

# Shelf Angles

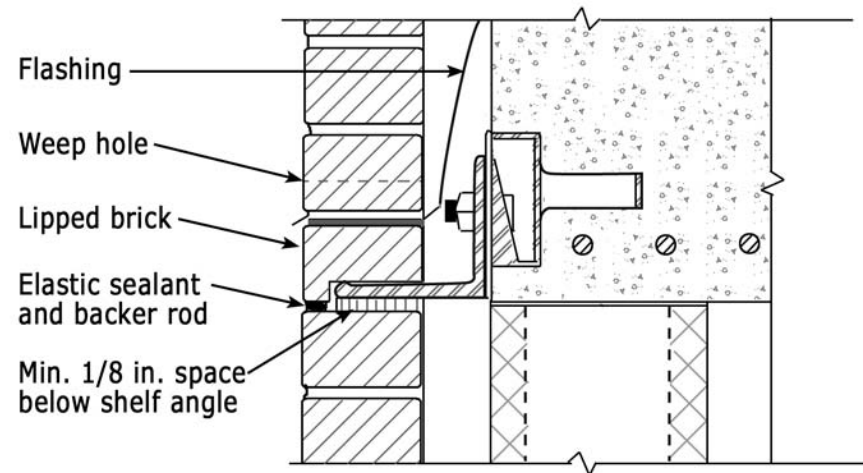
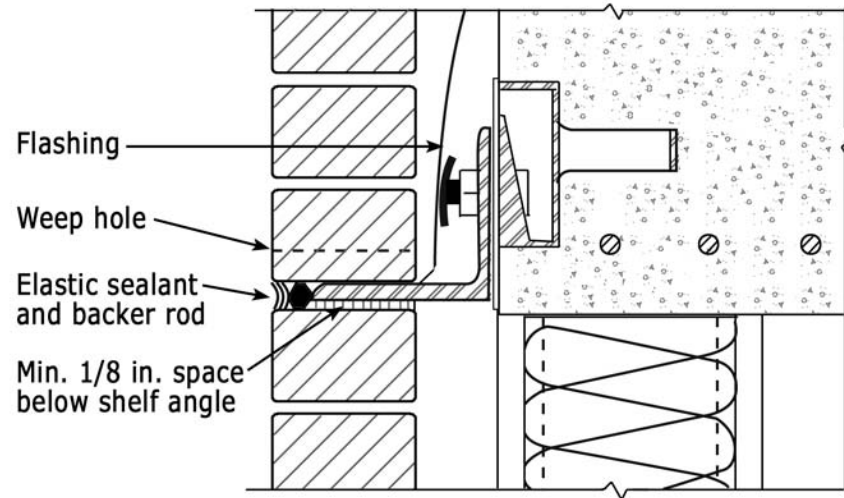


Image by MIT OCW.

# Flashing Single Wythe Walls

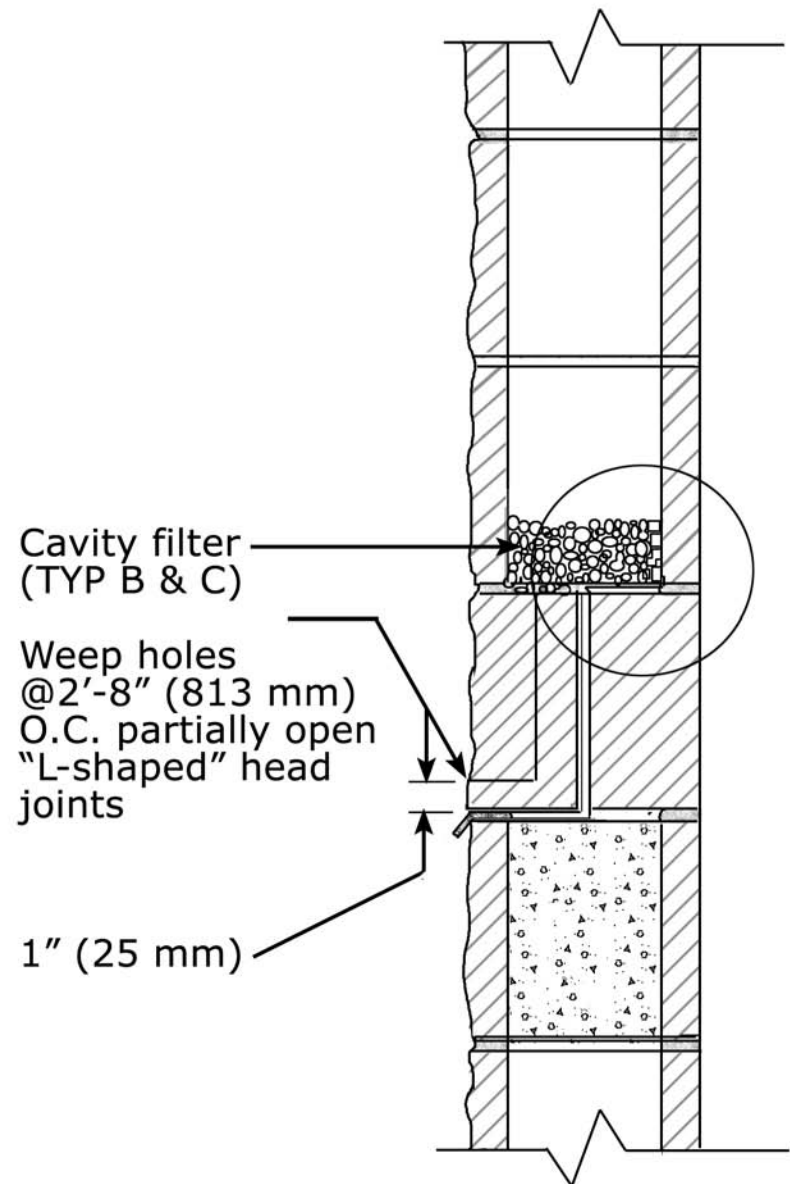


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# Flashing with Shear Transfer

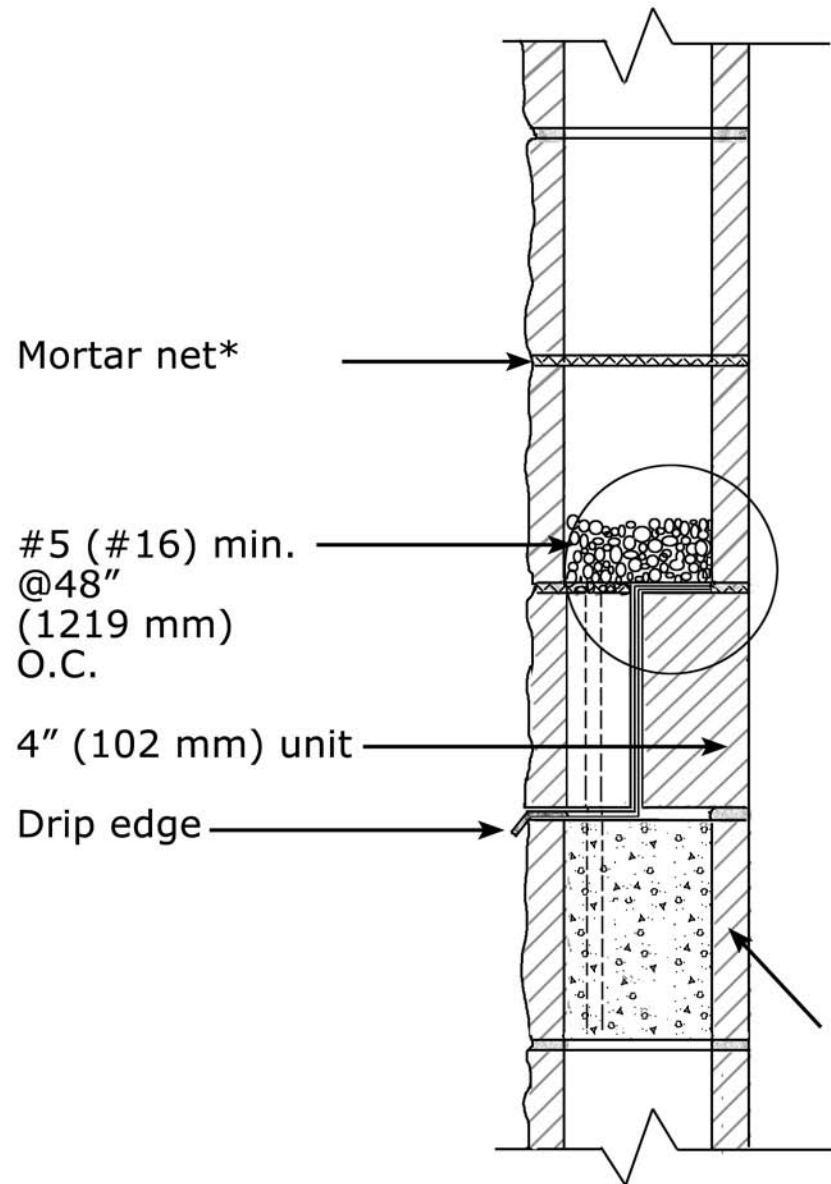
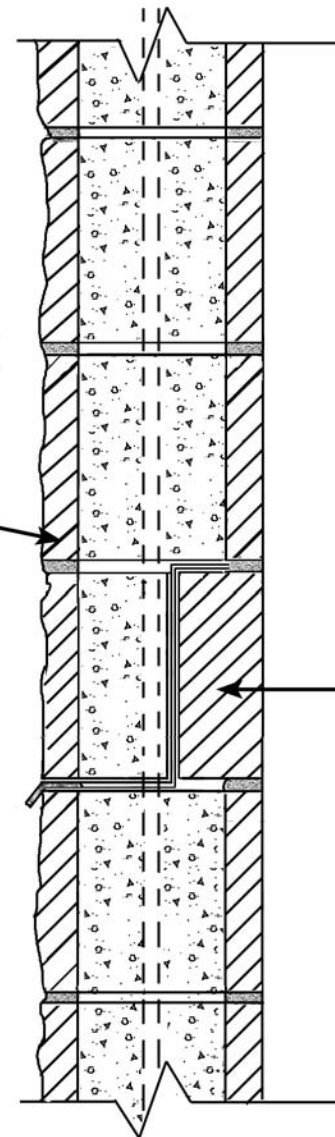


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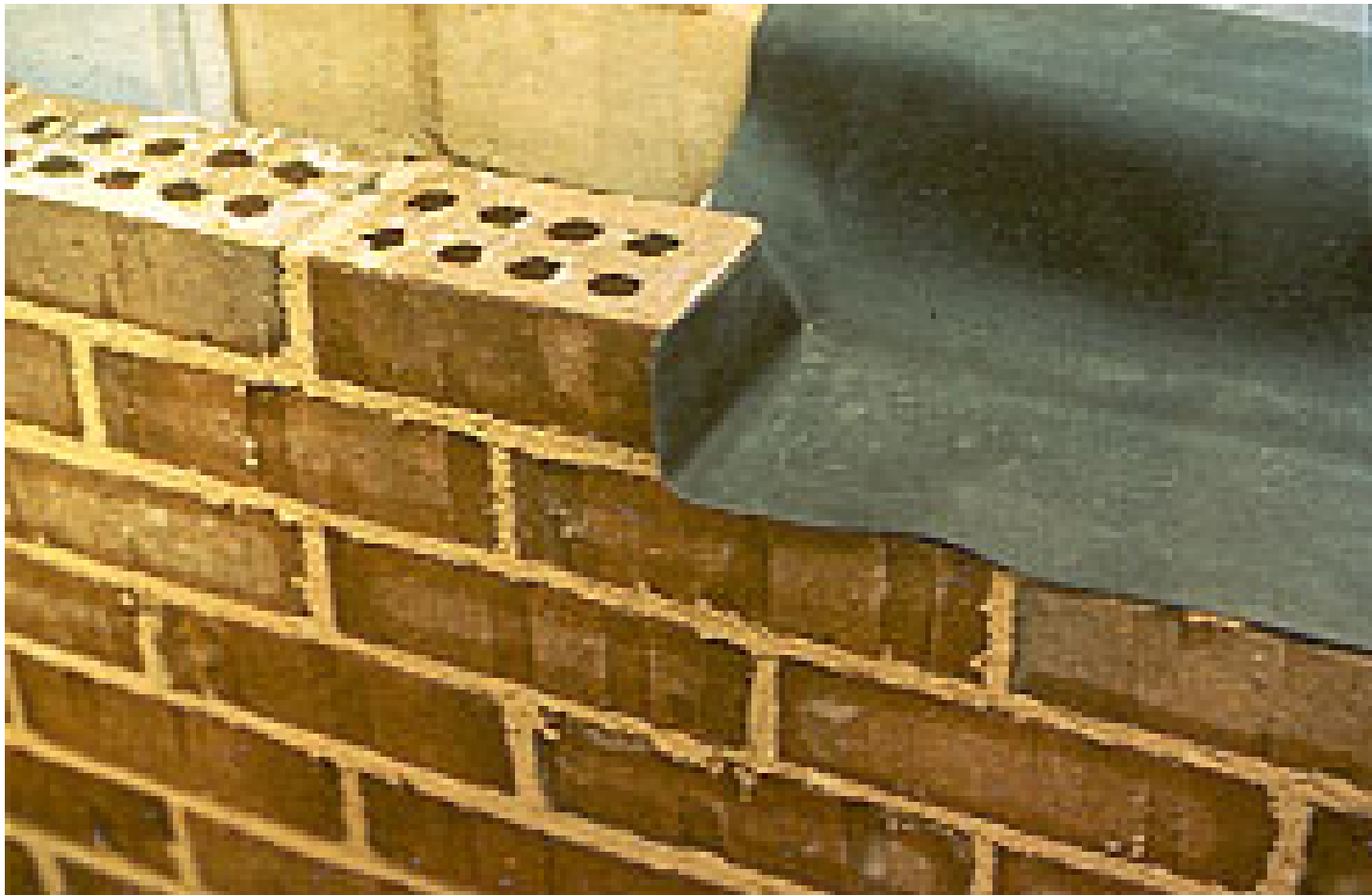
# Flashing Reinforced Wall

Architectural unit  
with inside faceshell  
and part of webs  
cut off to fit  
(TYP A & C)

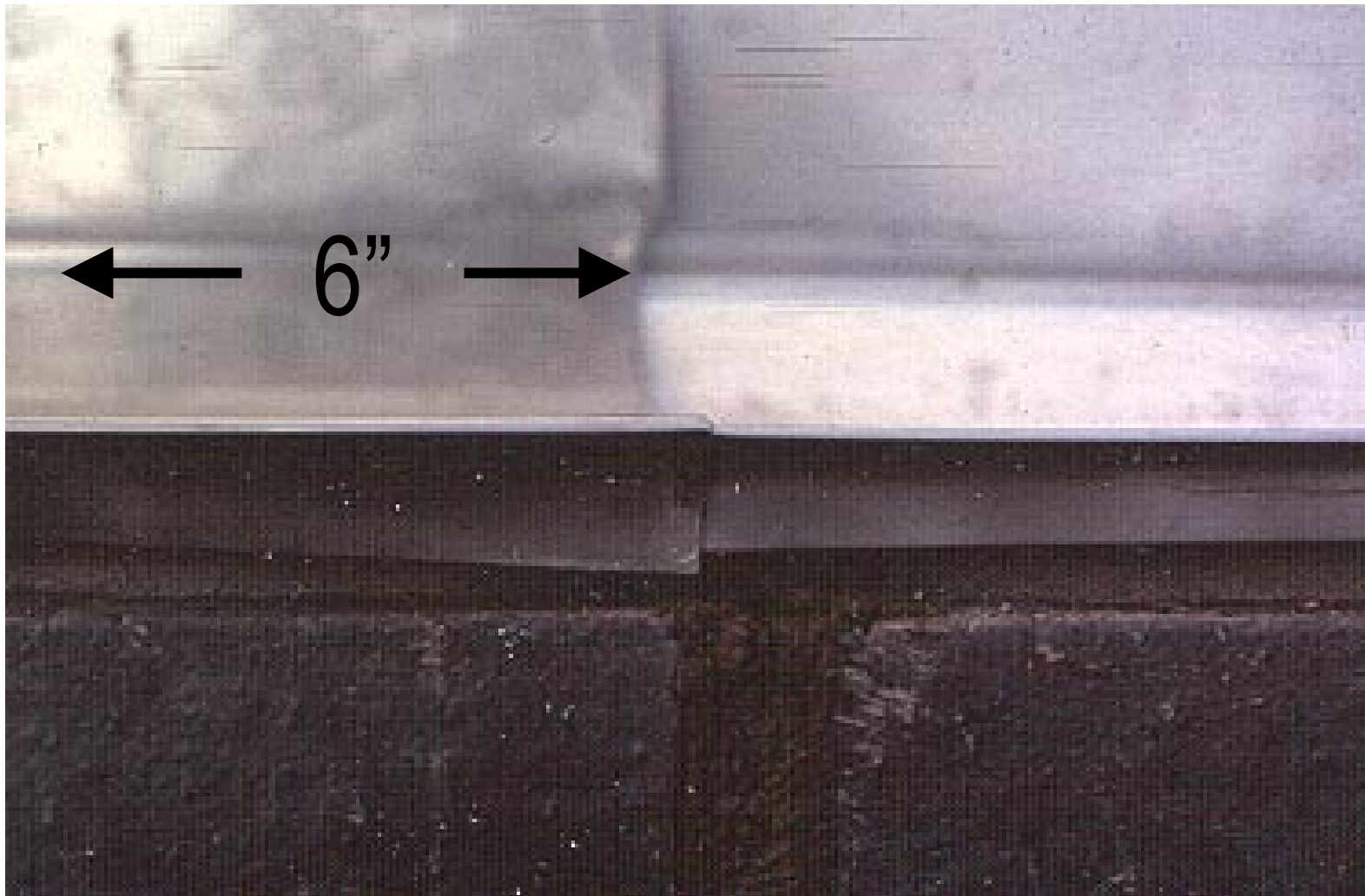


3" (76 mm) unit  
for 8" (203 mm) wall,  
4" (102 mm) unit  
for >8" (203 mm) wall

# End Dams



# Flashing Laps



# Drainage Materials



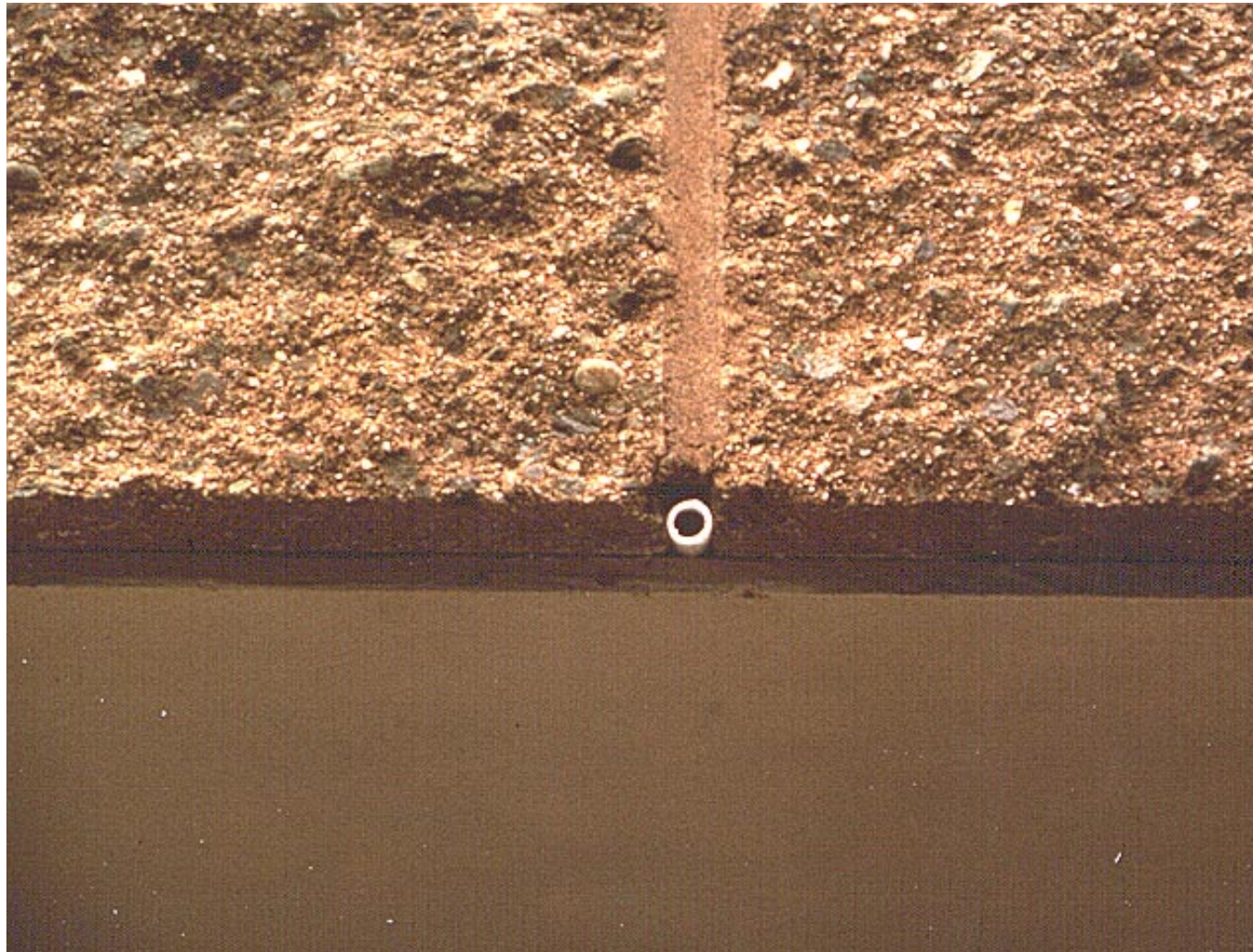


# Weep Holes





# Weep Tubes





# Vent Weep Holes



# Rope Wicks



# Flashing Materials

- Sheet Metal
- Composites
- Plastic and Rubber  
Compounds



# Sheet Metals

Material	Advantages	Disadvantages
Stainless Steel	Durable, non staining	Hard to solder and form
Cold-Rolled Copper	Durable	Damaged by excessive flexing and can stain
Galvanized Steel	Easy to paint and durable	Difficult to solder, corrodes early in acidic and salty air



# Composites

Material	Advantages	Disadvantages
Lead-coated copper	Flexible, durable, non-staining	Difficult to solder, damaged by excessive flexing, metal drip edge suggested
Copper laminates	Easy to form	Degrades in UV light, more easily torn than metal

# Plastics and Rubber Compounds

Material	Advantages	Disadvantages
EPDM	Flexible, easy to form, non-staining	Aesthetics if not used with a metal drip edge, full support recommended
Rubberized asphalt	Fully adhered, separate lap adhesive not needed, self healing, flexible, easy to form and join	Full support required, degrades in UV light, metal drip edge required
PVC	Easy to form and join, non-staining, low cost	Easily damaged, full support required, metal drip edge required, questionable durability



# Bldg felt and poly sheeting



# Bldg felt and poly sheeting



# Colorless Coatings

- Used for a variety of reasons
- Recommended for Concrete Masonry
- Questionable for Clay Masonry

# Possible Dangers

- Water can still penetrate
- Could cause spalling
- If efflorescence occurs under coating, it may be impossible to remove
- Recoating will be necessary

# Coating Types

- Colorless Coatings
- Paints

# Colorless Coatings

- Penetrating
  - Silanes
  - Siloxanes
- Film-forming
  - Acrylics
  - Stearates

# Coating Types

- Paints
  - Cement based
  - Latex
  - Alkyd
  - Oil-based Paints



# Differential Movement

- Movements
  - Temperature Movement
  - Moisture Movement
  - Elastic Deformation
- Movement Joints
  - Design
  - Placement

# Causes of Cracking

- Differential Movement
- Restraint
- Settlement
- Elastic Deformations
- Creep



# Types of Movement

**TABLE 1**  
**Types of Movement of Building Materials**

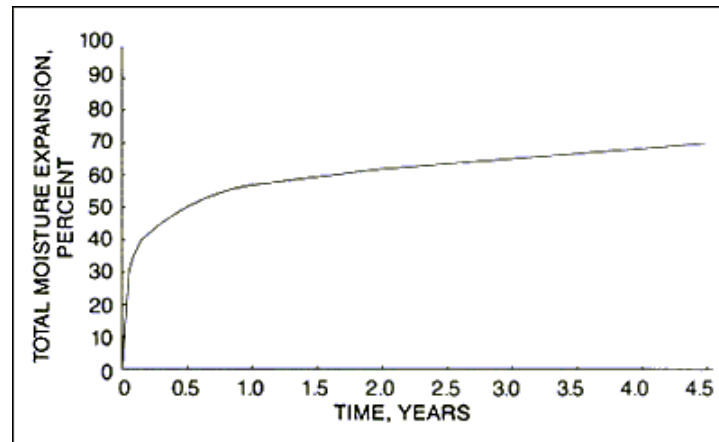
Building Material	Thermal	Reversible Moisture	Irreversible Moisture	Elastic Deformation	Creep
Brick Masonry	X	-	X	X	X
Concrete Masonry	X	X	-	X	X
Concrete	X	X	-	X	X
Steel	X	-	-	X	-
Wood	X	X	-	X	X

# Temperature Movement

- Coefficient of Thermal Expansion
  - Brick =  $3.6 \times 10^{-6}$
  - Concrete Masonry =  $4.3 \times 10^{-6}$
  - Aluminum =  $12.8 \times 10^{-6}$
  - Steel =  $6.5 \times 10^{-6}$

# Moisture Movement

- Brick - irreversible expansion



- Concrete masonry – drying shrinkage and carbonation

# Types of Movement Joints

- Expansion Joint - Brick Masonry
- Control Joint - Concrete Masonry
- Building Joint - Structures

# Expansion Joint

- Used in Clay Masonry
- Used to separate brick into sections so cracking will not occur
- Horizontal / Vertical
- Entire joint is unobstructed and formed from a highly elastic, continuous material



# Types of Expansion Joints (Details)

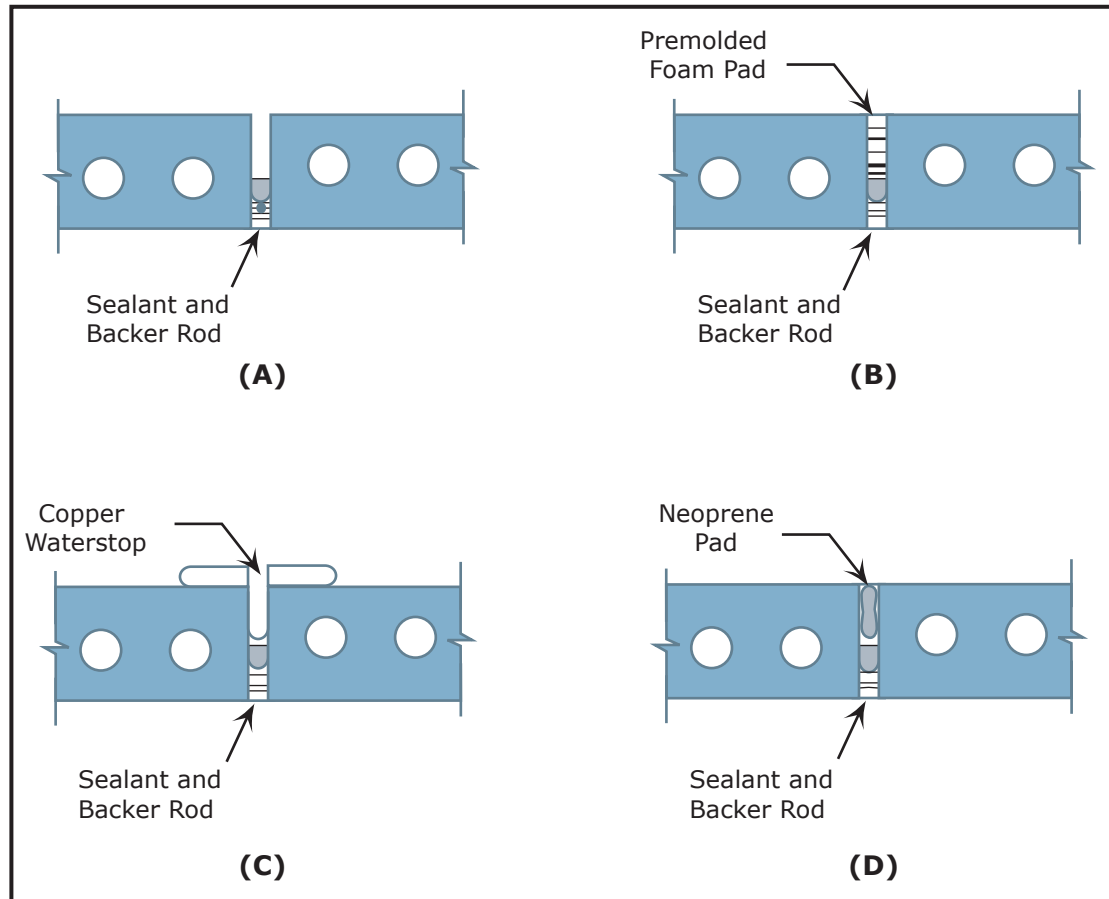
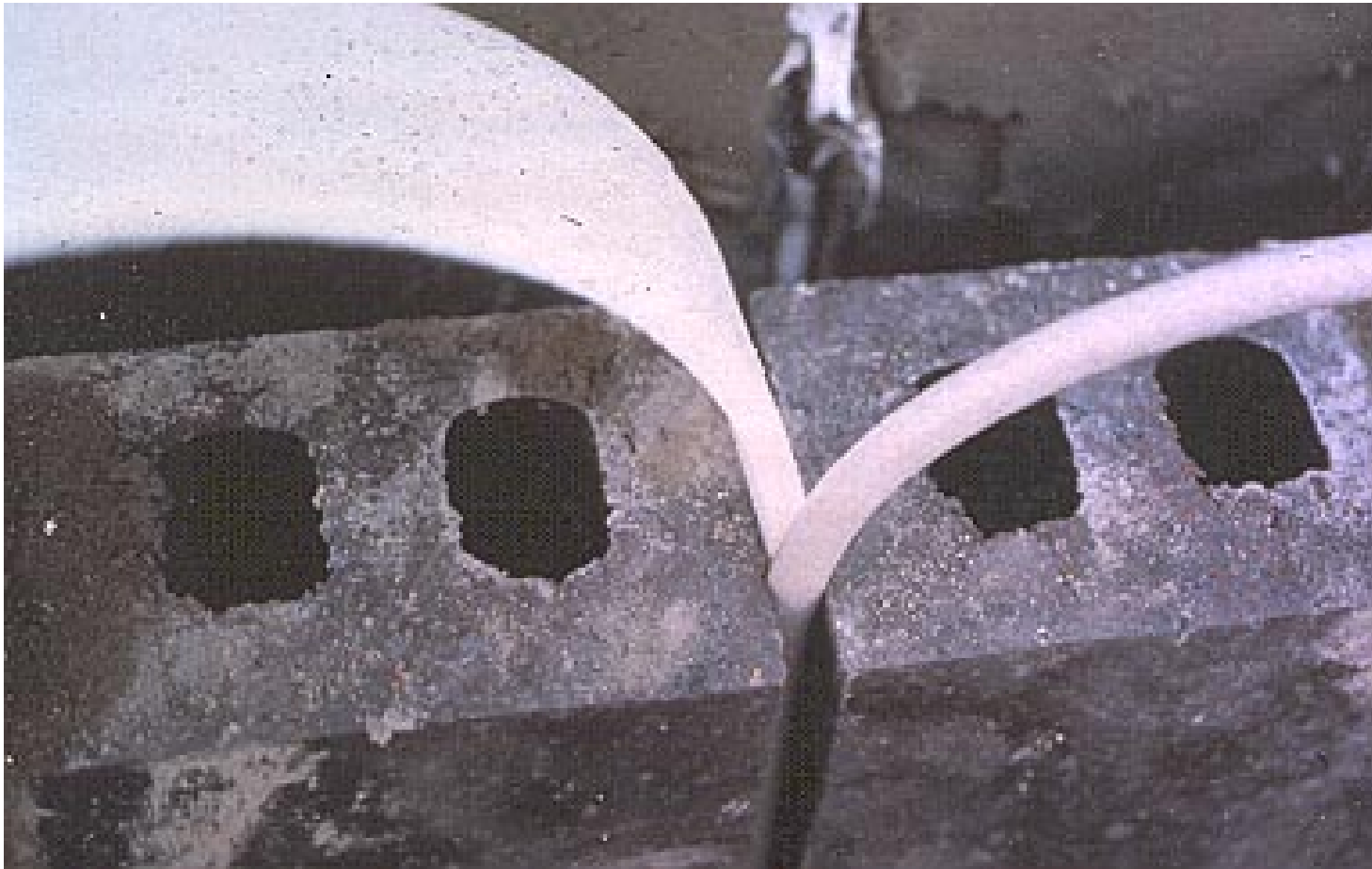


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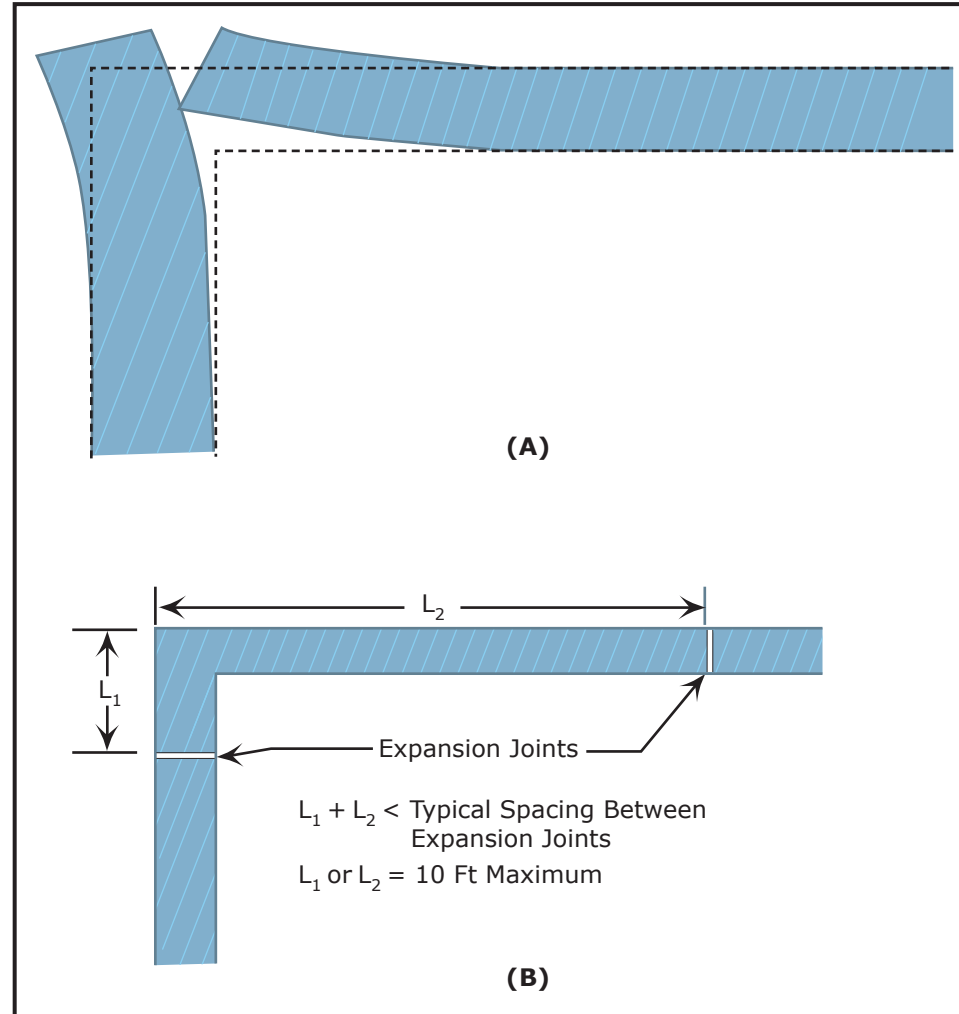
# Expansion Joint



# Typical Spacing and Locations of Expansion Joints

- Long Walls
- Corners
- Setbacks & Offsets
- Parapet walls
- Beneath shelf angles

# Expansion Joints at Corners



# Horizontal Expansion Joint

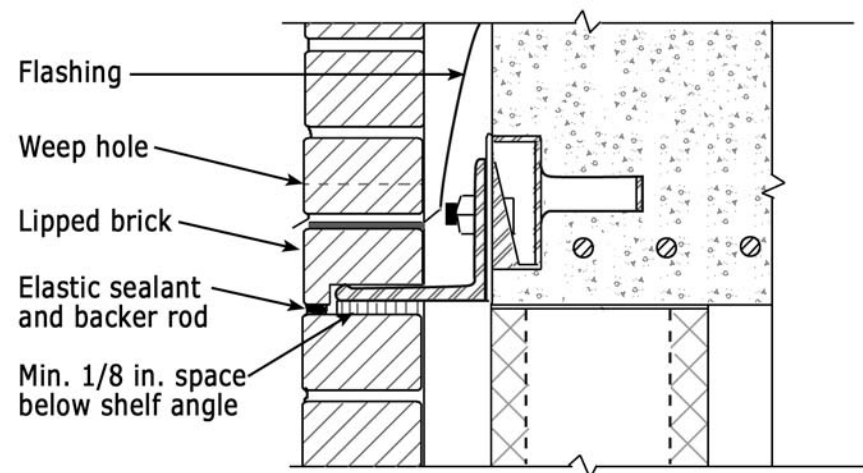
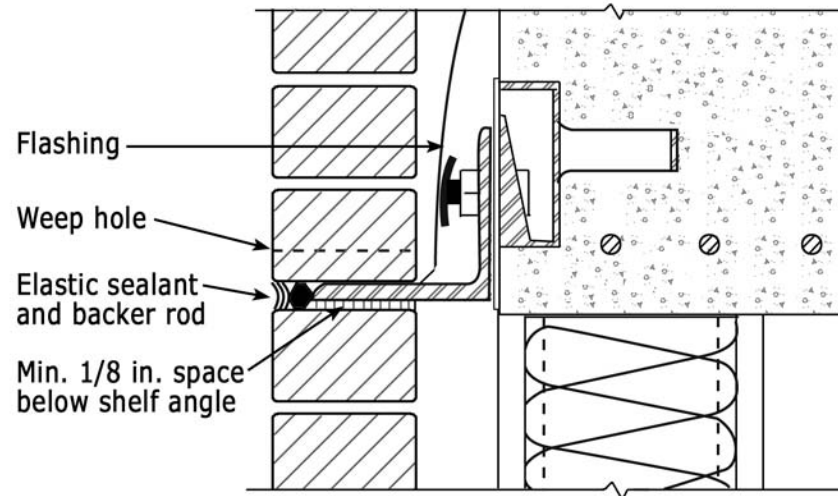


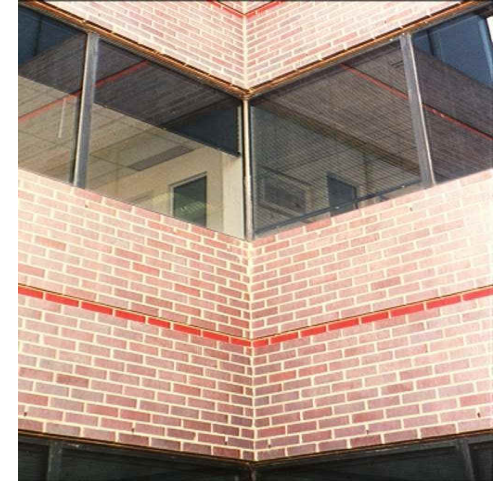
Image by MIT OCW.

# False Horizontal EJ





# Hiding Expansion Joints



# Control Joint

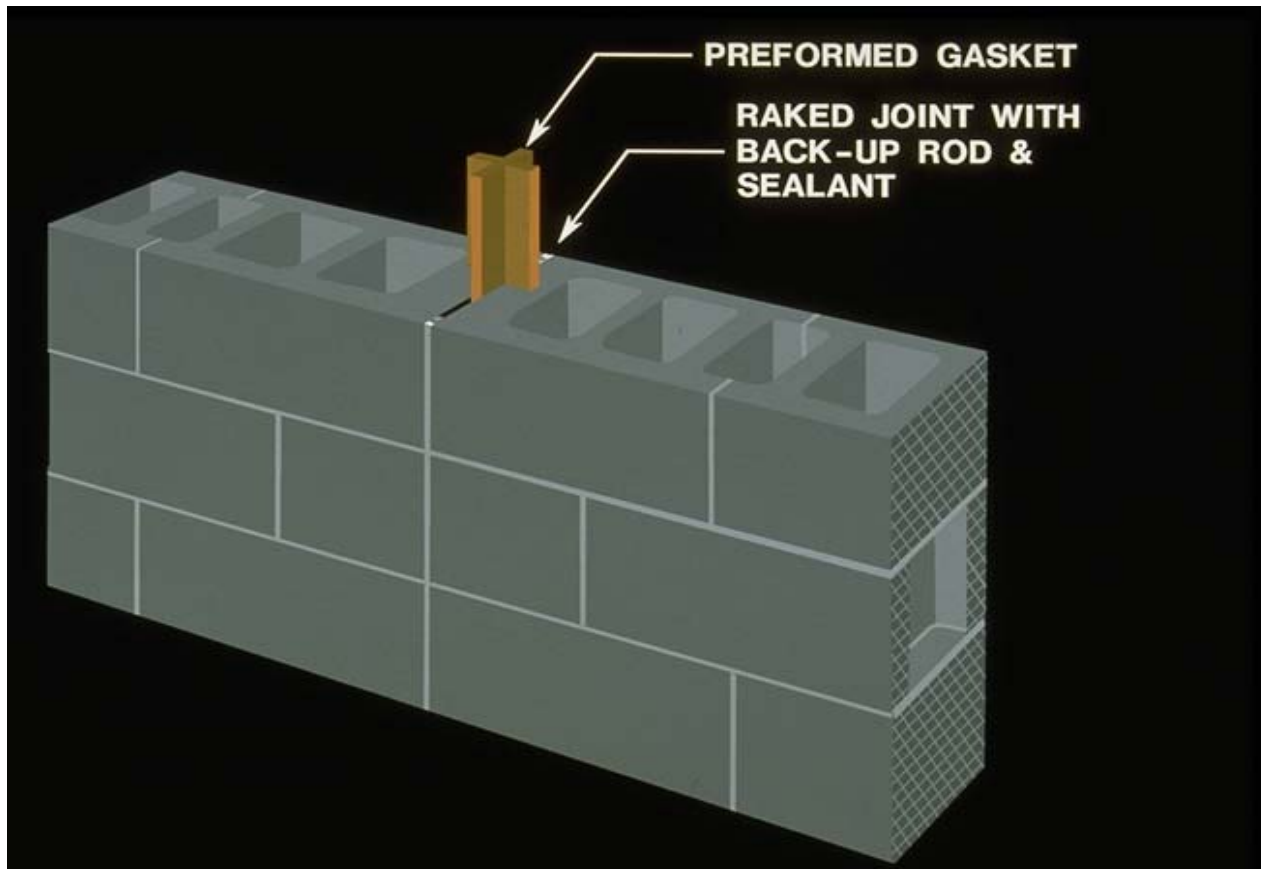
- Used in Concrete Masonry
  - Relieve horizontal tensile stresses
  - Reduce restraint and permit longitudinal movement
  - Separate dissimilar materials



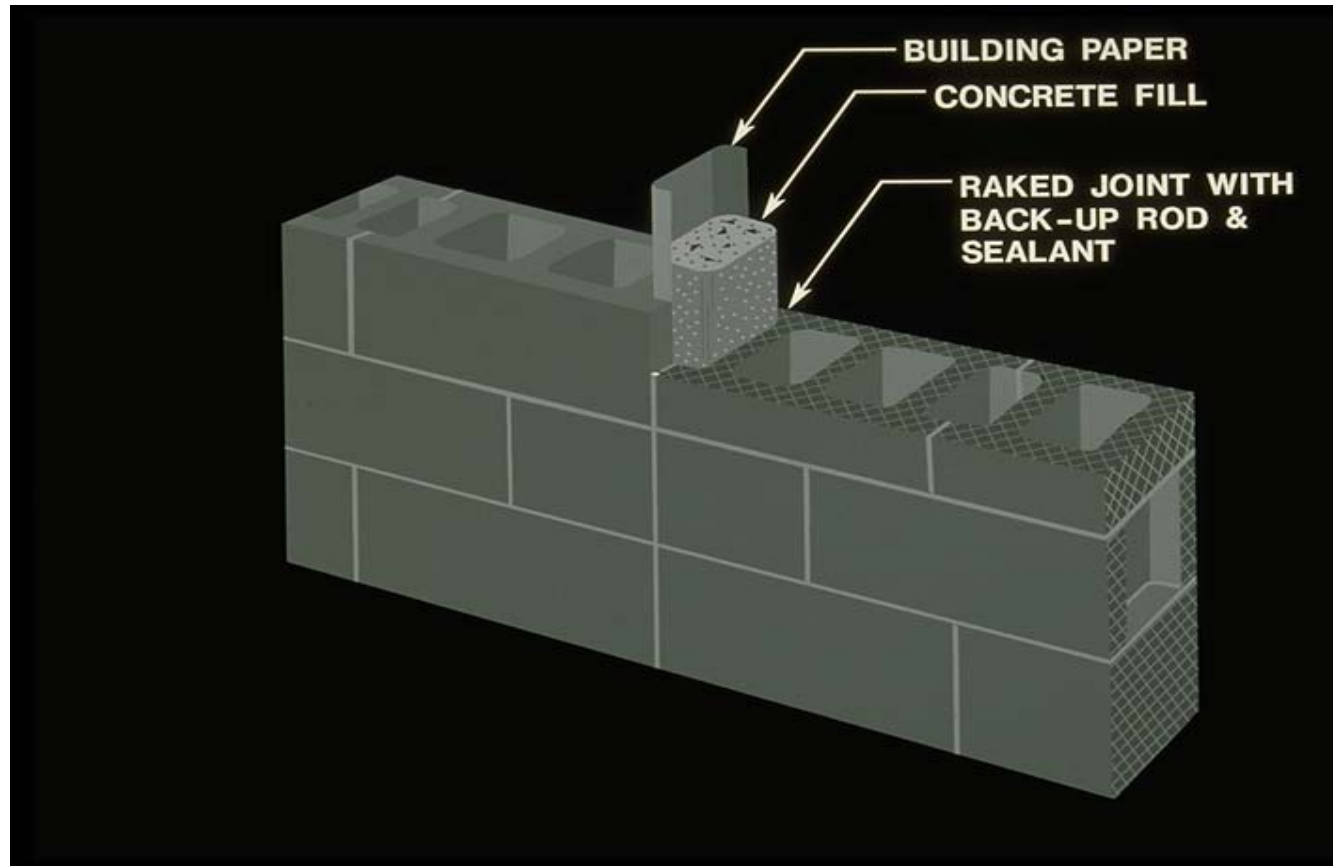
# Types of Control Joints

- Pre-formed gasket
- Formed paper
- Special shape units

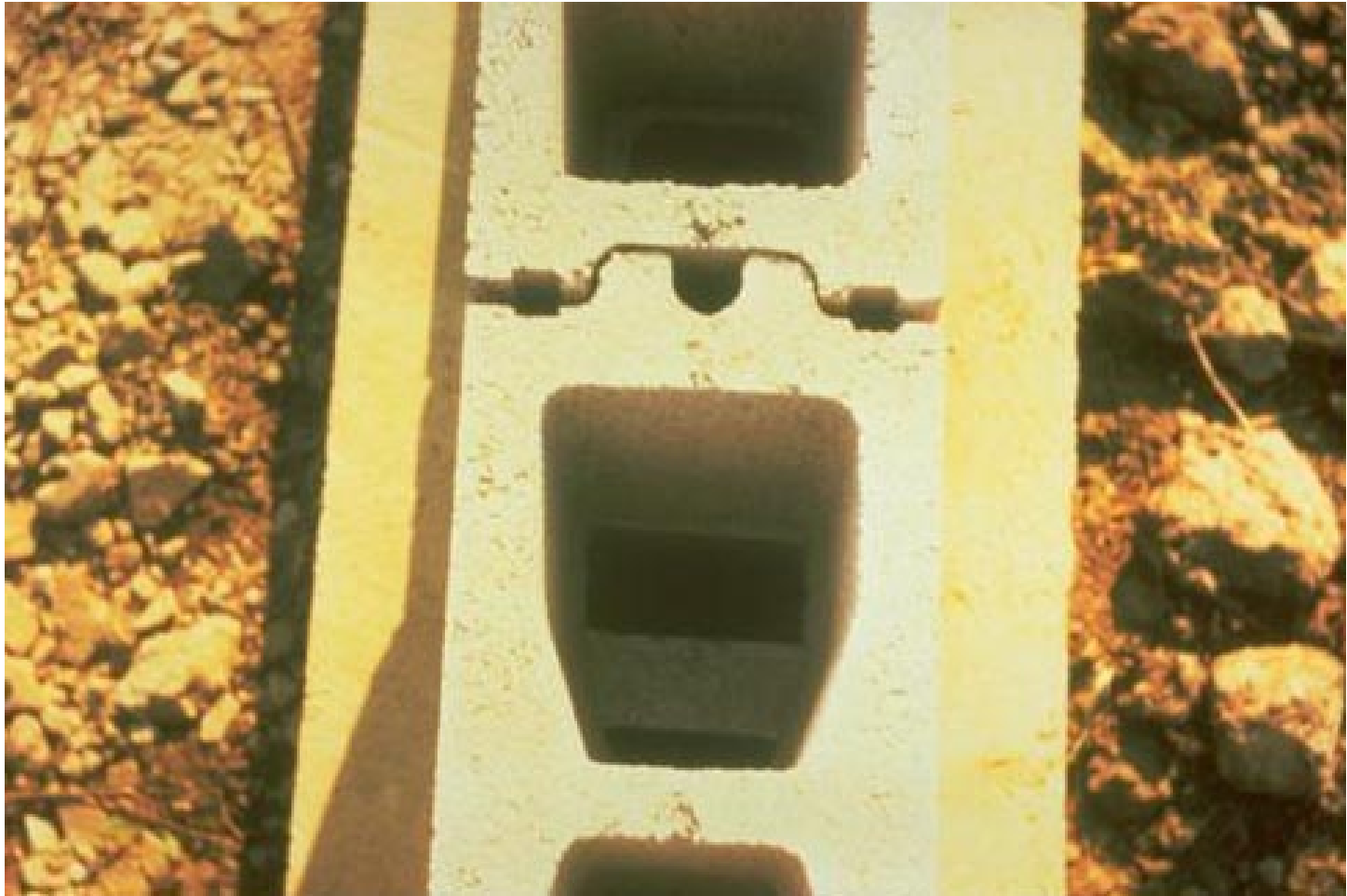
# Pre-formed Gasket



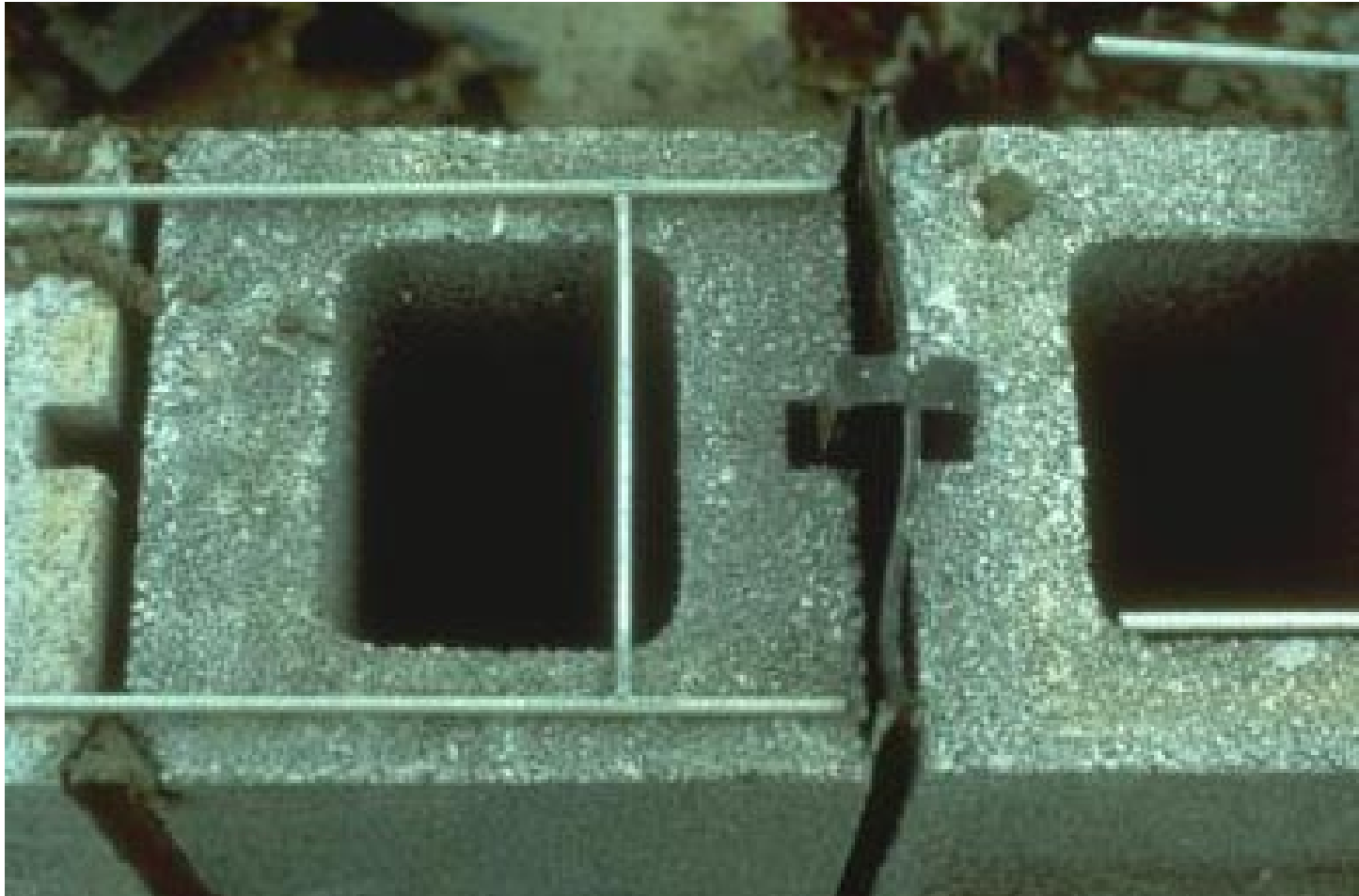
# Formed Paper (also known as Michigan Joint)



# Special Shape Unit



# Joint Reinforcement at CJ

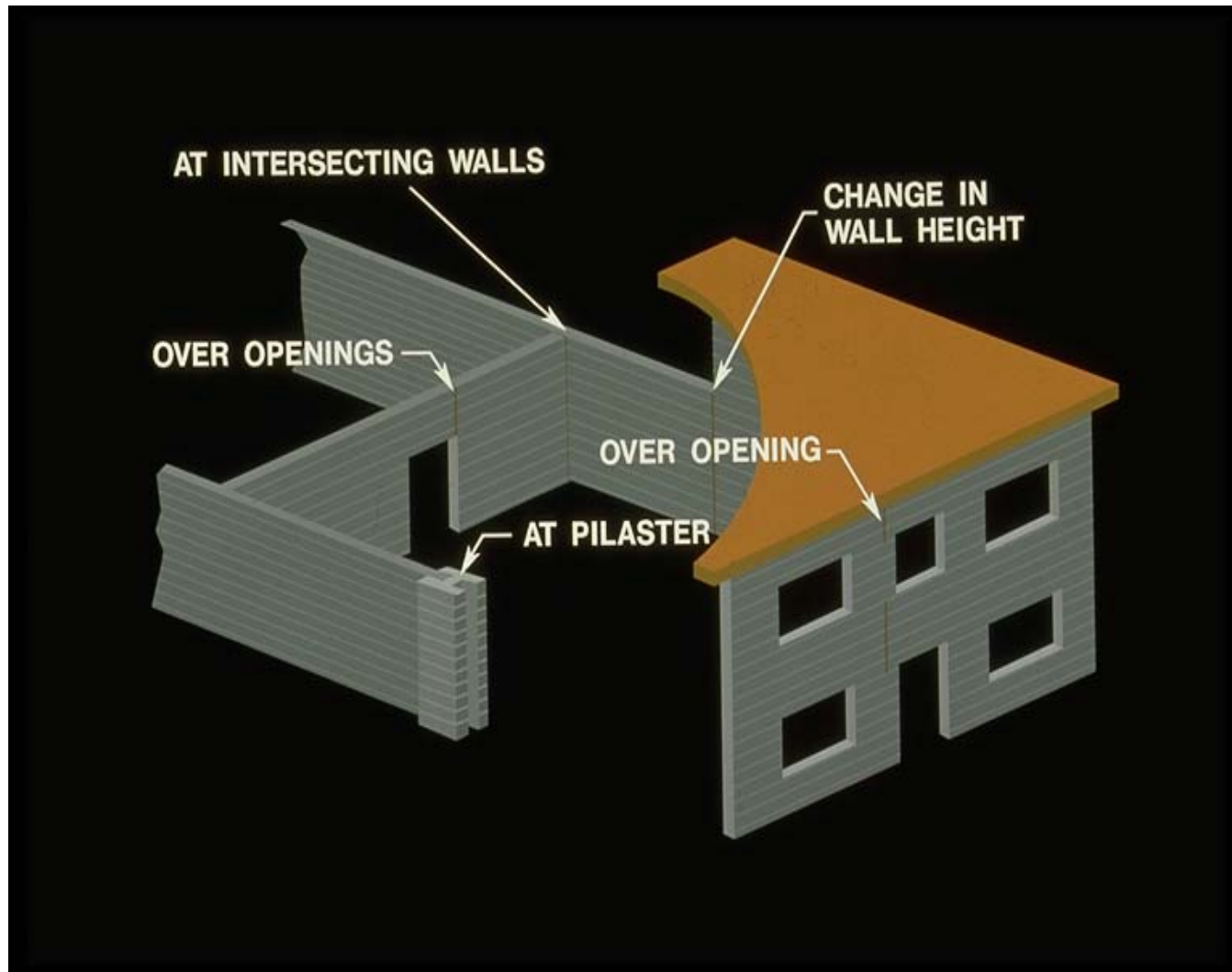


# Bond Beams

- Do not cut bond beam reinforcement unless specifically indicated on the plans



# Control Joint Locations





# Control Joint Spacing

- Two methods:
  - Empirical
    - based on historical performance
  - Engineered
    - based on a crack control coefficient



# Engineered Crack Control Criteria

		Crack Control Coefficient in./in. (mm/mm)	
		0.0010	0.0015
Maximum wall	<u>length, ft (m)</u>	25 (7.62)	20 (6.10)
panel dimensions	<u>length/height ratio</u>	2 ½	2
Min. horizontal reinf. ratio	$A_s/A_n$	0.0007	0.0007

Notes:

$A_s$  = cross-sectional area of steel, in<sup>2</sup>/ft (mm<sup>2</sup>/m)

$A_n$  = net cross-sectional area of masonry, in<sup>2</sup>/ft (mm<sup>2</sup>/m)

# Engineered Crack Control Criteria (cont.)

## Notes:

- Need not apply if  $A_s/A_n \geq 0.002$  - see Table 4.
- See Table 3 for  $A_s/A_n = 0.0007$  minimum requirement.
- Minimum reinforcement ratio need not apply if length is  $\leq \frac{1}{2}$  maximum length shown in table.
- CCC's less than 0.0010 may be available in some areas and spacing should be adjusted accordingly.
- Control joint spacing may be adjusted up or down based on local experience.

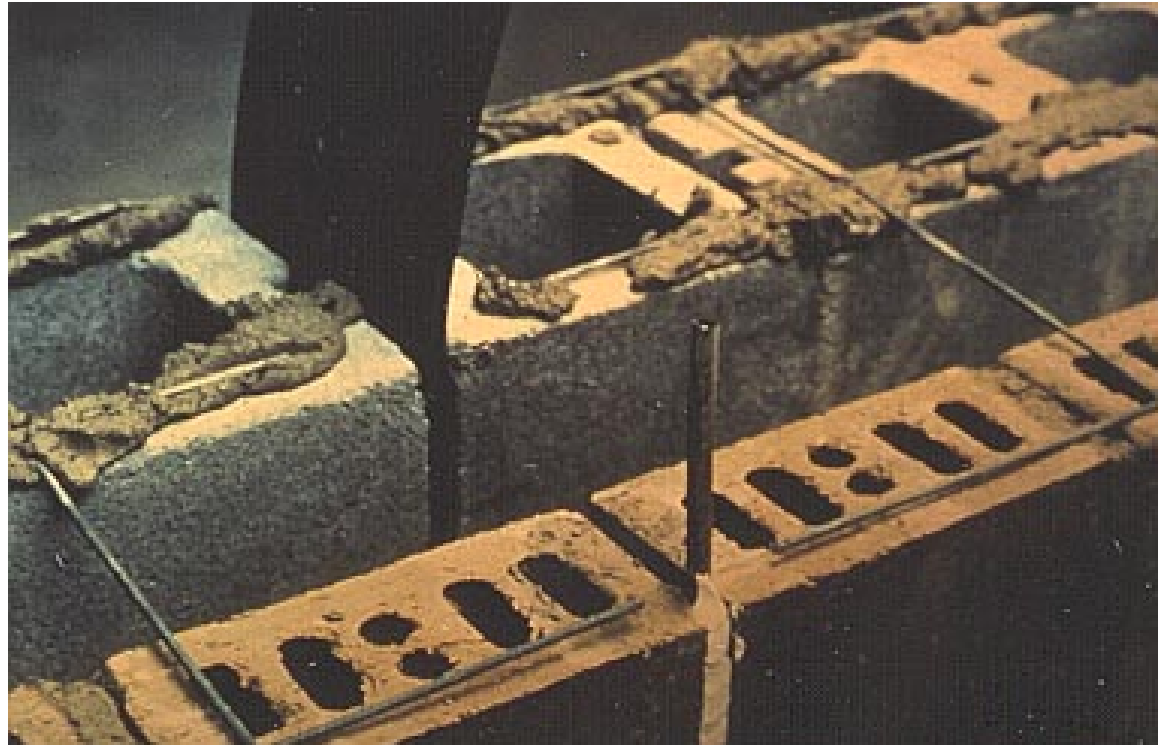
**Table 3—Maximum Spacing of Hor. Reinf. for  $A_s \geq 0.0007A_n^1$**

Wall thick in.	Maximum spacing of horizontal reinforcement, in. (mm) Reinforcement size								
	#5	#4	#3	4x 3/16	4 x 8 gage	4 x 9 gage	2x 3/16	2 x 8 gage	2 x 9 gage
<b>Ungouted or partially gouted walls</b>									
6	144	128	64	72	56	48	40	24	24
8	144	96	40	64	48	40	32	24	16
10	136	80	32	56	40	32	16	16	16
12	120	72	24	48	40	32	16	16	16

**1.  $A_n$  includes cross-sectional area of grout in bond beams.**

# Brick and Block Together

- Align  
Expansion  
Joints and  
Control  
Joints



# Bond Breaks

- Use to separate bands of different masonry types