Building Expansion Joints: When Movement and Air Tightness Must Go Hand-in-Hand

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Building Expansion Joints: When Movement and Air Tightness Must Go Hand-in-Hand

Learning Objectives

1. Discuss methods to integrate vertical and horizontal expansion joints constructed with different assemblies or materials.

2. Identify potential resources to assist in design and development of air and water-tight expansion joints.

3. Recognize critical areas of expansion joints that may require more in-depth analysis to achieve design objectives.

4. Develop a testing program for building expansion joints based on the needs of the project and complexity of the design.

Presentation Outline

- Expansion Joints – What, Why, and Where
- Expansion Joint Design Principles
- New Design/Construction: Expansion Joint Challenges
- Expansion Joint Best Practice / Concepts
- Case Studies
  - Below-grade expansion joint
  - Expansion joint below gutter
  - Expansion joint within standing seam roof and inlay gutter
  - Use of computer modeling to convey concepts and sequence drawings

Building Expansion Joints – What, Why and Where

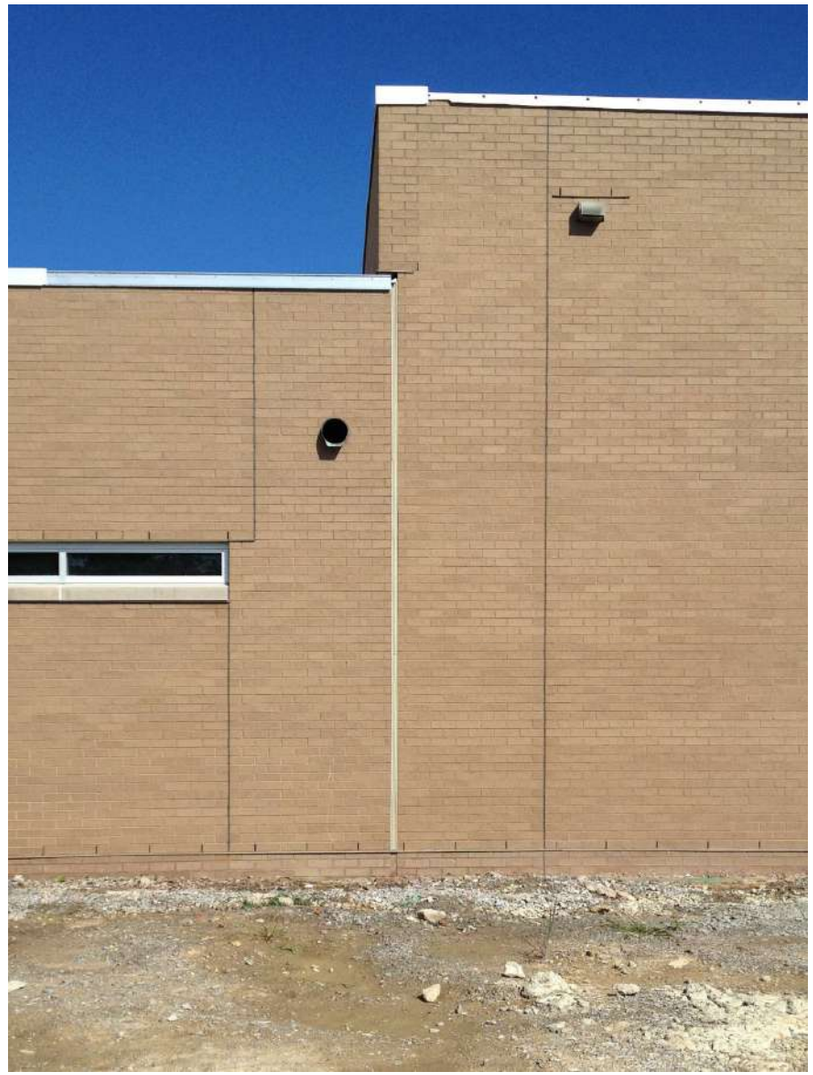
- Separation in structures to accommodate large structural movement

- A structural gap designed to accommodate the movement of a building in a controlled manner, preventing damage to the internal and external finishes of a building

- Expansion joints add to the overall integrity of structures by giving them the freedom to move. Without expansion joints, structures would eventually crack and fall apart over time.

Not to be confused with…

- **Component Expansion Joint**: A separation within a component to accommodate small material expansion
- **Component Control Joint**: A separation within a component to accommodate small material contraction
- **Construction/Cold Joint**: A separation within a component due to phased installation
- **Sealant Joint** : A separation between components to accommodate small material movement



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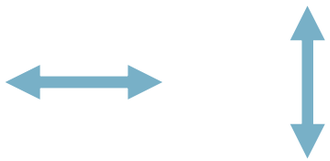
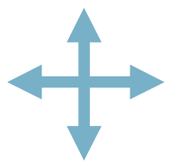
“Large Structural Movement”

- Thermal 
- Shear 
- Sway 
- Seismic 

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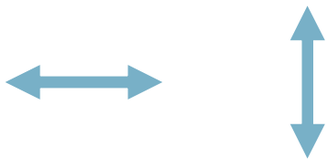
- Thermal 
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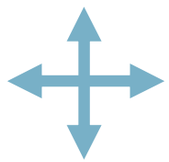
- Seismic 

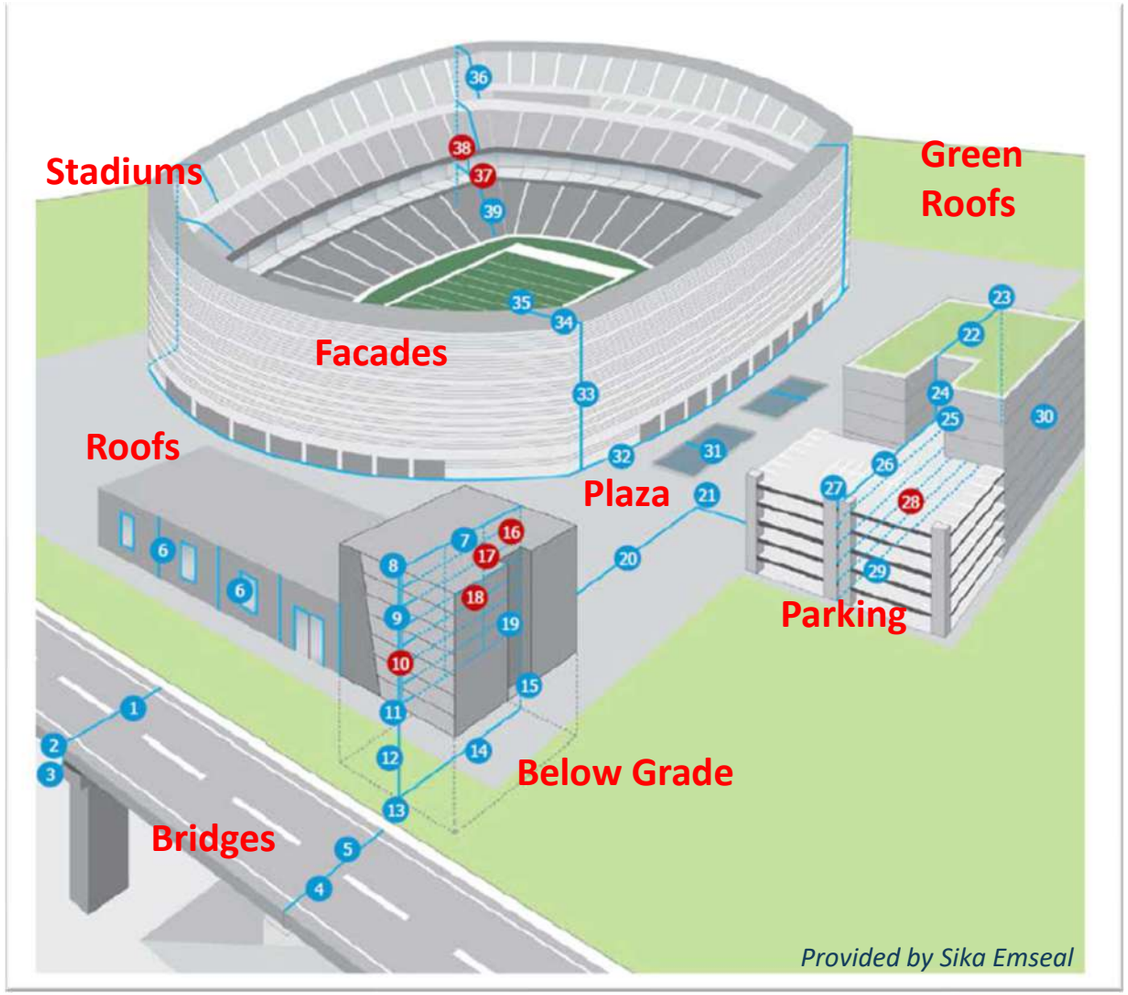
- Static-load deflection 
- Live-load deflection 
- Dynamic live-load deflection 
- Building settlement 

Building Expansion Joints – Where?

- Structural engineer's discretion
  - New construction-choice of structural system(s)
  - Additions-between new and existing
- Where separate wings of L, U, and T shaped buildings or similar configurations exist.
- Seismic zones
- Bridges
- Buildings w/ multiple structural systems

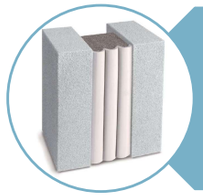
Building Expansion Joints - Where?

- Facades
- Roofs (Green Roof)
- Plazas
- Below Grade
- Parking
- Bridges

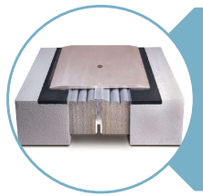


Building Expansion Joints - What?

Exterior Horizontal



Exterior Vertical



Interior

Decks/Parking

*

- +/- Fire Rated
- Prefab Transitions
- Sealants/Tapes
- Product Data

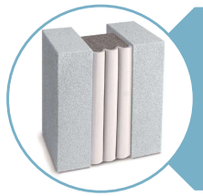
*Interchangeable

Types and Selection

Exterior Horizontal

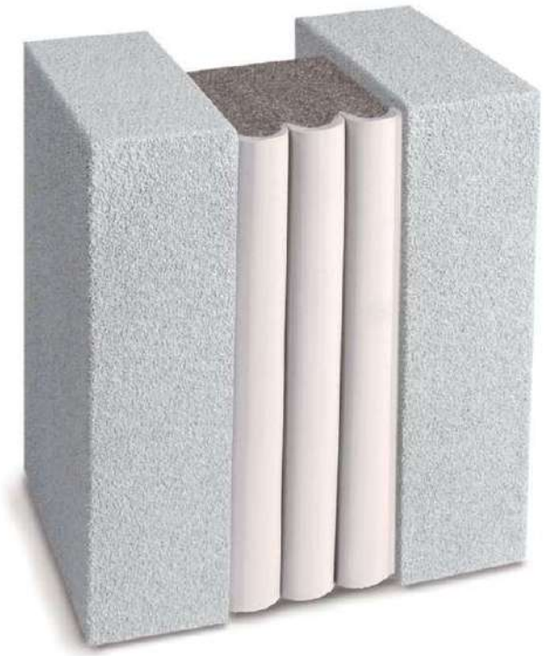
- 2-3”, 3-5”, 5-7”, 7-9”
- Roof, roof wall, plaza
- Double-flange profile
- NPVC or TVP

Types and Selection

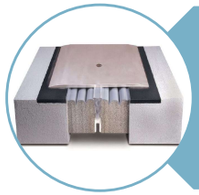


Exterior Vertical

- ½“ to 10”
- Wall Joints
- Anchorless
- Precompressed foam with silicone coat



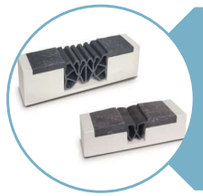
Types and Selection



Interior/High Traffic

- 2“ to 10”
- Floors
- Anchorless
- Cover plate over precompressed foam

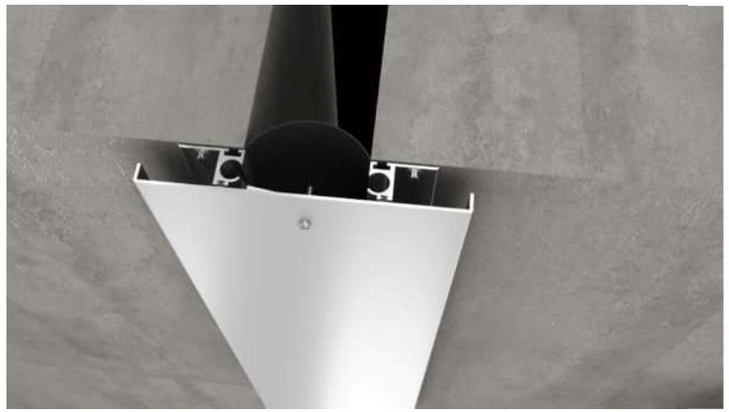
Types and Selection

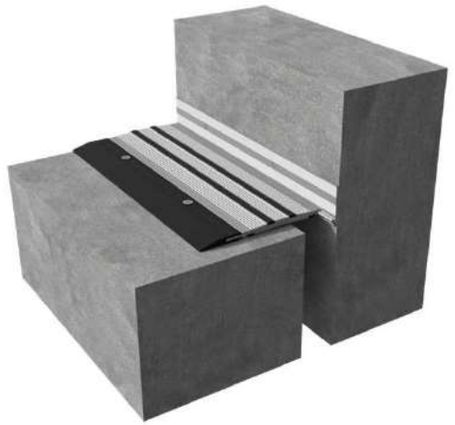


Decks/Parking

- 1-5 ½”
- Concrete substrates
- Nosing: elastomeric concrete
- Thermoplastic-rubber

Premanufactured Assemblies





Expansion Joint Designs – Primary vs Secondary

- Primary
  - Main line of defense, critical, integrated into the AWB
- Secondary
  - First line of defense, supplemental, protective layer for the primary

Expansion Joint Designs – Materials

Primary Materials

- Preformed Silicone Seals
- Liquid Flashing
- Roofing Membranes
- Sealant

Secondary Materials

- Manufactured Covers
- Sheet Metal Covers / Fabrications
- Topping Slab / Finished Surface
- Others

New Design/Construction – EJ Challenges

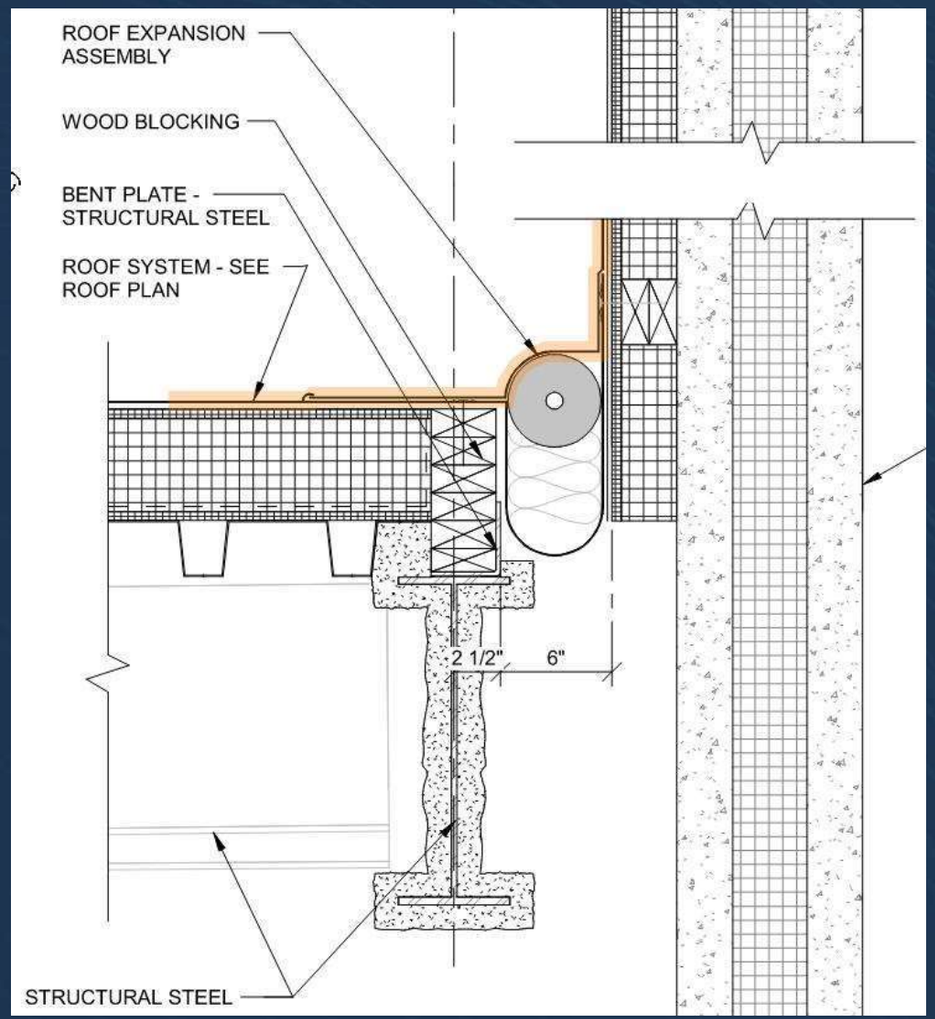
Contract Documents

- Standard/typical architectural details for building expansion joints
- Standard specification language for building expansion joints
- Typical manufacturer details for building expansion joints

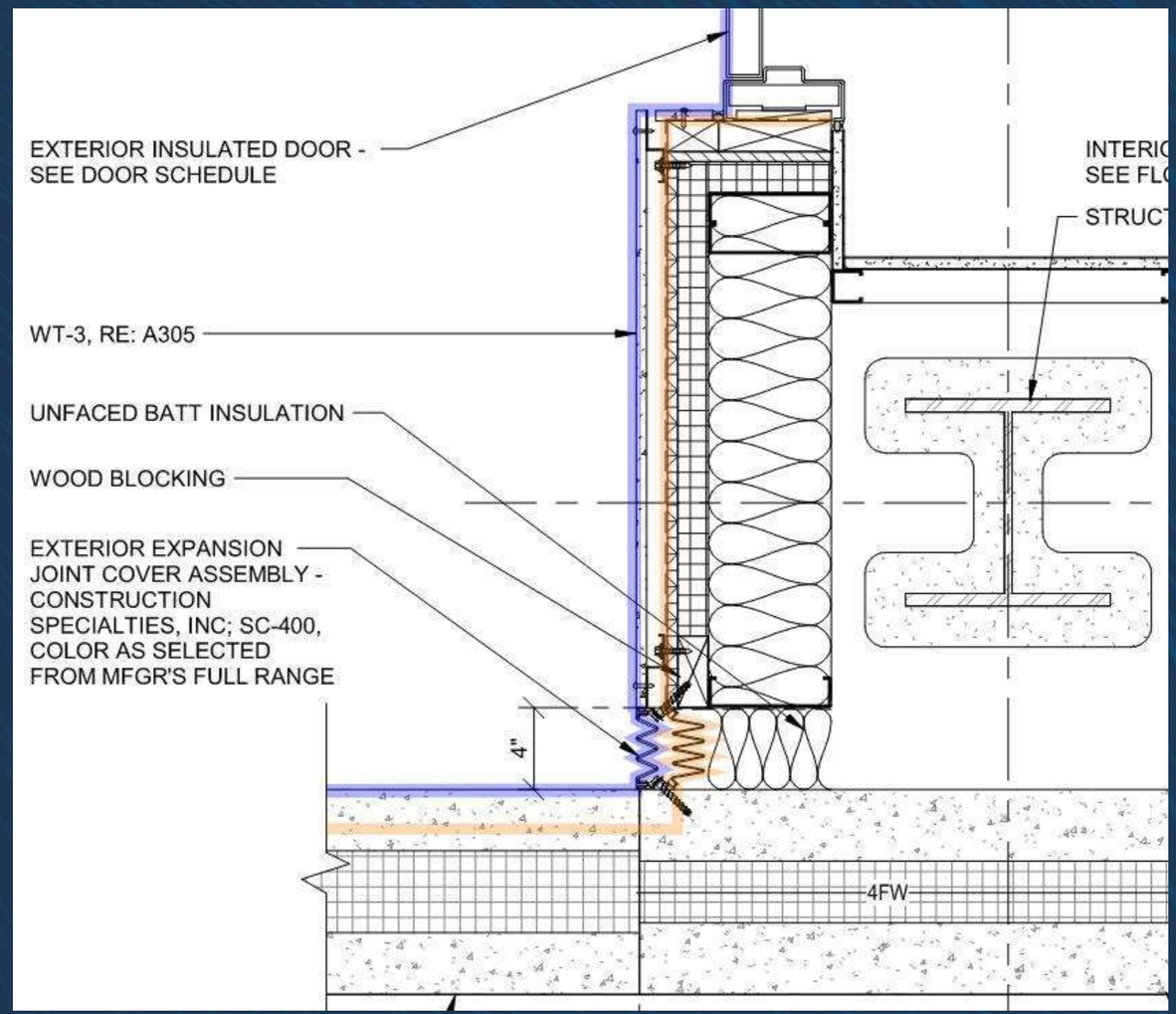
Is this enough to construct durable, air and water-tight building expansion joints???

DEPENDS…..

Challenge: Interfacing Roof / Wall Expansion Joints



Roof (Horizontal) Condition



Wall (Vertical)Condition

Challenge: Interfacing Roof Wall Expansion Joints

Roof (Horizontal) Condition

Wall (Vertical) Condition

Challenge: Expansion Joints Specification

3.2 INSTALLATION, GENERAL

A. Comply with manufacturer's written instructions for handling and installing roof expansion joints.

1. Anchor roof expansion joints securely in place, with provisions for required movement. Use fasteners, protective coatings, sealants, and miscellaneous items as required to complete roof expansion joints.
2. Install roof expansion joints true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.
3. Provide for linear thermal expansion of roof-expansion-joint materials.
4. Provide uniform profile of roof expansion joint throughout its length; do not stretch or squeeze membranes.
5. Provide uniform, neat seams.
6. Install roof expansion joints to fit substrates and to result in watertight performance.

B. Directional Changes: Install factory-fabricated units at directional changes to provide continuous, uninterrupted, and watertight joints.

C. Transitions to Other Expansion-Control Joint Assemblies: Coordinate installation of roof expansion joints with other exterior expansion-control joint assemblies specified in Section 07 9513.16 "Exterior Expansion Joint Cover Assemblies" to result in watertight performance.[**Install factory-fabricated units at transitions between roof expansion joints and exterior expansion-control joint systems.**]

D. Splices: Splice roof expansion joints to provide continuous, uninterrupted, and waterproof joints.

B. Shop Drawings: For each expansion joint cover assembly.

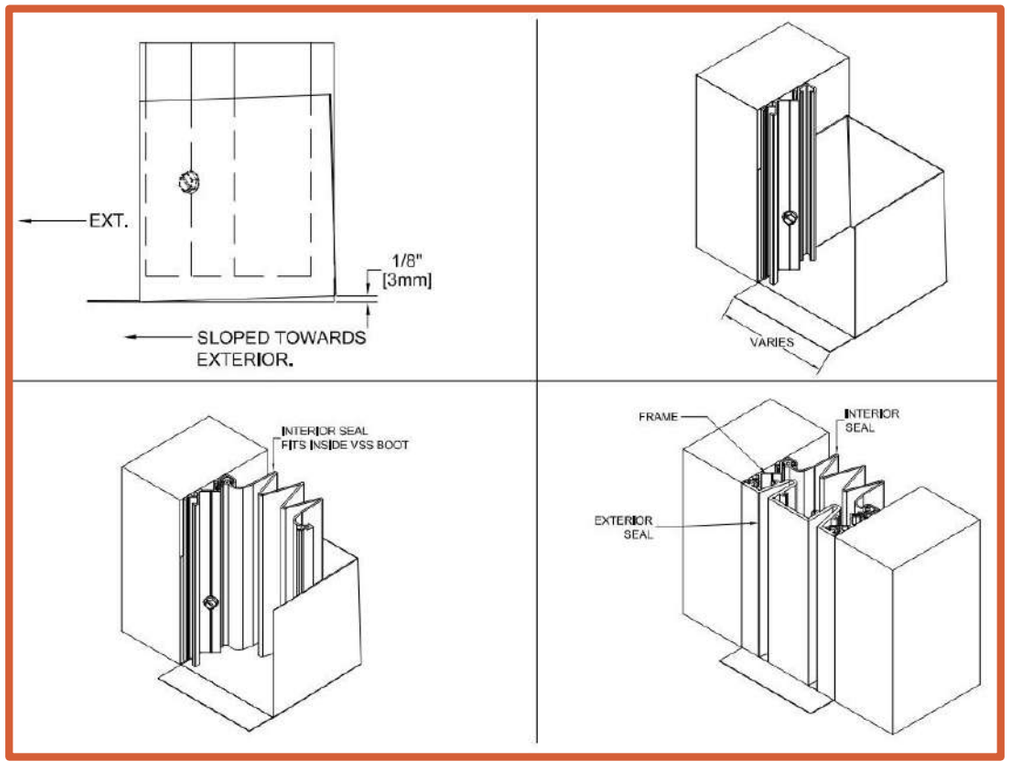
1. Include plans, elevations, sections, details, splices, block-out requirement, attachments to other work, and line diagrams showing entire route of each expansion joint.
2. Where expansion joint cover assemblies change planes, provide isometric or clearly detailed drawing depicting how components interconnect.

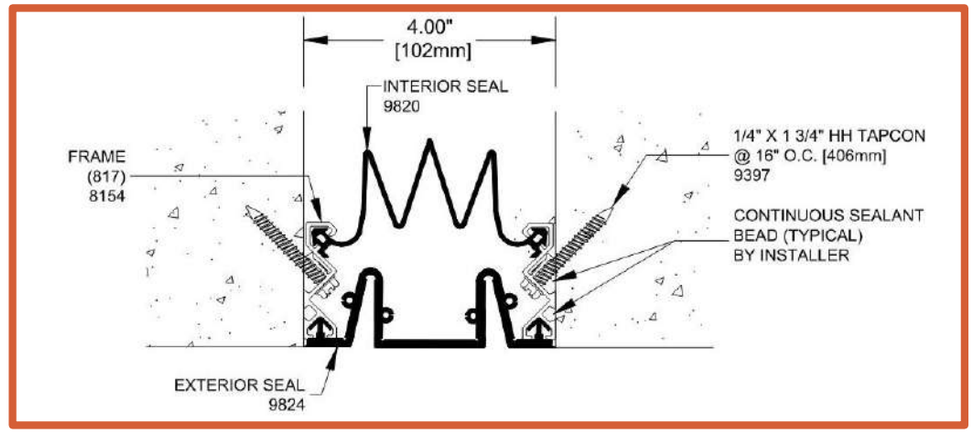
1.6 WARRANTY

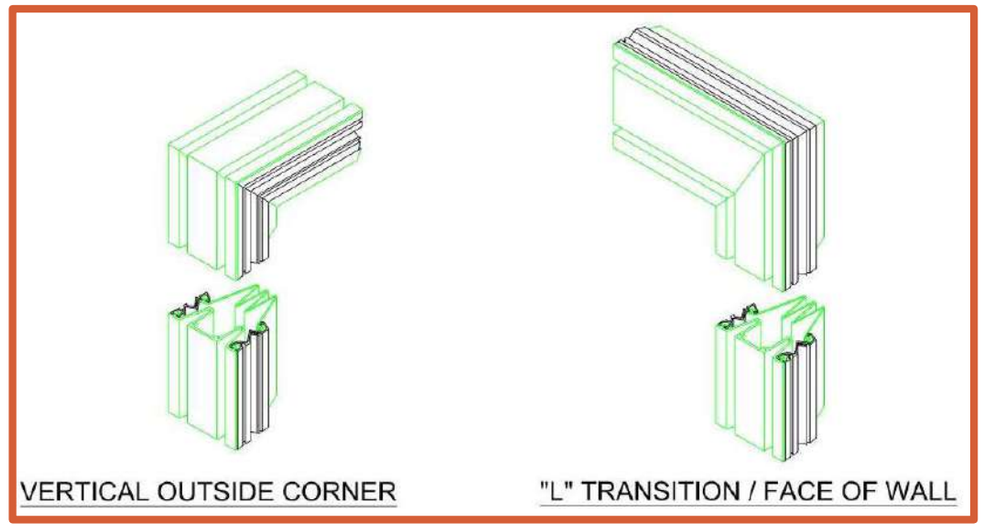
A. Special Warranty: Manufacturer and Installer agree to repair or replace roof expansion joints and components that leak, deteriorate beyond normal weathering, or otherwise fail in materials or workmanship within specified warranty period.

1. Warranty Period: **[Two]** <**Insert number**> years from date of Substantial Completion.

Challenge: Manufacturer EJ Details







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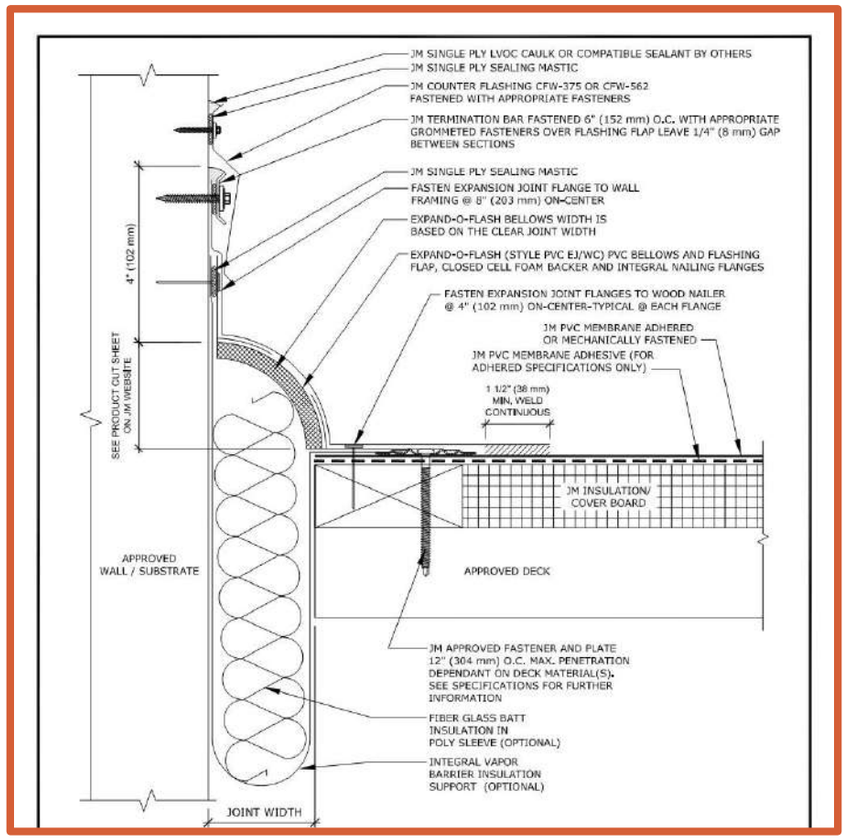
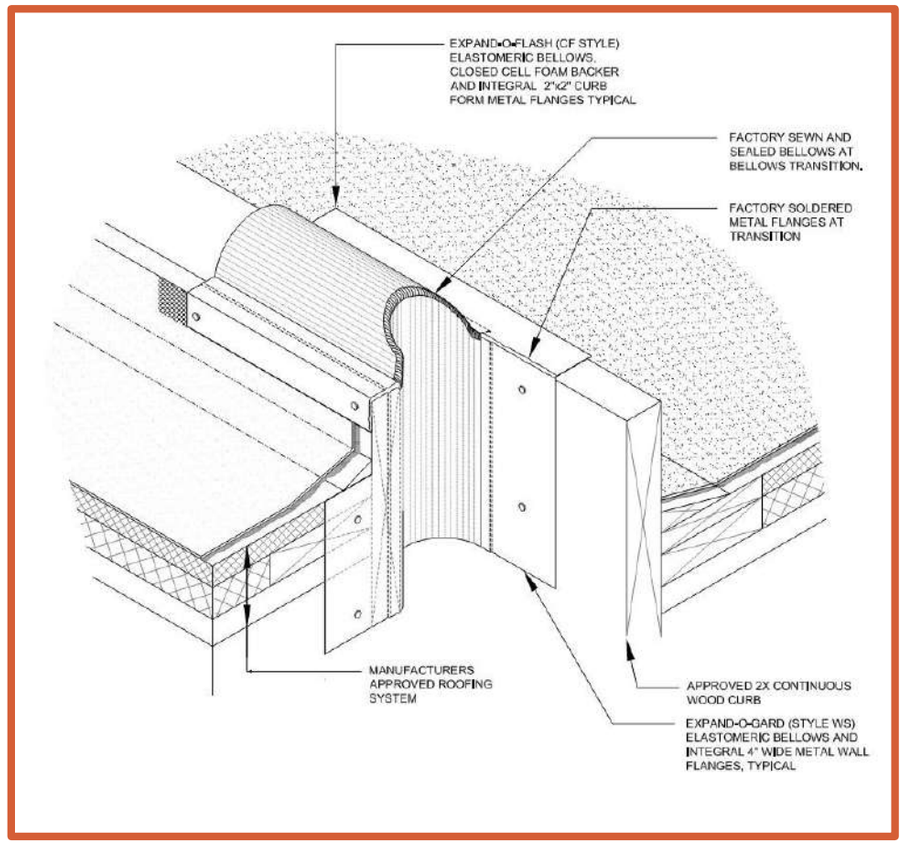
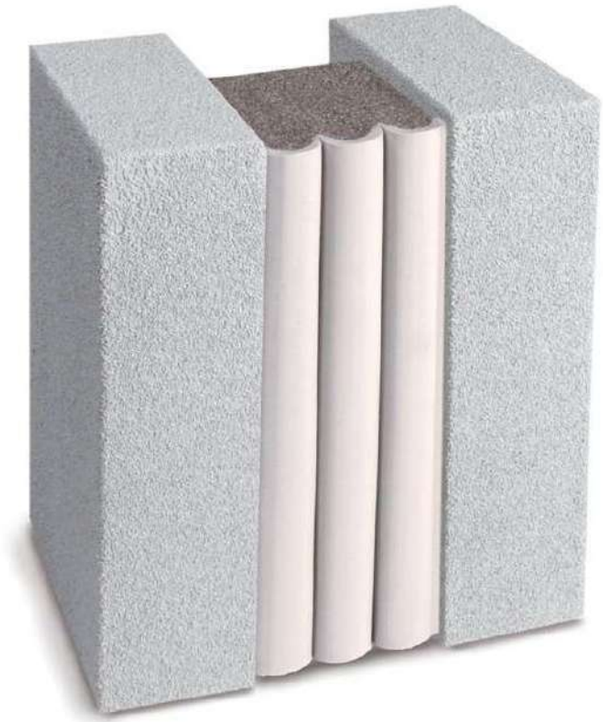
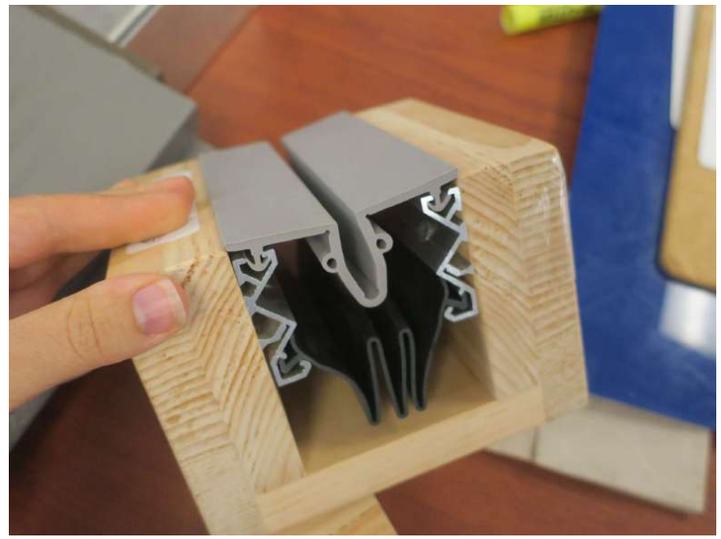




Challenge: Manufacturer EJ Details

How to interface Expansion Joint systems?





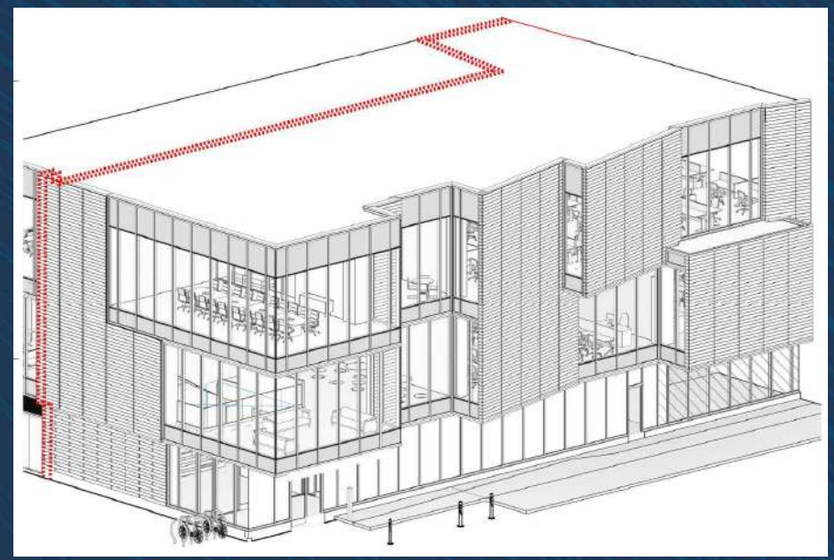
Expansion Joint Design – Best Practices

- Understand the expansion joint path and movement requirements.
  - Simplify the route as much as possible
  - Utilize 3D modeling as needed
- Select durable materials and reputable manufacturers
  - Limit the number of responsible trades and variations in joints as much as possible
- Elevate expansion joint above the roof surface
- Provide **two** lines of defense for air and water leakage
  - Primary line and secondary/water-shedding layer
- Primary line must interface with air water barrier
- Provide means of drainage between the primary and exterior water-shedding layers (when feasible). Provide slope to drain.

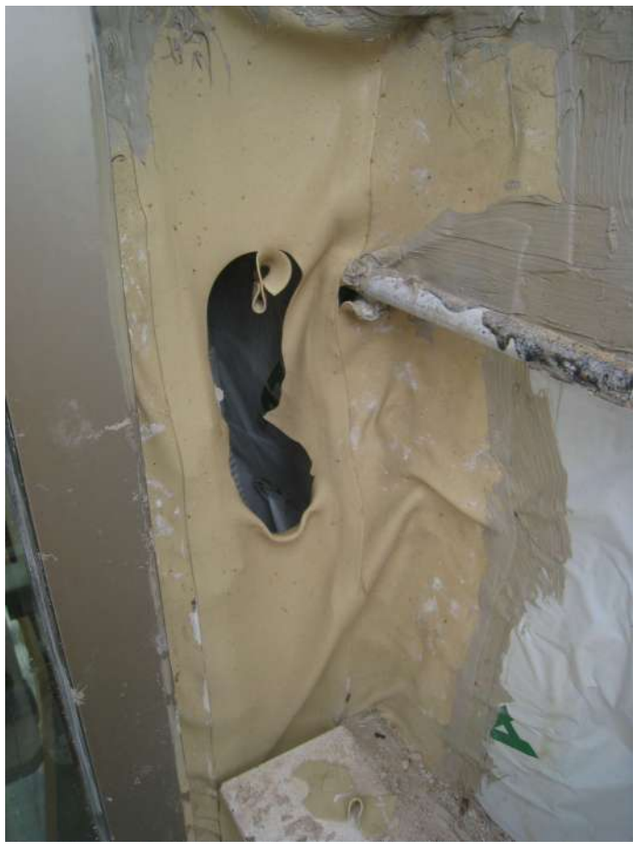
Path and Movement Requirements

- Map out EJ path – horizontal and vertical
  - Review EJ system in 3D
  - Identify transitions

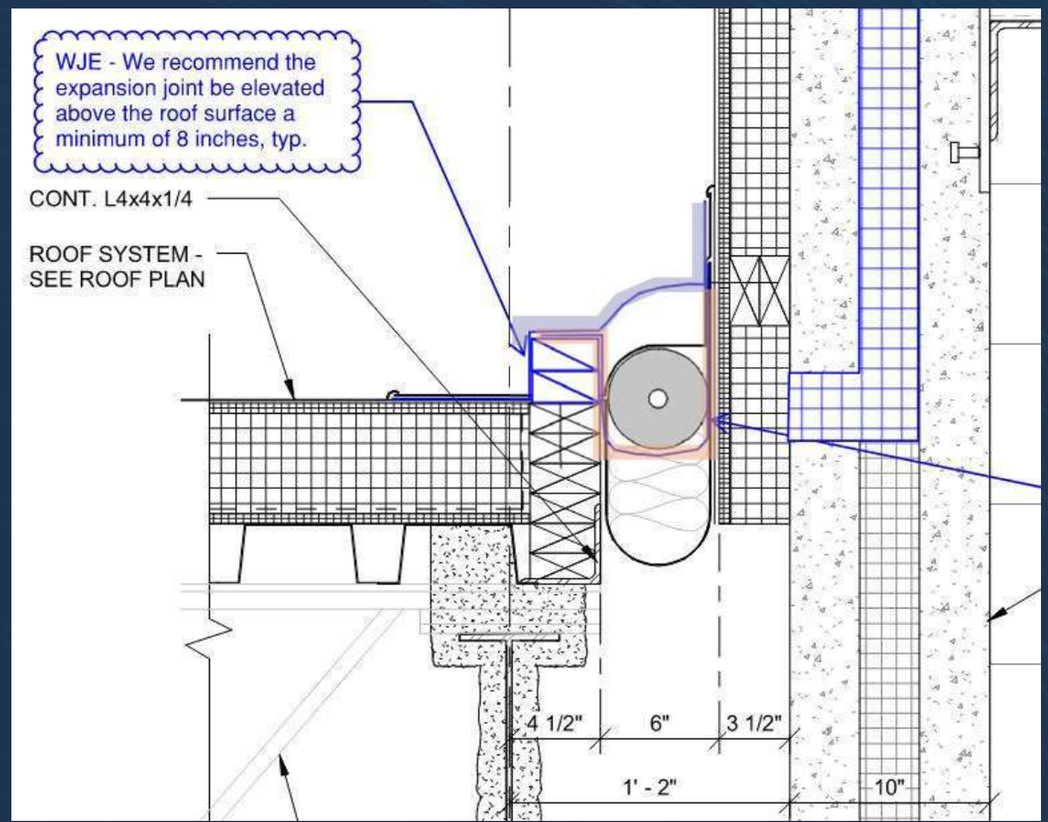
- Identify movement requirements (seismic)

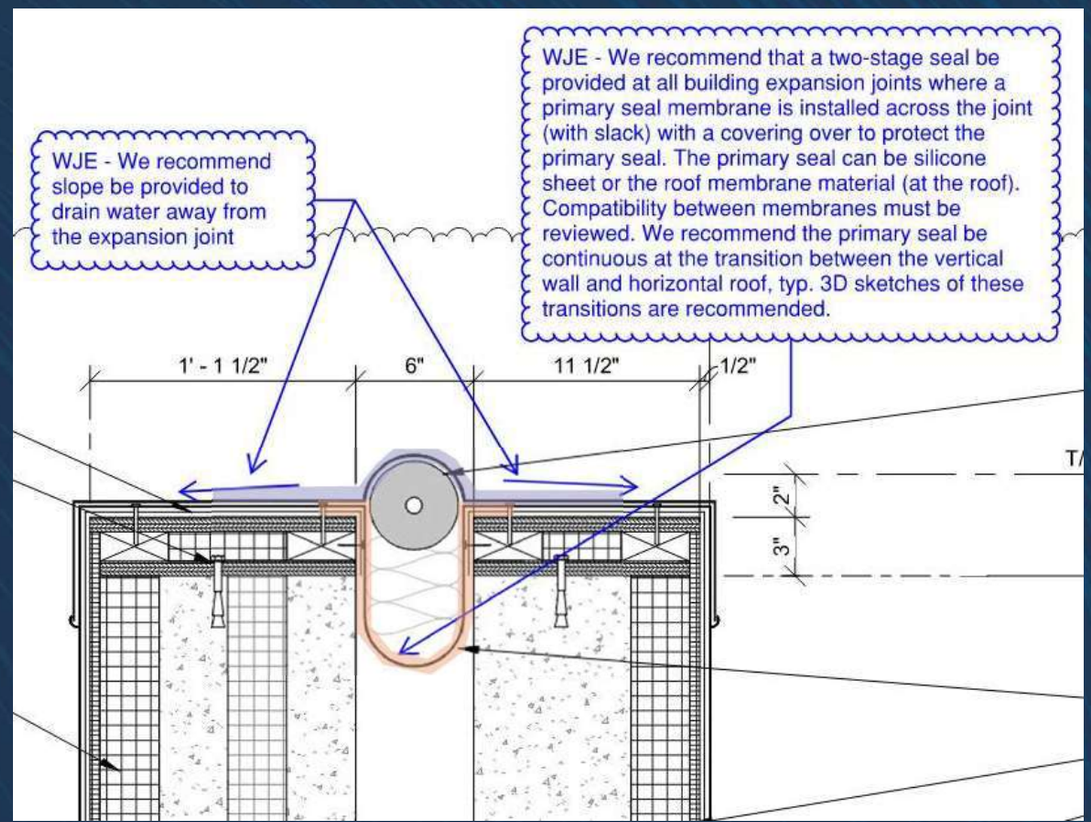


Durable Materials that Expand/Contract



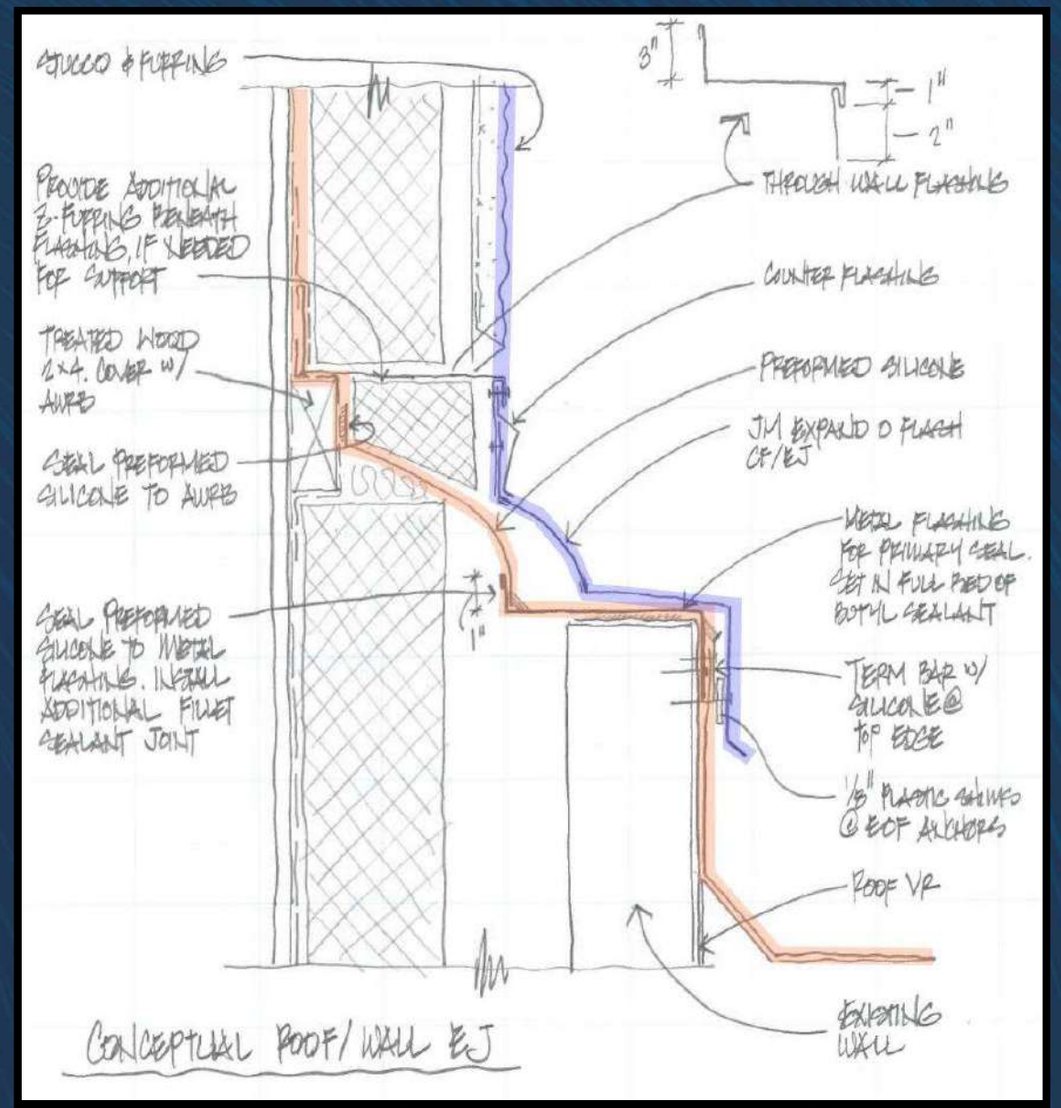
Elevate and Slope Expansion Joint





Building Expansion Joints: Best Practices

- Two lines of defense against air and water leakage
- Primary lines ties in with air water barrier
- Drainage provided between primary and water sheading layer
- Expansion joint is elevated above roof



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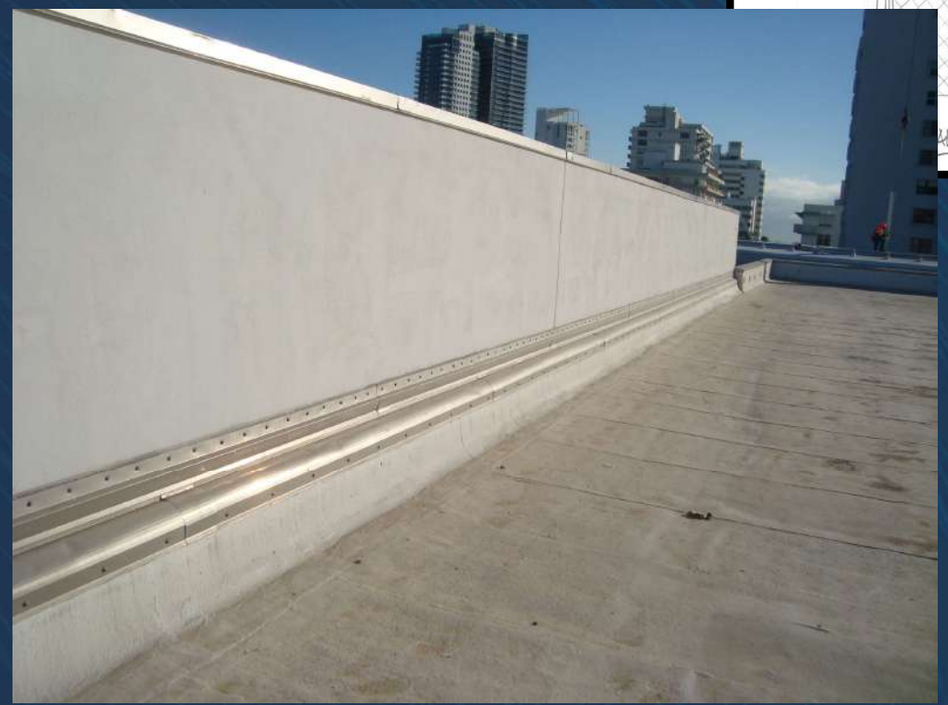
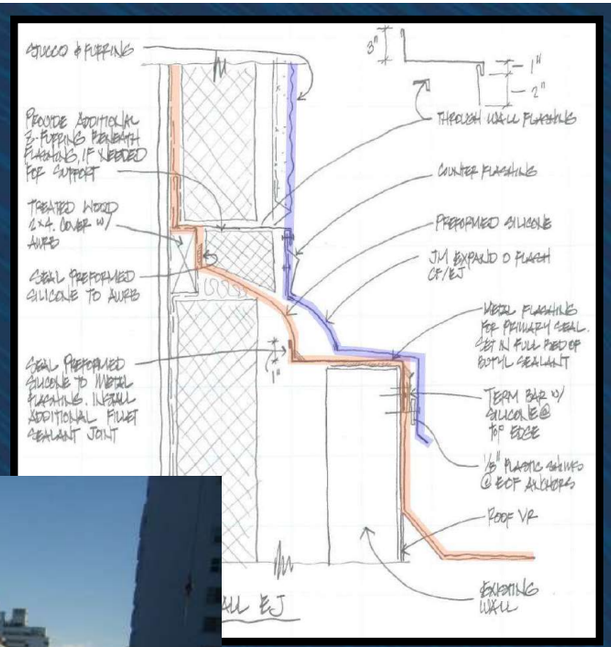
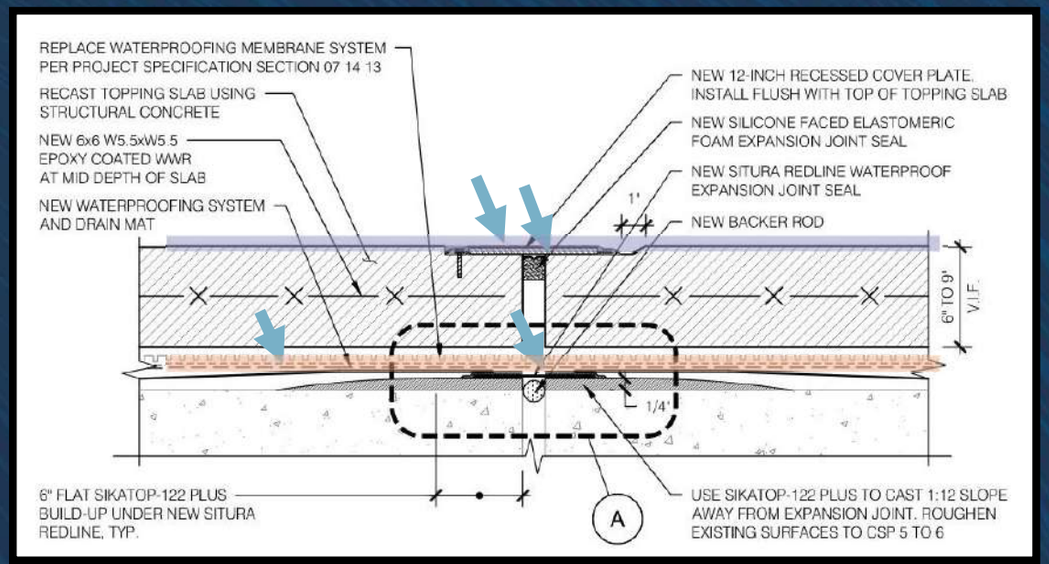




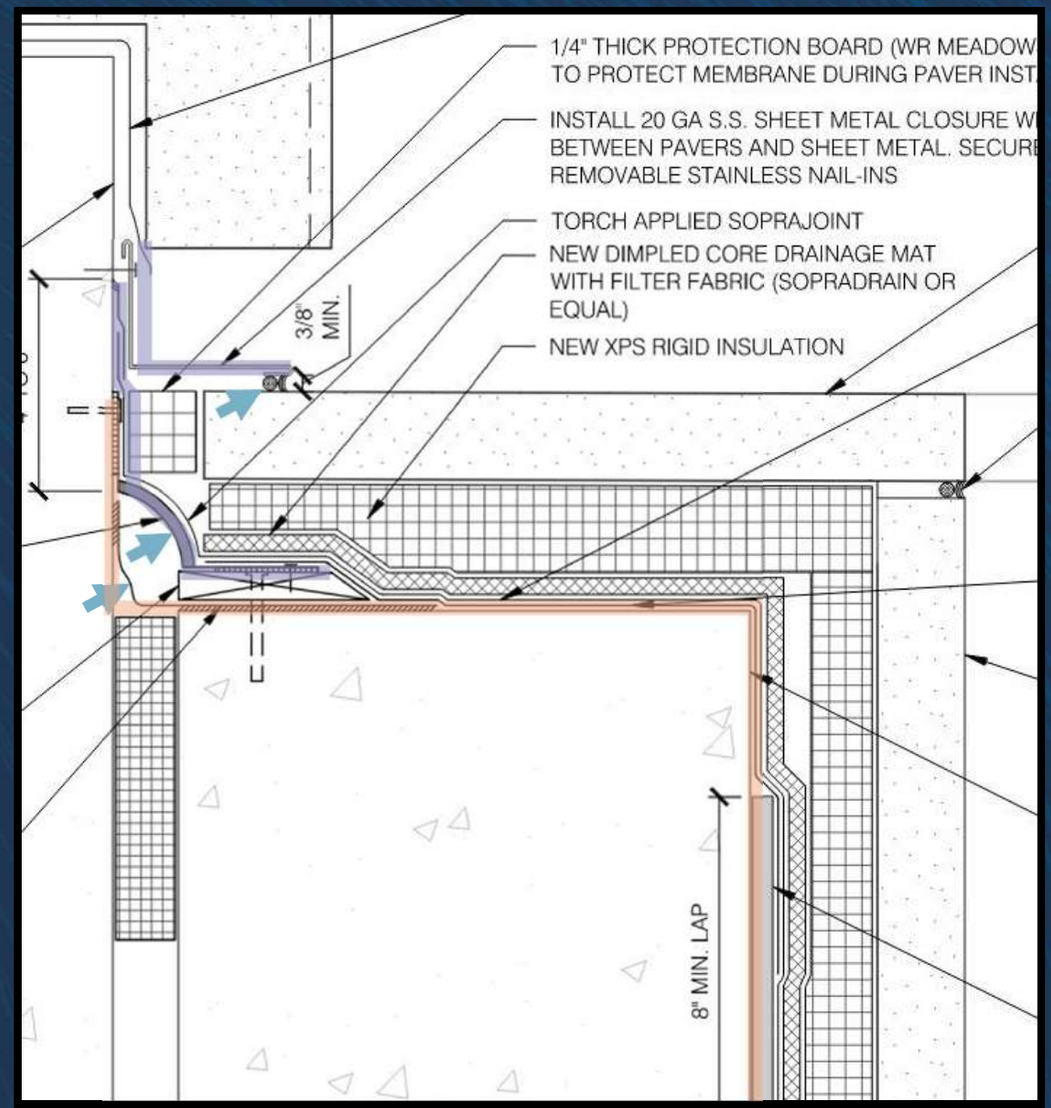
Building Expansion Joints: Best Practices

- Two lines of defense against air and water leakage
- Primary lines ties in with air water barrier
- Drainage provided between primary and water sheading layer
- Expansion joint is elevated above plaza substrate

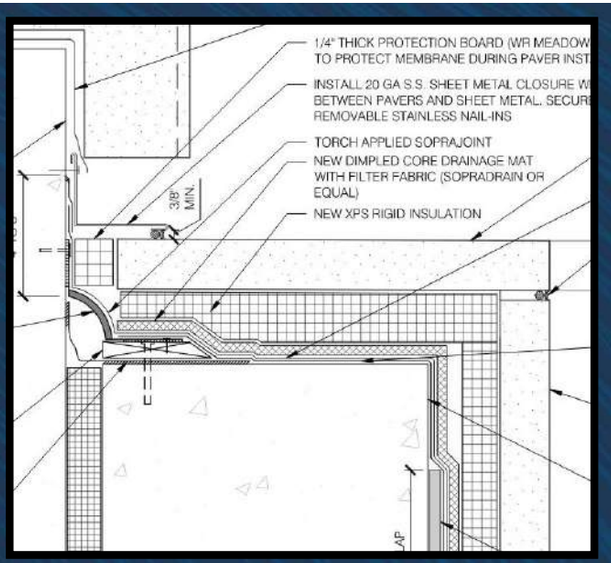


Building Expansion Joints: Best Practices

- Two lines of defense against air and water leakage
- Primary lines ties in with air water barrier
- Drainage provided between primary and water sheading layer
- Expansion joint bellows above roof-wall cavity

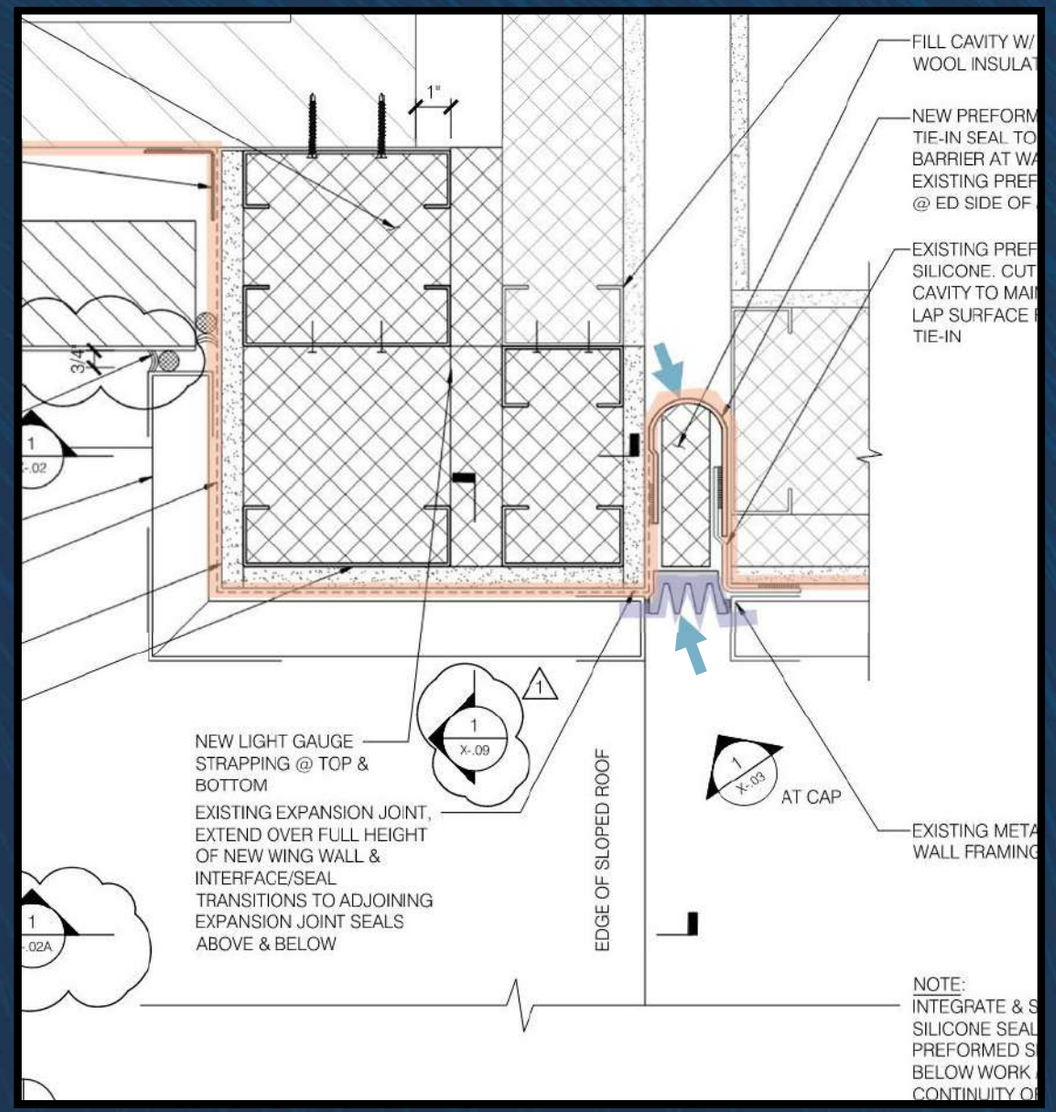


Building Expansion Joints: Best Practices

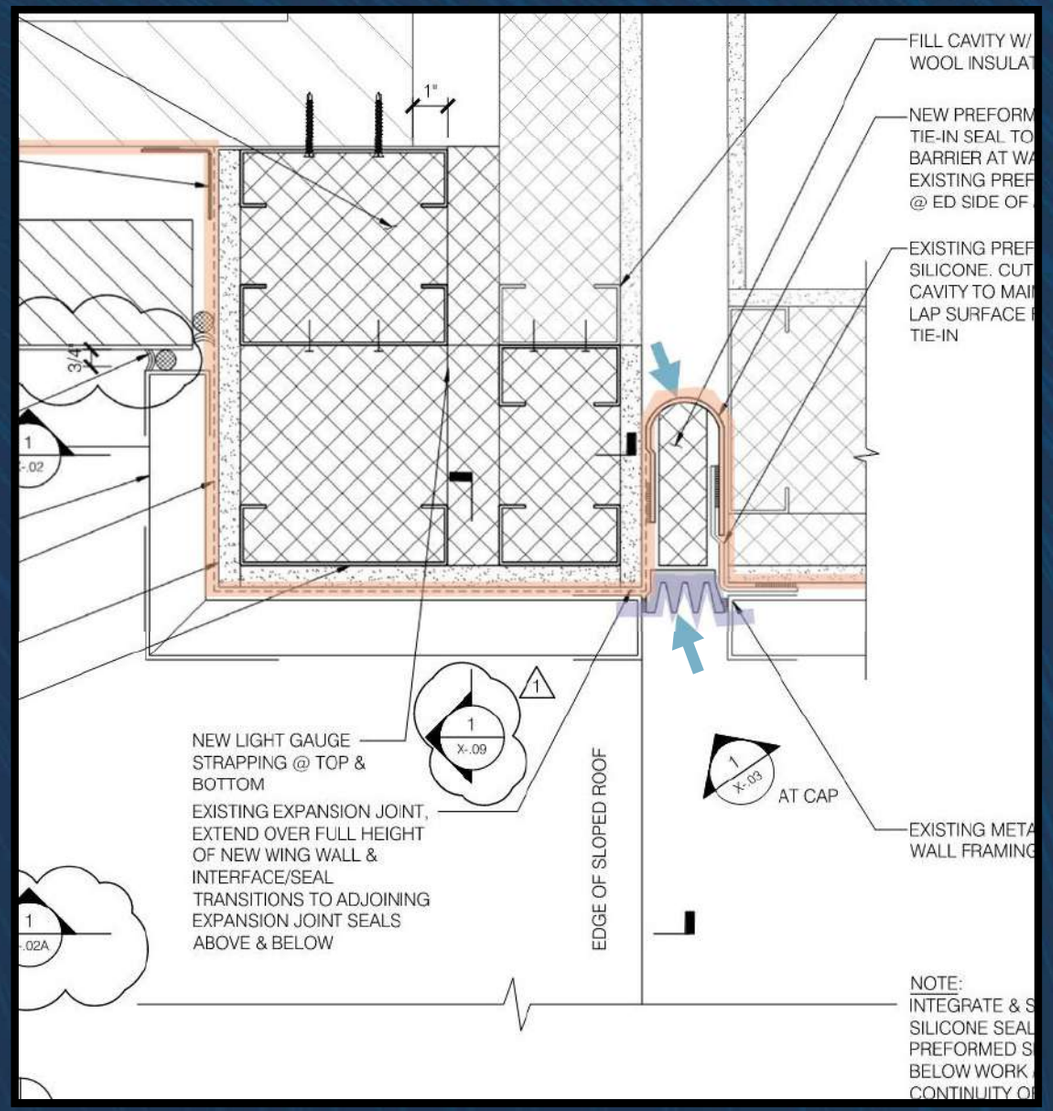


Building Expansion Joints: Best Practices

- Two lines of defense against air and water leakage
- Primary lines ties in with air water barrier
- Drainage provided between primary and water sheading layer
- Expansion joint cover protects against wind-driven rain

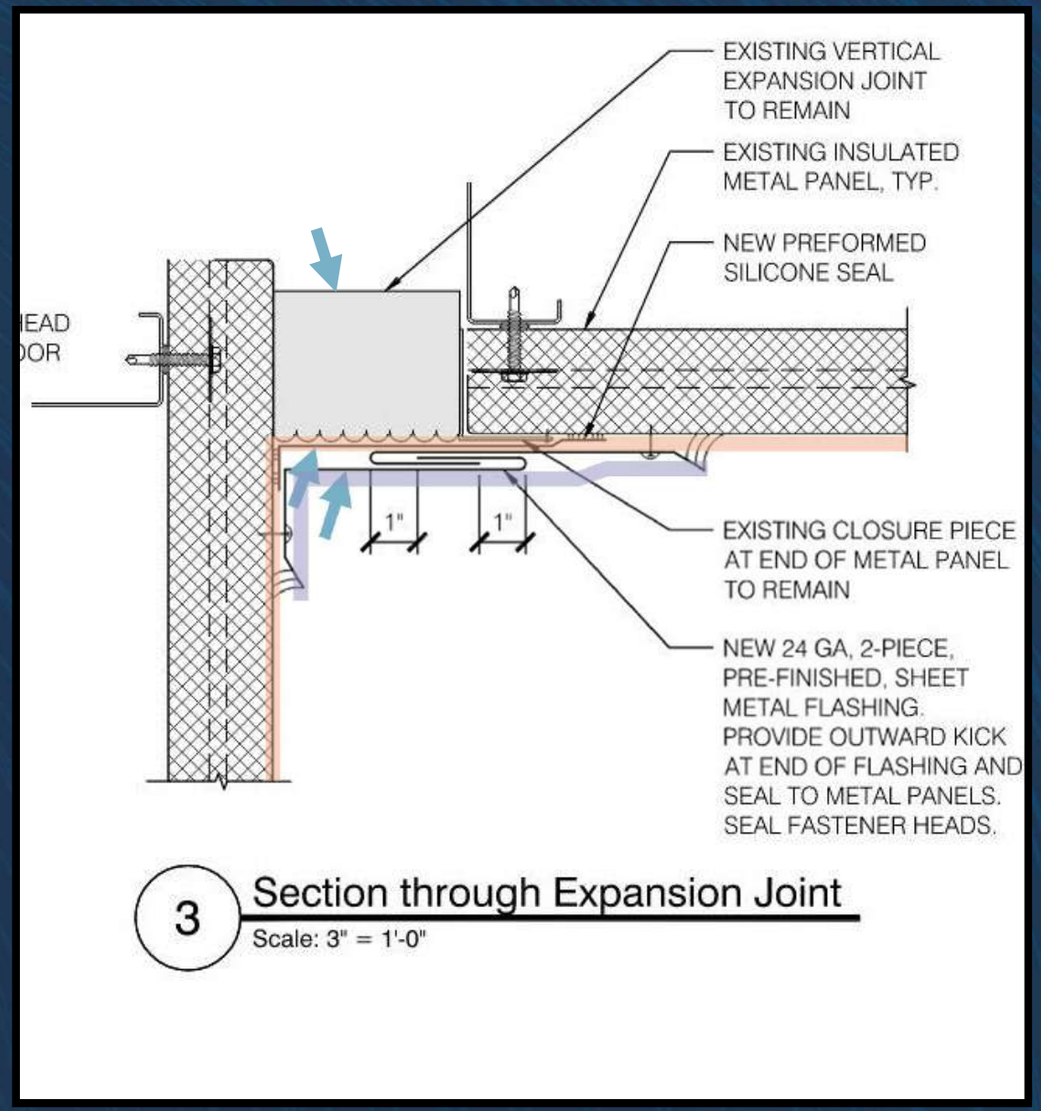


Building Expansion Joints: Best Practices

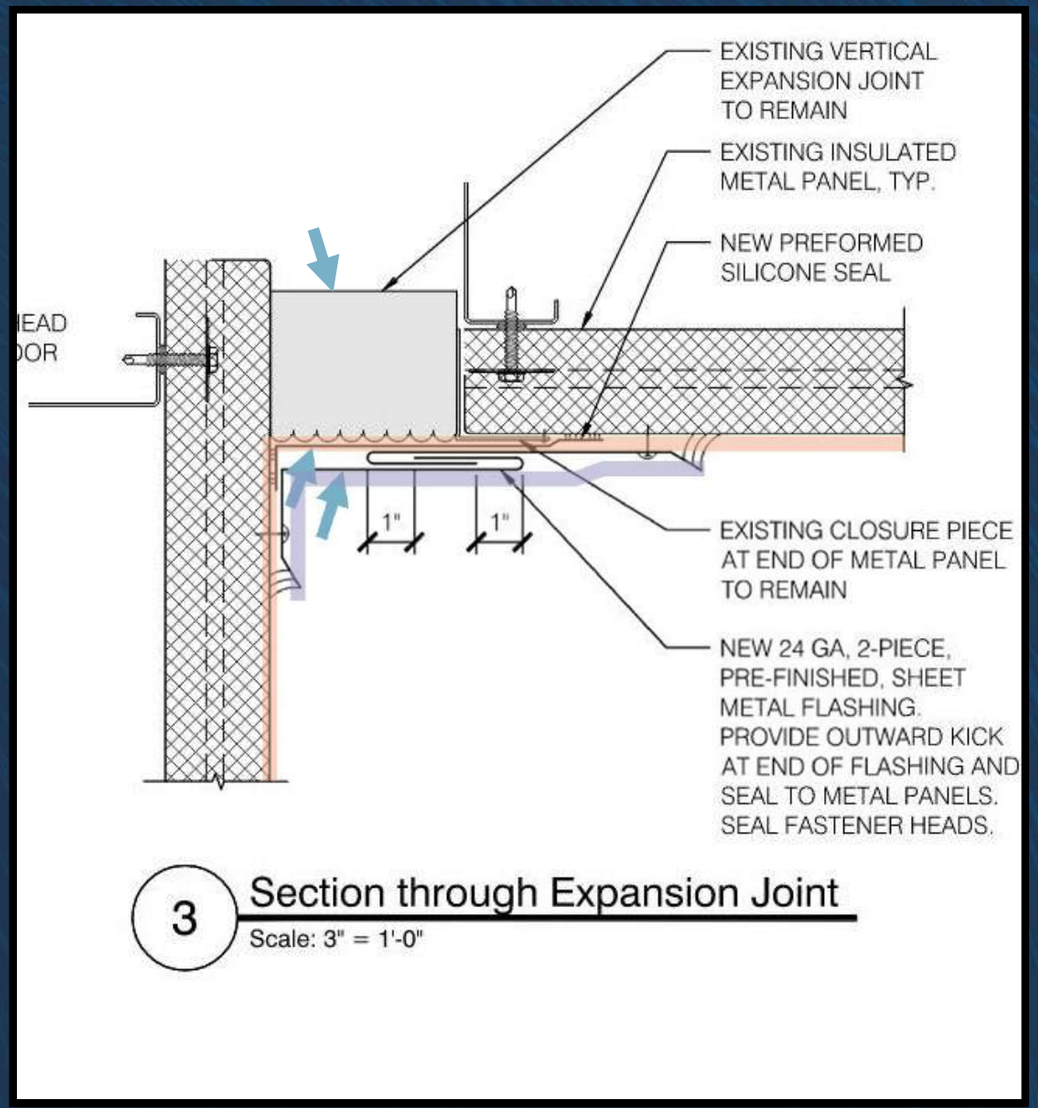


Building Expansion Joints: Best Practices

- Two new lines of defense against air and water leakage
  - Outboard of existing pre-compressed foam joint
- Primary lines ties in with air water barrier
- Barrier system approach while still facilitating movement



Building Expansion Joints: Best Practices

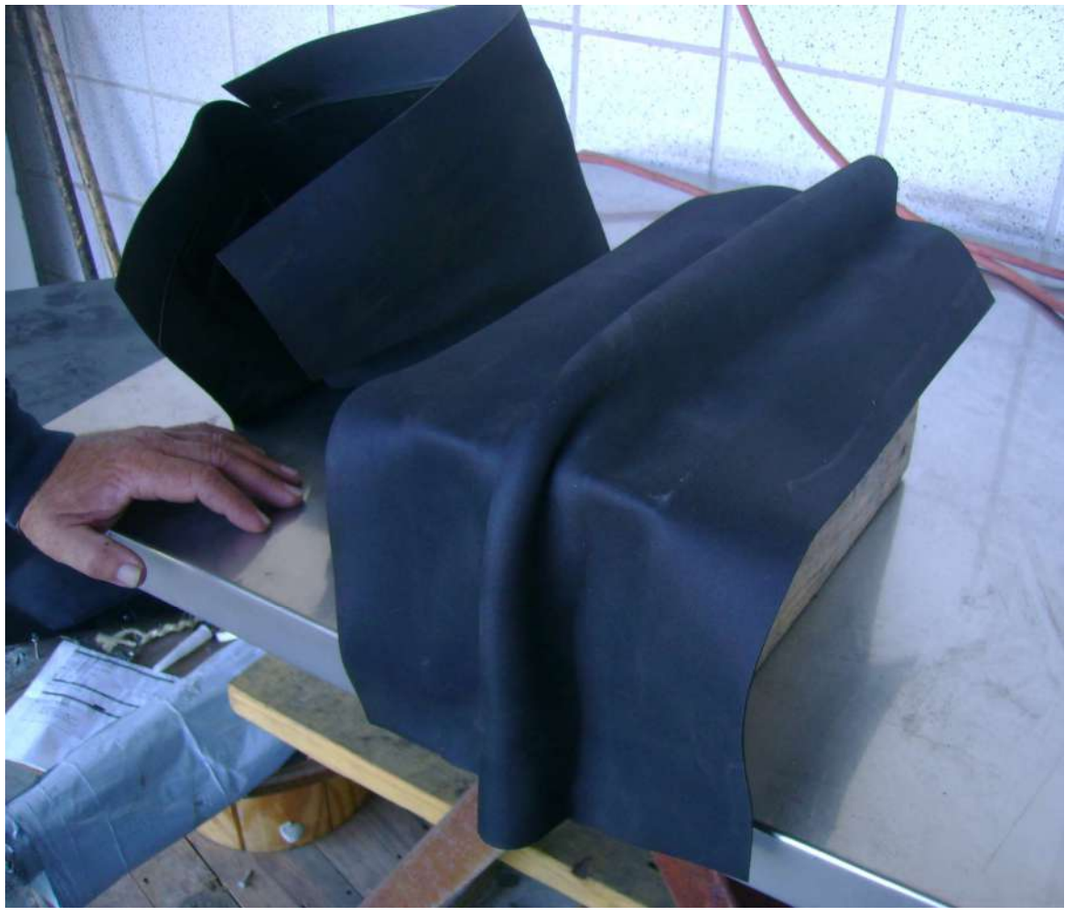


Expansion Joint Construction – Best Practices

- Confirm compatibility of materials of the EJ system
  - Utilize readily available materials where possible
- Preconstruction meeting with all associated Trades to review expectations
  - Understand division of scope & transition points
  - Sequence of construction (incompatible materials)
- Perform mockups of complicated interfaces
  - Supplement with 2D drawings & 3D sequence diagrams as needed
- Perform quality control testing (air and water testing)
  - Early on if a repetitive installation is to follow

Compatibility and Adhesion Testing

Mock-ups



Mock-ups

Quality Control Testing

Spray rack testing

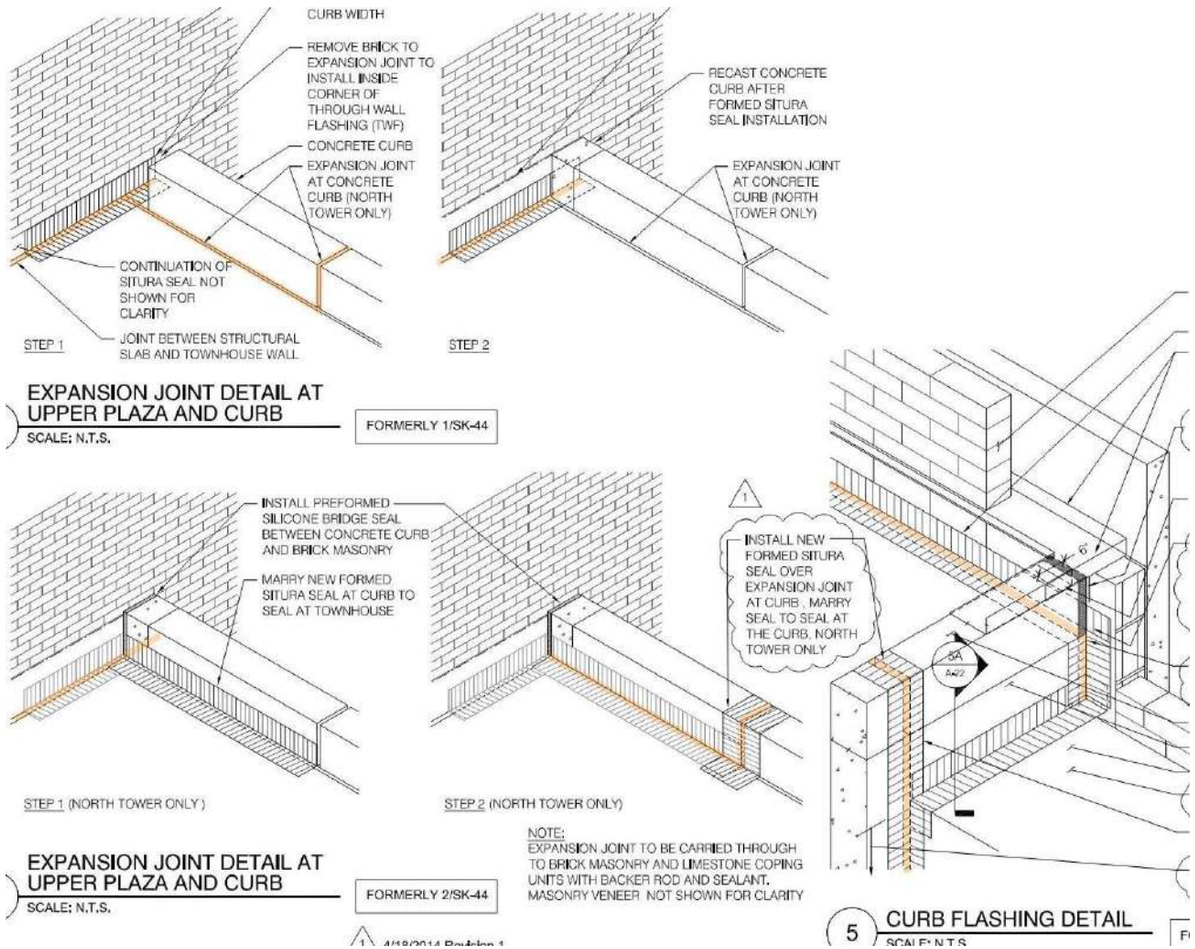
Flood testing

Quality Control Testing

Nozzle testing

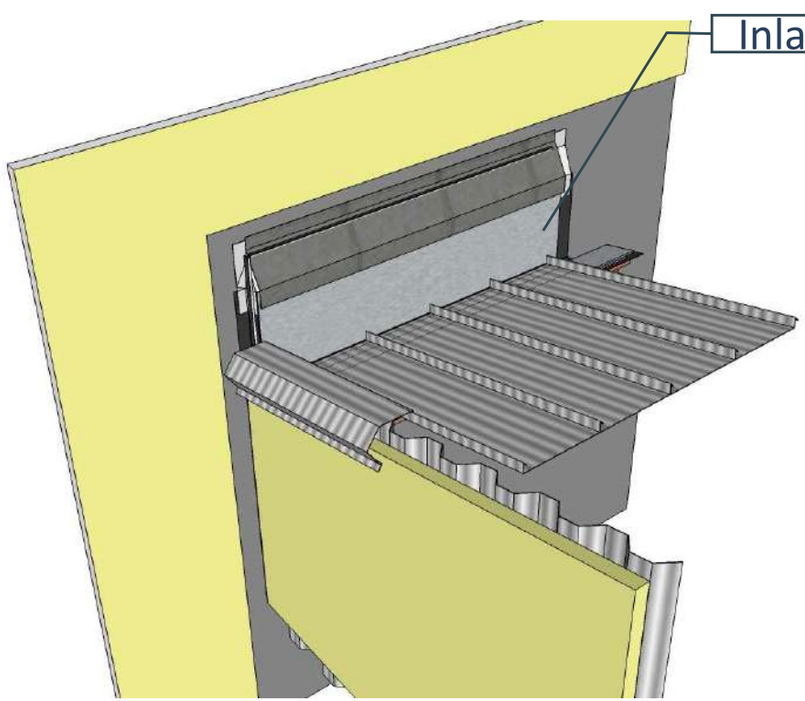
Spray rack testing

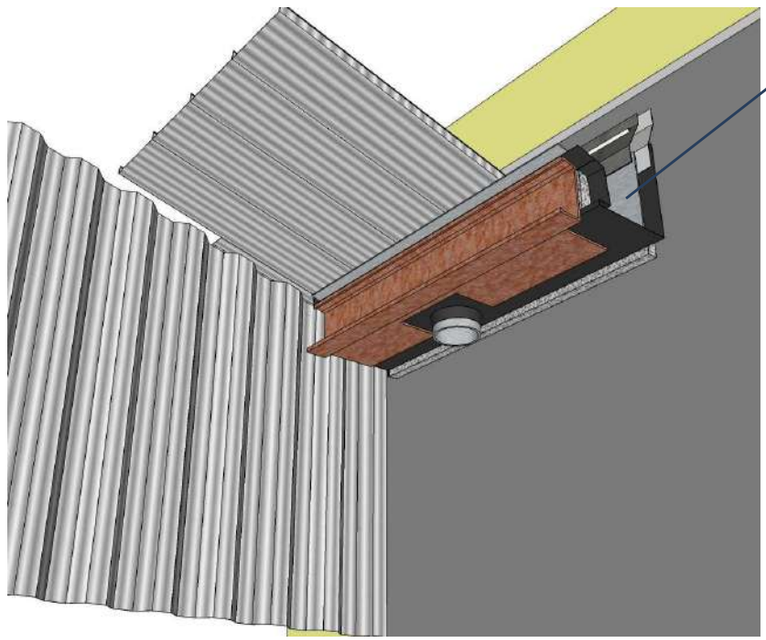
Case Study – Hot-Applied Waterproofing EJ

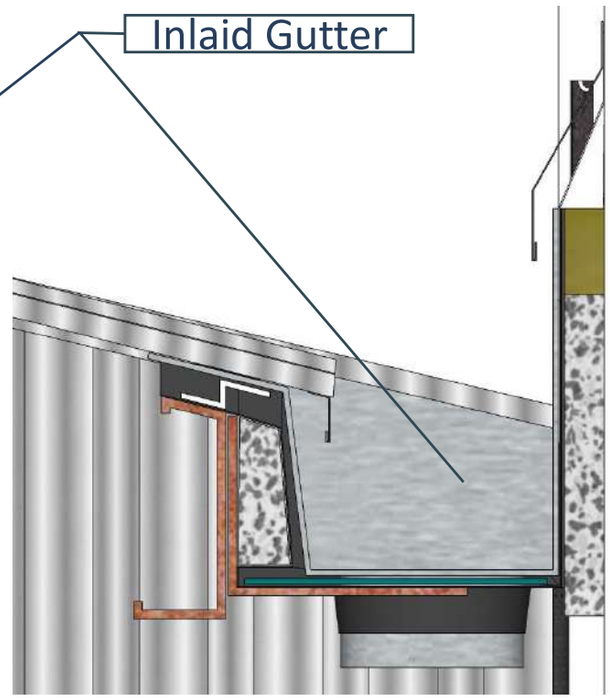


Case Study – Hot-Applied Waterproofing

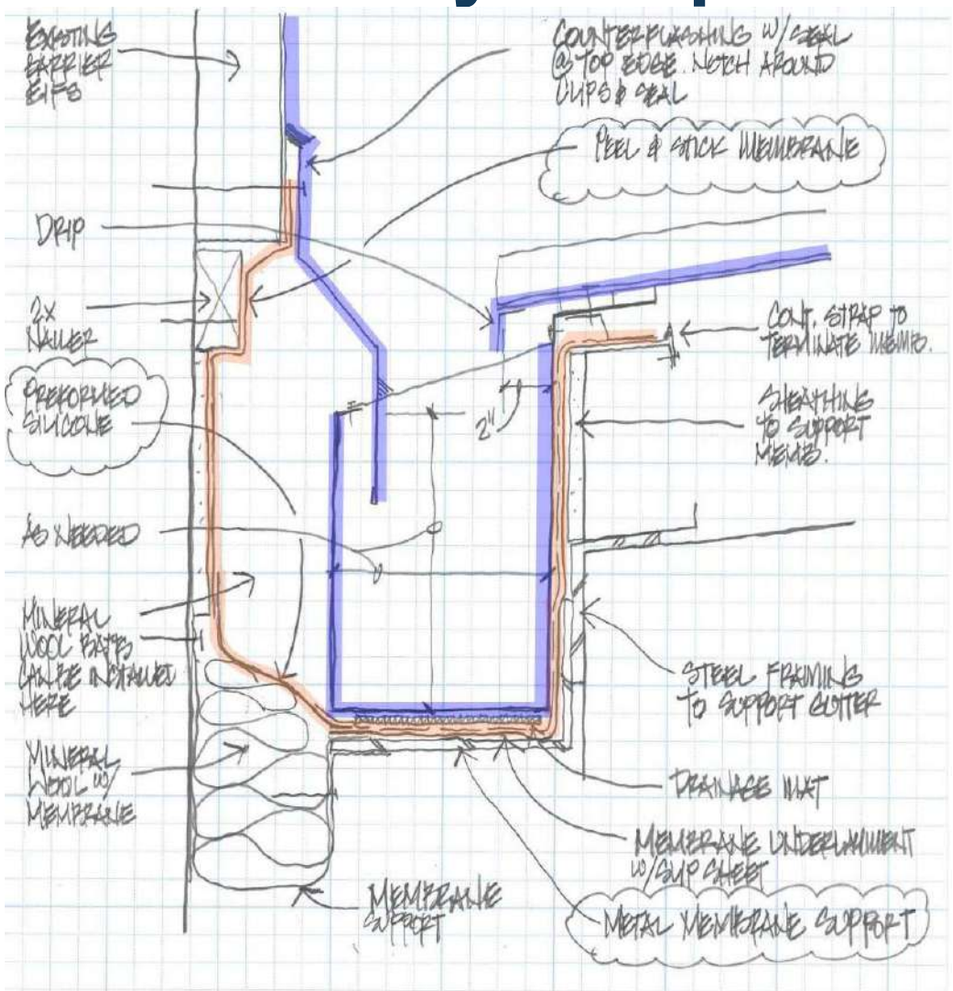
Case Study – Expansion Joint at Gutter

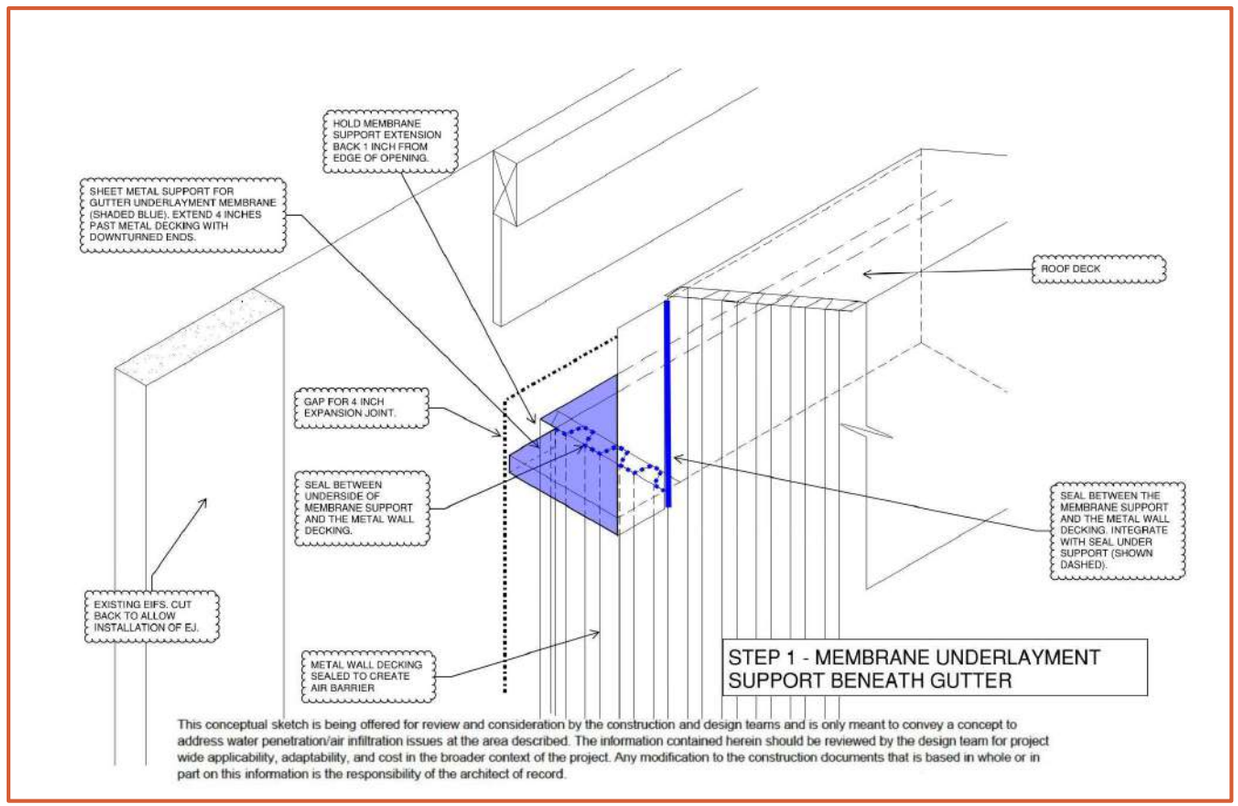




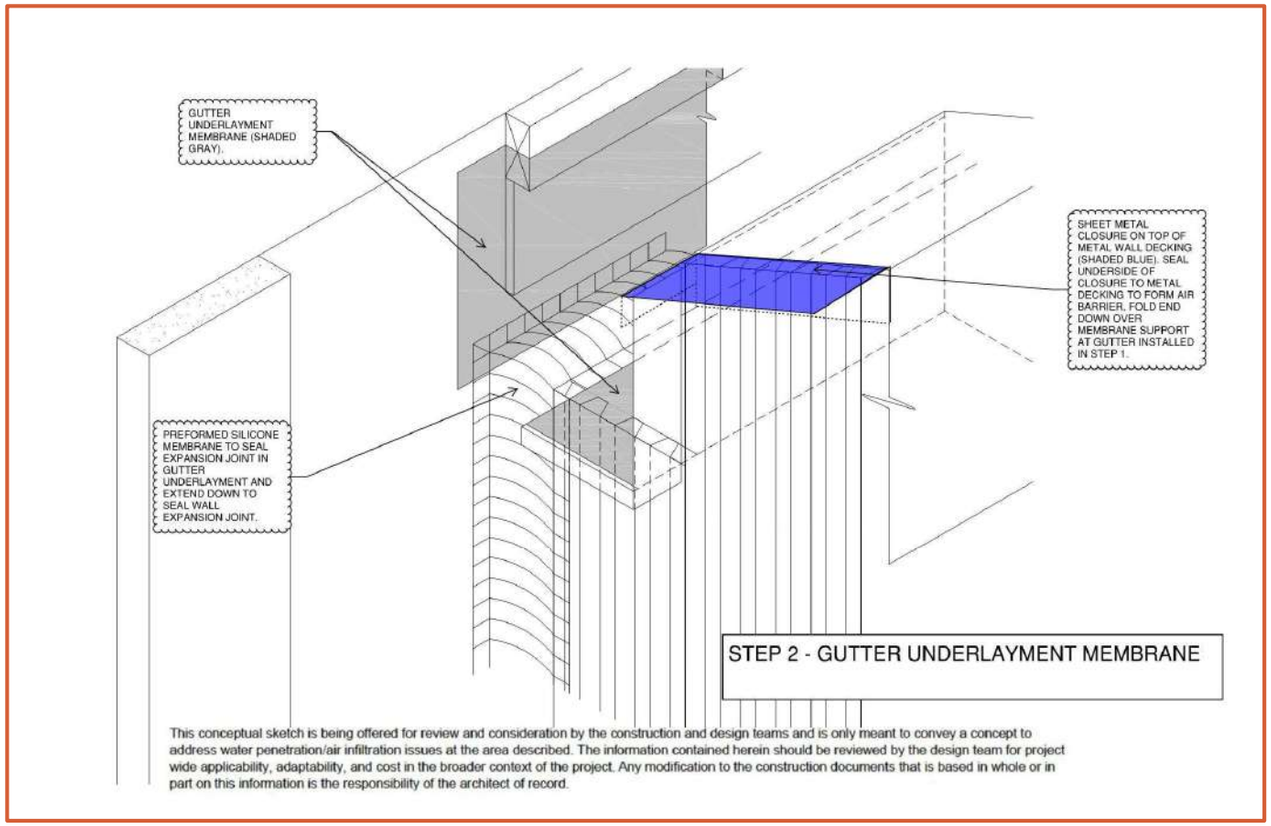


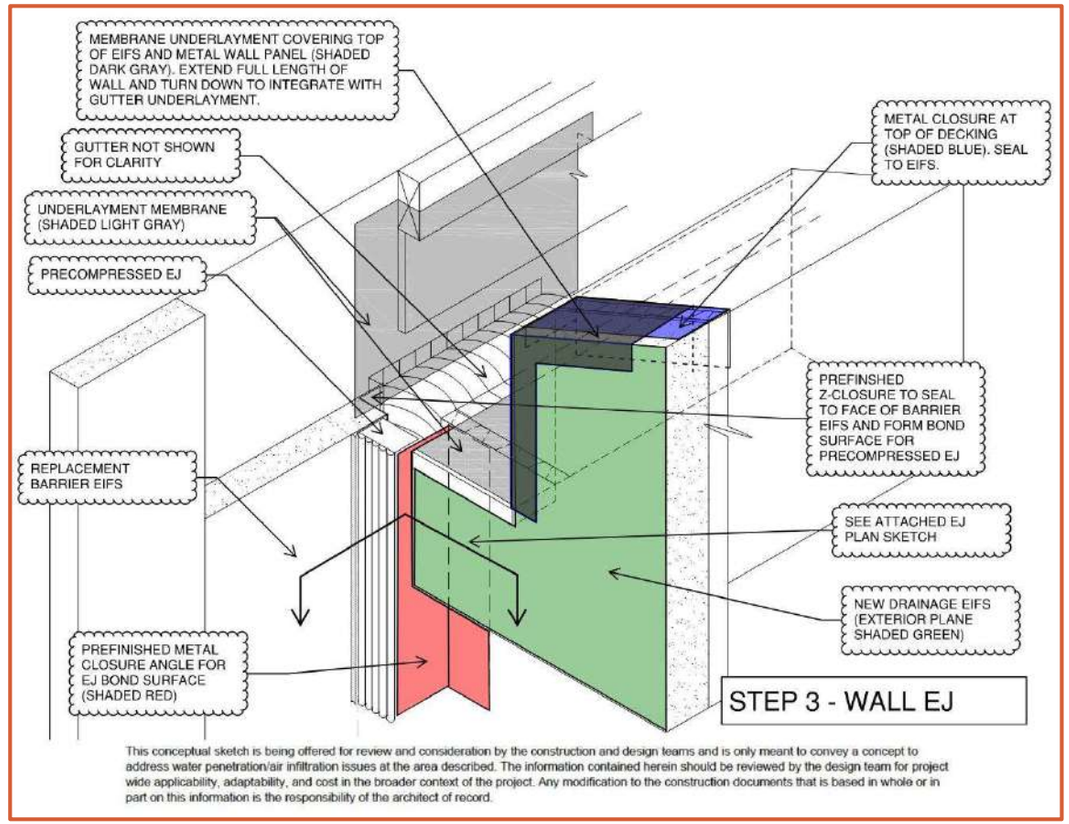
Case Study – Expansion Joint at Gutter



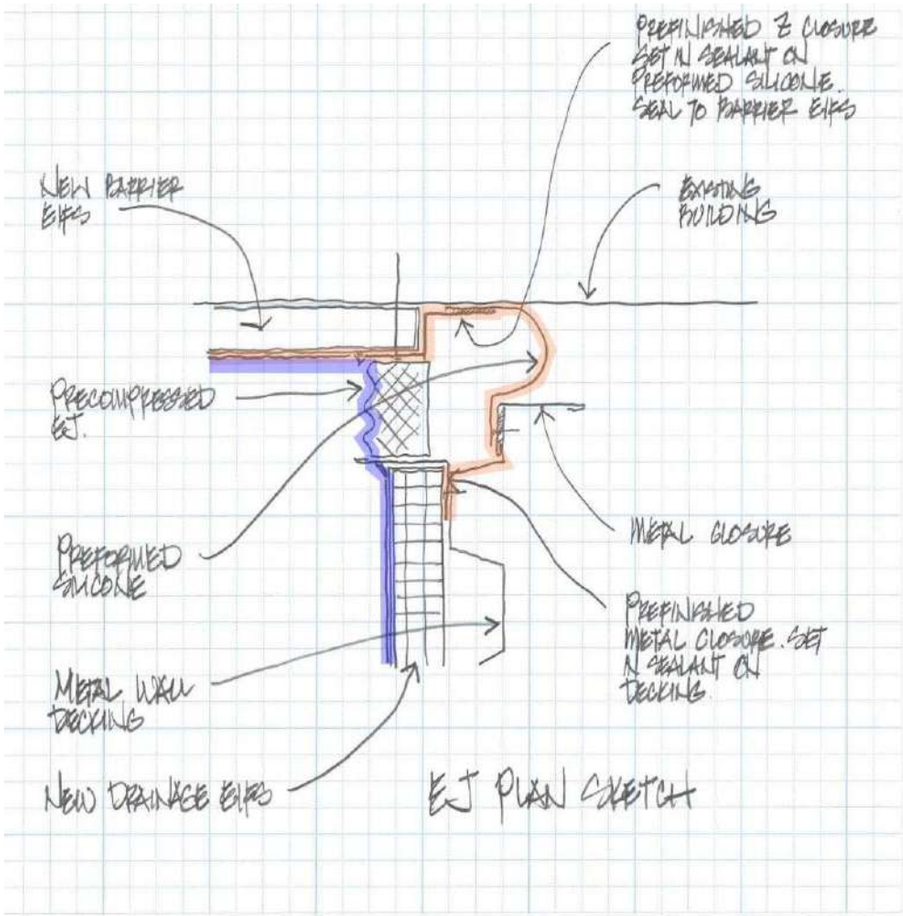


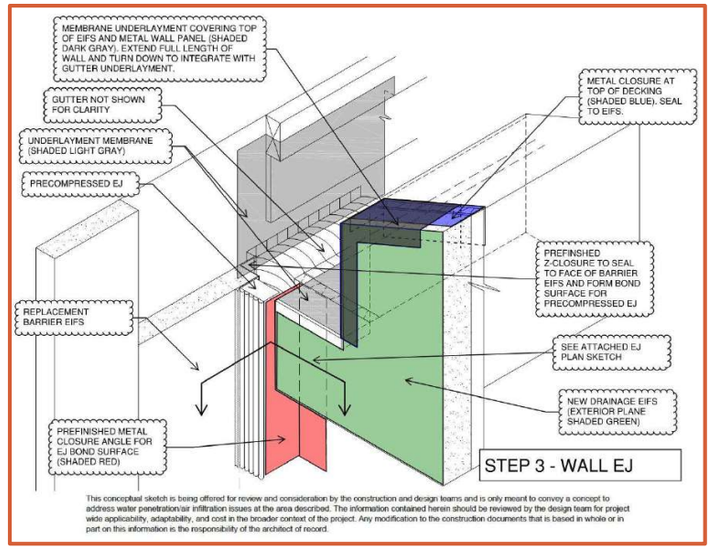
Case Study – Expansion Joint at Gutter





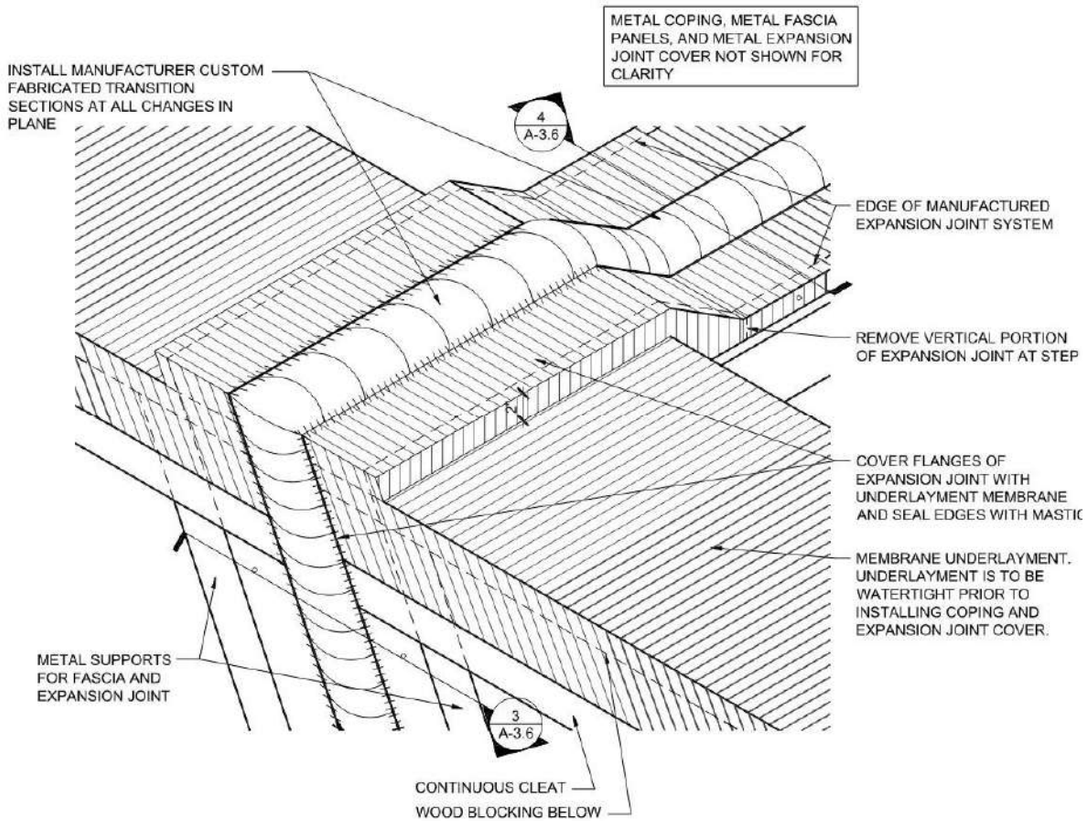
Case Study – Expansion Joint at Gutter



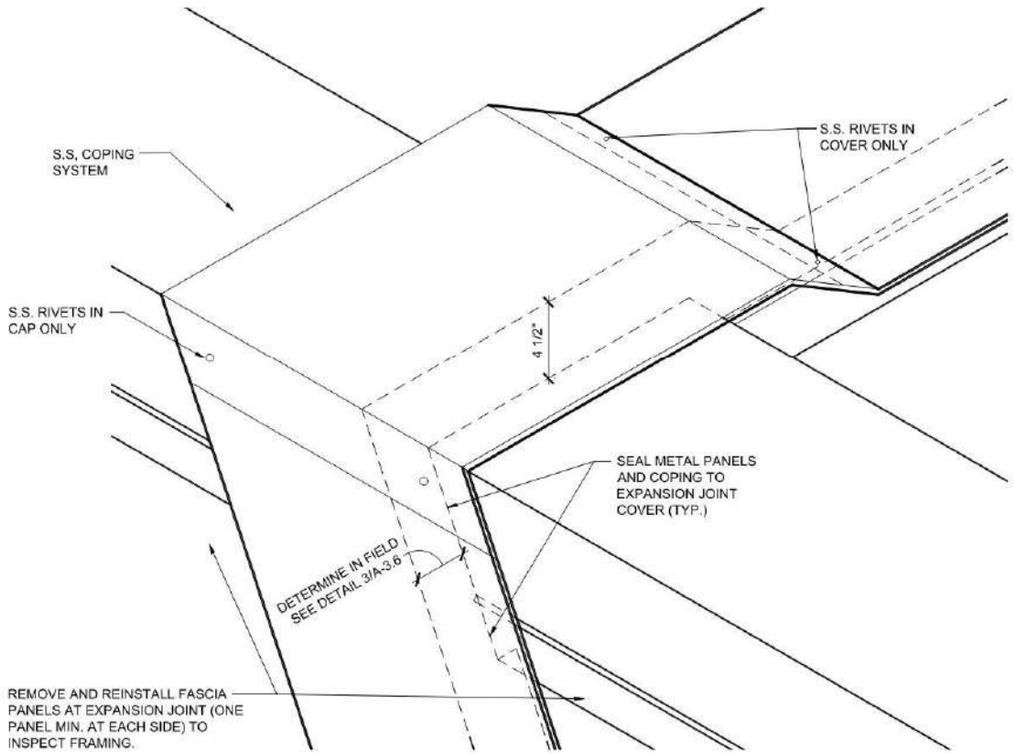


Case Study – Expansion Joint at Standing Seam Roof, Gutter, and Curtain Wall Transition

Case Study – Expansion Joint Standing Seam at Coping

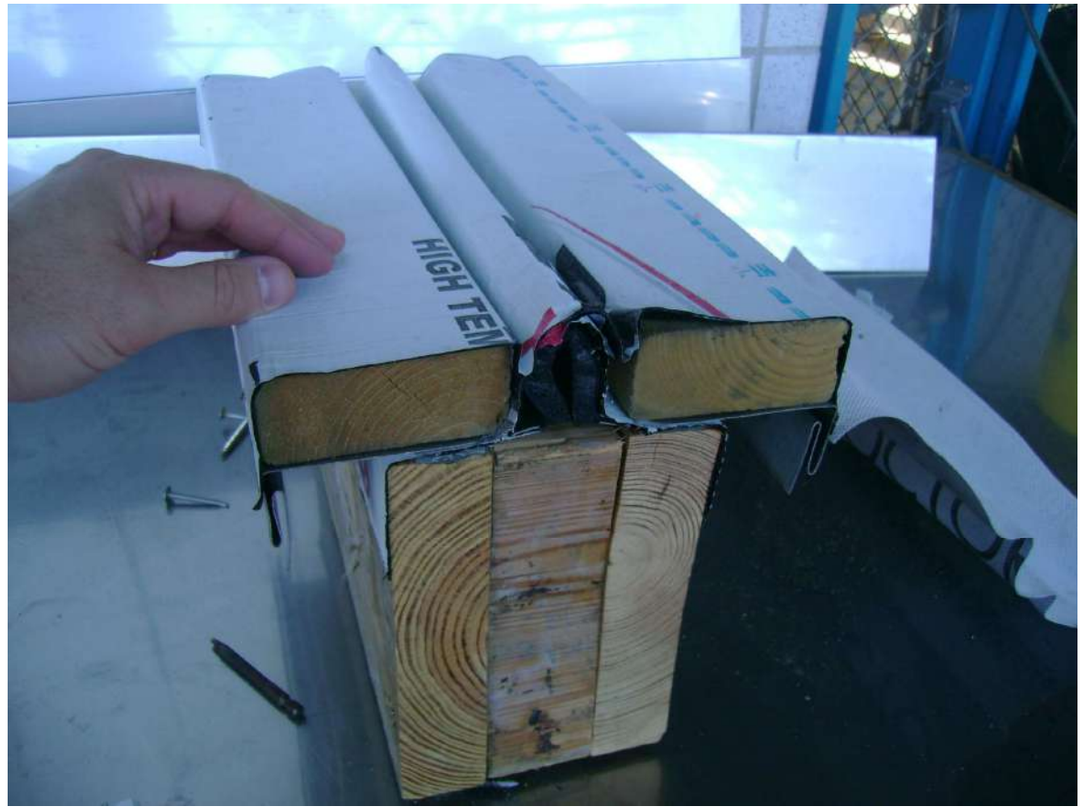


Case Study – Expansion Joint Standing Seam at Coping

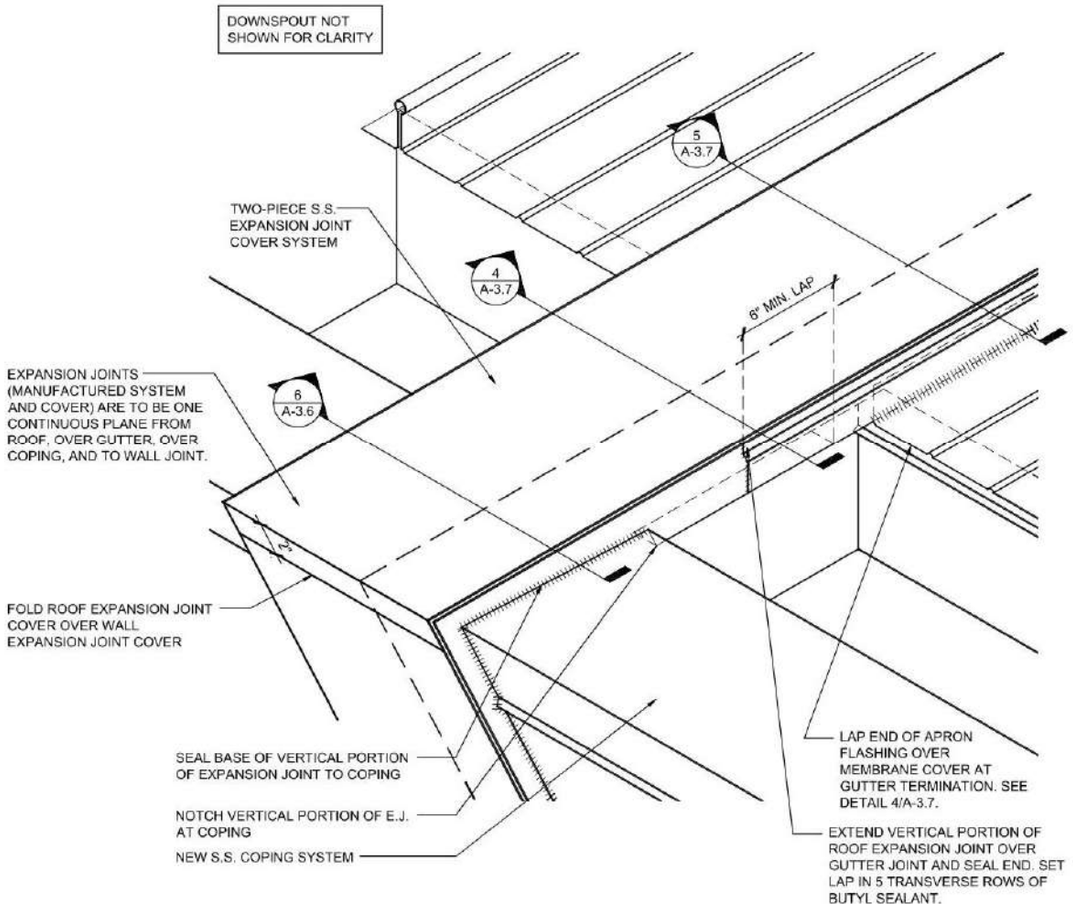


Case Study – Expansion Joint Standing Seam at Coping

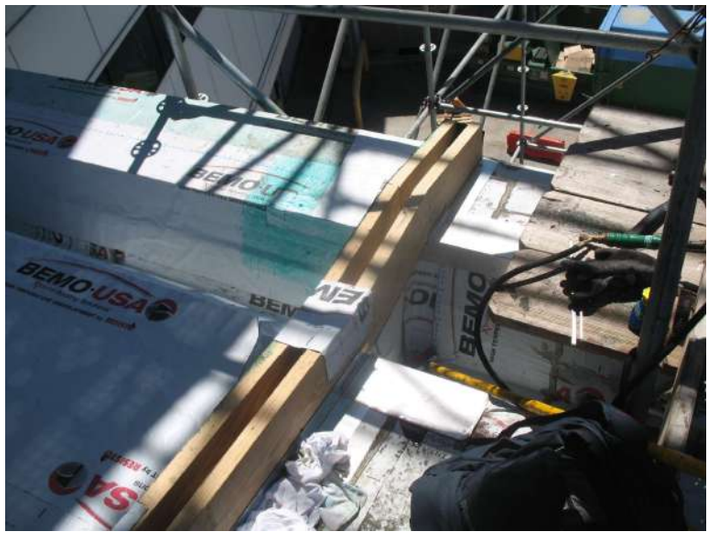
Mock-ups



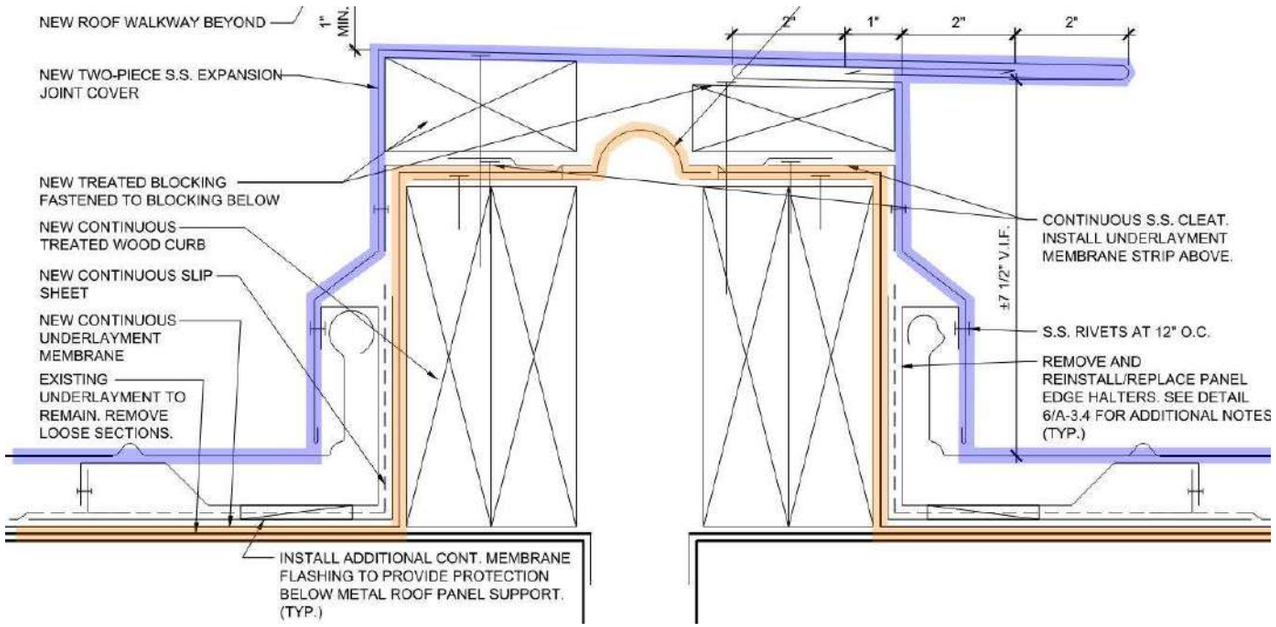
Case Study – Expansion Joint Standing Seam at Gutter



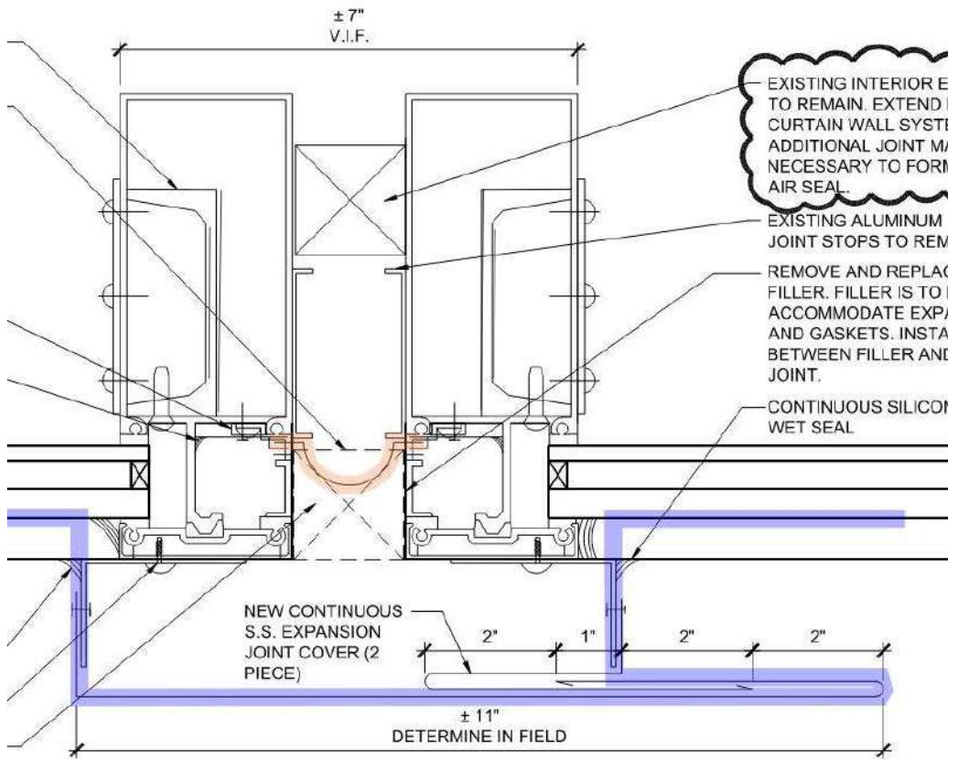
Case Study – Expansion Joint Standing Seam at Gutter

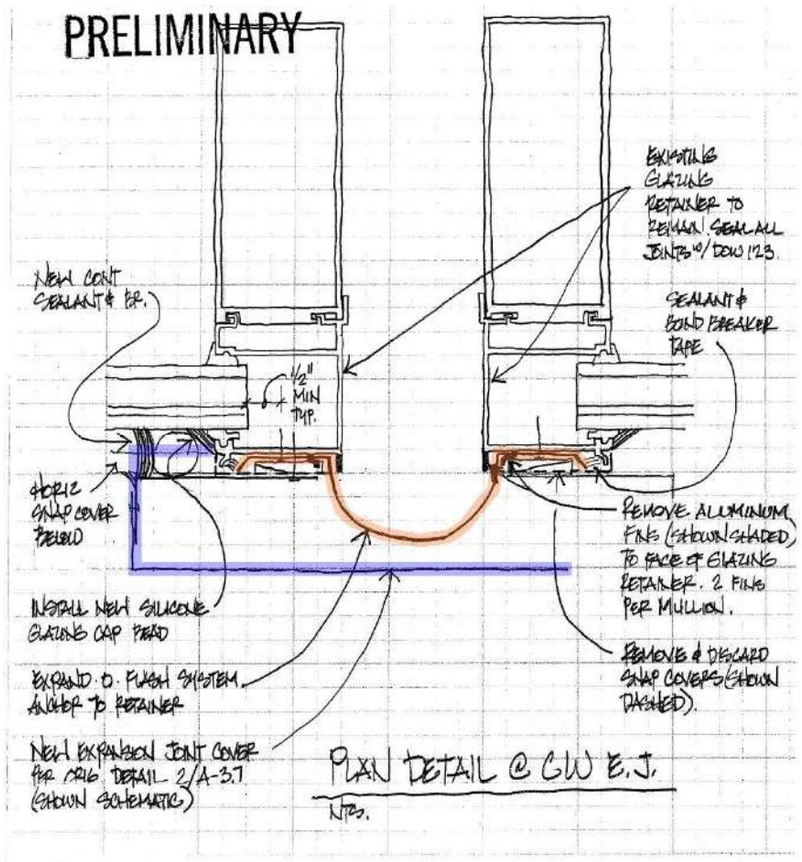


Case Study – Expansion Joint Standing Seam at Gutter

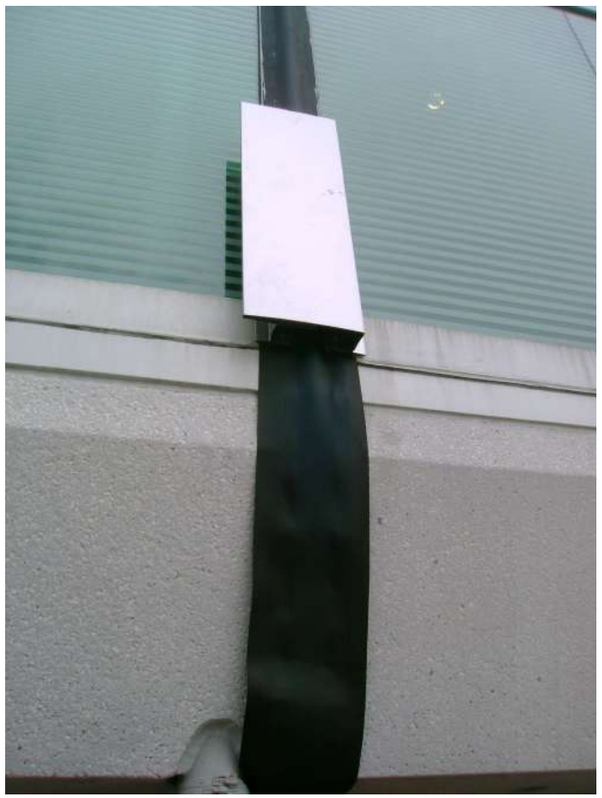


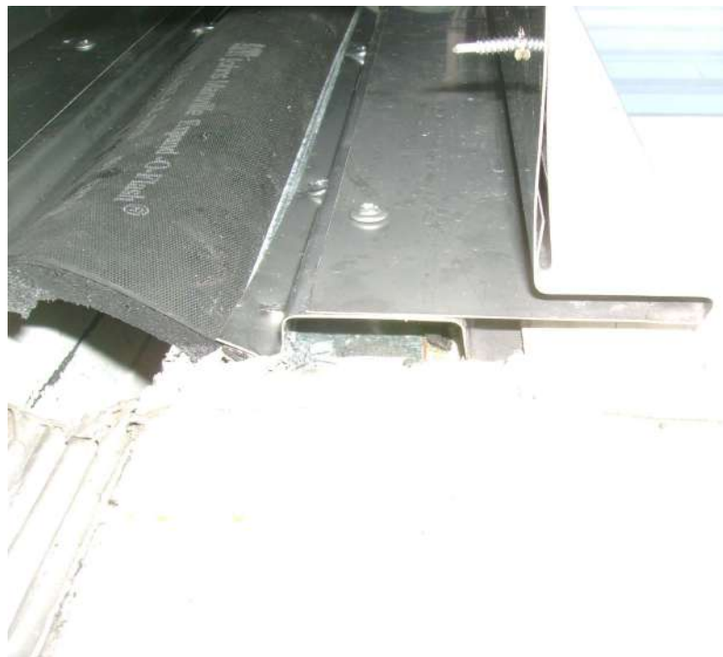
Case Study – Expansion Joint Standing Seam at Curtain Wall





Case Study – Expansion Joint Standing Seam at Curtain Wall





Case Study – Expansion Joint Standing Seam

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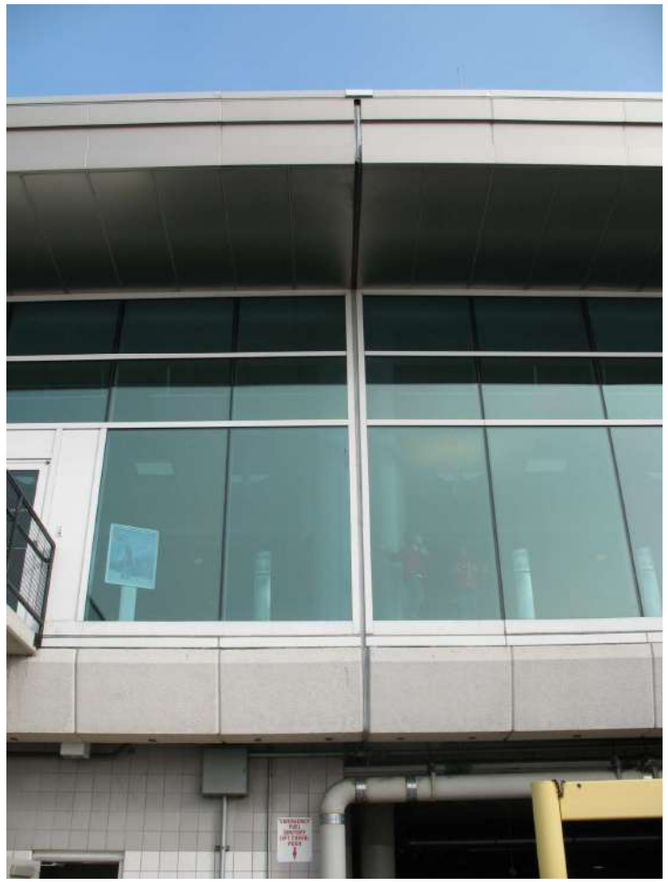
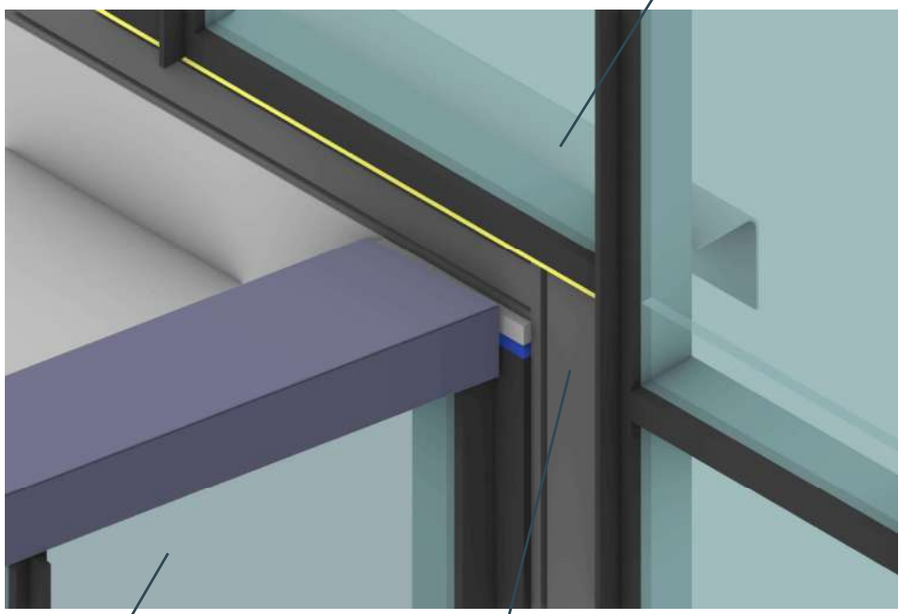
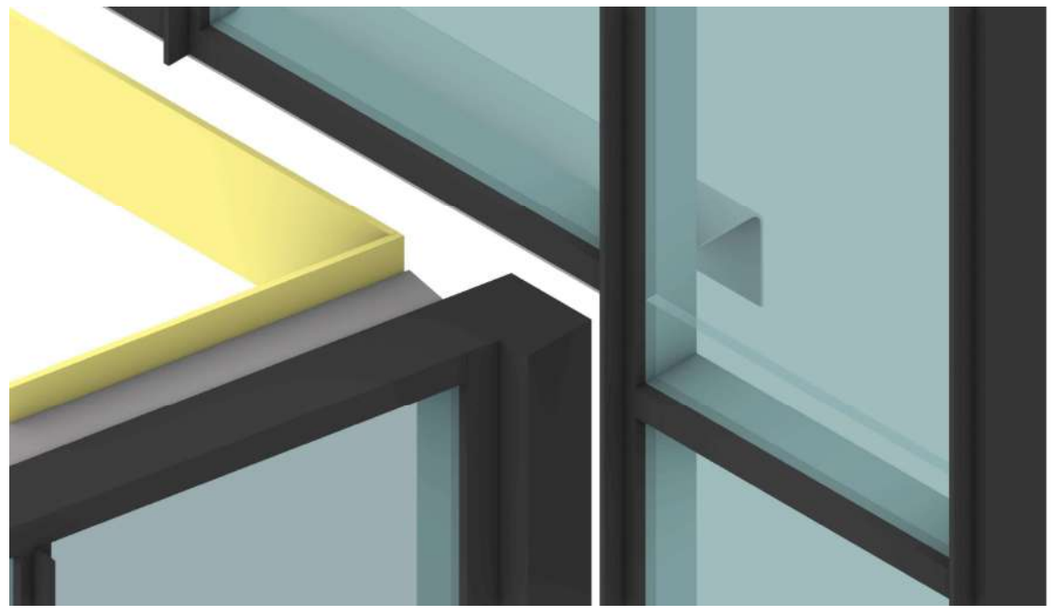
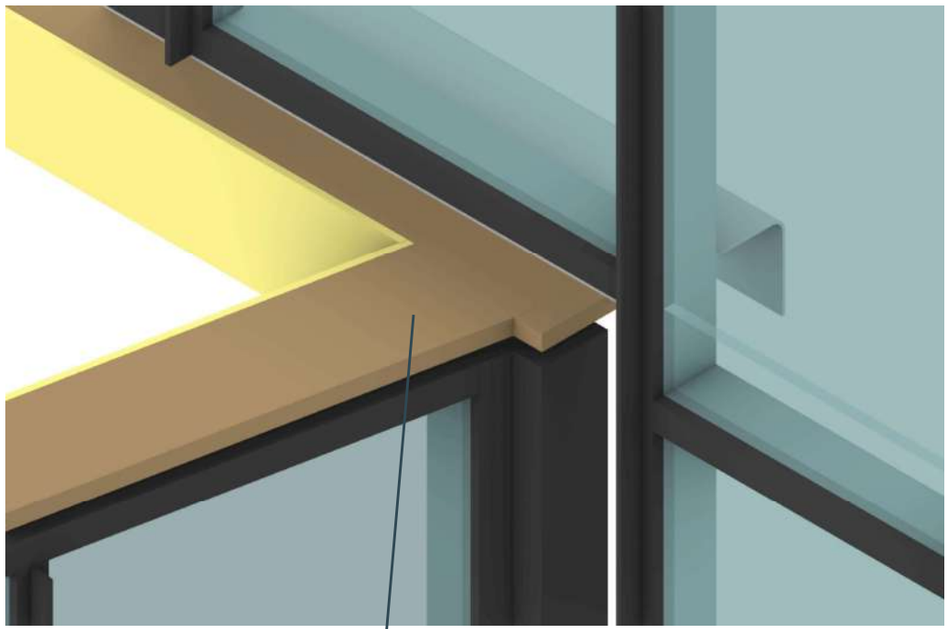


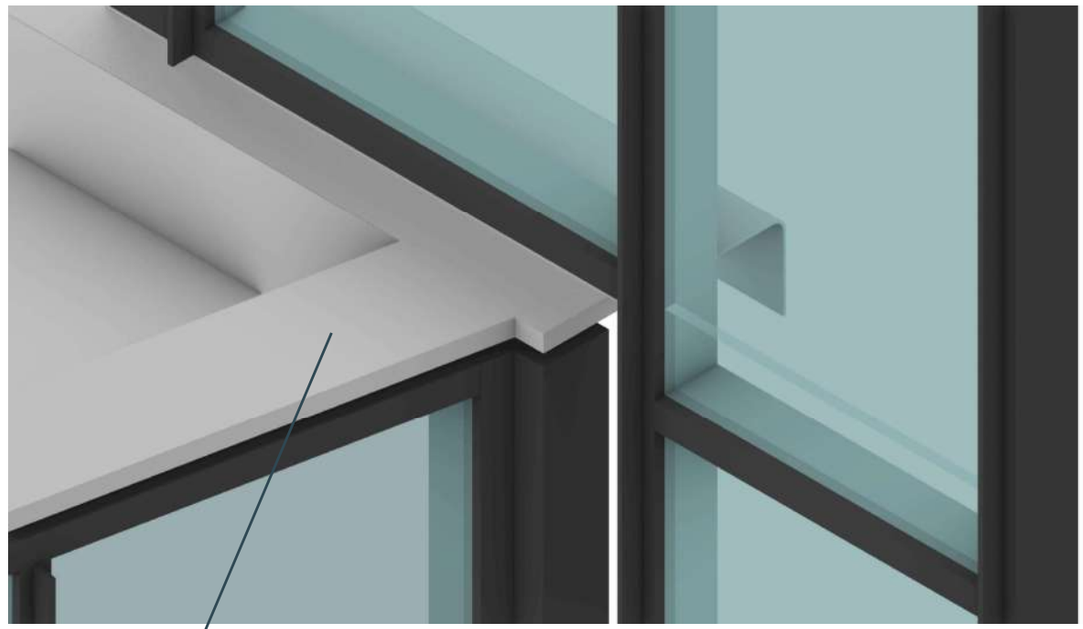
Case Study – Expansion Joint Corners



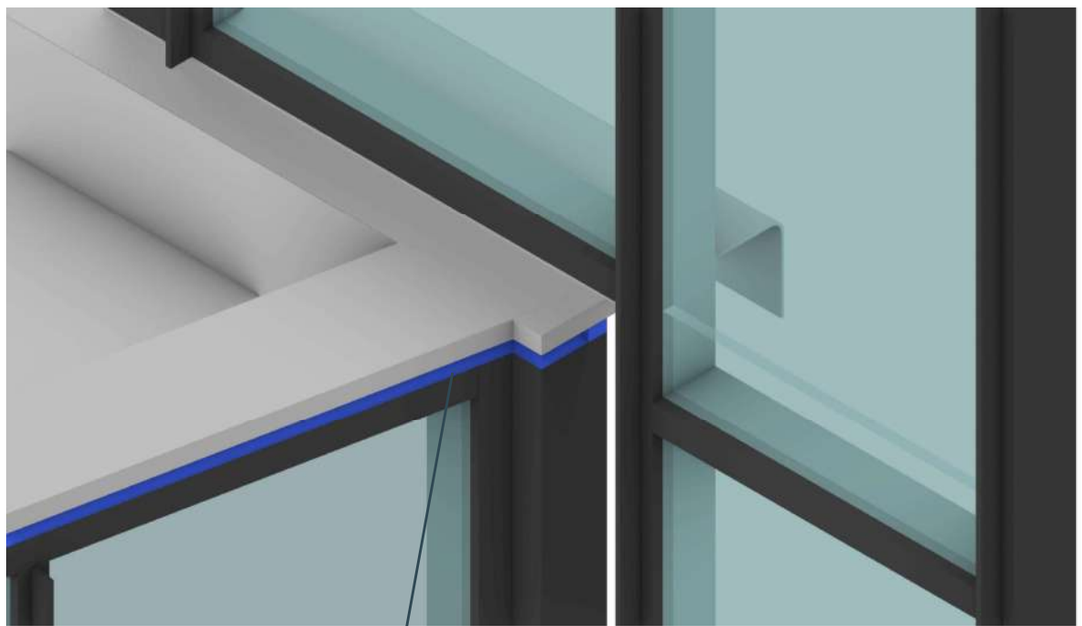


Case Study – Expansion Joint Corners



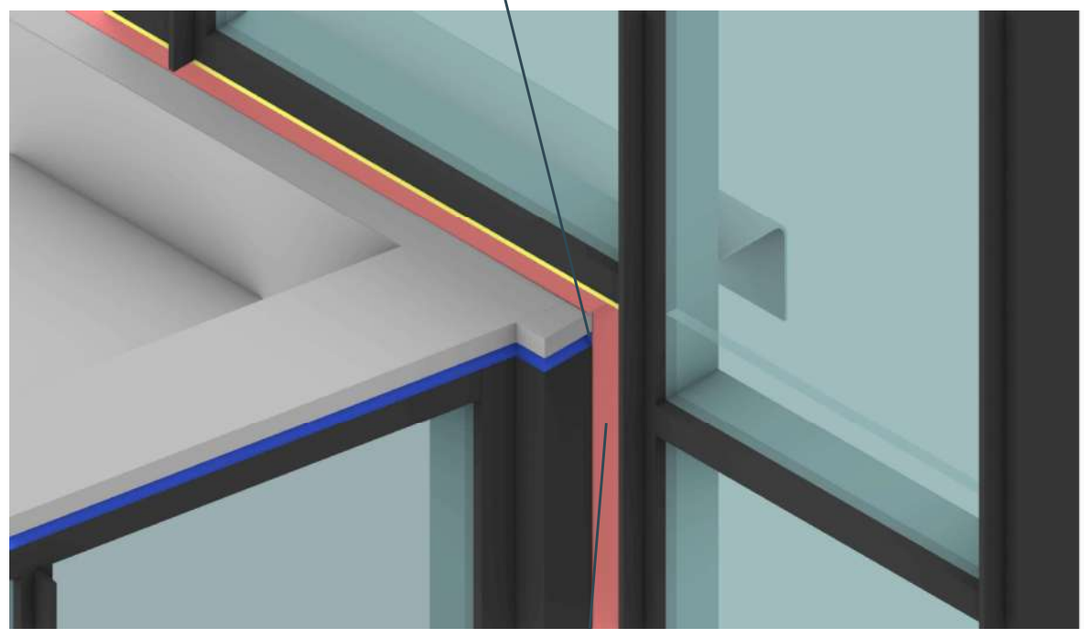


Case Study – Expansion Joint Corners



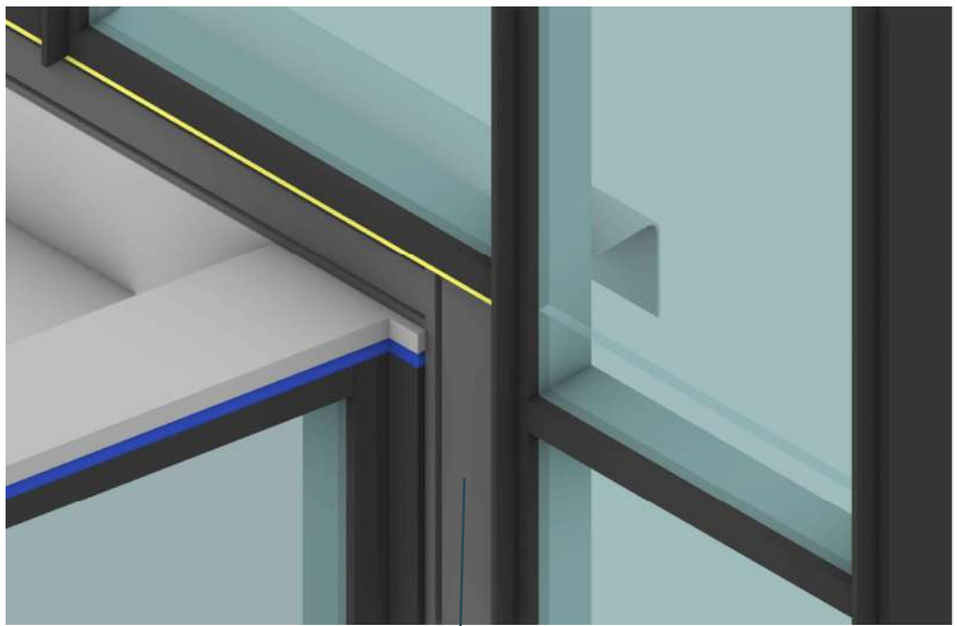
Primary seal at curtain wall shoulder.

Bond preformed silicone to sealant joint and tool additional sealant onto surface of preformed

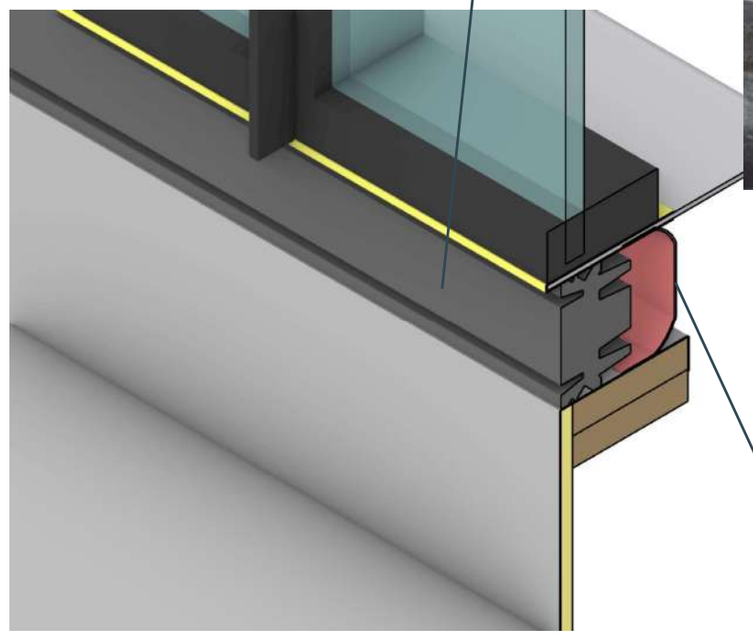


Install primary air/water seal (preformed silicone) at expansion joint

Case Study – Expansion Joint Corners



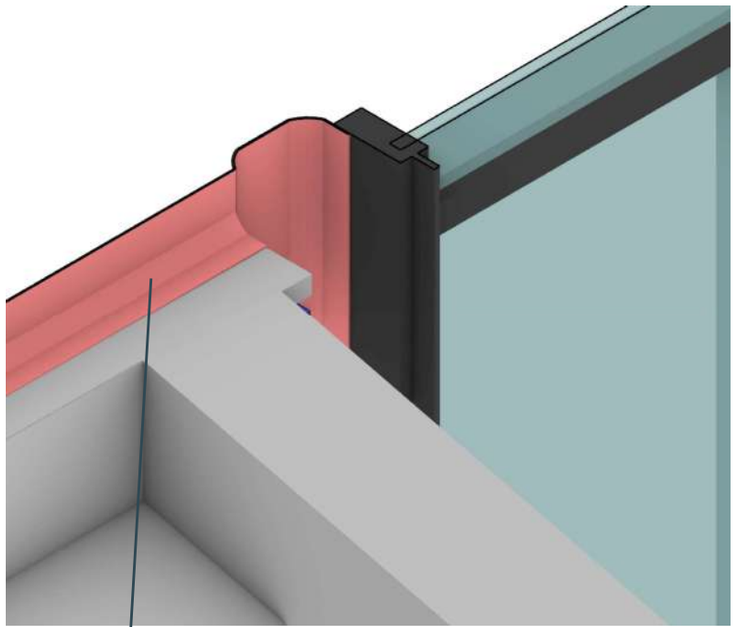
Exterior water-shedding cover



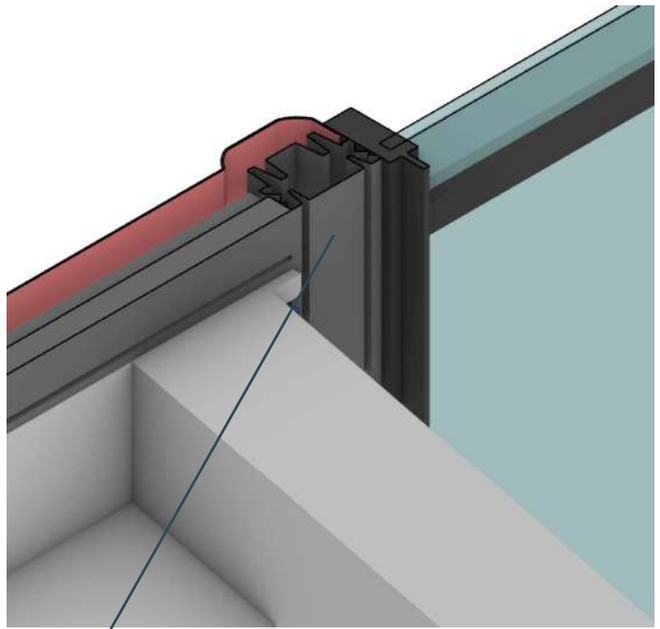
Exterior water-shedding cover

Primary air and water seal at expansion joint (preformed silicone seal). Sealed to air water barrier

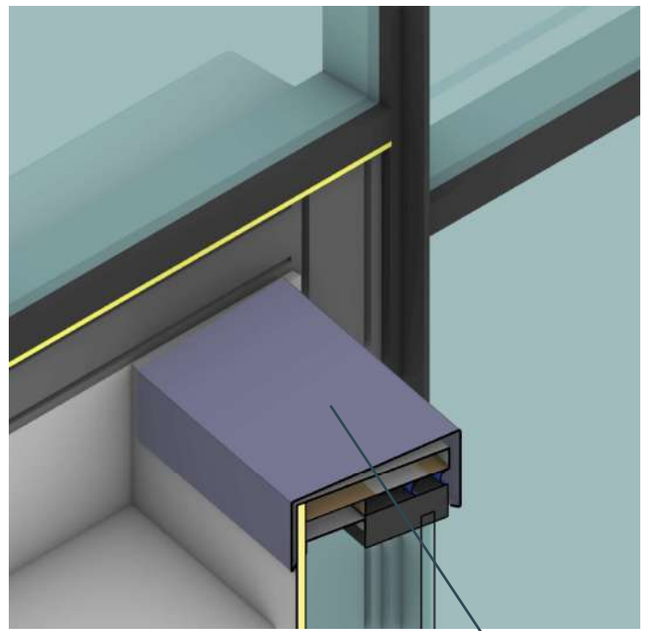
Case Study – Expansion Joint Corners



Preformed silicone seal

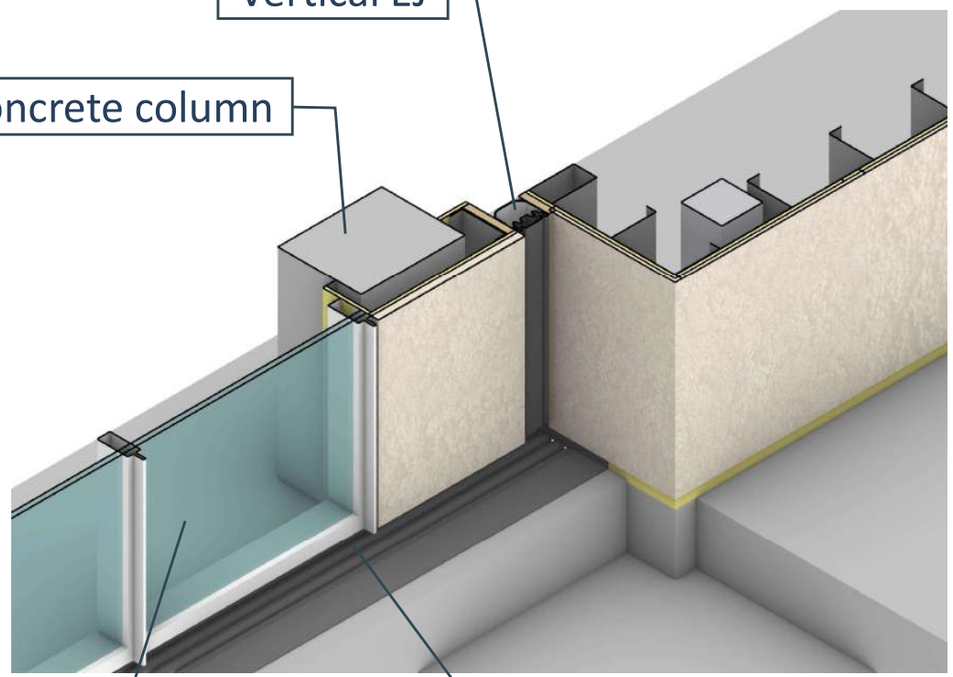


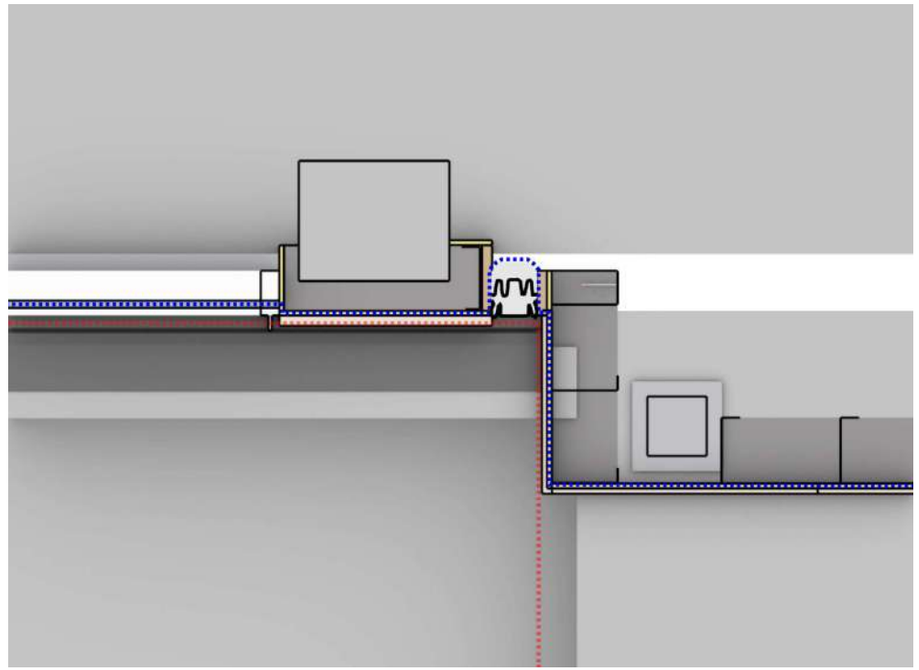
Exterior water-shedding cover



Adjacent coping interface

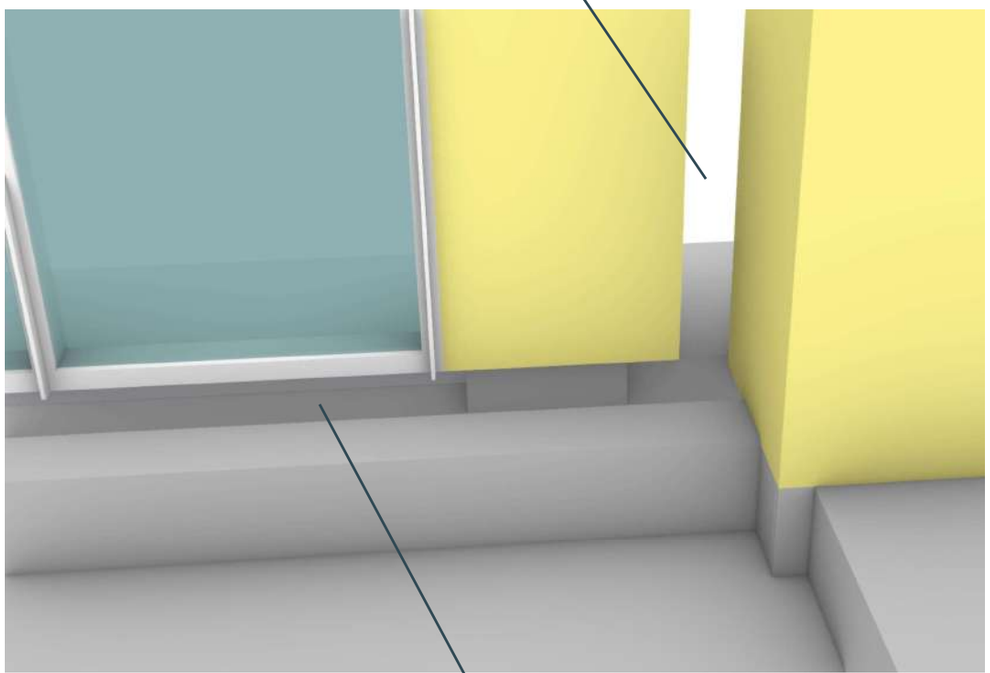
Case Study – Hot-Applied Waterproofing EJ

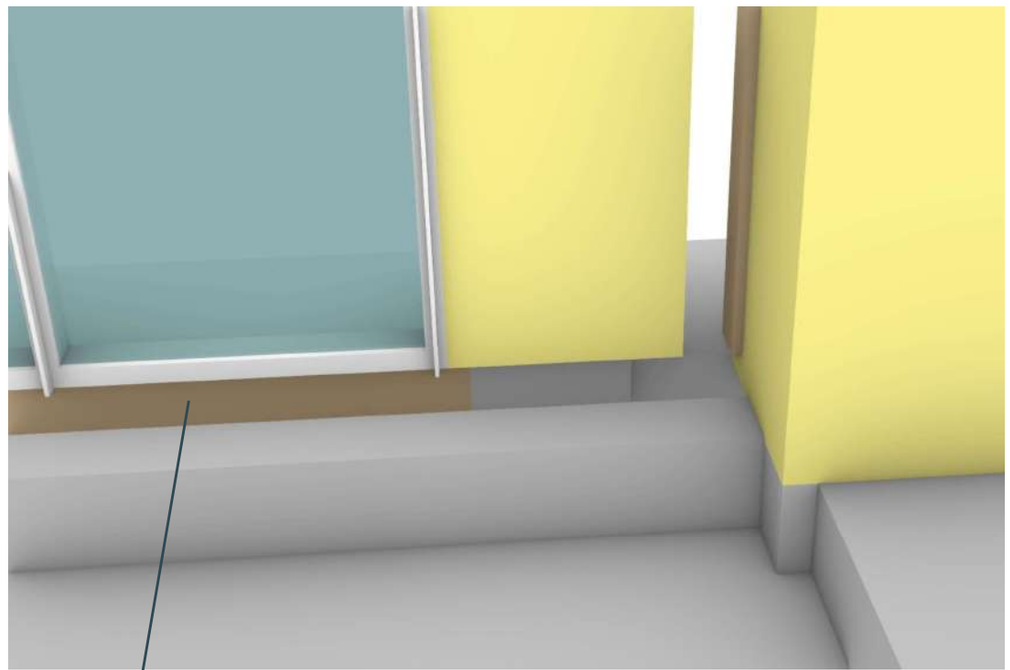




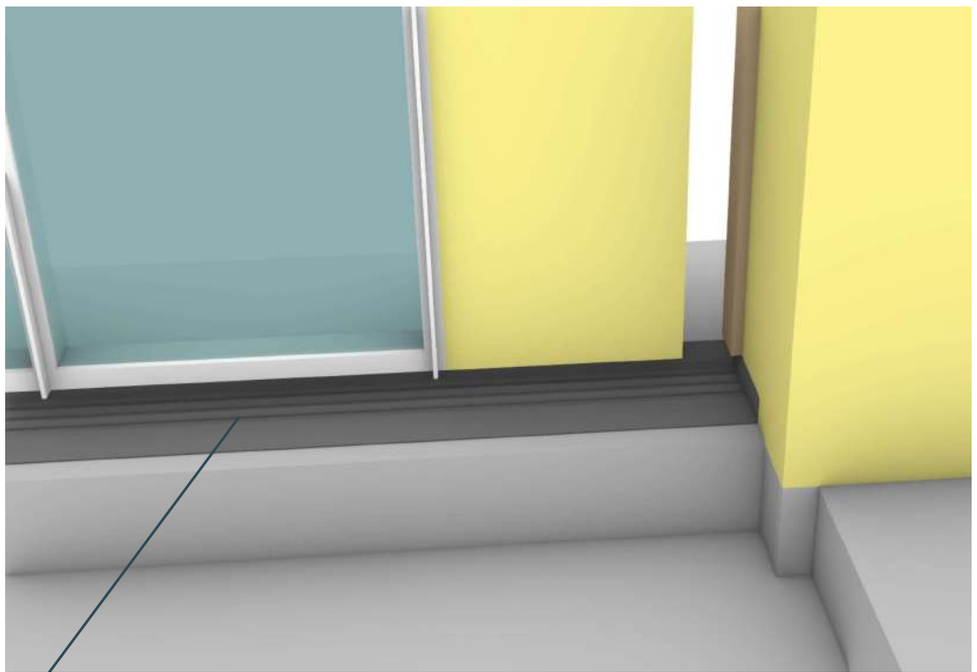
Plan View

Case Study – Hot-Applied Waterproofing EJ





Case Study – Hot-Applied Waterproofing EJ



Expansion joint compatible with hot-applied asphalt waterproofing

Case Study – Hot-Applied Waterproofing EJ

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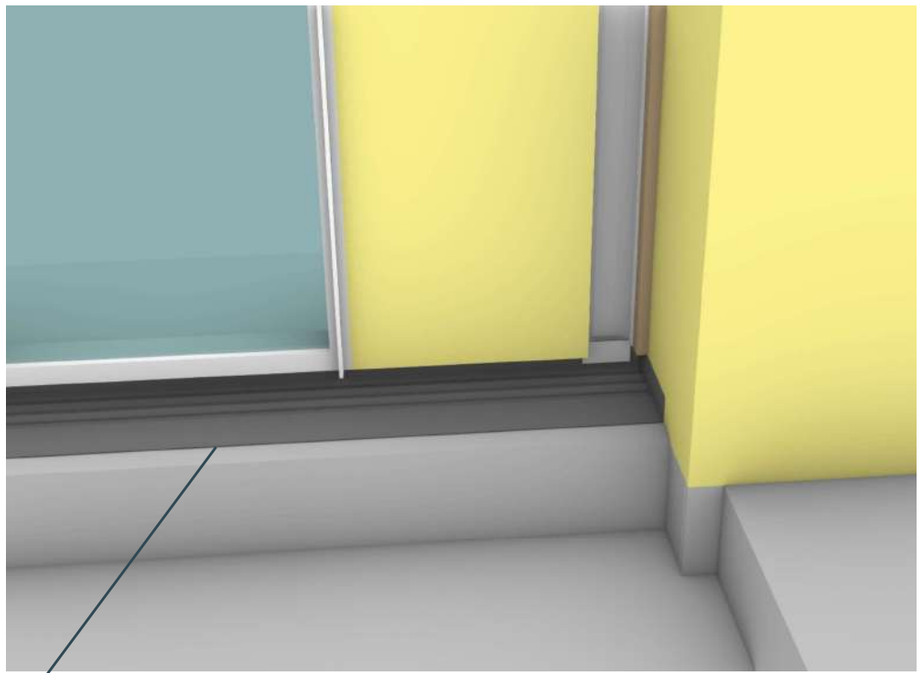
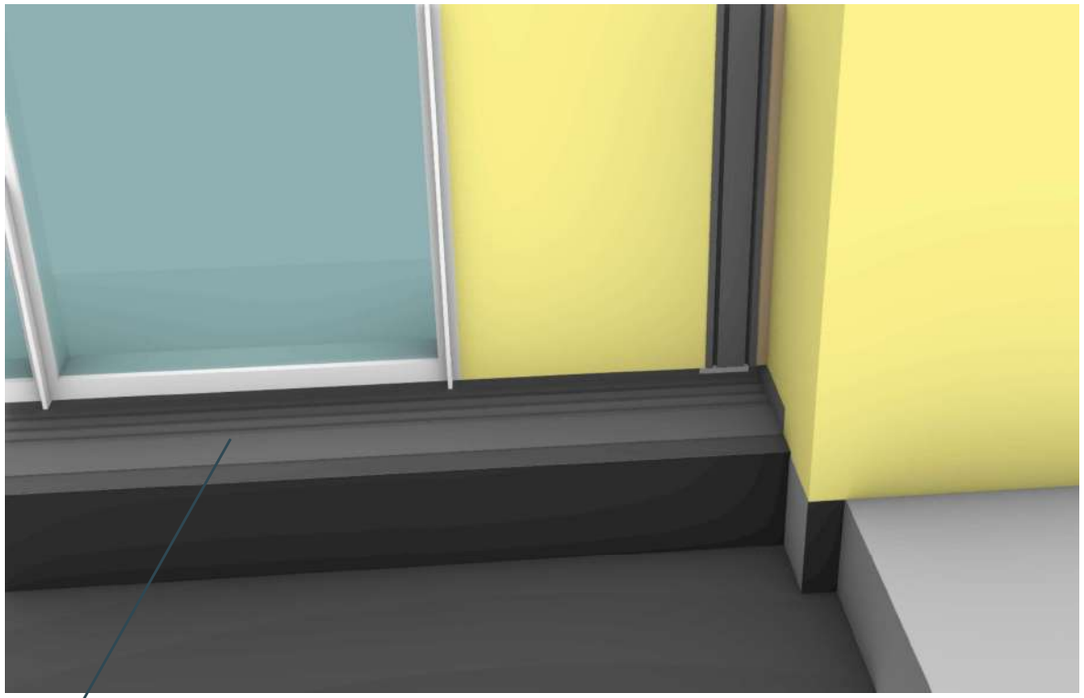


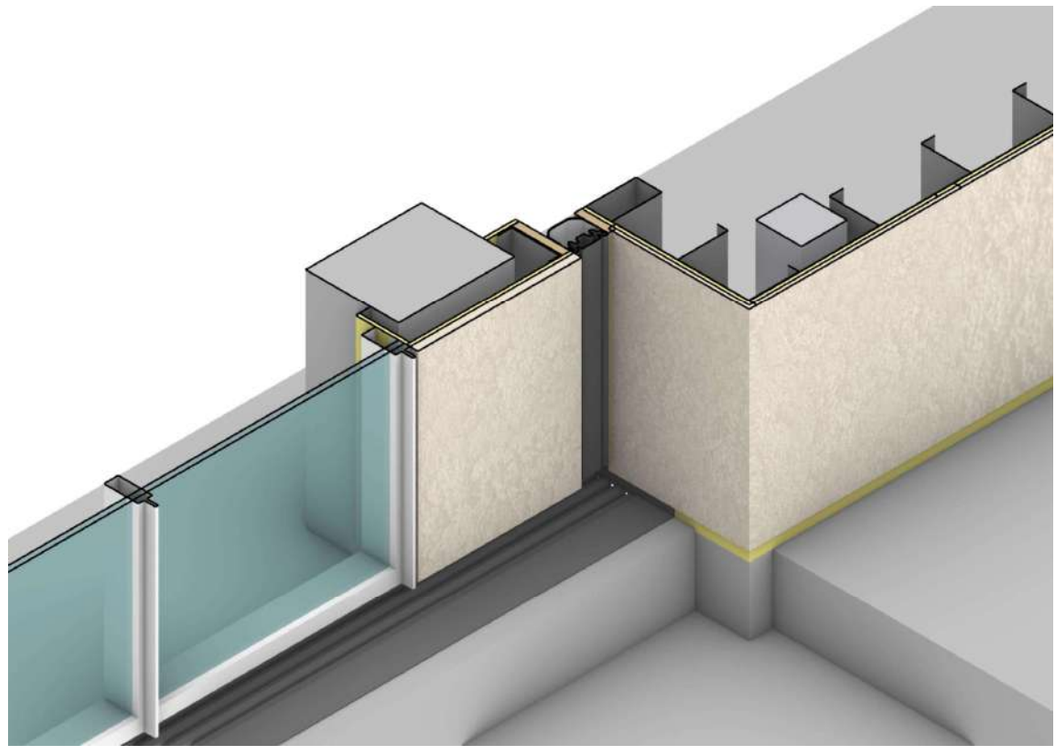
Expansion joint compatible with hot-applied asphalt waterproofing

Plan View

Case Study – Hot-Applied Waterproofing EJ



Case Study – Hot-Applied Waterproofing EJ



Summary and Conclusions

- Two lines of defense
- Continuity of the air barrier
- Interfacing at transitions are critical
- Contract documents may not be sufficient
- 3D sketches and sequence diagrams
- Quality control testing
- Materials and compatibility

Questions???

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