

FLASHING MASONRY

Single and Multi-Wythe Assemblies

Presented by Philippe Ledent, PE, SE
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AGENDA

Single Wythe Masonry Walls

- Introduction
- Moisture Sources
- Three Levels of Defense
 - Surface Protection
 - Internal Protection
 - Drainage/Drying
- Details

Multi-Wythe Masonry Walls

- Introduction
- Common Issues
- Flashing Materials
- Details

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SINGLE WYTHE MASONRY WALLS

- TMS defines a *wall* as a member, usually vertical, used to enclose or separate spaces or uses.
- But what does an exterior wall really do?
 - It keeps the outside out and the inside in.
- Poll Question 1: Is flashing required for single wythe masonry assemblies?

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SINGLE WYTHE MASONRY WALLS

- Section 1404.4 of the *Michigan Building Code* requires that flashing and weeps are installed for masonry units used in anchored and adhered veneer.
- Although the *Building Code* does not require flashing or weeps for single wythe masonry assemblies, MIM does recommend its usage!
 - Note: Many large box stores do not include flashing for their single wythe assemblies. Flashing is also not required for solid grouted single-wythe walls.
- NCMA TEK 19-02B addresses *Design for Dry Single-Wythe Concrete Masonry Walls*.

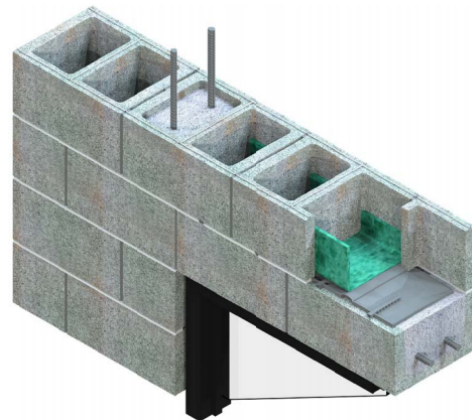
[BS] 1404.4 Masonry.

Exterior walls of masonry construction shall be designed and constructed in accordance with this section and Chapter 21. Masonry units, mortar and metal accessories used in anchored and adhered veneer shall meet the physical requirements of Chapter 21. The backing of anchored and adhered veneer shall be of concrete, masonry, steel framing or wood framing. Continuous insulation meeting the applicable requirements of this code shall be permitted between the backing and the masonry veneer.

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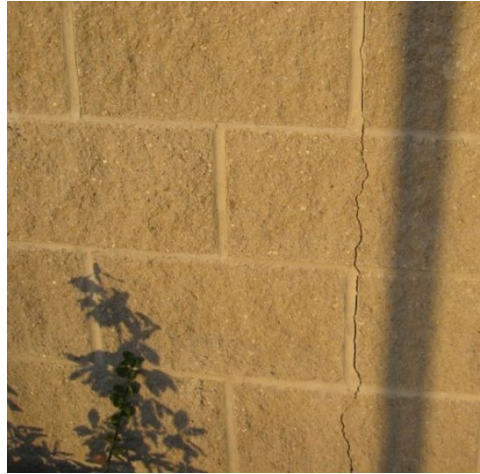
SINGLE WYTHE MASONRY WALLS

- Single wythe masonry walls are cost competitive because they provide structural form as well as an attractive and durable architectural façade.
- However, because they do not have a continuous drainage cavity (as do cavity and veneered walls), they require special attention to moisture penetration.
- The major objective in designing dry single wythe masonry walls is to keep water from entering or penetrating the wall.



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SINGLE WYTHE MASONRY WALLS

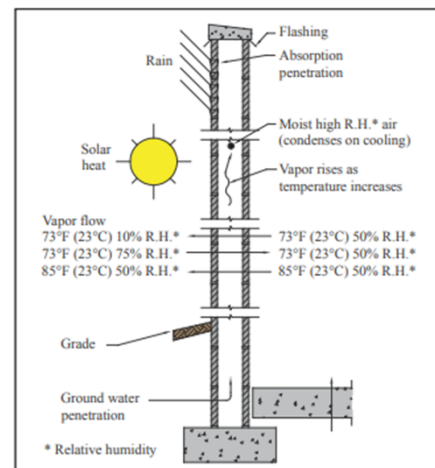


- The primary components of moisture mitigation in concrete masonry walls are:
 - Flashing and counter flashing
 - Weeps
 - Vents
 - Water repellent admixtures
 - Sealants
 - Post-applied surface treatments
 - Vapor retarders
 - Crack control measures

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SINGLE WYTHE MASONRY WALLS

- There are many sources of water/moisture in walls, including:
 - *Driving Rain:* Cracks are common points of water entry. The masonry unit-mortar interface can also be a susceptible location.
 - *Capillary Action:* Integral water repellents greatly reduce the absorption and adsorption characteristics of the units and mortar. Post-applied surface treatments reduce moisture penetration of masonry at the treated surface.
 - *Water Vapor:* DuPont will do free vapor analysis.
 - *Ground Water:* Below grade moisture tends to migrate from the damp soil to the drier area inside the basement. Watch out for landscaping!



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SINGLE WYTHER MASONRY WALLS



- When designing for moisture mitigation in walls, three levels of defense should be considered:
 - Surface protection (properly constructed mortar joints, surface water repellents, surface coatings)
 - Internal protection (integral water repellents)
 - Drainage/drying (flashing, weeps, vents)
- The most successful designs often provide redundancy among these three levels.

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SURFACE PROTECTION



1.1 This specification covers mortars for use in the construction of non-reinforced and reinforced unit masonry structures. Four types of mortar are covered in each of two alternative specifications: (1) proportion specifications and (2) property specifications.

ization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

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SURFACE PROTECTION

- Generally, MIM encourages designers to select the lowest strength mortar required for structural and durability considerations.

M a **S** o **N** w **O** r **K**
strongest weakest



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SURFACE PROTECTION

- Poll Question 2: What type of mortar is recommended for masonry veneers?

Location	Building Segment	Mortar Type	
		Recommended	Alternative
Exterior, above grade	Load-bearing wall	N	S or M
	Non-load bearing wall	O	N or S
	Parapet wall	N	S
Exterior, at or below grade	Foundation wall, retaining wall, manholes, sewers, pavements, walks, and patios	S	M or N
Interior	Load-bearing wall	N	S or M
	Non-bearing partitions	O	N
Interior or Exterior	Tuckpointing	See Appendix X3	See Appendix X3

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SURFACE PROTECTION



Portland Cement – Hydrated Lime

- a combination of cement and lime



Masonry Cement

- Proprietary product
- Contains Portland cement and fines, such as ground limestone
- Additives such as air entraining and water repellency agents.
- Simple batching and “fluffiness” due to entrained air leads to good productivity.
- Codes restrict use in high seismic areas.



Mortar Cement

- Proprietary product similar to masonry cement
- More stringent limitations on the amount of air
- Specified bond strength to a standard unit.
- Recognized by codes to be equivalent to PCL mortar.

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SURFACE PROTECTION

- ASTM C270 allows for mortars to be specified by the proportion specification or the property specification.
 - The Proportion Specification essentially gives a *recipe* for making mortar.
 - The Proportion Specification governs if neither is given.
 - The Property Specification is for laboratory made mortar, and not for field mortar.

Recommendation: Specify mix by proportions, even though it is default.

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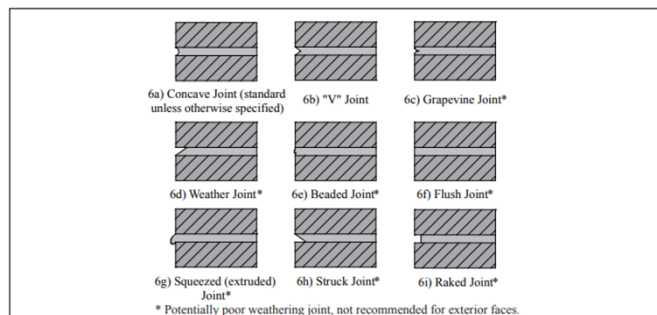
SURFACE PROTECTION

Mortar	Type	Proportion by Volume (Cementitious Materials)					Aggregate Ratio (measured in damp, loose conditions)
		Portland Cement	Masonry or Mortar Cement			Hydrated Lime or Lime Putty	
Portland- Cement Lime	M	1				$\frac{1}{4}$	2 $\frac{1}{4}$ to 3 times the sum of the separate volumes of cementitious materials
	S	1				$\frac{1}{4} - \frac{1}{2}$	
	N	1				$\frac{1}{2} - 1\frac{1}{4}$	
	O	1				$1\frac{1}{4} - 2\frac{1}{2}$	
Masonry or Mortar Cement	M	1			1		
	M		1				
	S	$\frac{1}{2}$			1		
	S			1			
	N				1		
	O				1		

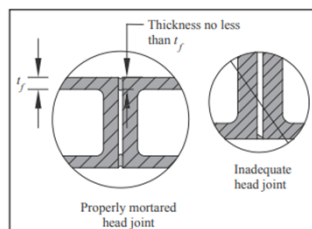
Proportion Specifications

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SURFACE PROTECTION



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- Concave or V-shaped joints are recommended for exterior uses.
- Raked, flush, struck, beaded, or extruded joints are not recommended for exterior uses.
- Mortar joints should be tooled when they are thumbprint hard.
- Head and bed joints should be the full thickness of the face shells. Head joints are particularly vulnerable to inadequate thickness.

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SURFACE PROTECTION

- MIM GWDC recommends that after cleaning; a compatible, breathable, field-applied water repellent is also field applied for single-wythe masonry wall assemblies.

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INTERNAL PROTECTION

- The physical characteristics of the units will affect permeability and moisture management.
- Open-textured concrete masonry units possessing large voids tend to be more permeable than closed-textured units.
- Architectural units and split-face units tend to be denser and less permeable.

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INTERNAL PROTECTION

- MIM and NCMA recommend that integral water repellents (IWRs) are incorporated into the concrete masonry units and the mortar.
 - Note: Ensure compatibility between the IWR in the mortar and the IWR in the block.
- IWRs have little impact on moisture entering through cracks and voids in the wall.
- When using IWRs, any water that does penetrate can not exit as easily.



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INTERNAL PROTECTION

- NCMA does not recommend using vapor barriers in most masonry wall assemblies unless there are specific humidity or moisture concerns. Vapor barriers and additional control layers can trap moisture in the wall assembly.
 - Note: The *Michigan Building Code* only requires vapor barriers for frame walls and not mass walls.

1405.3 Vapor retarders.

Vapor retarders as described in Section 1405.3.3 shall be provided in accordance with Sections 1405.3.1 and 1405.3.2, or an approved design using accepted engineering practice for hygrothermal analysis.

1405.3.1 Class I and II vapor retarders.

Class I and II vapor retarders shall not be provided on the interior side of frame walls in Zones 1 and 2. Class I vapor retarders shall not be provided on the interior side of frame walls in Zones 3 and 4. Class I or II vapor retarders shall be provided on the interior side of frame walls in Zones 5, 6, 7, 8 and Marine 4. The appropriate zone shall be selected in accordance with Chapter 3 [CE] of the *International Energy Conservation Code-Commercial Provisions*.

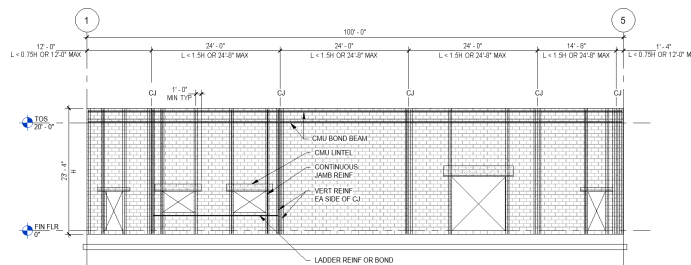
Exceptions:

1. Basement walls.
2. Below-grade portion of any wall.
3. Construction where moisture or its freezing will not damage the materials.
4. Conditions where Class III vapor retarders are required in Section 1405.3.2.

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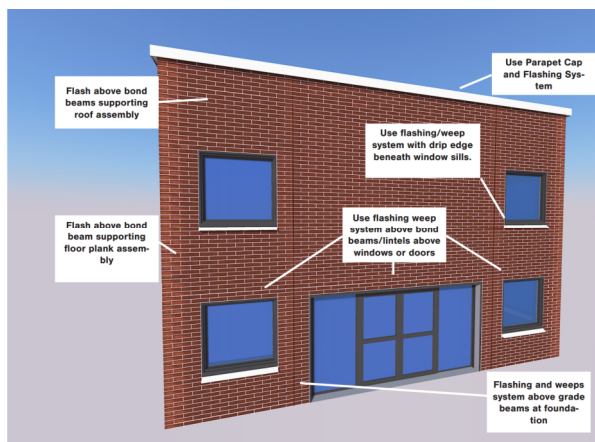
INTERNAL PROTECTION

- Since cracks have a large impact on the moisture resistance characteristics, special care should be taken to locate and detail movement joints in these walls and to include sufficient horizontal joint reinforcement.
- Note: MIM has a full presentation on movement control for concrete masonry and clay masonry veneers.



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DRAINAGE/DRYING



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- Flashing is typically installed above any interruption in the vertical drainage plane, including:

- Base
- Sill
- Head
- Top of wall
- Low roof/High wall

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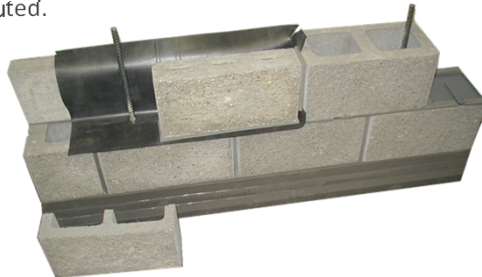
DRAINAGE/DRYING

- Flashings typically comprise a membrane, installed in a masonry wall system, which collects water that has penetrated and facilitates its drainage back to the exterior.
 - Remember: Keep the outside out!
- For single-wythe assemblies, the two most common types of flashing are membrane and pan flashing. MIM GWDC recommends pan flashing.
 - Note: Where it is necessary to retain some shear and flexural resistance capabilities, the best option is to use a flashing product that maintains some bond in both face shells.
 - Note: Ensuring that a buildup of mortar droppings does not clod the cells or weep holes is critical.

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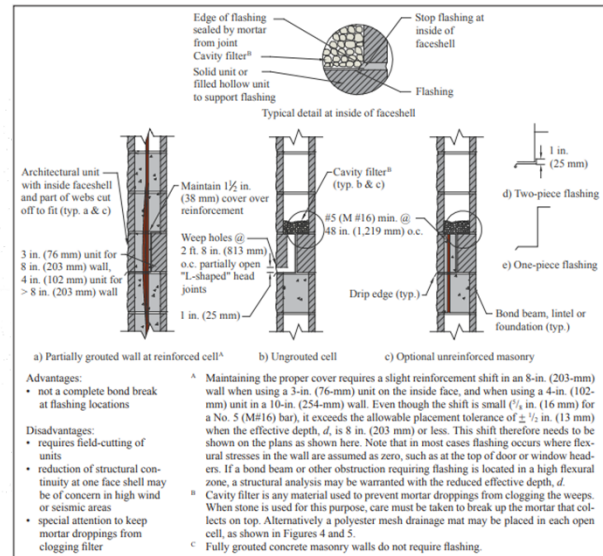
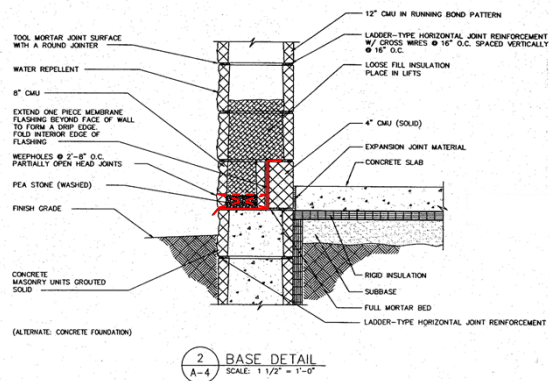
DRAINAGE/DRYING

- When using membrane flashings, one option to maintain structural capacity is to terminate the flashing within the face shell of the wall.
 - Note: In reinforced walls, some shear is provided through doweling and the reinforcement takes all tension. Proper grouting effectively seals around where the reinforcement penetrates the flashing.
 - Note: In URM, a short dowel can be provided through the flashing with cells above and below grouted.



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DRAINAGE/DRYING



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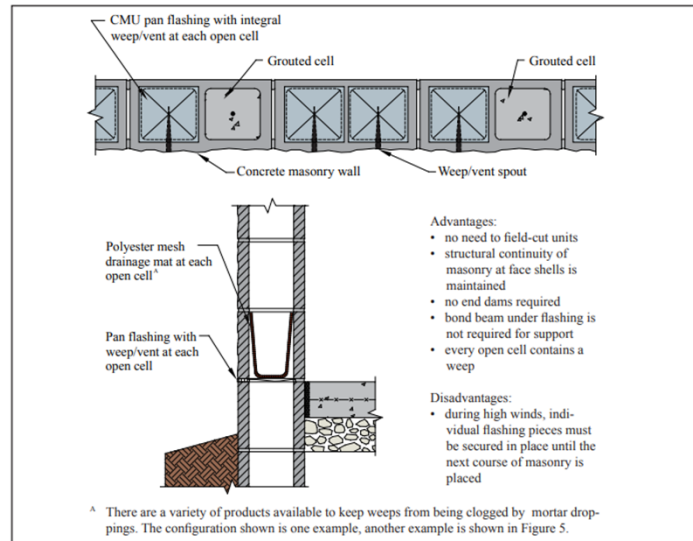
DRAINAGE/DRYING

Pan flashing systems are available, and **recommended**, that direct water away from the inside face of the wall to weep holes without compromising the bond at mortar joints in face shells.

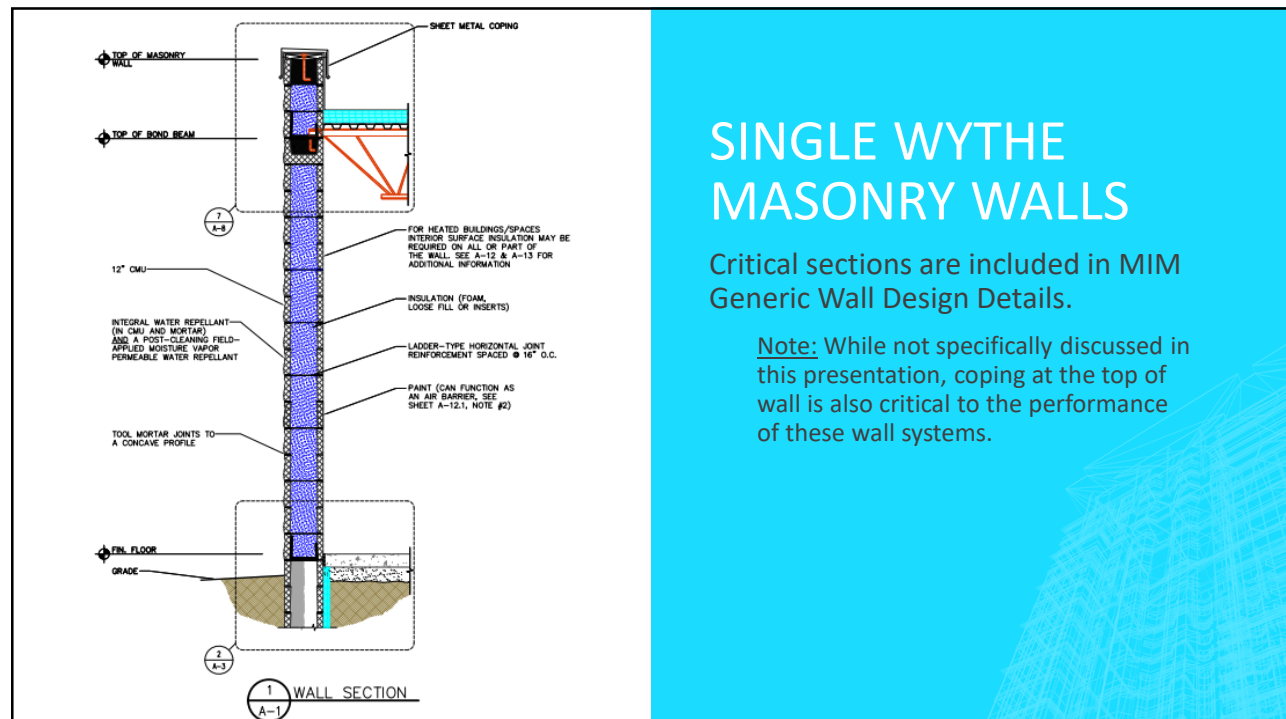


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DRAINAGE/DRYING



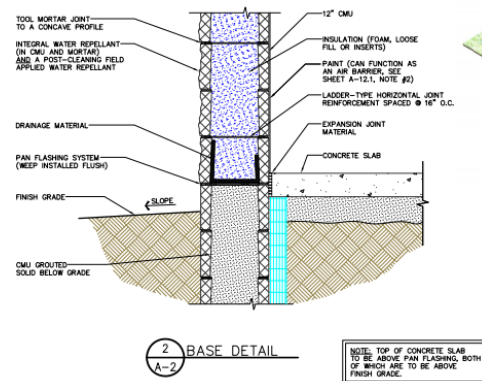
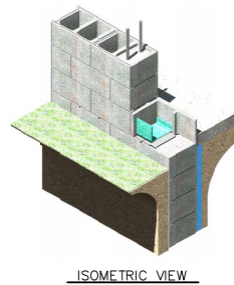
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SINGLE WYTHE MASONRY WALLS

MIM does recommend that the flashing location is below the top of slab (finish floor) and above the finish grade to prevent moisture migration.

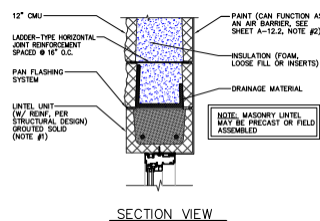
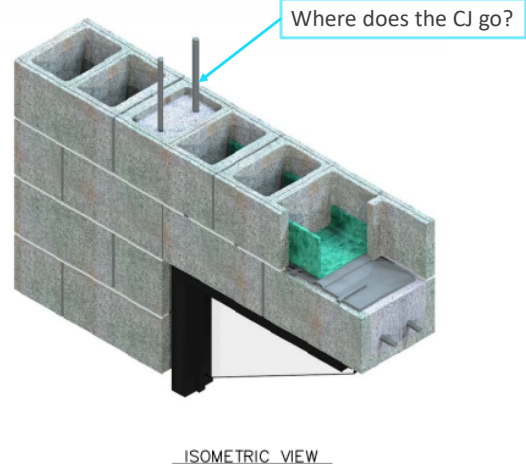


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SINGLE WYTHE MASONRY WALLS

MIM recommends using masonry lintels, although other lintel shapes are included in our GWDC details.

- Note: If you are using steel lintels, reach out to MIM and we will work with the engineer to use masonry lintels.



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SINGLE WYTHER MASONRY WALLS

Unprotected aluminum door and window frames can interact with cement-based materials and incur damage.

- PCA has more information on detailing specific to this condition, including leaving a 1/2" gap around the frame.

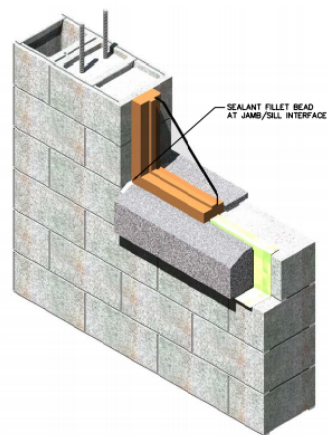


Protecting Aluminum Frames in Masonry Walls

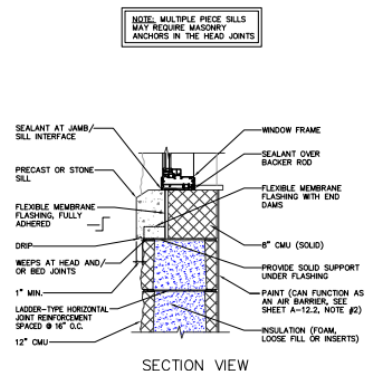
- Choose coatings for resistance to high pH.
 - Thicker coatings are generally better.
 - Organics are usually more resistant than non-organics (anodized coatings).
 - Temporary coatings (plastic film, paper, cloth, or petroleum jelly) can provide protection during construction.
- Place aluminum frames into walls after mortar has cured.
- Separate frame and masonry with a caulk gap.
- Remove fresh mortar from aluminum frames as quickly as possible.
- Direct water away from the wall with drips and flashings.

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SINGLE WYTHER MASONRY WALLS



ISOMETRIC VIEW

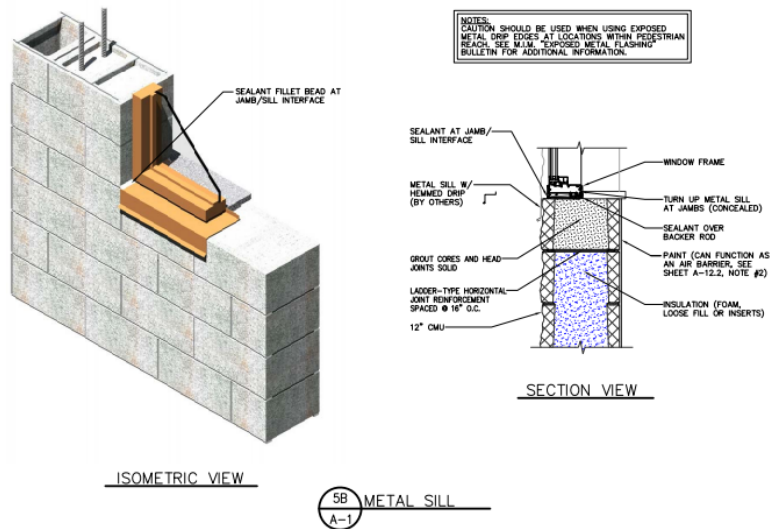


SECTION VIEW

5A PRECAST OR STONE SILL
A-1

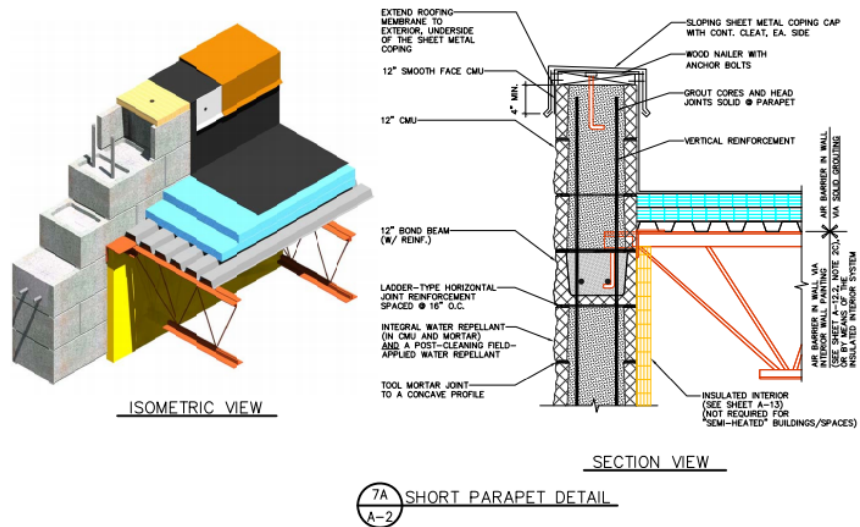
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SINGLE WYTHE MASONRY WALLS



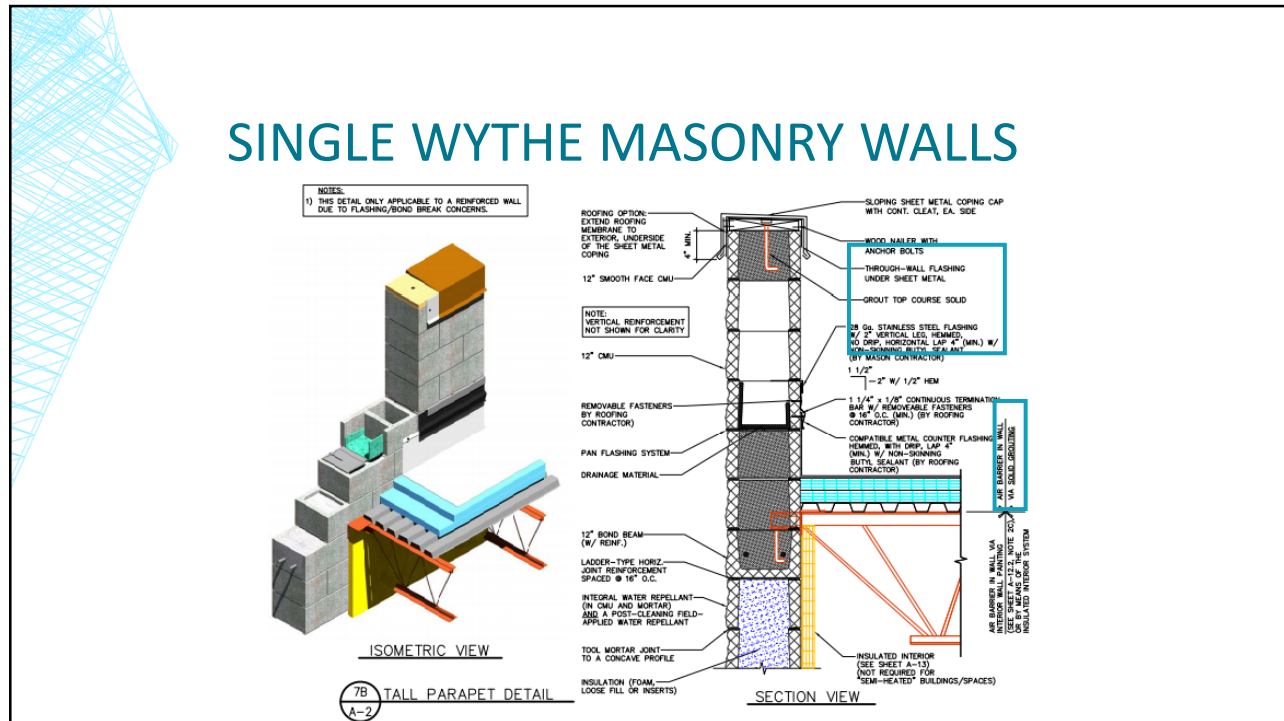
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SINGLE WYTHE MASONRY WALLS



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SINGLE WYTHE MASONRY WALLS



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SINGLE WYTHE MASONRY WALLS




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MULTI-WYTHE MASONRY WALLS

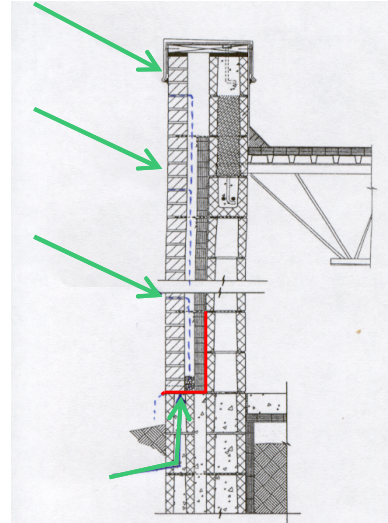


- When designing for moisture mitigation in cavity walls, two levels of defense should be considered:
 - Surface protection (properly constructed mortar joints)
 - Drainage/drying (flashing, weeps, vents)
- The most successful designs often provide redundancy among these levels.

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MULTI-WYTHER MASONRY WALLS

- Similar to single wythe masonry, flashing and weepholes are installed above any interruption in the vertical drainage plane, including:
 - Base
 - Sill
 - Head
 - Top of wall
 - Low roof/High wall
- If veneers are installed high enough that shelf angles are required, flashing is also installed at those locations.



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MULTI-WYTHER MASONRY WALLS

There are several reasons that flashing may ultimately fail, and we will discuss several of them:

- **Flashing that does not project from the face of the wall**



Reasons Flashing Fails, Norbert Krogstad, Magazine of Masonry Construction, November 1989

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MULTI-WYTHE MASONRY WALLS

There are several reasons that flashing may ultimately fail, and we will discuss several of them:

- **Top edge of the flashing is not sealed or covered**



Reasons Flashing Fails, Norbert Krogstad, Magazine of Masonry Construction, November 1989

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MULTI-WYTHE MASONRY WALLS

There are several reasons that flashing may ultimately fail, and we will discuss several of them:

- **Poor drainage**



Reasons Flashing Fails, Norbert Krogstad, Magazine of Masonry Construction, November 1989

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MULTI-WYTHE MASONRY WALLS

There are several reasons that flashing may ultimately fail, and we will discuss several of them:

- **Flashing stopped at corners**



Reasons Flashing Fails, Norbert Krogstad, Magazine of Masonry Construction, November 1989

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MULTI-WYTHE MASONRY WALLS

There are several reasons that flashing may ultimately fail, and we will discuss several of them:

- **No end dams where masonry meets other wall systems**



Reasons Flashing Fails, Norbert Krogstad, Magazine of Masonry Construction, November 1989

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MULTI-WYTHER MASONRY WALLS

There are several reasons that flashing may ultimately fail, and we will discuss several of them:

- **Improperly sealed flashing laps**



Reasons Flashing Fails, Norbert Krogstad, Magazine of Masonry Construction, November 1989

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MULTI-WYTHER MASONRY WALLS

- In order to select an appropriate flashing material, we first need to answer **What is the building's projected life?**



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MULTI-WYTHE MASONRY WALLS

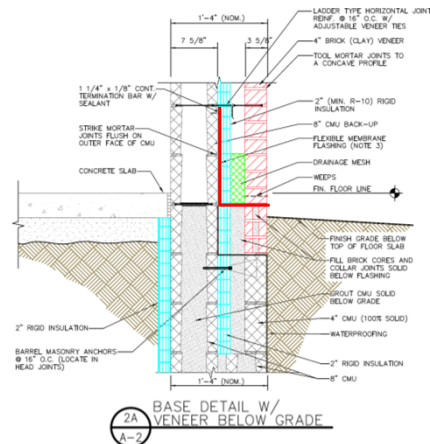
- Several flashing materials are summarized in MIM's Flashing Guide

Installed Thru-Wall Flashing Guide ^{1,7,8,9,10,12}												
Flashing Materials	Thickness or Weight	Exposure					Installation ⁵			Performance		
	minimum	UV resistance	require drip ³	water proof	corrosion resistance	staining masonry	ease of sealing laps	ease of field forming	self adhering ¹	air gap support required	expected building life	relative material and labor cost
Plastics and Rubbers												
Self-Adhered Rubberized Asphalt	40 mil	NA ¹¹	Y	H	H	Y ⁸	H	H	Y	Y	H	L
Ethylene Propylene Diene Monomer (EPDM)	40 mil	NA ¹¹	Y	H	H	N	M	M	N	Y	H	L
Composites												
Copper Laminate	3, 5, & 7 oz	NA ¹¹	Y	H	H	Y	M	H	N	Y	H	M/H
Self Adhered Stainless Steel Laminate	2 mil	NA ¹¹	Y	H	H	N	M	M	Y	Y	H	M/H
Stainless Steel Laminate	2 mil	Y	H	H	H	N	M	M	N	Y	H	M/H
Sheet Metals ⁶												
Stainless Steel Flashing	28 gauge	VH	Y	H	H	N	M	L	N	N	H	VH
Stainless Steel Drip	28 gauge	VH	Y	H	H	N	M	H	N	N	H	L
Not Recommended												
Polyvinyl Chloride (PVC), Copper Sheet Metal	1 Selection of a proper flashing material is of utmost importance because it is a critical element for the drainage system.											
Galvanized Steel, Aluminum	2 Hold fully adhered flashing back a minimum 3/4" from face of wall. Flush cutting not recommended for asphalt flashing.											
Lead	3 Substrates should be dry and clean for proper adhesion. Primers may be required. Confirm compatibility between flashing and sealants in the wall.											
4 For linear sections of sheet metal flashing consider the expansion and contraction at the laps												
5 For surfaced mounted applications consider a termination bar for positive attachment.												
6 If drooling occurs from asphalt flashing it may be desirable to remove and clean												
7 Use caution exposing sharp metal drip edges at all locations within pedestrian reach, including base of wall, first floor window sills, garden walls and site walls.												
8 All flashings based on per manufacturers installations guidelines, MIM details and MIM Exposed Metal Flashing Bulletin 2015												
9 A drainage space, flashing system and weep holes are required to remove moisture from behind the veneer												
10 The wall system must be designed and constructed to prevent water from entering the building.												
11 Although these materials perform well in regard to UV resistance, they are not intended to be exposed once installed due to exposed sharp edges and drool concerns.												
12 Verify material compatibility with the AVB system												
LEGEND: L-low, M-moderate, M/H-moderate/high, H-high, VH-very high, Y-yes, N-no NA-not applicable												

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MULTI-WYTHE MASONRY WALLS

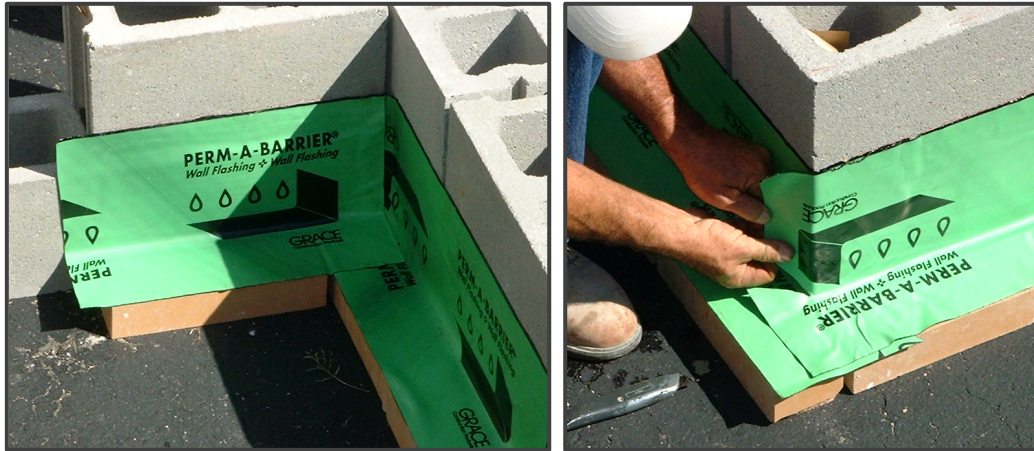
- MIM and the GWDC recommend using a termination bar to seal the top edge of the flashing material



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MULTI-WYTHE MASONRY WALLS

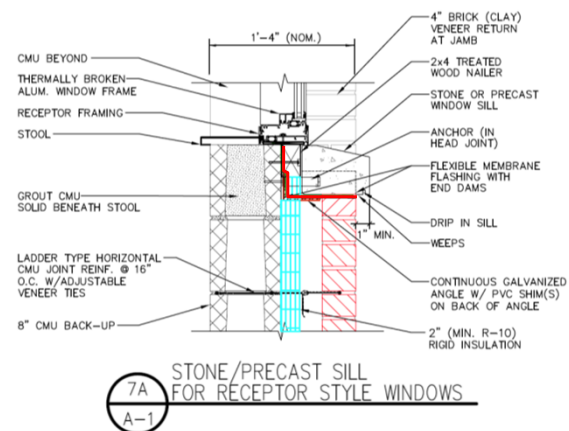
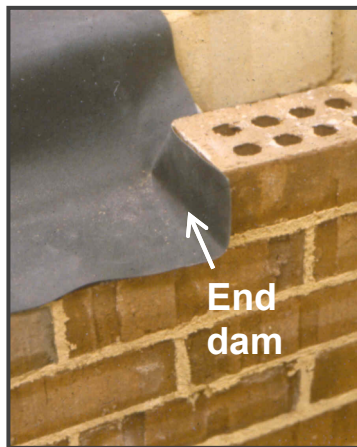
- Corners must be correctly installed and lapped for proper performance



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MULTI-WYTHE MASONRY WALLS

- End dams are required where masonry meets other wall systems

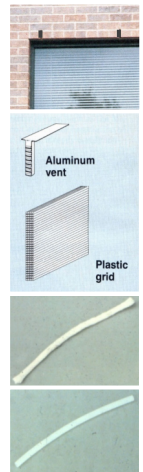


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The TMS 402 requires 33" o.c. maximum

MULTI-WYTHER MASONRY WALLS

- Weeps are installed at industry recommended spacings:
 - Open Head Joints (maximum 24" o.c.)
 - Vents/Grids (maximum 24" o.c.)
 - Oiled Roped *removed* (maximum 16" o.c.)
 - Wicks *100% cotton* (maximum 16" o.c.)
 - Plastic tubes **not recommended** (max 16" o.c.)
- What about vents?
 - From *Masonry Construction*, "I have heard people recommend using weep vents at the bottom and top of walls to help dry them out following a rain...The faster the walls dry out following rains, the less time available for salts and soluble compounds within the mortar to be carried to the surface...Although vents help dry walls following a rain, those near the top can also allow water to easily enter the walls during rains. Water penetrating the top vents can increase the potential for efflorescence and other moisture related problems. In this case, vents may do more harm than good. There are, however, creative ways of installing vents at the top of walls that protect them from rains..."



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MULTI-WYTHER MASONRY WALLS

Requiring exposed flashing

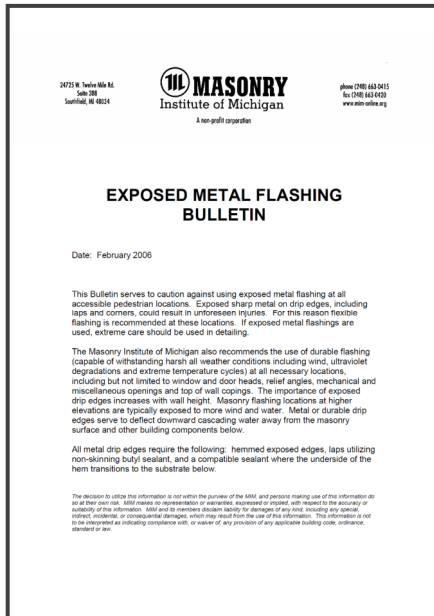
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1405.4.2 Masonry.

Flashing and weep holes in anchored veneer shall be located in the first course of masonry above finished ground level above the foundation wall or slab, and other points of support, including structural floors, shelf angles and lintels where anchored veneers are designed in accordance with Section 1405.6.

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MULTI-WYTHER MASONRY WALLS

MIM has issued a bulletin regarding the use of exposed metal flashing at accessible pedestrian locations and cautioning against it.

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MULTI-WYTHER MASONRY WALLS

Exposed metal flashings pose a potential risk to pedestrians with sharp edges.

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MULTI-WYTHER MASONRY WALLS

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MULTI-WYTHER MASONRY WALLS

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MULTI-WYTHE MASONRY WALLS

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MULTI-WYTHE MASONRY WALLS

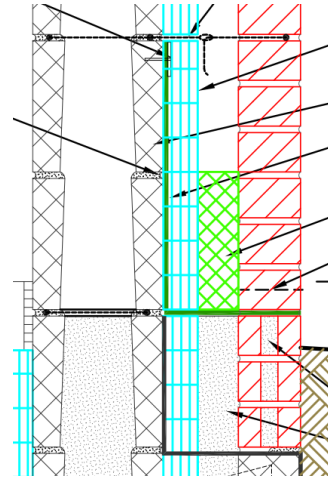
Exposed metal flashings pose a potential risk to pedestrians with sharp edges.

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MULTI-WYTHE MASONRY WALLS

MIM and the GWDC have a few options available for the **base detail only**:

1. **Cut flush (current)**
2. Exposed metal drop edge (45-degrees) (bulletin)
3. Non-exposed metal drip edge (180-degree hem) (new)
4. Hold membrane flashing back 1/2-inch (new)



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MULTI-WYTHE MASONRY WALLS

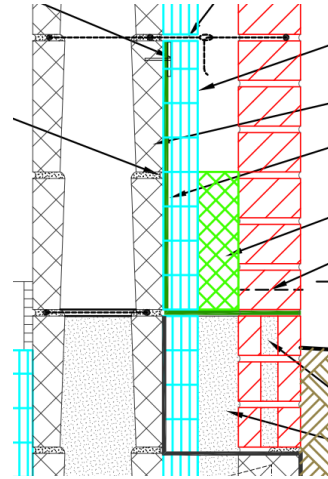


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MULTI-WYTHER MASONRY WALLS

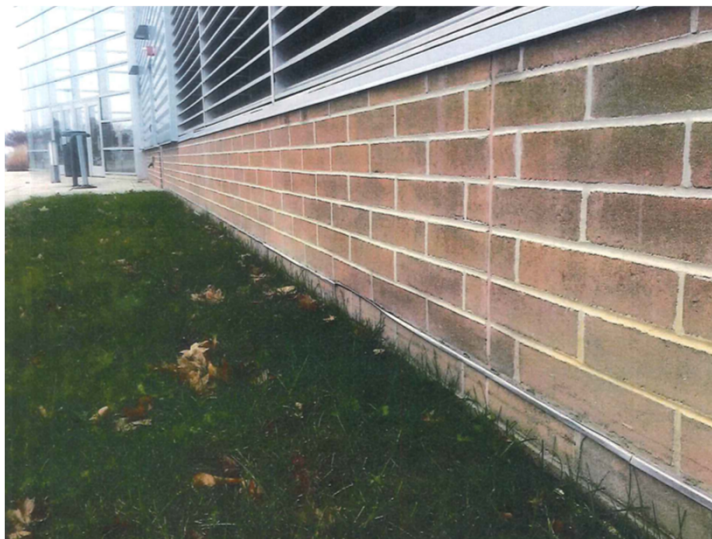
MIM and the GWDC have a few options available for the base detail only:

1. Cut flush (current)
2. Exposed metal drop edge (45-degrees) (bulletin)
3. Non-exposed metal drip edge (180-degree hem) (new)
4. Hold membrane flashing back 1/2-inch (new)



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MIM and the GWDC have a few options available for the base detail only:

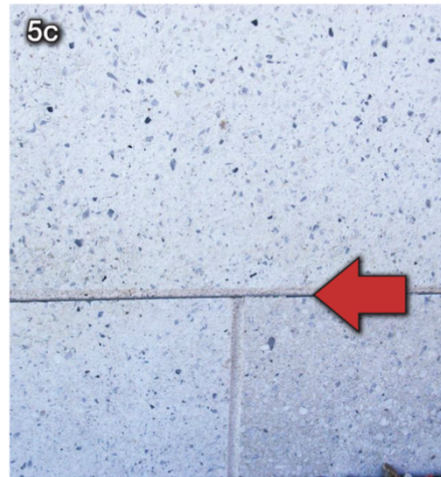
-
- Technical drawing of a wall cross-section. The wall is composed of several layers: a brickwork section on the left, a central core with a green cross-hatched section, and a brickwork section on the right. A blue vertical line indicates a specific layer or boundary. Arrows point to various components, and a scale bar is at the bottom.

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MULTI-WYTHER MASONRY WALLS



Aesthetics Versus Function, The Construction Specifier, April 2016

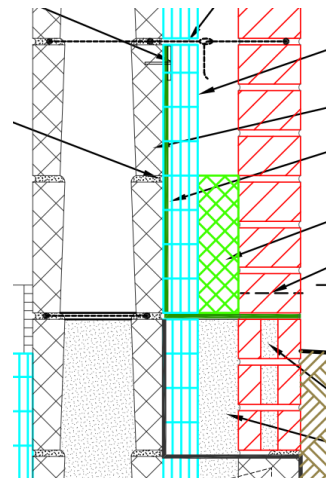


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MULTI-WYTHER MASONRY WALLS

MIM and the GWDC have a few options available for the base detail only:

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- If spray polyurethane foam is used in the cavity for air barrier/insulation requirements, dimensional stability needs to be considered.
 - Note: There is a published paper from A. Wagner and J. Peterson regarding this.

commonly occurring wall conditions. The responsibility for the detailing of exterior wall air and water barrier systems using SPF falls primarily to the designer of record. Their understanding of how to apply the manufacturer's standard details and recommendations for material compatibility to integrate the SPF system into the envelope is crucial for a properly performing building.

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FIG. 5 Self adhered membrane adhesion loss observed on a building mock-up following the installation of SPF.



In the short term, the development of typical details for the integration of SPF with flashings and critical details could be developed and provided as a standard guide. This would provide the design community a temporary solution for the use of spray foam in exterior wall assemblies until a more comprehensive set of design guidelines can be established. In order to ensure the integrity of the air, moisture, vapor barrier flashings and transitions to fenestrations will not be adversely affected, SPF should be detailed to minimize contact with materials that can be compromised by the inherent properties of the SPF. Simultaneously, these

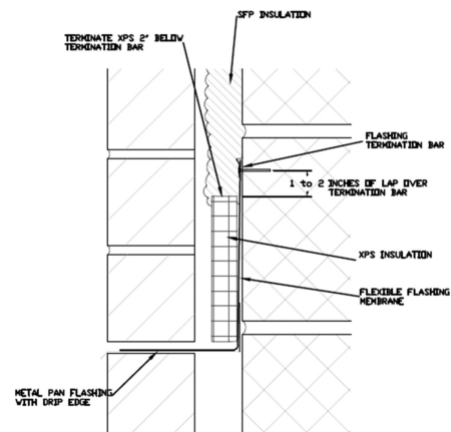
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FIG. 6 XPS used in conjunction with SPF to protect the self-adhered membrane.



FIG. 7 Sample detail of SPF integration with flexible flashing membranes using XPS to maintain a continuous thermal barrier and protect the flexible membrane from heat generated as part of the exothermic reaction of SPF.

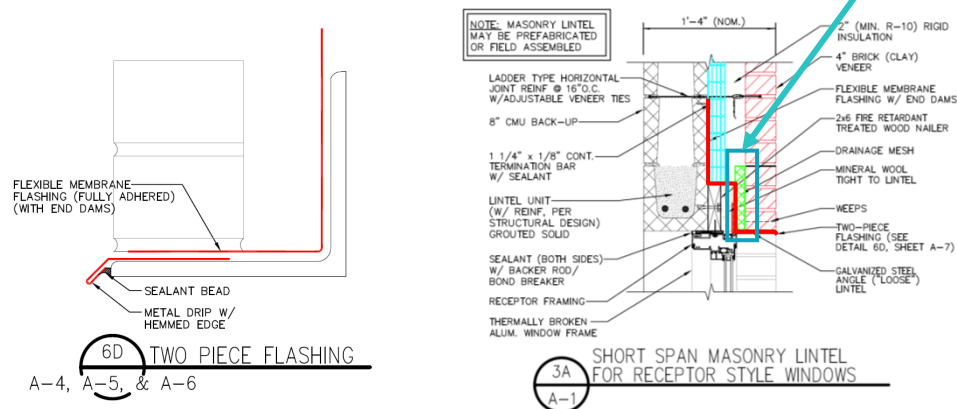


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Details are compliant with NFPA 285

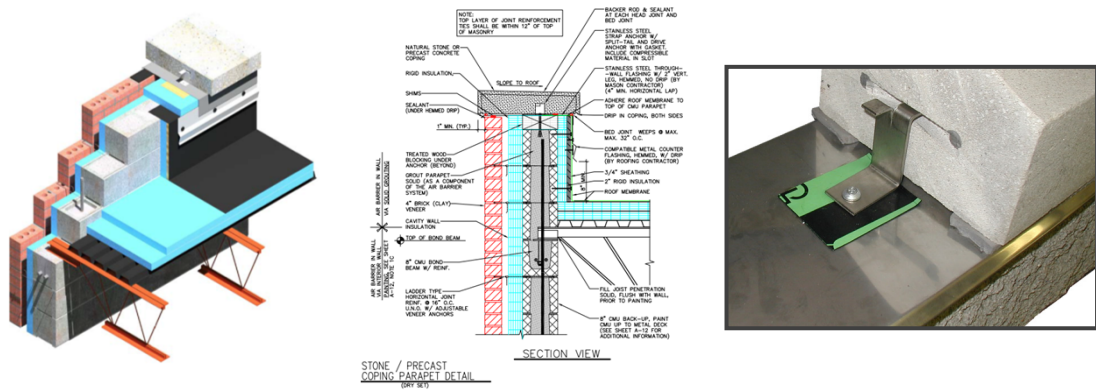
- MIM GWDC details have all of the conditions for head details included.



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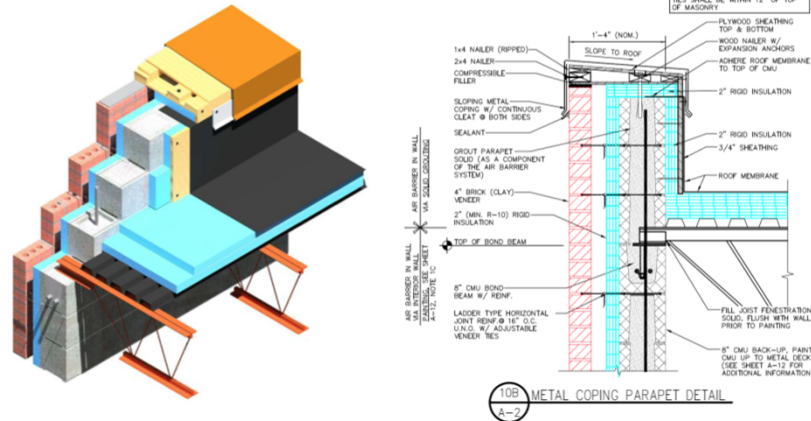
- Similar to single-wythe assemblies, the top of wall condition is also critical to wall performance.



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MULTI-WYTHER MASONRY WALLS

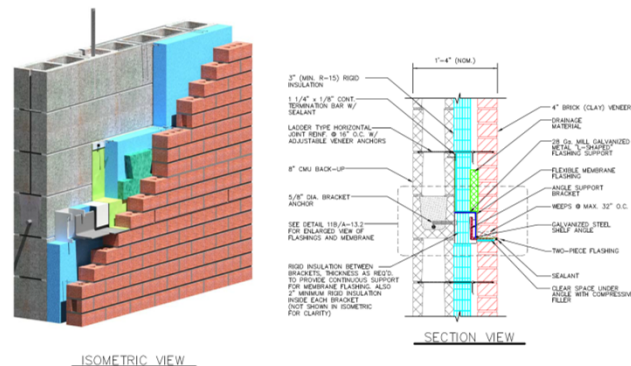
- Similar to single-wythe assemblies, the top of wall condition is also critical to wall performance.



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- The last condition we'll cover today is at a shelf angle supporting a veneer.



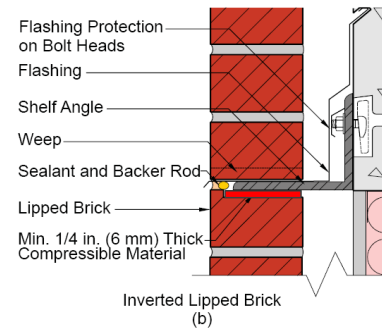
11A BRICK LEDGER DETAILS FOR CMU BACK-UP DETAIL
A-1

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MULTI-WYTHE MASONRY WALLS

Poll Question 3: What is the height limitation with a CMU backup?

- Under the prescriptive method of Chapter 12 of the TMS 402/602, it states the following:
 - For CFMF Backup (12.2.2.7) – If anchored veneer exceeds 30'-0" (or 38'-0") at the gable, the weight shall be supported by noncombustible construction at each story above 30'-0" in height
 - For wood backup (12.2.2.6.4) – Anchored veneer shall not exceed 30'-0" (or 38'-0") at the gable above the point of support.
 - For CMU backup there are no limitations on height!



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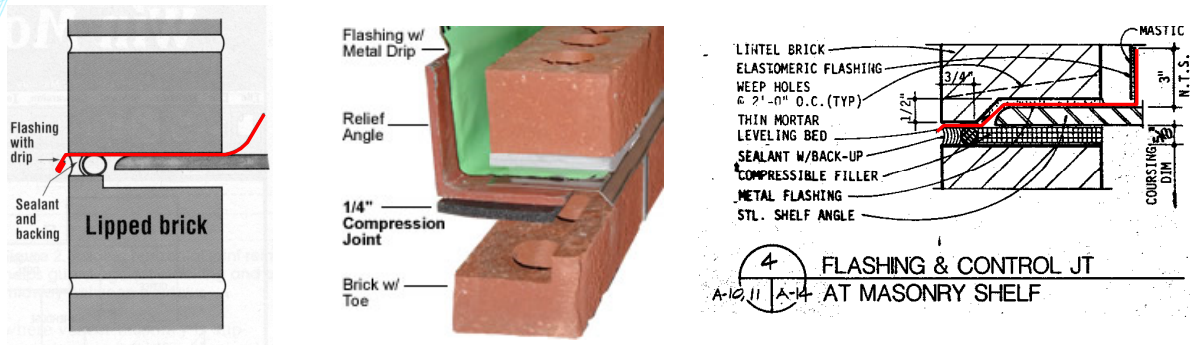
MULTI-WYTHE MASONRY WALLS

	Backing						
	Masonry		Concrete	Cold Formed Metal Framing	Wood Light Frame		
TMS 402-13	Wire	Adjustable or Joint Reinforcement	Adjustable	Adjustable	Corrugated Sheet Metal	Sheet Metal	Adjustable
Maximum Specified Cavity Width (in.)	4-1/2	4-1/2	4-1/2	4-1/2	1	4-1/2	4-1/2
Minimum Specified Air Space (in.)	1	1	1	1	1	1	1
TMS 402-16							
Maximum Specified Cavity Width (in.)	4-5/8	6-5/8	6-5/8	6-5/8	1	4-5/8	6-5/8
Minimum Specified Air Space (in.)	1	1	1	1	1	1	1
TMS 402-22¹							
Maximum Specified Cavity Width (in.)	6	6	6	6	1	4	6
Minimum Specified Drainage Space (in.)	1	1	1	1	1	1	1

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MULTI-WYTHE MASONRY WALLS

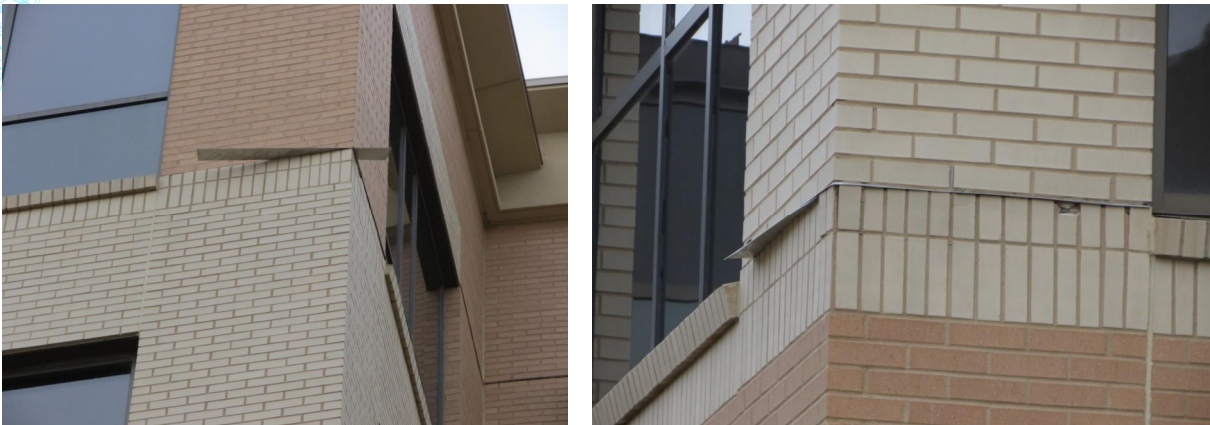
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MULTI-WYTHE MASONRY WALLS

The Mystery of the Wandering Drip Edge by *Masonry Magazine*



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MULTI-WYTHE MASONRY WALLS

The Mystery of the Wandering Drip Edge by *Masonry Magazine*



Self-adhering membrane flashing without backing paper removed



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QUESTIONS?

phil@masonryinfo.org
www.masonryinfo.org



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