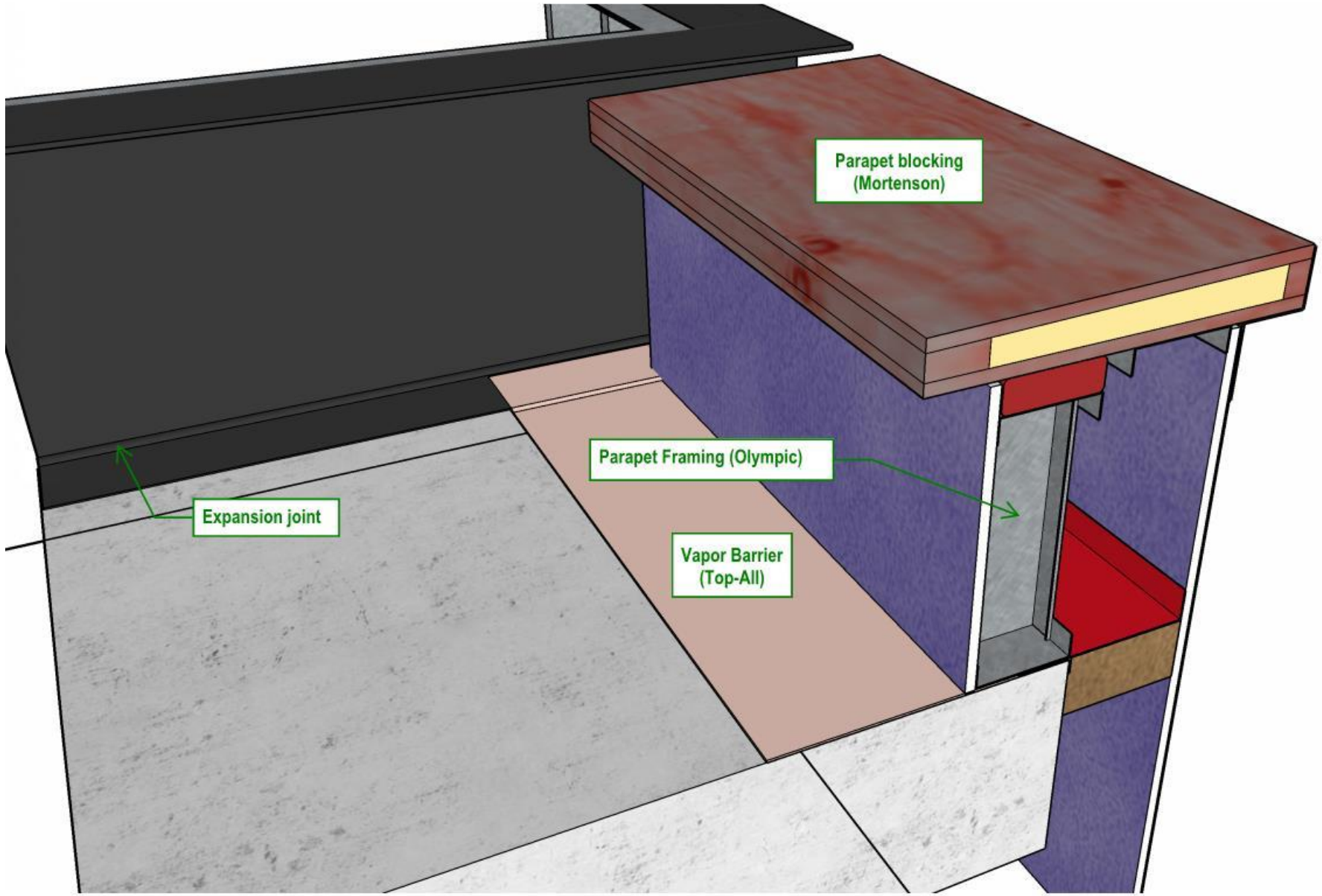
STEP 3



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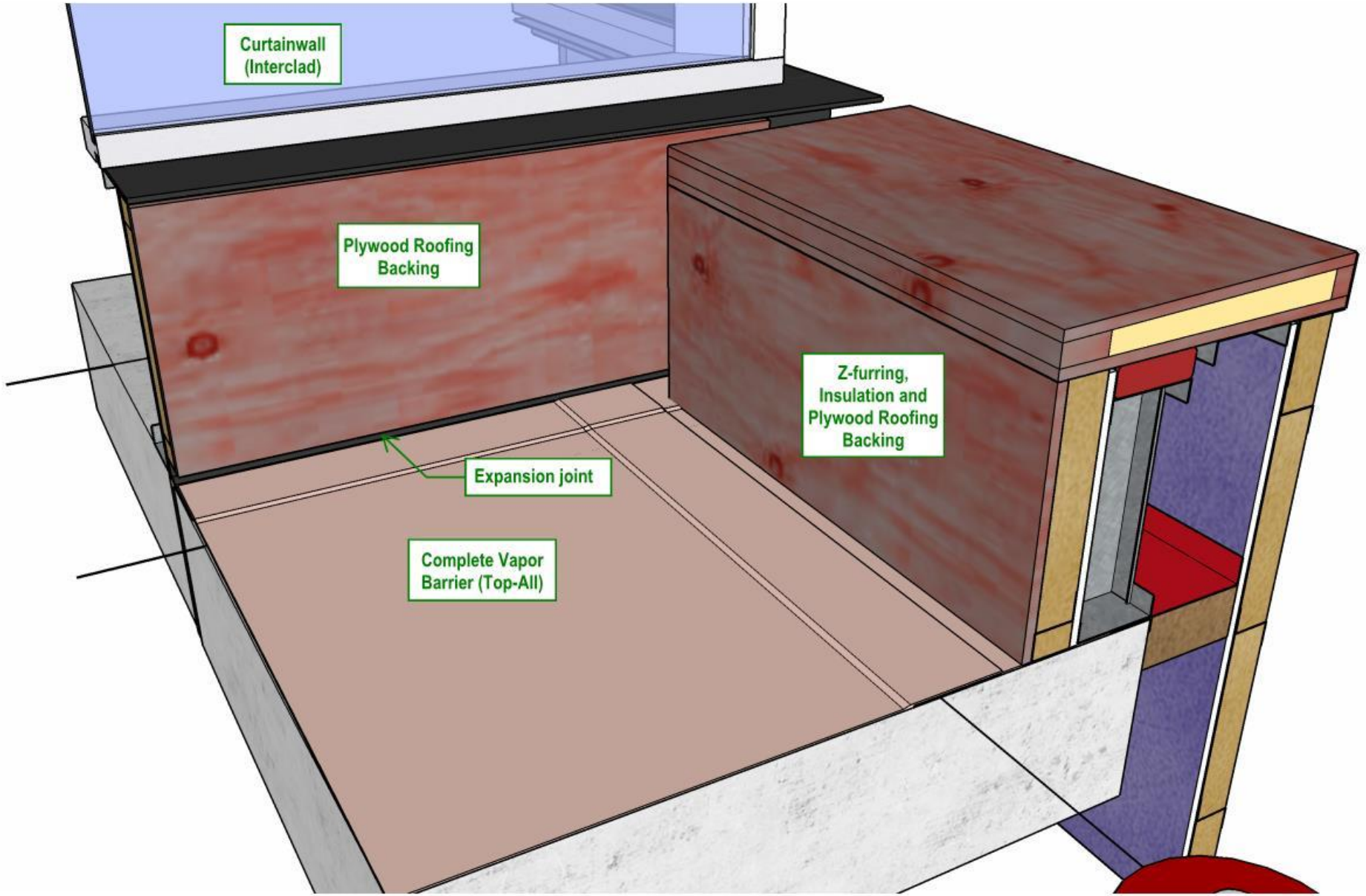
STEP 4



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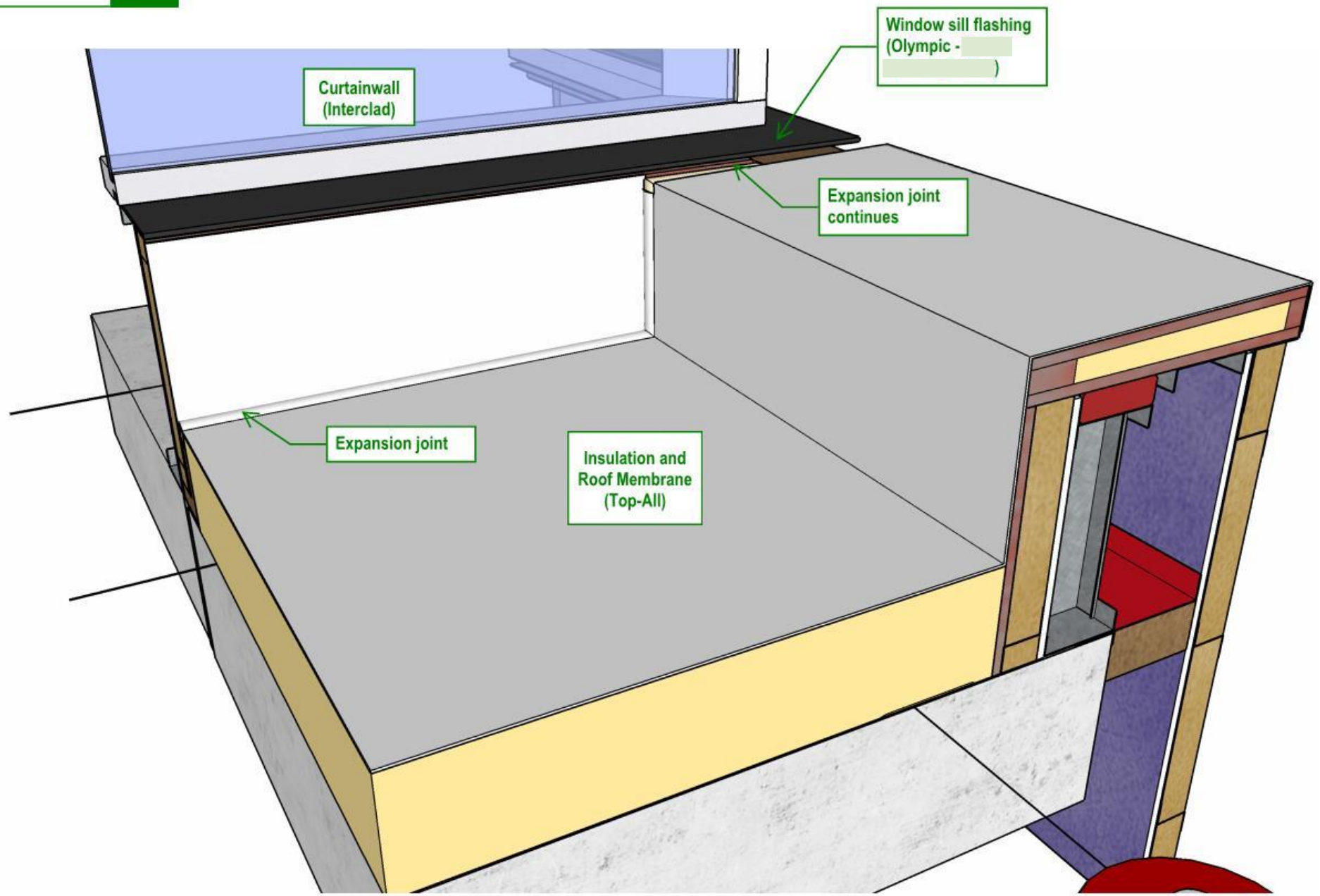
STEP 5



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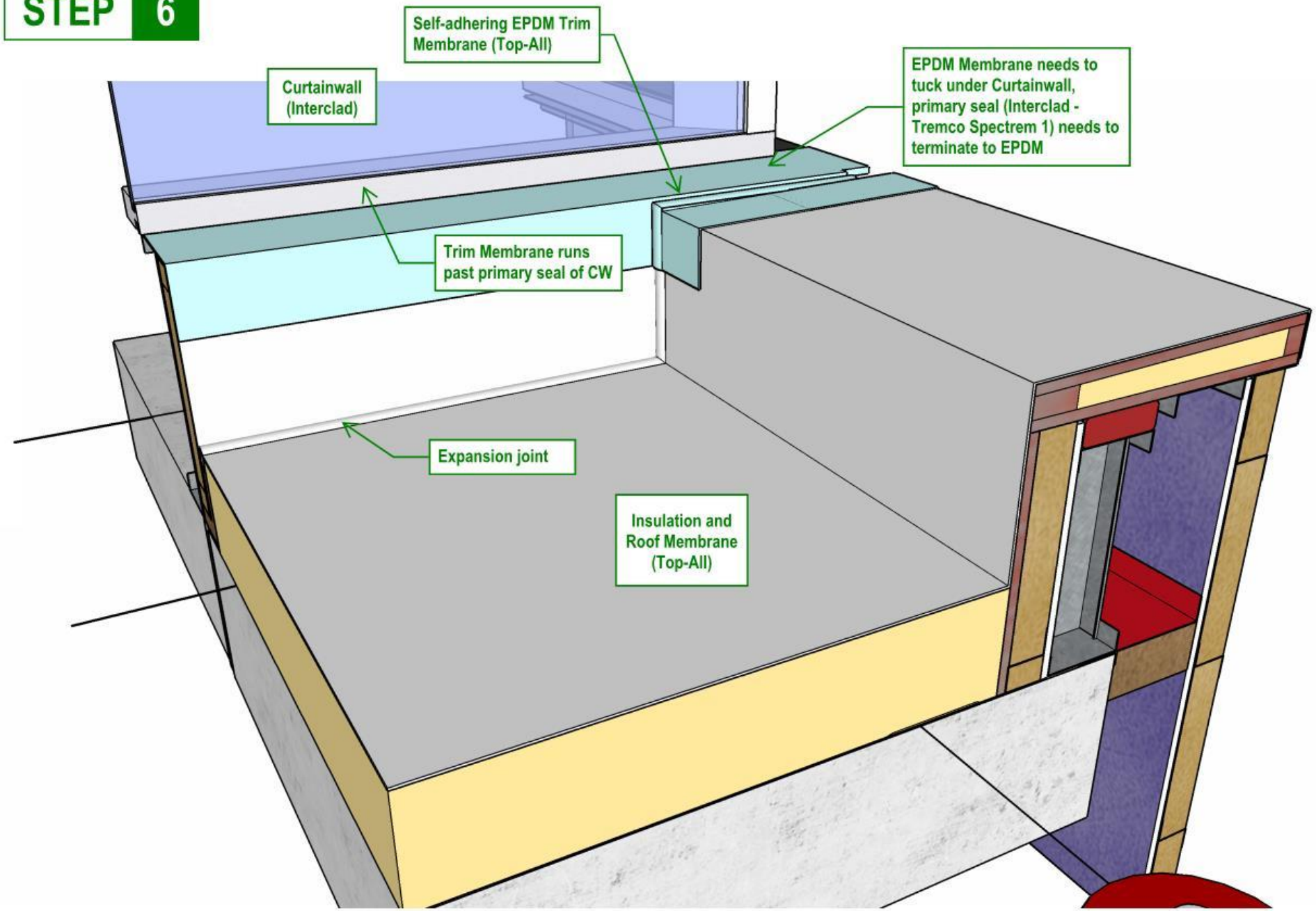
STEP 6



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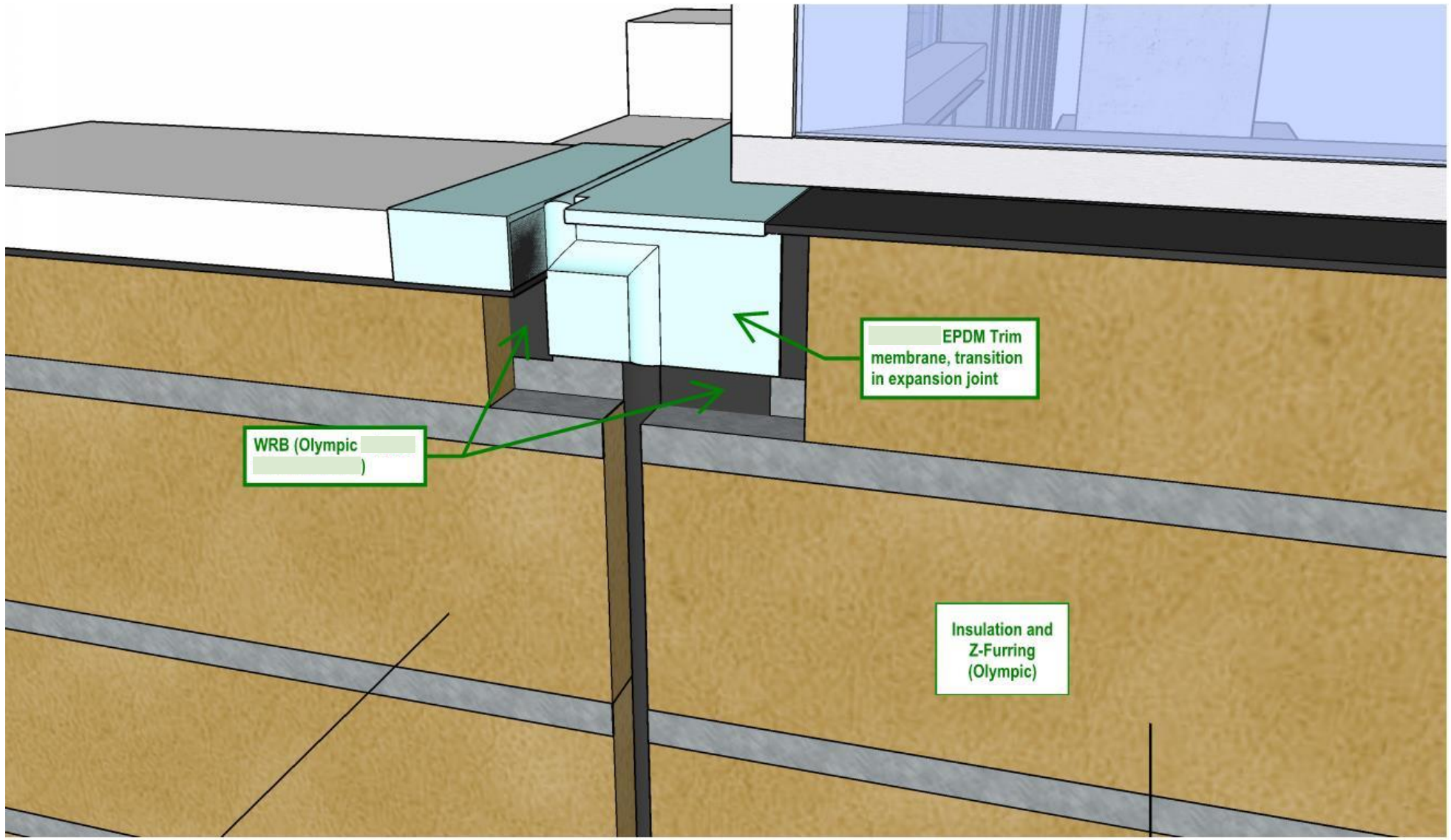
STEP 6a



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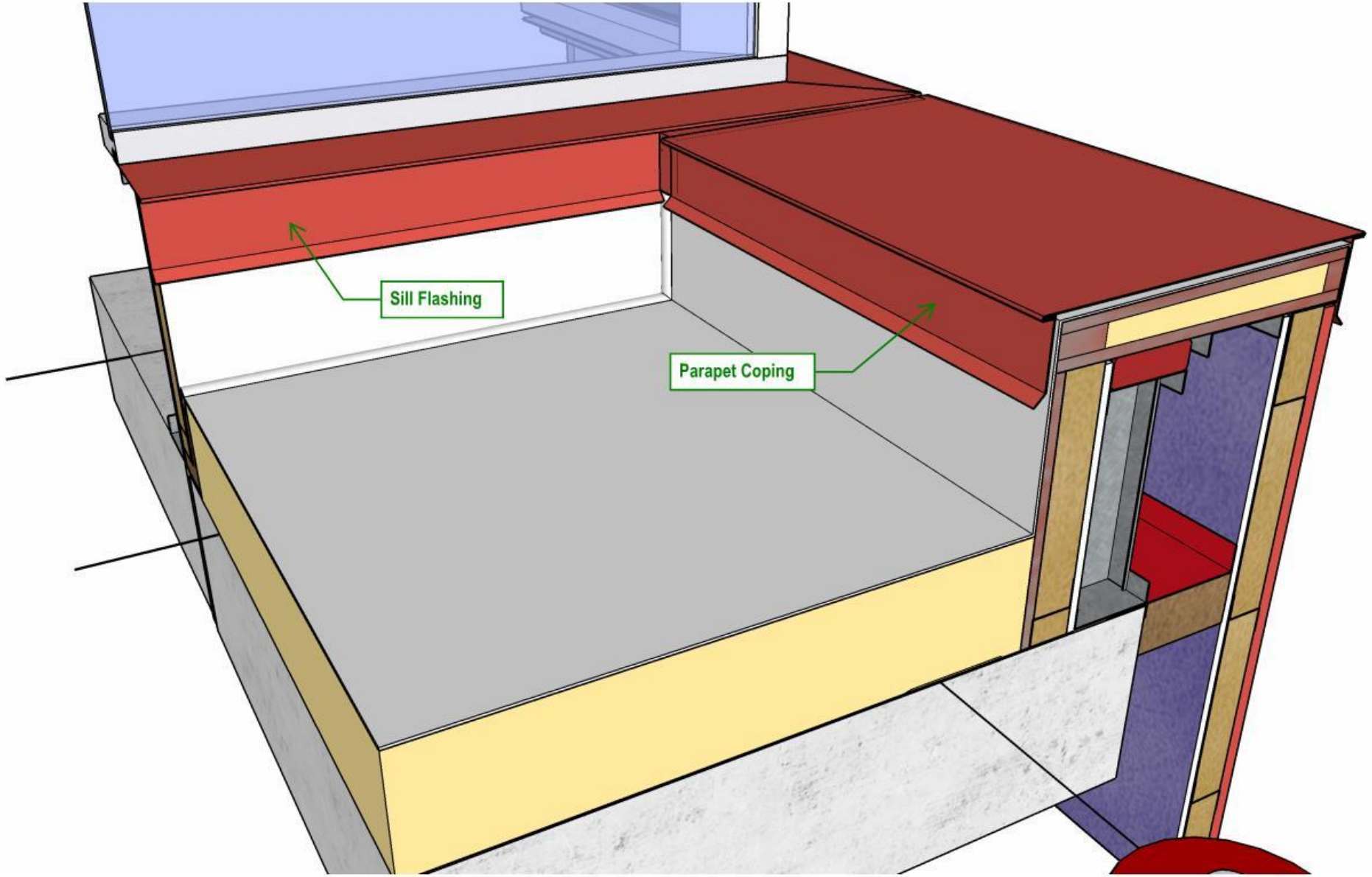
STEP 7



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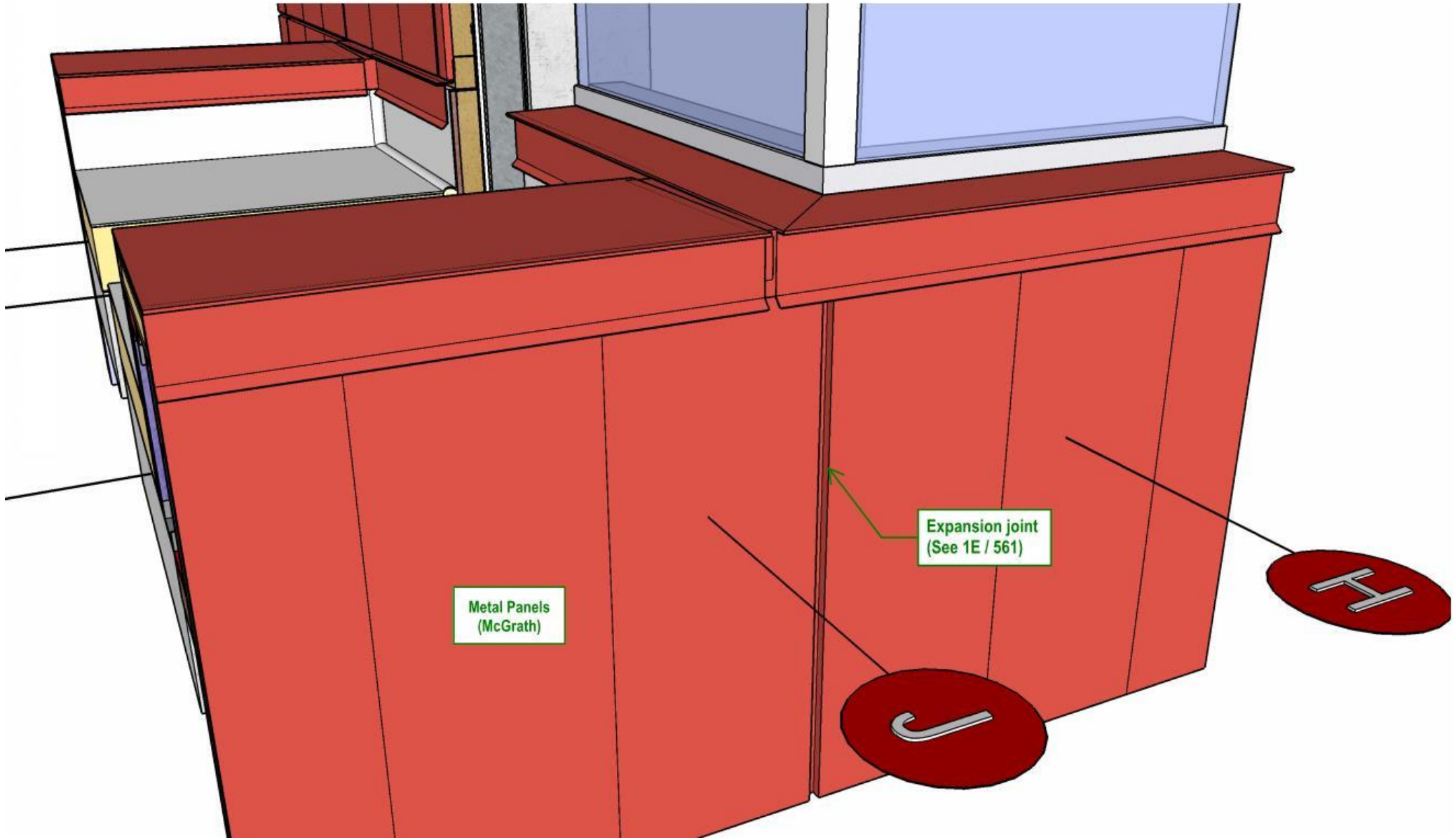
STEP 7a



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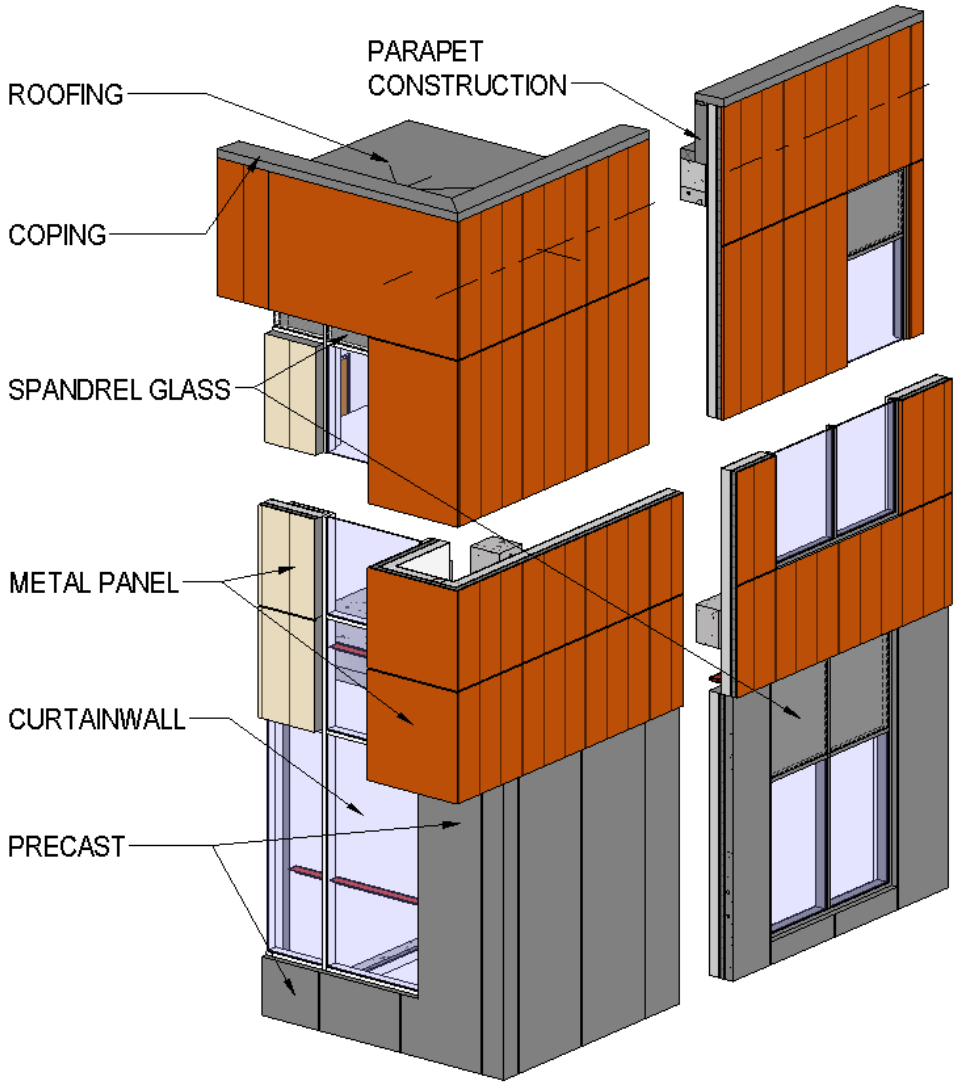
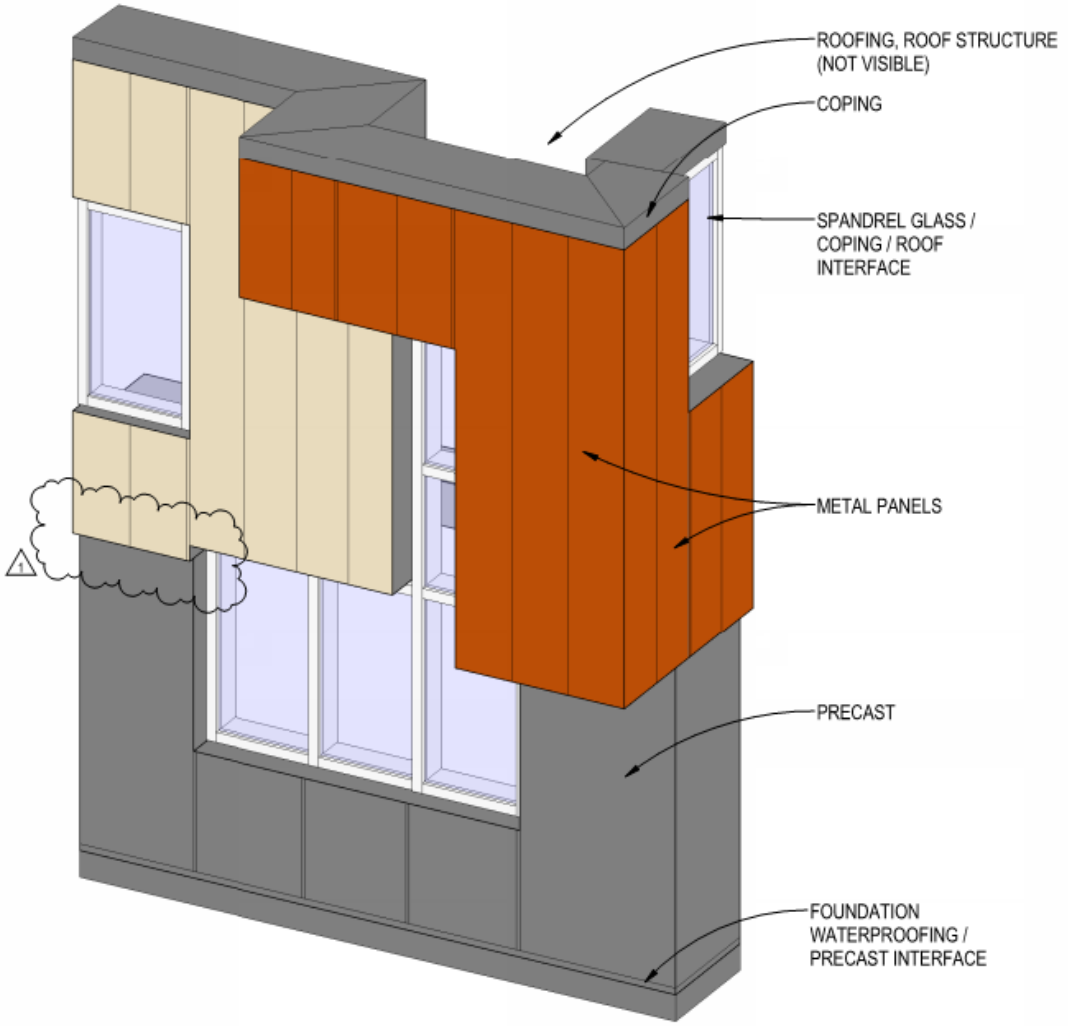
Physical Mockup





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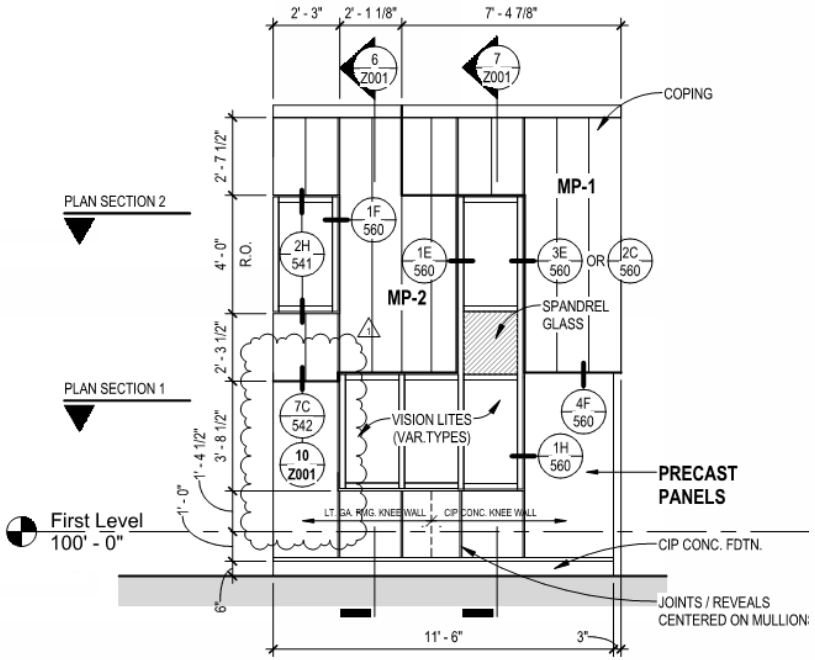
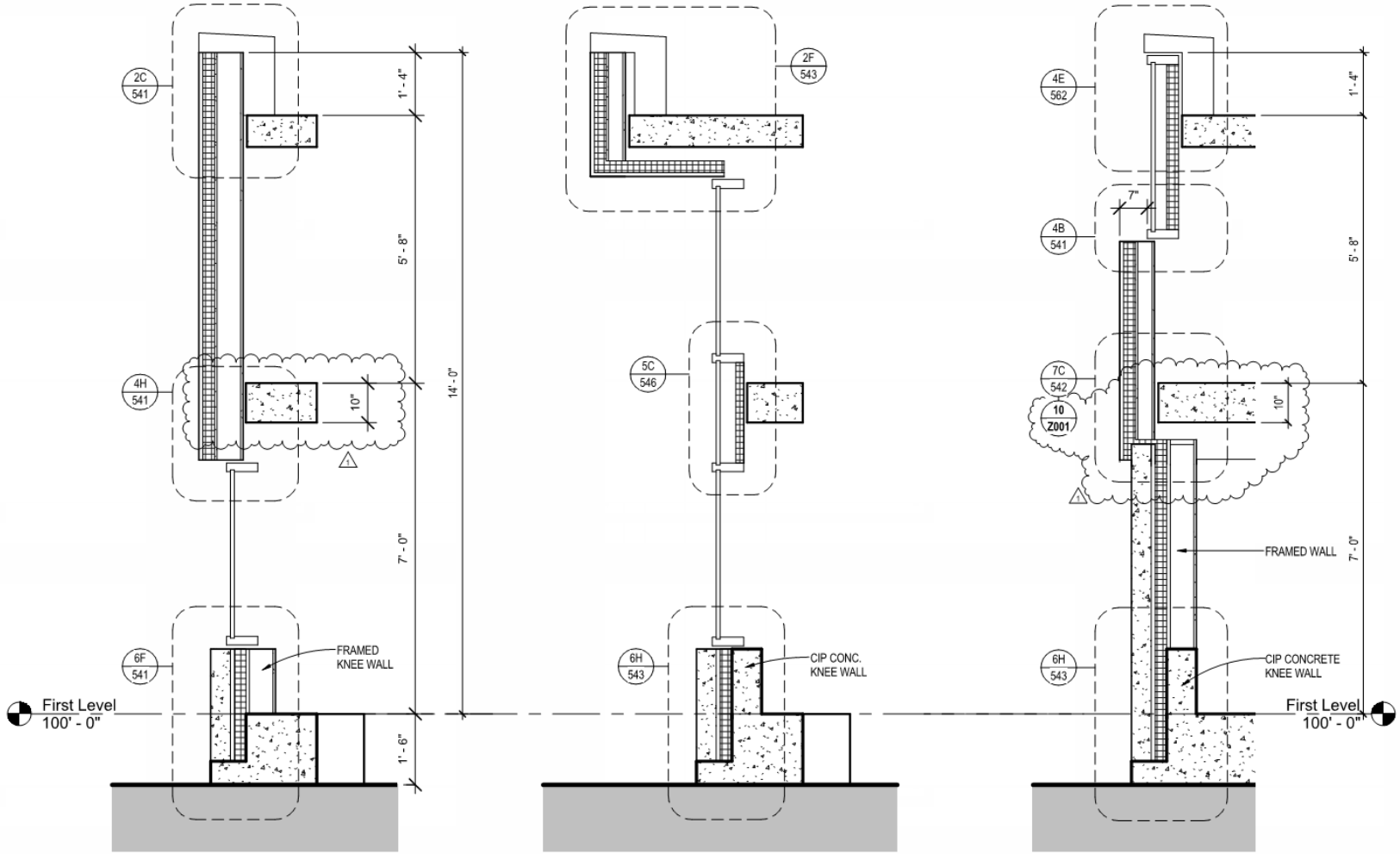


4 Z001 Front Side View 1/4" = 1'-0"



6 Z001 Section 1 1/2" = 1'-0"

7 Z001 Section 2 1/2" = 1'-0"

8 Z001 Section 3 1/2" = 1'-0"

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Physical Mockup

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Physical Mockup

Lessons Learned

- First test of revised precast back-up wall system
- Increased gauge of sheet metal plate frame around windows
- Expansion joint transition at vertical slot windows
- Sequencing of precast and second level stud framing
- Eliminated redundant detail membrane at window sill

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Strategies: Project Quality Plan (PQP)

Personnel

- Third Party Reviewer
- On-site Quality Manager
  - Scope Managers
    - GC Craft
    - Sub-contractors
- Testing Agency

Product

- Design Review
- Modeling
- Construct-ability Review
  - Physical Mockups
  - Virtual Mockups

Process

- Lean Construction
  - Last Planner Method
- Change Management
- Definable Feature of Work Log
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Inspections

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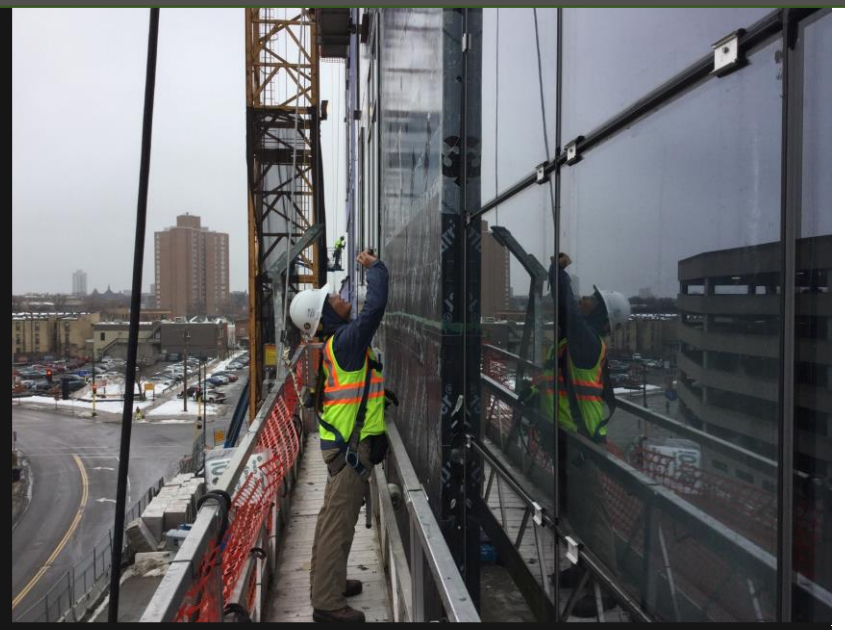
Inspections



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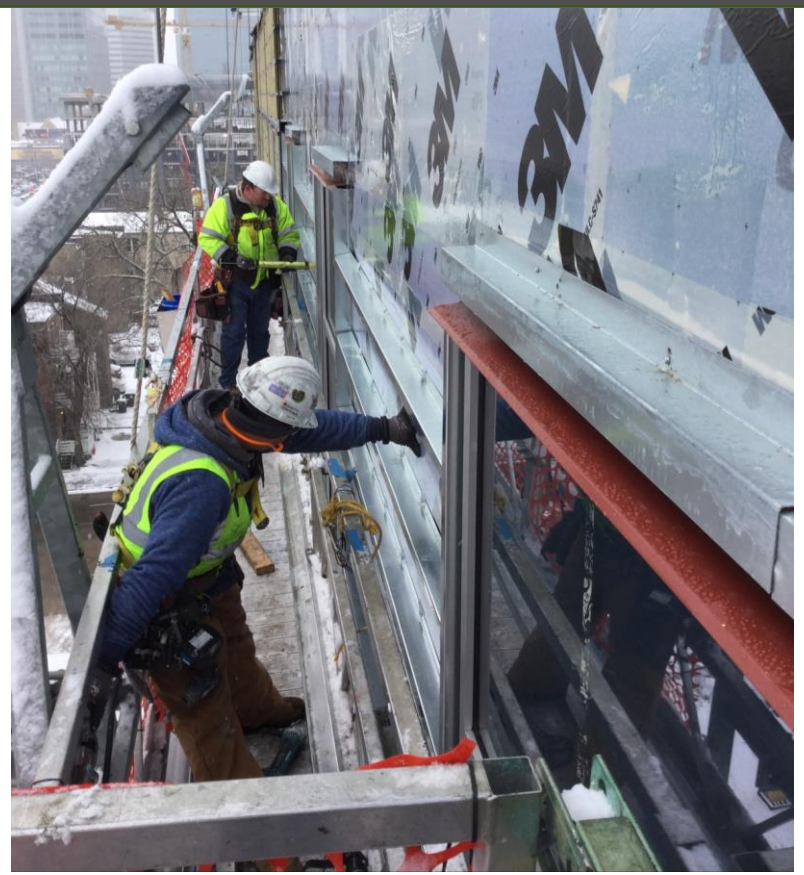

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Inspections

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Inspections

BRAUN INTERTEC

Enclosure Observation Daily Report

Report No.:	#02	**Date of this Report:**	09/21/2016	**Braun Project No.:**	B1601432
Project Name:	HCMC AOSC, Minneapolis, MN				
Client:	Mortenson Construction		**Workers:**		
Braun Project Mgr:	Jack R. Rasmussen		**Temp/Weather:**	68 degrees, mostly cloudy, 10 mph east winds	

Type of Observation:	Location of material:	Manufacturer:	Type of Material:
☐ Continuous	☐ Roofing		
☒ Periodic	☐ Wall Panels		
	☐ Pre-Cast Panels		
	☐ Windows	EFCO	5600 Series Curtain Wall
	☐ Air Barrier	Grace	Perm-A-Barrier (Self-Adhered)
	☐ Waterproofing	Grace	Procor

Description and location of work completed and list tests performed :

We observed the following area(s) of work:
- First floor around building perimeter.
- Window openings on the second floor

Type of Work Observed:
- Exposed top edge of waterproofing system above backfilled soil
- Self-adhered weather barrier installation
- Pre-cast veneer installation
- Curtain wall framing

Status of previous discrepancies: (Strike through indicates corrections completed) (Bold is additional comment)
1. ~~Plate at sill was trimmed and will not provide solid backing for the primary seal of the curtain wall. (Photo 11)~~
2. ~~Huber Stretch Tape observed at sill to jamb transition without backing and prone to puncture. Opposite jambs were installed with Grace SA Membrane and then wrapped in Huber Stretch Tape providing more durable installation. (Photo 12)~~
3. ~~Tear in waterproofing observed at pre-cast panel installation requiring patching/repair. (Photo 13)~~
4. ~~At curved wall, waterproofing installed prior to the precast panels minimally extends beyond the face of the panel. Care will be required with limited ability to tie the horizontal waterproofing together at this location. (Photo 14)~~
5. ~~Hole observed in Huber Stretch Tape at sill/jamb condition. (Photo 15)~~
6. ~~Detail 6H/546 shows a drip flashing at the bearing ledge and the weather barrier lapping onto it protecting the floor slab edge. The membrane in place terminates onto the concrete vertical without drip flashing. When installed, the membranes and flashings should be in shingle lap fashion to direct water out of wall assembly. (Photo 16)~~

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Photograph 1

Overview of west elevation.

Photograph 2

Curtain wall framing at north elevation.

Photograph 3

Overview of east half of north elevation.

Photograph 4

Partial east elevation viewed from north.

Page 2 of 5	Project Number B1601432	HCMC AOSC Minneapolis, MN	BRAUN INTERTEC The Science You Build On.

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Inspections

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	WEST ELEVATION				SOUTH ELEVATION								EAST ELEVATION						South Expansion	
	LEVEL 7 WEST ROOF				PENTHOUSE ROOF												NORTH EAST CORNER		EAST	SOUTH
	LIFT NORTH	LIFT SOUTH	MISC		SWING 1	SWING 2	SWING 3	SWING 4	LIFT	SWING 6	LIFT		SWING 1	SWING 2	LIFT @ CRANE	SWING 3	LIFT		LIFT	LIFT
Desk 1 11.7.15	WINDOW TRIM McGRATH			Desk 1 11.7.15	MEMBRANE OLYMPIC							Desk 1 11.7.15								
Desk 2 11.8.15	WINDOW TRIM McGRATH			Desk 2 11.8.15	MEMBRANE OLYMPIC							Desk 2 11.8.15								
Desk 3 11.9.15	2 FURRING / INSULATION OLYMPIC			Desk 3 11.9.15	WINDOW TRIM McGRATH							Desk 3 11.9.15								
Desk 4 11.10.15	2 FURRING / INSULATION OLYMPIC			Desk 4 11.10.15	WINDOW TRIM McGRATH							Desk 4 11.10.15								
Desk 5 11.11.15	2 FURRING / INSULATION OLYMPIC			Desk 5 11.11.15	WINDOW TRIM McGRATH							Desk 5 11.11.15								
Desk 6 11.14.15	MOVE SWING 1 TO SWING 2 SOUTH		2 FURRING / INSULATION OLYMPIC	Desk 6 11.14.15		MOVE SWING 1 WEST TO SWING 2 SOUTH						Desk 6 11.14.15	INSTALL SWING 1 EAST McGRATH	INSTALL SWING 2 EAST McGRATH		INSTALL SWING 3 EAST McGRATH	INSTALL SWING 3 EAST McGRATH	Desk 6 11.14.15		
Desk 7 11.15.15	MOVE SWING 1 TO SWING 2 SOUTH		2 FURRING / INSULATION OLYMPIC	Desk 7 11.15.15		MEMBRANE OLYMPIC						Desk 7 11.15.15	INSTALL SWING 1 EAST McGRATH	INSTALL SWING 2 EAST McGRATH		INSTALL SWING 3 EAST McGRATH	INSTALL SWING 3 EAST McGRATH	Desk 7 11.15.15		
Desk 8 11.16.15			2 FURRING / INSULATION OLYMPIC	Desk 8 11.16.15		MEMBRANE OLYMPIC						Desk 8 11.16.15		INSTALL SWING 2 EAST McGRATH		INSTALL SWING 3 EAST McGRATH	INSTALL SWING 3 EAST McGRATH	Desk 8 11.16.15		
Desk 9 11.17.15			2 FURRING / INSULATION OLYMPIC	Desk 9 11.17.15		MEMBRANE OLYMPIC	MOVE SWING 2 WEST TO SWING 3 SOUTH					Desk 9 11.17.15						Desk 9 11.17.15		
Desk 10 11.18.15			2 FURRING / INSULATION OLYMPIC	Desk 10 11.18.15		MEMBRANE OLYMPIC	MOVE SWING 2 WEST TO SWING 3 SOUTH					Desk 10 11.18.15						Desk 10 11.18.15		
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10-Mar			METAL PANELS McGRATH	10-Mar					METAL PANELS McGRATH	2 FURRING / INSULATION OLYMPIC		10-Mar	METAL PANELS McGRATH	METAL PANELS McGRATH	2 FURRING / INSULATION OLYMPIC			10-Mar		
13-Mar			METAL PANELS McGRATH	13-Mar						METAL PANELS McGRATH		13-Mar	METAL PANELS McGRATH	METAL PANELS McGRATH	2 FURRING / INSULATION OLYMPIC	METAL PANELS McGRATH	METAL PANELS McGRATH	13-Mar		
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15-Mar	WINDOW PANELS McGRATH	WINDOW PANELS McGRATH		15-Mar						METAL PANELS McGRATH		15-Mar	METAL PANELS McGRATH	METAL PANELS McGRATH	2 FURRING / INSULATION OLYMPIC	METAL PANELS McGRATH	METAL PANELS McGRATH	15-Mar		
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29-Mar				29-Mar							METAL PANELS McGRATH	29-Mar	WINDOW PANELS McGRATH	WINDOW PANELS McGRATH	METAL PANELS McGRATH			29-Mar		
30-Mar				30-Mar						WINDOW PANELS McGRATH	METAL PANELS McGRATH	30-Mar	WINDOW PANELS McGRATH	WINDOW PANELS McGRATH	METAL PANELS McGRATH			30-Mar		

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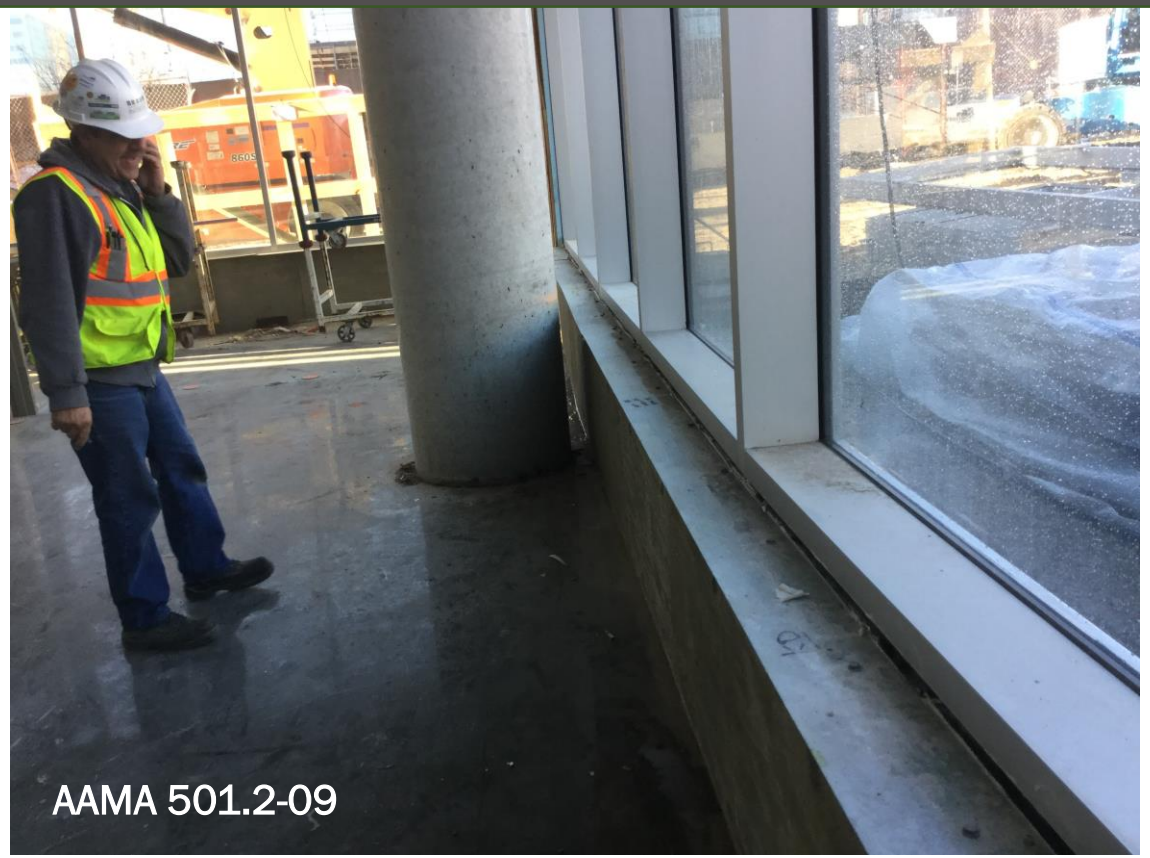
Testing: Windows and Curtainwall



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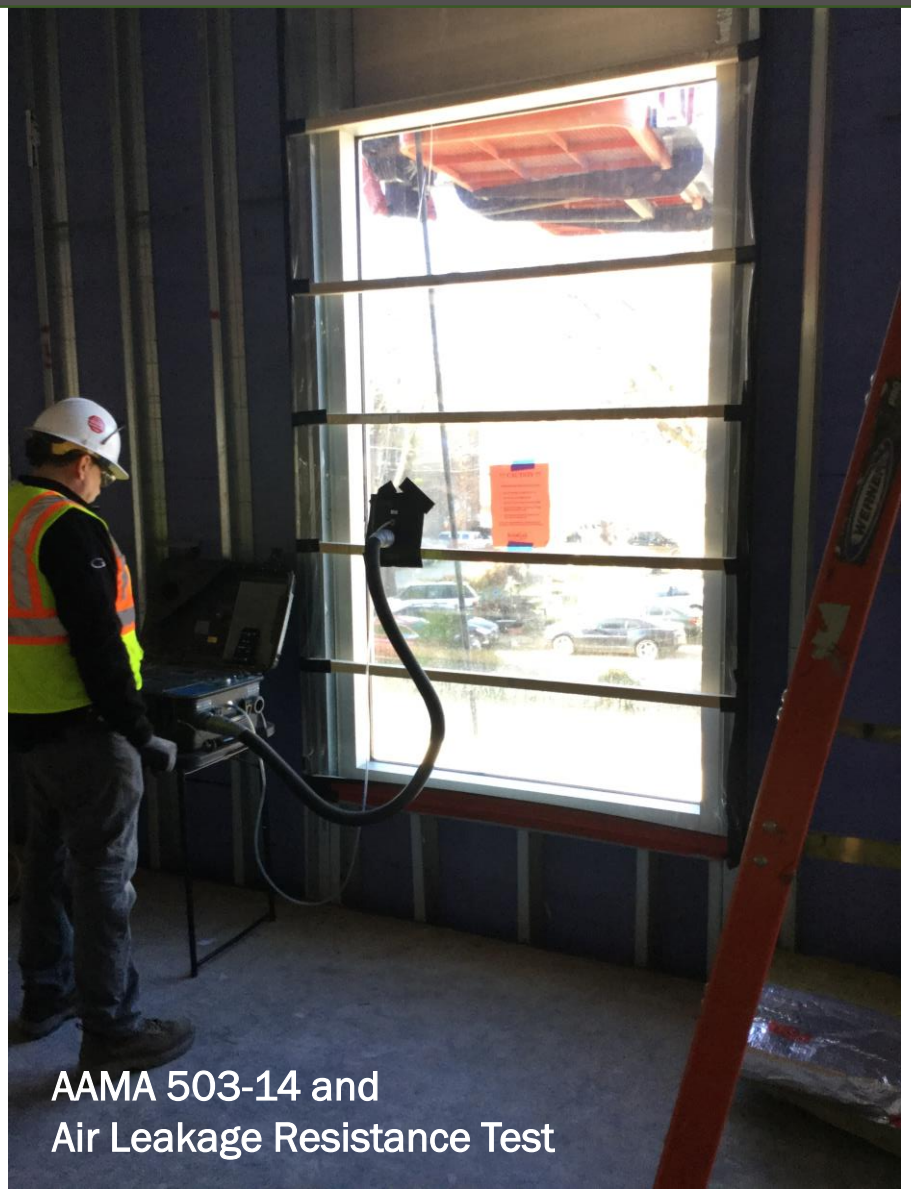

AAMA 503-14 and
Air Leakage Resistance Test

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Testing: Windows and Curtainwall

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Testing: Windows and Curtainwall

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Summary:
Robust on-site Quality Management program includes:

1. Have the right people in place
    - Train and “deputize” the whole construction team
    - Third Party reviewers
    - Inspections and testing agencies

2. Manage the process
    - Plan, Execute, Monitor/Control, Close
    - Make sure changes are properly documented
    - Use processes that add value
    - Is risk being managed appropriately?
    - Start early, talk quality often.
    - Construction is a team sport

3. Review the documents
    - Is it constructible?
    - Are the details consistent?
    - What areas need further study?
    - What’s the goal?

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