CHAPTER 5:

INTERIOR-INSULATED CMU WALL

Assembly 5 is a **mass wall design approach** with a concrete masonry unit (CMU) wall structure with interior insulation. The components of this assembly, from interior to exterior, are described in Fig. 5-1. It is most appropriate for low- to mid-rise commercial applications but may be used for residential application and higher-rise structures. An example application of this assembly is shown in Fig. 5-2 on page 5-3. Benefits and special considerations for this assembly are discussed in Table 5-1 on page 5-2.

Building Enclosure Control Functions and Critical Barriers

As noted in the Introduction, an above-grade wall assembly should provide control of water, air, heat, vapor, sound, and fire to serve as an effective and durable environmental separator. Control of these elements is provided by critical barriers such as a water-shedding surface (WSS), water-resistive barrier (WRB), air barrier system (AB), thermal envelope, and vapor retarder (VR). Refer to Fig. i-8 on page i-15 of the introductory chapter for a list of primary building enclosure control functions and associated critical barriers.

Fig. 5-3 on page 5-3 illustrates the locations of the critical barrier locations

INTERIOR

- Interior gypsum board
- Steel-framed wall
- Closed-cell spray foam insulation between studs
- Minimum 2 inches continuous closed-cell spray foam insulation
- Single-wythe CMU wall with water-repellent admixture
- Clear water repellent

EXTERIOR

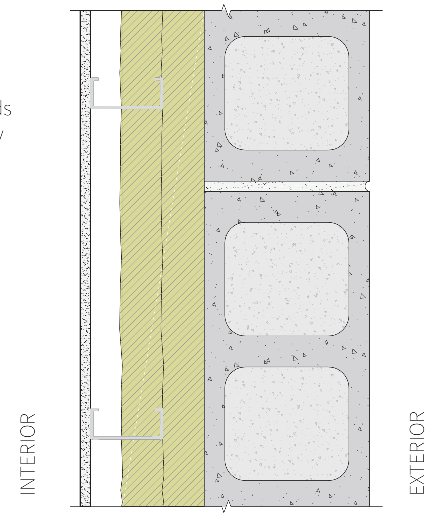


Fig. 5-1 Typical Assembly 5 components from interior to exterior.

Table 5-1 Assembly 5 comparison matrix excerpt from the introductory chapter

Assembly	#5
Assembly Comparison Category	**Interior-Insulated CMU Wall**
Recommended Occupancy Type	Residential OR Commercial
Building Enclosure Design Approach and Recommended Exposure	Mass Wall Design Approach, Low- to Mid-Rise Exposure
Long-Term Wall Assembly Durability	Structural durability high. Water repellents (admixture and surface applied) and/or opaque coatings provide water resistivity.
Typical Wall Thickness	Continuous insulation and offset framing increase thickness vs. CMU wall (Chapter #4 Assembly)
Typical Cladding Design Compliance	Prescriptive/Engineered
Typical Thermal Performance	Interior closed-cell spray foam insulation provides highest R-value per inch
Special Construction Considerations	Multiple functions of interior spray foam reduces construction complexity; added measures for moisture control recommended
Construction Ease with Limited / No Exterior Access (property line applications)	No exterior access required; however, installation of repellents or coating is limited
Fire Resistivity Considerations	Fire resistivity high. Insulation may affect fire propogation requirements.
Maintenance Considerations	Regular maintenance required; clear water repellent recommended.
Price Per Square Foot	Low and High Baseline Cost: $49.50 - $60.75

for this assembly. The critical barriers for typical Chapter 5 assembly details are also provided adjacent to each detail at the end of this chapter.

As shown in Fig. 5-3, the WRB and WSS critical barriers occur at the CMU wall structure face. The AB layer occurs at the closed cell spray foam insulation (CCSPF). The CCSPF also provides the thermal envelope of this assembly and functions as a VR.

The following sections provide more information and discuss best practices for the specific critical barriers of this assembly.

Water-Shedding Surface (WSS)

The WSS is a critical barrier that controls water.

The CMU wall along with grouted cores provide the WSS of this assembly. Additional components include sheet-metal flashings and drip edges, sealant joints, and fenestration systems as shown on the details included at the end of this assembly chapter.

Water repellent admixtures are added to block and mortar of this assembly and a surface applied clear-water repellent is also recommended. These repellents along with other measures such as tooled "V" or concave shape

Fig. 5-2 Typical assembly 5 application

(preferred) mortar joints, sufficient sheet-metal parapet cap design, and other general design recommendations as discussed in the Northwest Concrete Masonry Association (NWCMA) TEK Note on Rain Resistant Architectural Concrete Masonry serve to encourage water shed.

When finished, the WSS critical barrier should be free of gaps. Movement joints and joints around fenestrations and penetrations should be continuously sealed with a backer rod and sealant.

Critical Barriers

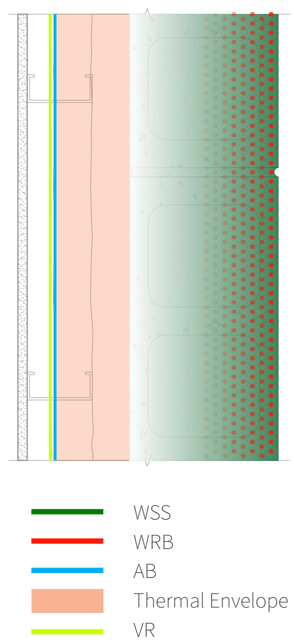


Fig. 5-3 Critical barrier locations for Assembly 5

Water-Resistive Barrier (WRB)

The WRB is a critical barrier that controls water.

Like the WSS, the CMU wall itself, along with grouted cores provide the WRB of this assembly. The addition of water repellent admixtures within the block and mortar and the use of a surface applied clear water repellent at the wall face will assist with increasing the water-resistivity of the assembly. Additional measures, such as those discussed in the Water-Shedding Surface (WSS) section of this chapter and addressed within the NWCMA Tek Note on Rain Resistant Architectural Concrete Masonry increase the water-resistivity of the assembly.

Additional WRB components include sheet-metal flashings and drip edges, sealant joints, fenestration systems, and rough opening fluid-applied flashing membranes as shown on the details included at the end of this chapter.

The CCSPF insulation at the interior face of the CMU may also provide additional water-resistivity. For this reason, and others discussed in the sections below, the CCSPF should be installed as continuously as possible—up to rough openings and tight to penetrations—to function as an effective critical barrier. Recommended CCSPF material properties are included in the Air Barrier (AB) section of this chapter.

Although masonry is defined as a noncombustible cladding material, the use of a combustible air and water-resistive barrier or foam plastic insulation within a wall cavity can trigger fire propagation considerations and requirements. Depending on the local jurisdiction, IBC Section 1403.5 regarding vertical and lateral flame propagation as it relates to a combustible water-resistive barrier may require acceptance criteria for NFPA 285. The use of foam plastic insulation within a wall cavity should also be addressed for IBC Chapter 26 provisions.

The WRB layer must be continuous across the wall face to serve as an effective critical barrier. Whereas this wall manages water at the CMU face and may manage some water at the CCSPF layer, window rough openings between these two planes must also have a WRB component. Typically, this is a fluid-applied air and water-resistive barrier membrane (AB/WRB), commonly referred to as an air and water-resistive barrier (AB/WRB). It protects rough opening against water ingress and air leakage and is depicted it the details at the end of this chapter.

Air Barrier (AB)

The AB is a critical barrier which primarily controls air, heat, and vapor. The AB also controls water, sounds, and fire.

The AB system in this assembly is typically the CCSPF interior of the CMU wall structure and has the following material properties:

- ☑ **Air Penetration Resistance:** As discussed in the introductory chapter
- ☑ **Water Vapor Transmission:** A maximum of 1 perm at 2-inch thickness when tested to ASTM E96
- ☑ **Closed-Cell Content:** > 95% when tested to ASTM D6226
- ☑ **Density:** ≥ 2 lb/ft3 when tested to ASTM C518

To serve as an effective AB system and to reduce the risk of air leakage condensation on the interior CMU face, CCSPF should be installed continuously up to rough openings, penetrations, and roof and floor structures.

Fig. 5-4 Closed-cell spray foam insulation installed between steel studs

Perform installation of CCSPF insulation in strict conformance with the manufacturer's installation instructions to avoid excessive heat buildup. Improper installation could lead to premature cracking, delamination from the substrate, and increases the risk of fire during installation. Use only experienced applicators who are approved by the CCSPF product manufacturer.

Other considerations when using closed-cell spray foam insulation includes fire propagation and volatile organic compound (VOC) compliance. Product selection, application, and use should comply with local jurisdiction requirements.

Install steel studs prior to the first lift of CCSPF as shown in Fig. 5-4. This eliminates the difficulty of installing studs against the irregular surface of the first lift and promotes continuity of the CCSPF when multiple lifts are installed.

Thermal Envelope

The thermal envelope is a critical barrier which controls heat and assist with controlling vapor, sound, and fire.

The interior CCSPF insulation serves as the thermal envelope critical barrier. At transition details, the thermal envelope includes interior insulation across bond beams and up to rough openings, windows and doors, and roof assembly insulation as well as slab and foundation insulation.

The thermal envelope should be as continuous as possible across all assemblies and transitions to minimize heat loss, reduce condensation risk, and improve occupant thermal comfort. Continuity of interior insulation can be difficult to achieve at areas such as floor line slab edges and some wall to roof transitions. These transitions should be carefully considered for whole building energy performance implications as well as energy code compliance.

The CMU wall of this assembly is also a thermal mass; thus, may provide thermal mass benefits as discussed in the introductory chapter.

Additional thermal envelope discussion is provided in the Thermal Performance and Energy Code Compliance section of this chapter and the introductory chapter.

Insulation Selection

CCSPF is recommended for this assembly, as noted in the preceding sections. Use of alternate insulation types should be carefully considered along with the projects specific application and exposure.

- Vapor- and Air-Permeable Insulation. This includes fiberglass and mineral fiber batt or semi-rigid mineral fiber insulation. These products alone do not serve as VR, AB, or WRB critical barriers; thus, require additional products or systems. When additional products are implemented to serve as these critical barriers, the risk for condensation on the interior face of the CMU wall should be carefully considered. Lack of a fully adhered WRB at the interior (or exterior face) of this assembly reduces the water-resistivity as compared to the CCSPF application.
- Rigid Board Insulation. This includes extruded polystyrene (XPS) or moisture-resistant foil-faced polyisocyanurate insulation types. These products provide a VR and AB when the interior face of the product is fully taped and/or sealed at seams, edges, penetrations and to perimeter elements such as floor slabs. Rigid board insulation products require notching around wall projections such as roof joists and pipe penetrations; thus, additional insulating and sealing mechanisms should be considered at these locations to ensure a continuous barrier is provided. Rigid board insulation products do not provide continuous adhesion to the CMU wall structure like a CCSPF product. As a result, if water is allowed to bypass the CMU wall structure it is not contained within the wall but instead may reach horizontal elements. This risk can be minimized by stepping foundation elements to terminate the insulation at a lower elevation than floor slab finishes and by installing an elastomeric coating to the exterior wall face (see the introductory chapter for more information).

Vapor Retarder (VR)

The VR critical barrier is a layer that retards or greatly reduces (e.g., vapor barrier) the flow of water vapor due to vapor pressure differences across enclosure assemblies.

In this assembly the VR is the CCSPF which controls vapor diffusion. As this assembly is insulated to the interior, it is important that the VR is continuous across the walls interior face and up to rough openings and penetrations.

The CCSPF insulation has a minimum 2 lb/ft^3 density and is applied at a minimum of 2 inches to be considered a Class II vapor retarder (perm rating greater than 0.1 and less than or equal to 1.0).

Manufacturer installation requirements for closed-cell spray foam insulation should be strictly followed to ensure VR performance.

Thermal Performance and Energy Code Compliance

This chapter assembly is typically classified as a "mass" above-grade wall for energy code compliance purposes. Prescriptive energy code compliance values for this assembly are summarized in Table 5-2 on page 5-10 and describe:

- Minimum insulation R-values for a **prescriptive R-value compliance strategy.**
- Maximum assembly U-factors for a **prescriptive U-factor alternative compliance strategy.** Note, the equivalent assembly effective R-value of this maximum U-factor has been calculated and is denoted in parenthesis ( ) for easy comparison to thermal modeling results included within this chapter.
- Footnote (2) for compliance by **exception**. The ability to use this option depends on the jurisdiction, building's occupancy type, and availability of CMU cores to be filled with insulation. If this exception is to be used, refer to the Chapter 4 Thermal Performance and Energy Code Compliance section.

When a **non-prescriptive compliance option** (e.g., a trade-off strategy or whole-building modeling strategy) is used for energy code compliance, this assembly's effective thermal performance will need to be calculated; however, it may or may not be required to meet the prescriptive values shown in Table 5-2.

Fig. i-17 on page i-29 of the introductory chapter describes the typical process of navigating energy code compliance strategies and options. Thermal modeling results demonstrated within this chapter may be used to assist with estimating the location of steel framing and insulation thicknesses to achieve a target thermal performance value. Options for thermally optimizing this assembly, as determined through the modeling results, are also provided.

Project-specific thermal performance values for the opaque above-grade wall assembly of this chapter should be used for energy code compliance and should be determined from a source that is approved by the local governing jurisdiction. Sources may include the Appendices of the WSEC and SEC, ASHRAE 90.1, COMcheck, thermal modeling, or other industry resources.

Assembly Effective Thermal Performance

The depth and location of the steel studs in this assembly will impact the assemblies effective thermal performance depending on placement relative to the assemblies interior insulation. As shown in Fig. 5-5 and Fig. 5-6, various levels of thermal bridging can occur depending on steel stud placement relative to the CMU and insulation product. This thermal bridging reduces the assembly's effective thermal performance.

Three-dimensional thermal modeling demonstrates this assembly's effective thermal performance with various framing locations (relative to the insulation and CMU wall) and insulation thicknesses. A discussion on the modeling performed for this guide is included in the Introduction Chapter and the Appendix.

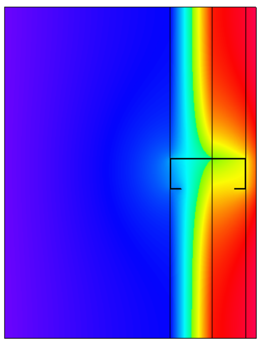


Fig. 5-5 Two-dimensional thermal model image 2-inches closed-cell spray foam insulation between studs which are tight to the CMU wall. Warm interior shown at right and cool exterior shown at left.

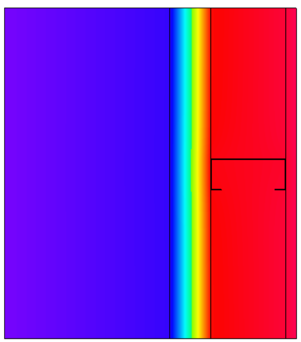


Fig. 5-6 Two-dimensional thermal model image of 2-inch continuous closed-cell spray foam between studs and CMU wall. Warm interior shown at right and cool exterior shown at left.

Thermal Modeling: Variables

The following are modeling variables specific to this assembly—CMU wall with interior insulation:

- **Wall Structure:** An 8-inch medium-weight block.
- **Wall Framing:** Galvanized steel studs at 16-inches on-center, including a top and bottom track. Various assembly options for locating framing relative to insulation are considered and depicted in Fig. 5-7 on page 5-11.
- **Insulation:** R-6/inch insulation product either continuous or bridged by steel studs as indicated in the results table. The R-value selected demonstrates a typical CCSPF thermal resistance and is used consistently for all thermal modeling analysis in this chapter to demonstrate comparative thermal performance results.

Thermal Modeling: Results

The results of this modeling are shown in Table 5-3 on page 5-11 and demonstrate the effective assembly R-value of the assembly under various conditions. Of the modeling results presented, many of the insulation strategies provide an effective assembly R-value that satisfies the various prescriptive energy code requirements shown in Table 5-2. Although these strategies may meet minimum allowable thermal envelope performance requirements, additional considerations for how the various insulation strategies impact the remaining critical barriers is also discussed in this section. Key points for thermally optimizing this assembly are ***italicized in boldface.***

- Option 4 with 2 inches of CCSPF between the CMU and steel studs and an additional 2 inches of CCSPF between studs provides an effective assembly R-value of R-23.4. The continuous CCSPF option provides an uninterrupted VR and AB/WRB installation. The installation of 2-inches of CCSPF within the stud space leaves room for services to be installed between the insulation and interior gypsum board if needed. ***Installation of both continuous insulation and insulation bridged by framing provides good thermal performance without compromising floor space or stud space needed for services.***
- As shown with Option 3, 4 inches of CCSPF may be installed between the CMU wall and steel studs to provide an effective assembly R-value of 27.2. ***When thermally optimizing this assembly it is most effective to add continuous insulation rather than insulation bridged by steel stud framing.***

Table 5-2 Assembly 5 prescriptive energy code compliance values

OPAQUE ABOVE-GRADE WALL - THERMAL ENVELOPE REQUIREMENTS											
		Energy Code	2012 SEC		2012 WSEC		2014 OEESC		2012 IECC			
		Climate Zone	5 and Marine 4		5, 6 and Marine 4		5 and Marine 4		5 and Marine 4		6	
Guide Assembly #		Classification	All Other	Group R	All Other	Group R	All Other	Group R	All Other	Group R	All Other	Group R
5	Interior Insulated CMU	Mass	Interior: R-13 + R-6ci, or R-13 + R-10ci[1]	Interior: R-13 + R-6ci, or R-13 + R-10ci[1]	R-9.5ci[2]	R-13.3ci[2]	R-11.4ci	R-13.3ci	R-11.4ci	R-13.3ci	R-13.3ci	R-15.2ci
			U-0.057 (R-17.5)	*U-0.057 (R-17.5)*	*U-0.104[2] (R-9.6)*	*U-0.078 (R-12.8)*	*U-0.150[2] (R-6.7)*	*U-0.090[2] (R-11.1)*	*U-0.078 (R-12.8)*	*U-0.078 (R-12.8)*	*U-0.078 (R-12.8)*	*U-0.071 (R-14.1)*

[1] When using interior insulation: R-13 + R-6 ci for wood studs or R-13 + R-10 ci for metal stud; when using exterior insulation R-16 ci

[2] Provided at least 50% of block cores are filled with vermiculite (or equivalent fill insulation), and enclosing one of the following uses: gymnasium, auditorium, church chapel, arena, kennel manufacturing plant, indoor swimming pool, pump station, water and waste water treatment facility, storage facility, restroom/concessions, mechanical/electric structures, storage area, warehouse (storage and retail), and motor vehicle service facility. In Washington, where additional uses not listed (such as office, retail, etc.) are contained within the building, the exterior walls that enclose these areas may not utilize this exception.

- Cavity-only insulation produces an assembly effective R-value of 7.2 for 2 inches of CCSPF (Option 2) and an assembly effective R-value of 9.1 for 4 inches (Option 5). This option significantly reduces the thermal performance of the insulation (e.g., by 42 to 62%). Whereas the steel studs and CCSPF may still provide a vapor retarder for this assembly, the foam insulation is debridged from the CMU at vertical framing and head and sill tracks, creating discontinuities in the AB/WRB. ***Providing cavity-only insulation within this assembly is not the most effective insulation strategy.***

- Commonly, a 1-inch air cavity is provided between CMU wall and steel studs. In this case, cavity insulation is only provided. This strategy is often considered with the hope of reducing thermal bridging between the CMU and steel stud framing. As shown in Table 5-3, this option results in a slightly higher effective R-value (R-9.1 to R-12.1 when comparing Options 5 and 6) than when in direct content. ***Little thermal benefit is gained when separating the insulation from the CMU wall; a more thermally effective option is to fill the offset with CCSPF.***

Movement Joints

The CMU wall of this assembly functions as both the WSS and the structure. CMU is a concrete-based product. It, along with the mortar, will shrink over time due to initial drying, temperature fluctuations, and carbonation. Not only will shrinkage movement need to be considered, but differential movement between the CMU

Table 5-3 Assembly 5 Effective R-value comparison chart. Insulation options may be referenced from Fig. 5-7

Insulation Option	Interior Insulation Depth	CMU Walls with Interior Spray Foam: Nominal Insulation R-Value		3D Thermal Modeling Effective R-Value (ft²·°F·hr/Btu)
1	2"	12 ci		15.2
2	2"	12 cavity		7.2
3	4"	24 ci		27.2
4	4"	12 cavity + 12 ci		23.4
5	4"	24 cavity		9.1
6	4"	24 cavity[1]		12.1

[1] with 1-inch air space between framing and CMU

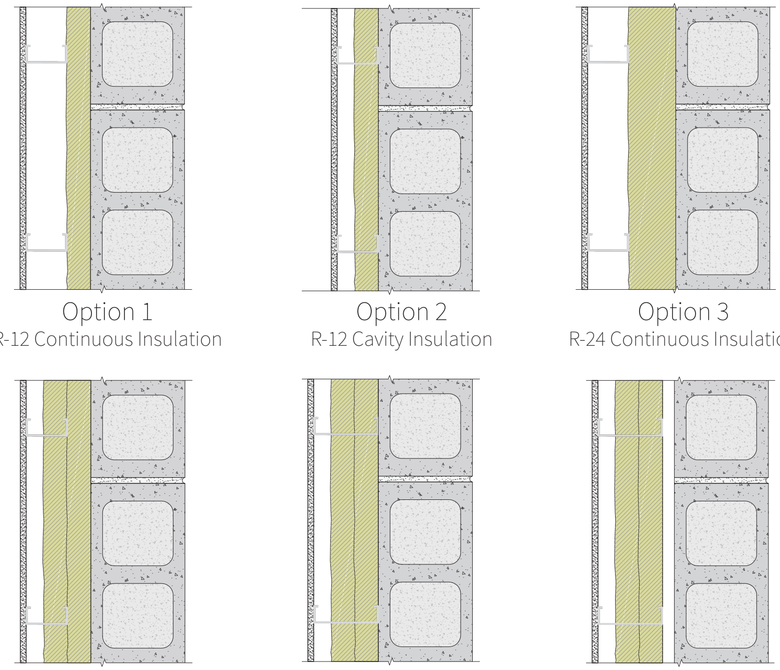


Fig. 5-7 Assembly 5 insulation options reflected in three-dimensional thermal modeling results shown in Table 5-3

structure and other structural elements, deflection, settlement, and various design loads will need to be addressed.

Crack control within the CMU should be considered to increase water-resistivity of this assembly. Material properties and reinforcing methods of the CMU structural wall should be implemented to reduce cracking; however, control joints within the CMU wall should be implemented to provide a plane of weakness to reduce shrinkage stresses and provide continuity of the WSS at these locations. Control joints in CMU can be constructed in a number of ways. Regardless of the method used, a continuous backer rod and sealant joint should be installed at the joint to assist with water shed and water penetration resistance.

Refer to the introductory chapter for more information on locating movement joints and sealant joint best practices.

Structural Considerations

The CMU block wall of this assembly provides the primary structure of this assembly. It is the responsibility of the Designer of Record to ensure that all structural elements are designed to meet project-specific loads and local governing building codes. Generic placement of the grouted and reinforced elements are demonstrated within the details of this chapter and are provided for diagrammatical purposes only.

CMU Wall

The CMU in this assembly should comply with ASTM C90. Mortar designed for the CMU should conform to ASTM C270 as well as ASTM C1714 when specifying preblended mortar. The mortar type selected should be appropriate for the CMU application; Type S is typically specified. Grout components should comply with ASTM C 476 while aggregate within the grout should comply with ASTM C 404.

Block and mortar should both be specified and provided with a water-repellent admixture as discussed in the Water Repellents section of this chapter and the introductory chapter. Refer to the Northwest Concrete Masonry Association for additional information on specifying block, mortar, and grout.

The CMU and mortar joints should be installed in conformance with industry standard best practices, manufacturer requirements, and guidelines outlined in the NWCMA Tek Note on Rain Resistant Architectural Concrete Masonry. Appropriate product selection and installation of CMU and mortar materials is necessary to provide a durable and water-resistive cladding system. The specifics of architectural characteristics and structural properties of the block, mortar, grout, and reinforcing should be designed and reviewed by a qualified Designer of Record. Various industry resources are available to assist with CMU wall design and are listed in the resources section at the back of this guide.

Corrosion Resistance

For sheet-metal flashings that are integrated within this assembly (including through-wall flashings and sheet-metal drip flashings), it is best practice to provide components that are manufactured of ASTM A167 Type 304 or 316 stainless steel, which is nonstaining and resistant to the alkaline content of mortar and grout materials.

Whereas the use of stainless steel sheet-metal flashing components is not always economically feasible or aesthetically desireable, prefinishing sheet-metal may be considered. Where used, the base sheet metal should receive a minimum G90 hot-dipped galvanized coating in conformance with ASTM A653 or minimum AZ50 galvalume coating in conformance with ASTM A792. The exposed top finish of the sheet metal is recommended to have an architectural-grade coating conforming to AAMA 2605.

Water Repellents

Both integral water-repellent admixtures and a surface-applied clear water repellent are included with this assembly and assist with reducing the water absorption of the CMU wall and encourage watershed. Water-repellent admixtures should be used both in the CMU and mortar. Admixture within block units should comply with NCMA TEK 19-7 while mortar admixture should comply with ASTM C1384. More discussion on surface-applied clear water repellents is provided in the introductory chapter.

Both CMU and mortar admixtures as well as surface-applied water repellent should have known compatibility performance.

Pricing Analysis

A pricing analysis for this assembly is provided on Table 5-4 on page 5-15. Pricing demonstrates the relative price per square foot and is based on a 10,000-square-foot wall area with easy drive-up access. Pricing provided does not include interior finishes or steel framing components.

Pricing is valued for the 2015–2016 calendar year. Current pricing is also available at www.masonrysystemsguide.com.

Online Availability

The content of this guide and additional resources may be accessed online at www.masonrysystemsguide.com. Also available online are downloadable versions of two- and three-dimensional assembly details and cutaway sections as well as sample project specifications. Ongoing updates to references and resources included within this guide can also be accessed.

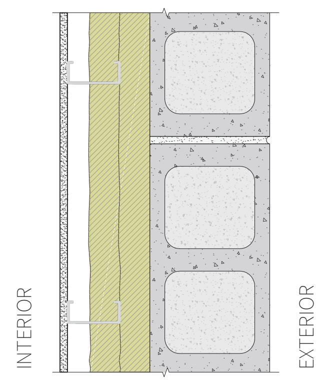
Table 5-4 Assembly 5 CMU wall with interior insulation pricing analysis

Assembly 5: CMU Wall with Interior Insulation					
	Assembly Component	Baseline Product	Alternate (call for estimate)	Baseline Cost/ft^2 (incl. labor)	
				Low	High
INTERIOR					
1	Interior gypsum board	No evaluation of these components provided.			
2	Steel framing				
3*	Closed-cell spray foam insulation between studs	2-lb density closed-cell spray polyurethane foam, 2" thickness	No specified alternate	$4.00	$4.00
4*	Continuous closed-cell spray polyurethane foam insulation	2-lb density closed-cell spray polyurethane foam, 2" thickness	No specified alternate	$4.00	$4.00
5*	Single-wythe cmu wall	8"x8"x16" standard block, fully grouted with standard code-required rebar	No specified alternate	$18.00	$24.00
6*	Clear water repellent	Silane/siloxane blend	Antigraffiti clear water repellent	$1.75	$2.25
EXTERIOR					
Total cost to install 10,000 sq ft wall area w/easy drive-up access -->				$27.75	$34.25

Pricing Analysis Discussion

- Low and high baseline costs are based on the baseline products listed. Call for an estimate for alternate product pricing.
- Baseline costs provided will vary based on product specifics and should be used as an estimate only.
- Block unit prices are for typical units as noted. Pricing can vary based on size, color, and finish and should be confirmed with the unit manufacturer.
- *See the Resources section of this guide for a list of resources related to this component.

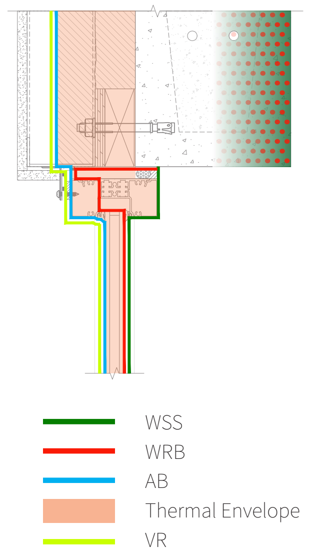
Assembly Plan View

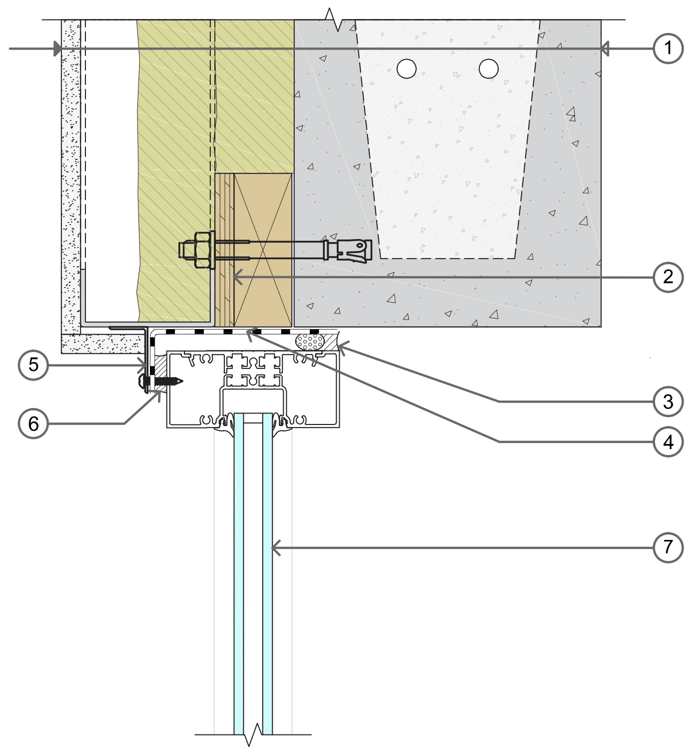


LEGEND

1. Typical Assembly:
   - Interior gypsum board
   - Steel-framed wall
   - Closed-cell spray foam insulation between studs (CCSPF)
   - 2 inches continuous closed-cell spray foam insulation (CCSPF)
   - Single-wythe CMU wall with water-repellent admixture
   - Clear water-repellent
2. Preservative treated blocking and plywood
3. Sealant over backer rod
4. Fluid-applied AB/WRB flashing membrane
5. Continuous back dam angle at rough opening perimeter, minimum 1 inch tall. Fasten window through back dam angle per window manufacturer recommendations.
6. Continuous AB sealant, tie to continuous seal at window perimeter
7. Storefront window

Critical Barriers





Detail Discussion

- A sheet-metal flashing as shown in Chapter 4 Fig. 4-6 on page 4-13 may also be considered.
- AB continuity is provided by the CCSPF, by fluid-applied flashing membrane at the rough opening, and by AB sealant transition to the storefront.
- WRB continuity is provided at the CMU face, fluid-applied flashing membrane at the rough opening, and at the AB sealant transition to the storefront.
- Preservative-treated blocking and plywood provide a low thermal conductivity structural support for the window perimeter and a suitable substrate for the fluid-applied flashing membrane application.

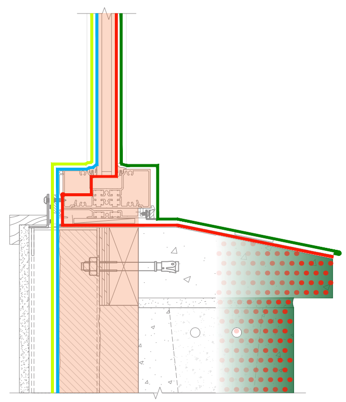
Storefront Window Head

Detail 5-A

LEGEND

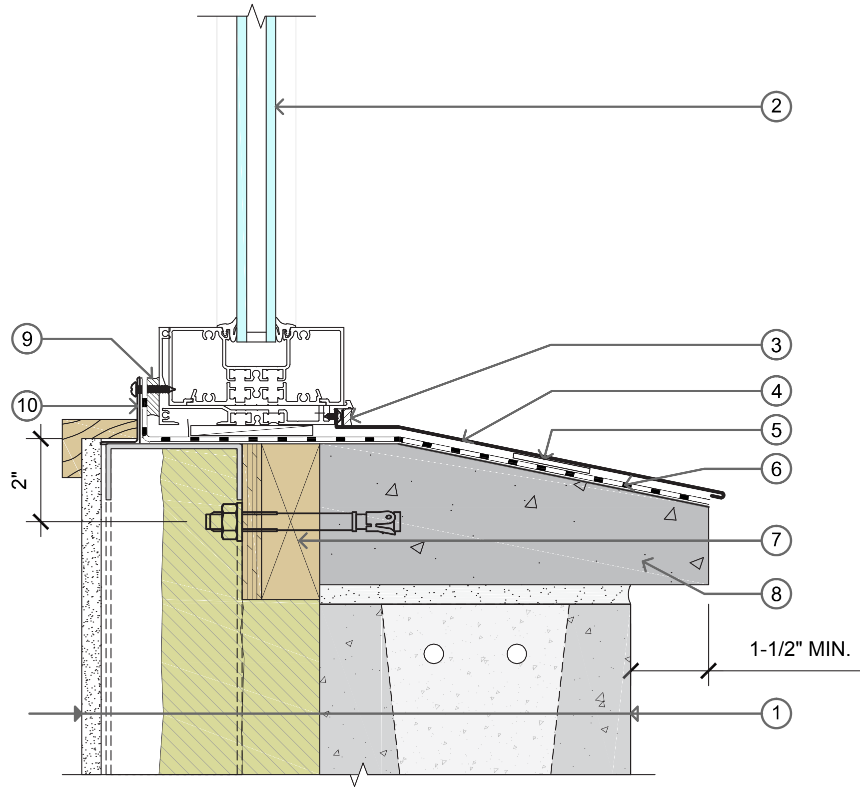
1. Typical Assembly:
   - Interior gypsum board
   - Steel-framed wall
   - Closed-cell spray foam insulation between studs (CCSPF)
   - 2 inches continuous closed-cell spray foam insulation (CCSPF)
   - Single-wythe CMU wall with water-repellent admixture
   - Clear water-repellent
2. Storefront window on minimum 1/4-inch intermittent shims
3. Sealant over bond breaker tape
4. Sheet-metal sill flashing with 1/2-inch hemmed drip edge
5. Drainage mesh or minimum 1/4-inch intermittent shims
6. Fluid-applied AB/WRB flashing membrane
7. Preservative-treated blocking and plywood
8. Sloped precast concrete sill
9. Continuous AB sealant, tie to continuous seal at window perimeter
10. Continuous back dam angle at rough opening perimeter, minimum 1 inch tall. Fasten window through back dam angle per window manufacturer recommendations.

Critical Barriers



Detail Discussion

- AB continuity is provided by the CCSPF, fluid-applied flashing membrane at the rough opening, and AB sealant transition to the storefront.
- Intermittent shims below the storefront window and sheet-metal sill flashing encourage drainage of the window rough opening to the exterior environment.
- The sheet-metal sill flashing promotes watershed at the sill area and protects the fluid-applied AB/WRB flashing from UV exposure. The projected precast sill also promotes watershed away from the wall face.
- Anchor locations for rough opening preservative-treated blocking should be confirmed with the project's structural engineer.



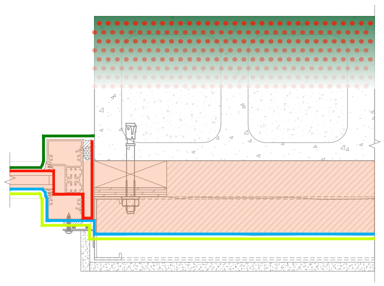
Precast Window Sill

Detail 5-B

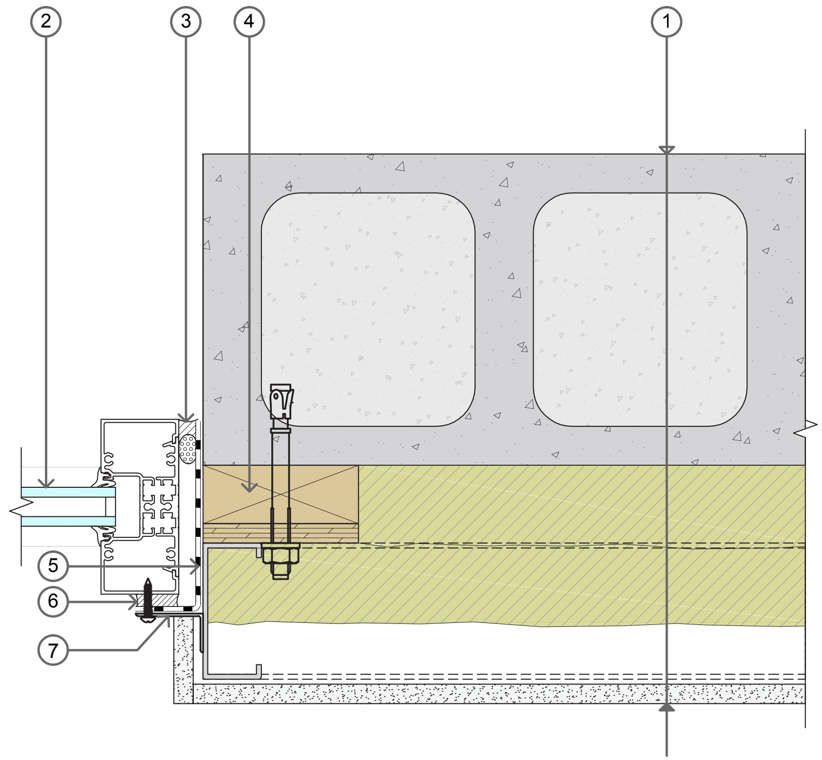
LEGEND

1. Typical Assembly:
   - Interior gypsum board
   - Steel-framed wall
   - Closed-cell spray foam insulation between studs (CCSPF)
   - 2 inches continuous closed-cell spray foam insulation (CCSPF)
   - Single-wythe CMU wall with water-repellent admixture
   - Clear water-repellent
2. Storefront window
3. Sealant over backer rod
4. Preservative-treated blocking and plywood
5. Fluid-applied AB/WRB flashing membrane
6. Continuous AB sealant, tie to continuous seal at window perimeter
7. Continuous back dam angle at rough opening perimeter, minimum 1 inch tall. Fasten window through back dam angle per window manufacturer recommendations.

Critical Barriers



- WSS
- WRB
- AB
- Thermal Envelope
- VR



Detail Discussion

- AB continuity is provided by the CCSPF, fluid-applied flashing membrane at the rough opening, and AB sealant transition to the storefront.
- The sealant and backer rod joint between the storefront window and CMU wall provides WSS layer continuity.
- The continuous back dam angle shown allows for perimeter attachment of the storefront window without the need for F-clips or similar anchors, which often inhibit the AB system critical barrier at the window perimeter. Attachment methods for the storefront window should be confirmed with the window manufacturer during the design phase of the project.

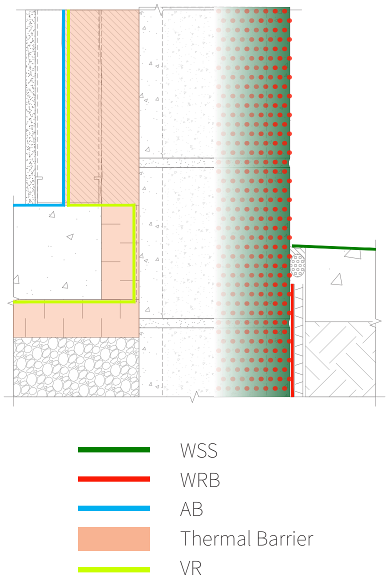
Storefront Window Jamb

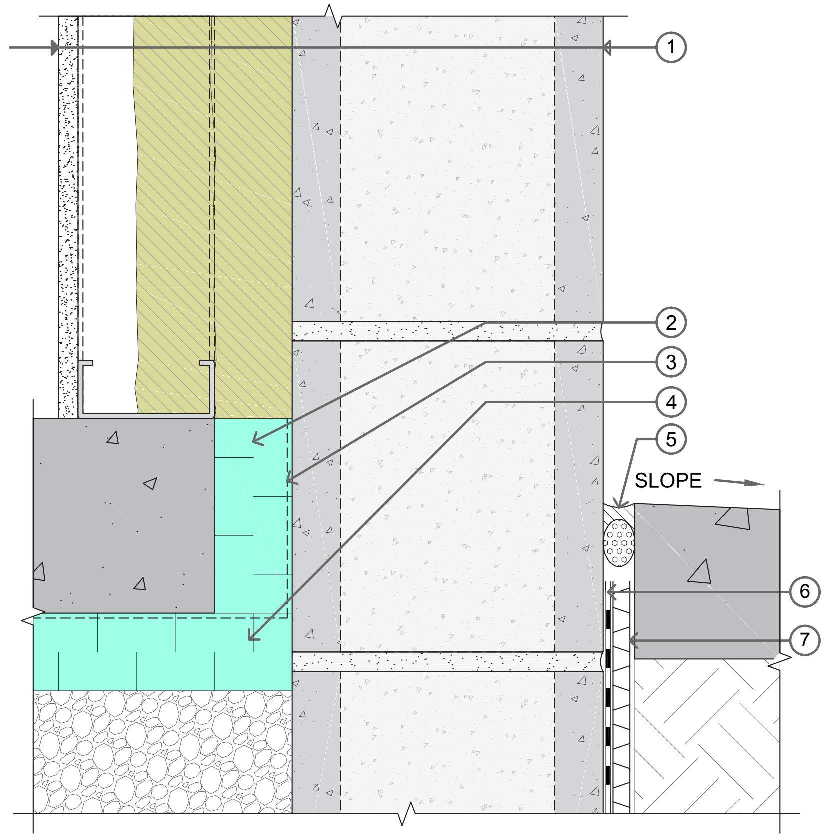
Detail 5-C

LEGEND

1. Typical Assembly:
   - Interior gypsum board
   - Steel-framed wall
   - Closed-cell spray foam insulation between studs (CCSPF)
   - 2 inches continuous closed-cell spray foam insulation (CCSPF)
   - Single-wythe CMU wall with water-repellent admixture
   - Clear water-repellent
2. Rigid XPS insulation thermal break
3. Underslab vapor barrier
4. Rigid XPS underslab insulation
5. Hardscape joint at sidewalk
6. Damp-proofing
7. Drainage composite or gravel backfill

Critical Barriers





Detail Discussion

- The XPS insulation between the concrete floor slab and concrete foundation wall acts as a thermal break. It reduces the amount of heat loss at the floor slab perimeter.

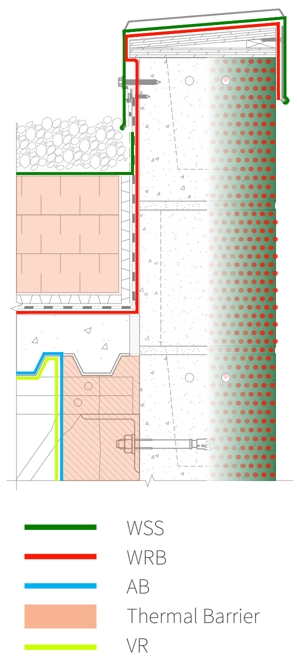
Typical Foundation

Detail 5-D

LEGEND

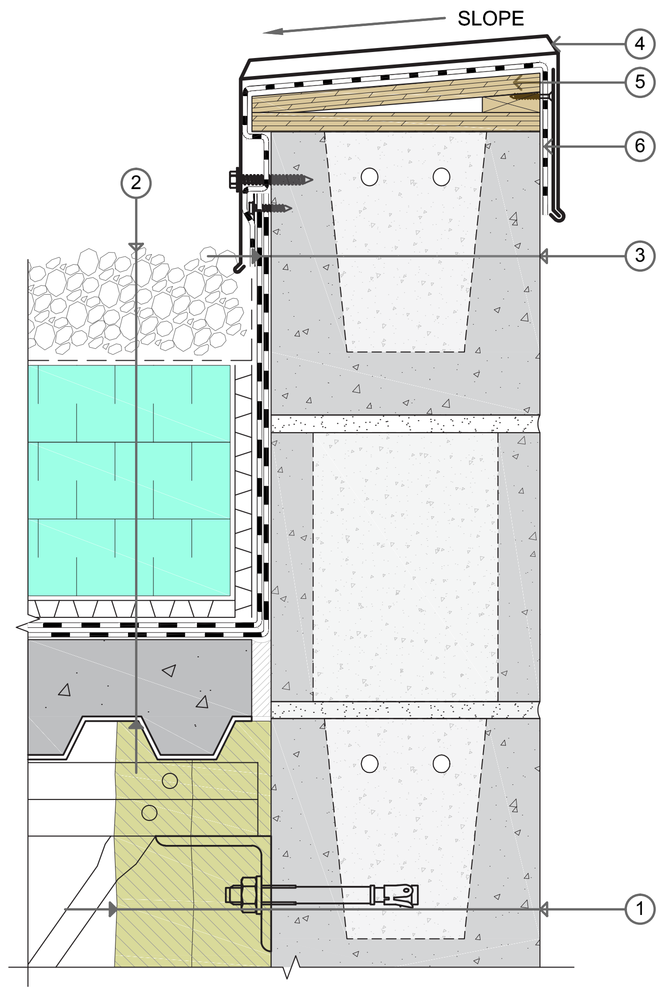
1. Typical Assembly:
   - Interior gypsum board
   - Steel-framed wall
   - Closed-cell spray foam insulation between studs (CCSPF)
   - 2 inches continuous closed-cell spray foam insulation (CCSPF)
   - Single-wythe CMU wall with water-repellent admixture
   - Clear water-repellent
2. Inverted roof membrane assembly
3. Parapet Assembly:
   - Inverted roof membrane
   - Single-wythe CMU wall with water-repellent admixture
   - Clear water repellent
4. Standing-seam sheet-metal coping with gasketed washer fasteners
5. Preservative-treated blocking
6. High-temperature self-adhered membrane

Critical Barriers



Detail Discussion

- The sheet-metal coping with hemmed drip edge protects the wall top and assists with shedding water away from the CMU wall face.
- The CCSPF extends tight up to the underside of the deck, around roof structure and anchor elements. This reduces the opportunity for warm moisture-laden interior air from contacting the deck and CMU wall where it's coldest.



Typical Parapet at Inverted Roof Membrane Assembly

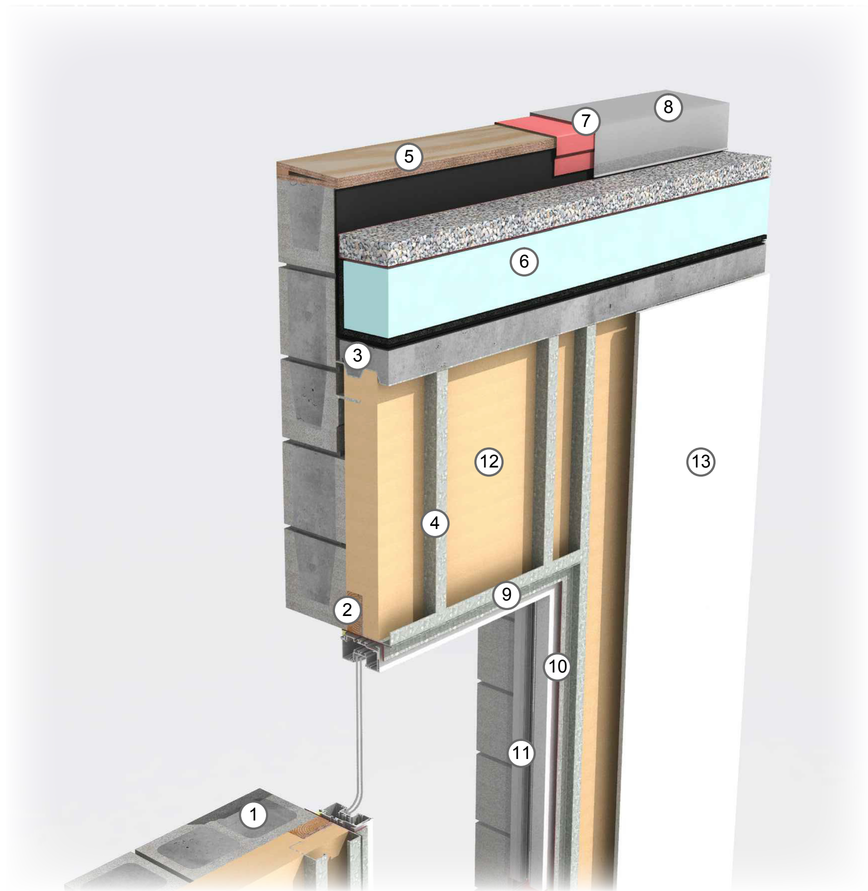
Detail 5-E

LEGEND

1. Single-wythe CMU wall with water-repellent admixture
2. Preservative-treated blocking and plywood anchored to CMU wall
3. Roof structure
4. Steel-framed wall
5. Preservative-treated blocking
6. Inverted roof membrane assembly
7. High-temperature self-adhered membrane
8. Standing-seam sheet-metal coping with gasketed washer fasteners
9. Continuous back dam angle at rough opening perimeter, minimum 1 inch tall. Fasten window through back dam angle per window manufacturer recommendations.
10. Continuous AB sealant. Tie to continuous seal at window perimeter.
11. Storefront window
12. CCSPF per assembly
13. Interior gypsum board

3-D Detail Discussion

- Three-dimensional cutaway sections on the next three pages represent two-dimensional details of this assembly.
- As shown in Detail 5-F, the preservative-treated blocking and plywood at the window rough opening provide a low thermal conductivity structural support for the window perimeter and also provide suitable substrate for the fluid-applied flashing membrane. The preservative-treated blocking and plywood is 2 inches deep to accommodate the minimum continuous CCSPF depth necessary to achieve a VR layer.
- As shown in Detail 5-F, the steel studs bridge the interior most 2 inches of CCSPF. The steel-stud framing may be moved inboard of the insulation entirely to eliminate thermal bridging and improve the assembly's thermal performance.
- Detail 5-H describes a typical rough opening with continuous back dam angle. The sill back dam angle creates a sill pan below the window; intermittent shims below the storefront window promote drainage at the sill and out through the sealant joint weeps.
- As shown in Detail 5-G, the XPS insulation between the concrete floor slab and concrete foundation wall acts as a thermal break and reduces the amount of heat loss at the floor slab perimeter. This detail allows continuous interior insulation from the wall to the floor slab.

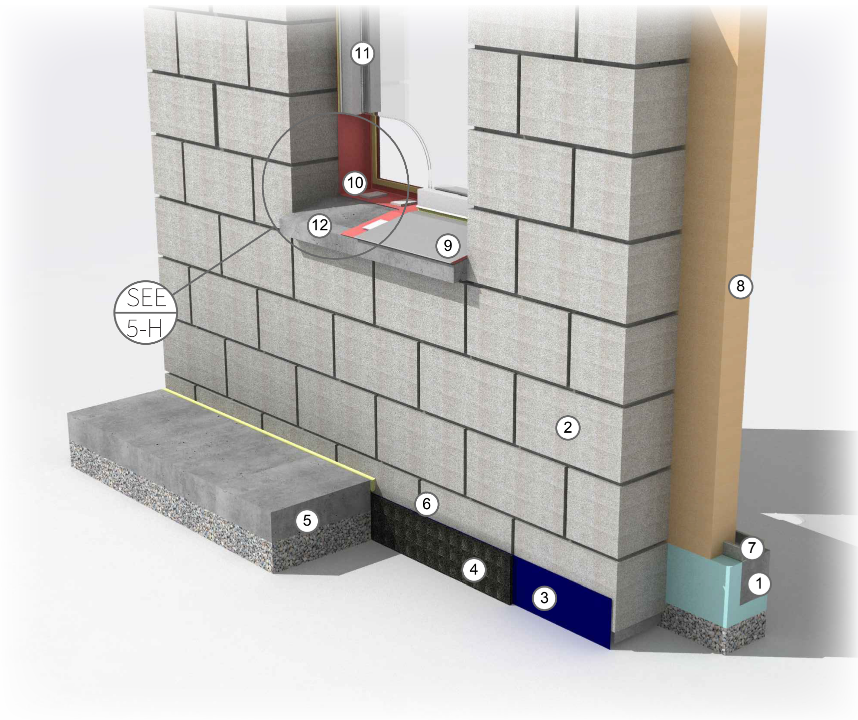


Parapet Assembly Section Cutaway (Interior)

Detail 5-F

LEGEND

1. Concrete floor slab
2. Single-wythe CMU wall with water-repellent admixture
3. Damp-proofing
4. Drainage composite or gravel backfill
5. Hardscape
6. Hardscape sealant joint between hardscape and CMU wall
7. Steel-framed wall
8. CCSPF insulation per assembly
9. Sheet metal flashing
10. Fluid-applied AB/WRB flashing membrane
11. Storefront Window
12. Sloped precast concrete sill

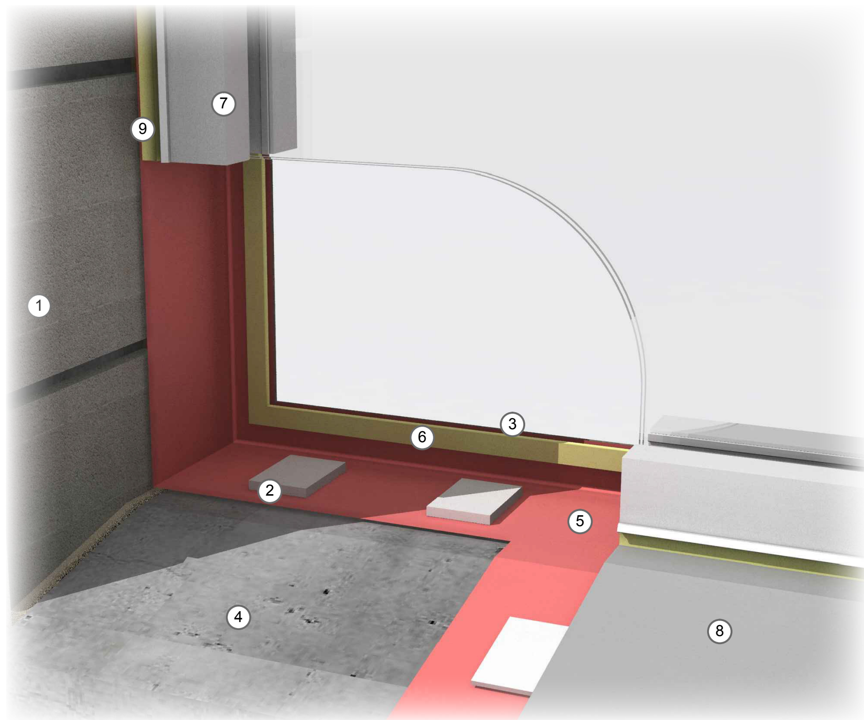


Base of Wall Cutaway Section

Detail 5-G

LEGEND

1. Single-wythe CMU wall with water-repellent admixture
2. Minimum 1/4 inch intermittent shims
3. Continuous back dam angle at rough opening perimeter, minimum 1 inch tall. Fasten window through back dam angle per window manufacturer recommendations.
4. Sloped precast concrete sill
5. Fluid-applied AB/WRB flashing membrane
6. Continuous AB sealant. Tie to continuous seal at window perimeter.
7. Storefront window
8. Sheet-metal sill flashing over drainage mesh or minimum 1/4-inch intermittent shims
9. Sealant over backer rod



Window Jamb and Sill Section Cutaway Section

Detail 5-H