Welcome to
Oldcastle APG University

Oldcastle APG
A CRH COMPANY

Masonry Best Practices

Chris Bettinger – Oldcastle APG

Architectural Product Specifications

- chris.bettinger@oldcastle.com
- Cell: (321) 302-4505

Lisa Pelham CSI CDT – Oldcastle APG

Architectural Product Specifications

- lisa.pelham@oldcastle.com
- Cell: (813) 255-4737

LEARNING OBJECTIVES

Course Learning Objectives:

- Review ASTM standards for clay brick
- Understand the quality protections built into the ASTM standards for clay brick
- Understand minimum code requirements and best practices for resilient masonry construction in Florida.
- Understand the best method for material sampling and selection insuring the design intent of a project.

AGENDA

1. Clay Brick Specification
    - ASTM Standards

2. Masonry Best Practices
    - Flashing
    - Weeps
    - Movement

3. Specification and sampling of Clay Brick

Masonry Best Practices

CLAY BRICK SPECIFICATION

ASTM C216

ASTM C652

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2017 FBC Clay Brick Reference:

SECTION 2103
MASONRY CONSTRUCTION MATERIALS

2103.1 Masonry units. Concrete masonry units, clay or shale masonry units, stone masonry units, glass unit masonry and AAC masonry units shall comply with Article 2.3 of TMS 602/ACI 503.1/ASCE 6. Architectural cast stone shall conform to ASTM C1364.

TMS 602 SPECIFICATION

2.3 B. Provide clay or shale masonry units that conform to ASTM C34, C56, C62, C126, C212, C216, C652, C1088, or C1405 or to ANSI A 137.1, as specified.

What is a Brick?
ASTM Definitions

Designation: ASTM C1232 – 12, Standard Terminology of Masonry

brick, *n*—a solid or hollow masonry unit of clay or shale, usually formed into a rectangular prism, then burned or fired in a kiln; brick is a ceramic product.

facing brick, *n*—brick for general purposes where appearance properties such as color, texture, and chippage are important; see Specification C 216 and Specification C 652.

NOTICE: This standard has either been superseded and replaced by a new version or withdrawn.
Contact ASTM International (www.astm.org) for the latest information

Designation: C216 – 13

StandardSpecification for
Facing Brick (Solid Masonry Units Made from Clay or

Designation: C216 – 13

StandardSpecification for Facing Brick (Solid Masonry Units Made from Clay or Shale)[1]

This standard is issued under the fixed designation C216; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

describe the brick.

1.5.1 This standard and its individual requirements shall not be used to qualify or corroborate the performance of a masonry unit made from other materials, or made with other forming methods, or other means of binding the materials.

1.6 Three types of brick in each of two grades are covered.

1.7 The text of this specification references notes and footnotes which provide explanatory material. These notes and

content not exceeding the 24-h cold water absorption. Two grades of facing brick are covered and the requirements are given in Section 7.

4.1.1 *Grade SW (Severe Weathering)* —Brick intended for use where high resistance to damage caused by cyclic freezing is desired.

4.1.2 *Grade MW (Moderate Weathering)*—Brick intended for use where moderate resistance to cyclic freezing damage is permissible.

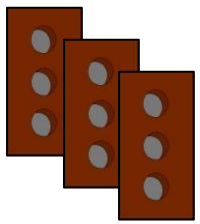
[1] This specification is under the jurisdiction of ASTM Committee C15 on Manufactured Masonry Units and is the direct responsibility of Subcommittee C15.02 on Brick and Structural Clay Tile.

Current edition approved June 15, 2013. Published June 2013. Originally approved in 1947. Last previous edition approved in 2012 as C216 – 12a. DOI: 10.1520/C0216-13.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The last approved version of this historical standard is referenced on www.astm.org.

***A Summary of Changes section appears at the end of this standard**



Designation: C652 – 13

StandardSpecification for Hollow Brick (Hollow Masonry Units Made From Clay or Shale)[1]

This standard is issued under the fixed designation C652; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

Designation: C652 – 13

StandardSpecification for
Hollow Brick (Hollow Masonry Units Made From Clay or Shale)[1]

elevated temperatures (firing). The heat treatment shall develop sufficient fired bond between the particulate constituents to provide the strength and durability requirements of this specification. Additives or recycled materials are permitted to be included at the option of the manufacturer. (See "firing" and "firing bond" in Terminology C1232.)

1.3.1 This specification and its individual requirements shall not be used to qualify or corroborate the performance of a masonry unit made from other materials, or made with other forming methods, or other means of binding the materials.

1.4 Hollow brick differ from unglazed structural clay tile (Specifications C34 and C212) and solid brick (Specifications C62 and C216). Hollow brick require greater shell and web

C67 Test Methods for Sampling and Testing Brick and Structural Clay Tile
C212 Specification for Structural Clay Facing Tile
C216 Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale)
C902 Specification for Pedestrian and Light Traffic Paving Brick
C1232 Terminology of Masonry
E835/E835M Guide for Modular Coordination of Clay and Concrete Masonry Units (Withdrawn 2011)[3]

3. Terminology

3.1 *Definitions*—For definitions relating to masonry and hollow brick, refer to Terminology C1232.

[1] This specification is under the jurisdiction of ASTM Committee C15 on Manufactured Masonry Units and is the direct responsibility of Subcommittee C15.02 on Brick and Structural Clay Tile.

Current edition approved June 1, 2013. Published June 2013. Originally approved in 1970. Last previous edition approved in 2012 as C652 – 12a. DOI: 10.1520/C0652-13.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The last approved version of this historical standard is referenced on www.astm.org.

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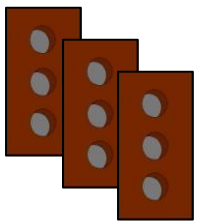

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Contact ASTM International (www.astm.org) for the latest information

Designation: C216 – 13

StandardSpecification for Facing Brick (Solid Masonry Units Made from Clay or Shale)[1]

This standard is issued under the fixed designation C216; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

4.1.1 *Grade SW (Severe Weathering)* —Brick intended for use where high resistance to damage caused by cyclic freezing is desired.

1.3 The brick are prismatic units available in a variety of sizes, textures, colors, and shapes. This specification is not intended to provide specifications for paving brick (see Specification C902).

1.4 Brick are ceramic products manufactured primarily from clay, shale, or similar naturally occurring earthy substances and subjected to a heat treatment at elevated temperatures (firing). Additives or recycled materials are permitted to be included at the option of the manufacturer. The heat treatment must develop a fired bond between the particulate constituents to provide the strength and durability requirements of this specification (see Terminology C1232).

1.5 Brick are shaped during manufacture by molding, pressing, or extrusion, and the shaping method is a way to describe the brick.

1.5.1 This standard and its individual requirements shall not be used to qualify or corroborate the performance of a masonry unit made from other materials, or made with other forming methods, or other means of binding the materials.

1.6 Three types of brick in each of two grades are covered.

1.7 The text of this specification references notes and footnotes which provide explanatory material. These notes and

Structural Clay Tile
C902 Specification for Pedestrian and Light Traffic Paving Brick
C1232 Terminology of Masonry
C1272 Specification for Heavy Vehicular Paving Brick
E835/E835M Guide for Modular Coordination of Clay and Concrete Masonry Units (Withdrawn 2011)[3]

3. Terminology

3.1 *Definitions*—For definitions relating to masonry and facing brick, refer to Terminology C1232.

4. Classification

4.1 *Grades*—Grades classify brick according to their resistance to damage by freezing when saturated at a moisture content not exceeding the 24-h cold water absorption. Two grades of facing brick are covered and the requirements are given in Section 7.

4.1.1 *Grade SW (Severe Weathering)* —Brick intended for use where high resistance to damage caused by cyclic freezing is desired.

4.1.2 *Grade MW (Moderate Weathering)*—Brick intended for use where moderate resistance to cyclic freezing damage is permissible.

[1] This specification is under the jurisdiction of ASTM Committee C15 on Manufactured Masonry Units and is the direct responsibility of Subcommittee C15.02 on Brick and Structural Clay Tile.

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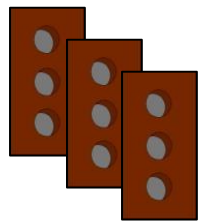


TABLE 1 Physical Requirements

Designation	Minimum Compressive Strength psi, (MPa) gross area		Maximum Water Absorption by 5-h Boiling, %		Maximum Saturation Coefficient[A]	
	Average of 5 brick	Individual	Average of 5 brick	Individual	Average of 5 brick	Individual
Grade SW	3000 (20.7)	2500 (17.2)	17.0	20.0	0.78	0.80
Grade MW	2500 (17.2)	2200 (15.2)	22.0	25.0	0.88	0.90

[A] The saturation coefficient is the ratio of absorption by 24-h submersion in cold water to that after 5-h submersion in boiling water.

NOTE 1—Measurement of moisture content of brick in buildings indicates that, when the building is designed and constructed to reduce water penetration, the 24-h cold water absorption is unlikely to be exceeded.

4.2 *Types*—Three types of facing brick are covered:

4.2.1 *Type FBS*—Brick for general use in masonry.

4.2.2 *Type FBX*—Brick for general use in masonry where a higher degree of precision and lower permissible variation in size than permitted for Type FBS is required.

4.2.3 *Type FBA*—Brick for general use in masonry selected

4.2.1 *Type FBS*—Brick for general use in masonry.

5. Ordering Information

5.1 Orders for facing brick under this specification shall include the following information:

5.1.1 *Grade* (Section 4.1)—Grade SW governs when grade is not specified.

5.1.2 *Type* (Section 4.2)—Type FBS governs when type is not specified.

5.1.2.1 For Type FBA, specify chippage (10.1), tolerances (Section 9), or approve a designated sample.

5.1.3 Color, color range, and texture (10.4) by approving a sample.

5.1.3.1 Finish on more than one face and one end (10.5).

5.1.4 *Size* (9.1)—Specify width by height by length.

5.1.5 *Sampling* (12.2)—Person to select samples and place or places of selection of samples for testing.

5.2 Orders for facing brick under this specification may include the following information:

5.2.1 *Strength* (7.2)—Specify only if above minimum compressive strength in Table 1.

5.2.2 *Coring* (11.1)—At option of manufacturer if not specified.

5.2.3 *Frogging* (11.2)—Frog permitted in one bearing face if not specified.

5.2.4 *Costs of Tests* (Note 14)—Party who will pay and conditions for payment of compliance testing.

NOTE 2—Color, color range, and texture are best specified by identifying a particular manufacturer and unit designation. Nominal dimensions should not be used to specify size.

NOTE 3—See sections 7.3 and 8 for optional information.

6. Materials and Manufacture

6.1 Colors and textures produced by application of inorganic coatings to the faces of the brick shall be permitted with the consent of the purchaser, provided that evidence is furnished of the durability of the coatings. Brick that are colored by flashing or textured by sanding, where the sand does not form a continuous coating, shall not be considered as surface-colored brick for the purpose of this specification.

NOTE 4—When surface-colored brick, other than sanded or flashed, are specified for *exterior* use, the purchaser should require that data be submitted showing that after 50 cycles of freezing thawing there is no observable difference in the applied finish when viewed from a distance of 10 ft (3.0 m) under an illumination of not less than 50 fc (538 lx) by an observer with normal vision

strength or performance of the construction.

6.3 If any post-firing coatings or surface treatments are applied by the manufacturer, the manufacturer shall report the type and extent of these coatings or surface treatments in all certificates of compliance with this specification.

7. Physical Properties

7.1 *Durability*—When grade is not specified, the requirements for Grade SW shall govern.

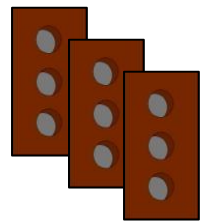
7.1.1 *Physical Property Requirements*—The brick shall conform to the physical requirements for the grade specified as prescribed in Table 1. For the compressive strength requirements in Table 1, test the unit with the compressive force perpendicular to the bed surface of the unit, with the unit in the stretcher position.

7.1.2 *Absorption Alternate*—The saturation coefficient requirement does not apply provided that the 24-h cold water absorption of each of the five units tested does not exceed 8.0 %.

7.1.3 *Freezing and Thawing Alternative*—The requirements for 5-h boiling water absorption and saturation coefficient do not apply, provided a representative sample of five brick, meeting the strength requirements of Table 1, passes the freezing and thawing test as described in the Rating Section of the Freezing and Thawing test procedures of Test Methods C67:

NOTE 5—The 50 cycle freezing and thawing test is used as an alternative only when the brick do not conform to either Table 1 requirements for maximum water absorption and saturation coefficient, or to the requirements of the Absorption Alternate in 7.1.2.

7.1.3.1 *Grade SW: Breakage and Weight Loss Requirement*—No individual unit separates or disintegrates resulting in a weight loss greater than 0.5 % of its original dry weight.



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NOTE 4—When surface-colored brick, other than sanded or flashed, are

5.1.1 *Grade* (Section 4.1)—Grade SW governs when grade is not specified

5. Ordering Information

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5.1.4 *Size* (9.1)—Specify width by height by length.

5.1.5 *Sampling* (12.2)—Person to select samples and place or places of selection of samples for testing.

perpendicular to the bed surface of the unit, with the unit in the stretcher position.

5.2.2 *Coring* (11.1)—At option of manufacturer if not specified

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NOTE 2—Color, color range, and texture are best specified by identifying a particular manufacturer and unit designation. Nominal dimensions should not be used to specify size.

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the Freezing and Thawing test procedures of Test Methods C67:

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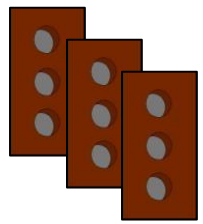
7.1.3.1 *Grade SW: Breakage and Weight Loss Requirement*—No individual unit separates or disintegrates resulting in a weight loss greater than 0.5 % of its original dry weight.



Specifying Brick

	Solid ASTM C216	Hollow ASTM C652
Durability (Grade)	MW	MW
	SW	SW
Appearance (Type)	FBA	HBA
	FBS	HBS/HBB
	FBX	HBX
Class		HV40
		HV60

Specifying Brick - Characteristics to Consider

ASTM C216 & C652

Efflorescence – clay does not effloresce

Variable Characteristics

Chips
Racking
Defects & Distortion
Size and Consistency

Masonry Best Practices

Flashing | Weeps |Movement

TMS 402/ACI 530/ASCE 5 (MSJC)
As referenced in the Florida Building Code – 7th Edition

Oldcastle APG
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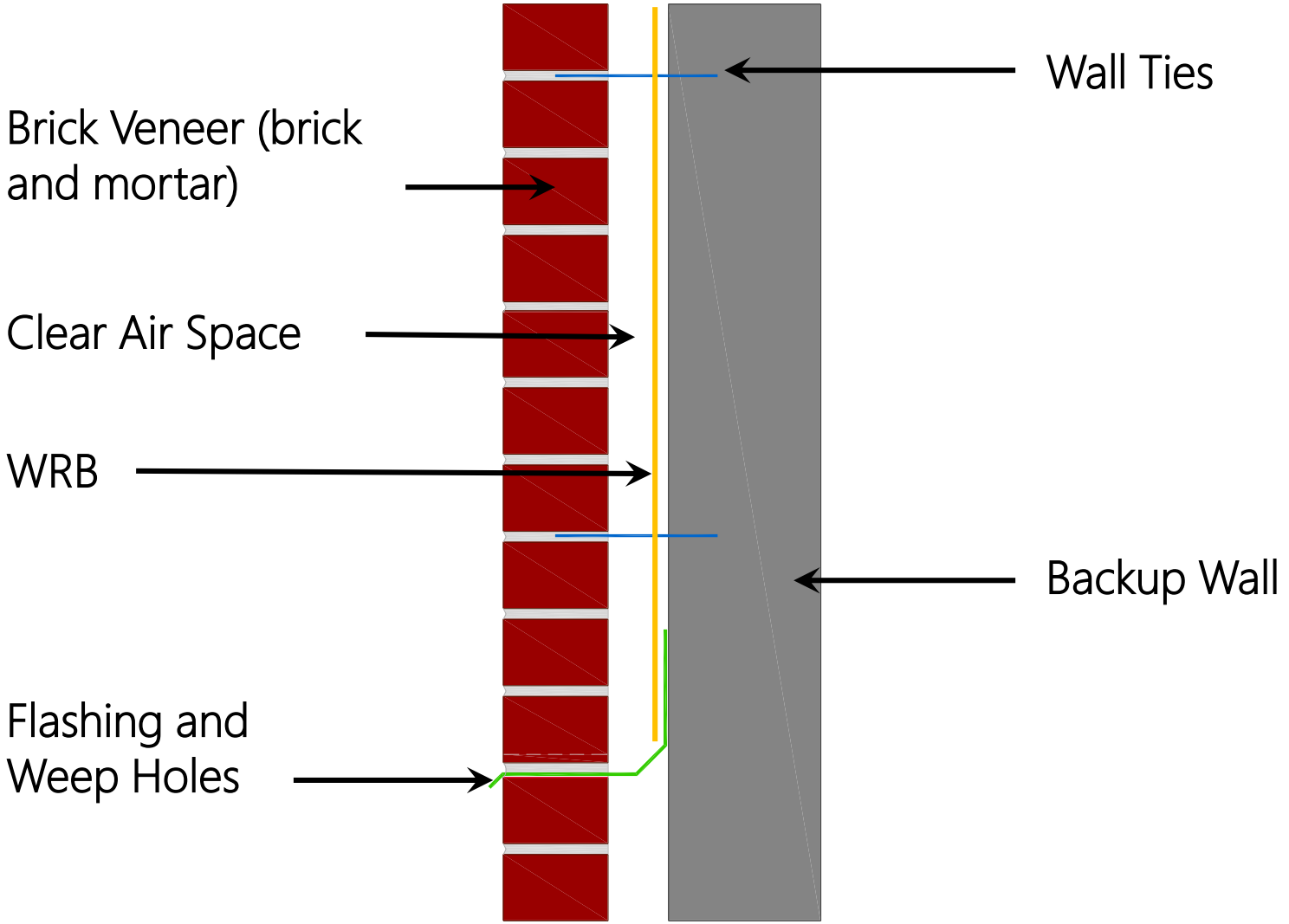
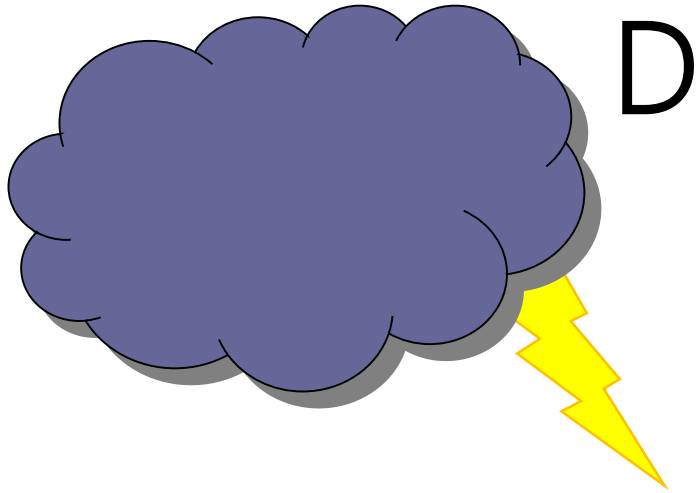
DRAINAGE WALL COMPONENTS



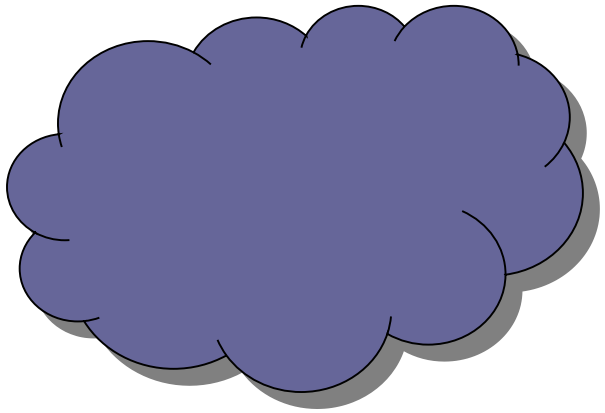
DRAINAGE WALL CONCEPT



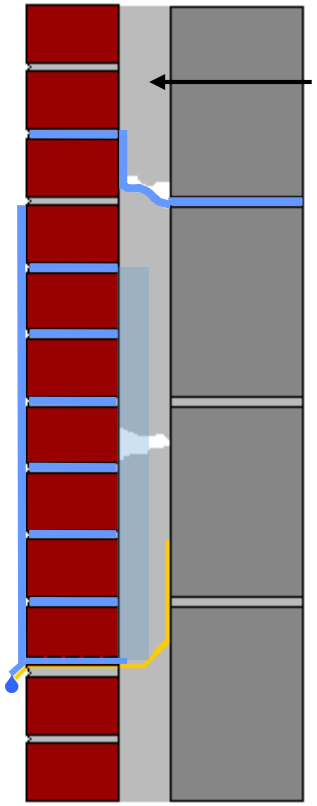
Water may penetrate brick masonry

Water runs down back of brick

Water exits wall at flashing at weep holes.



BARRIER WALL CONCEPT



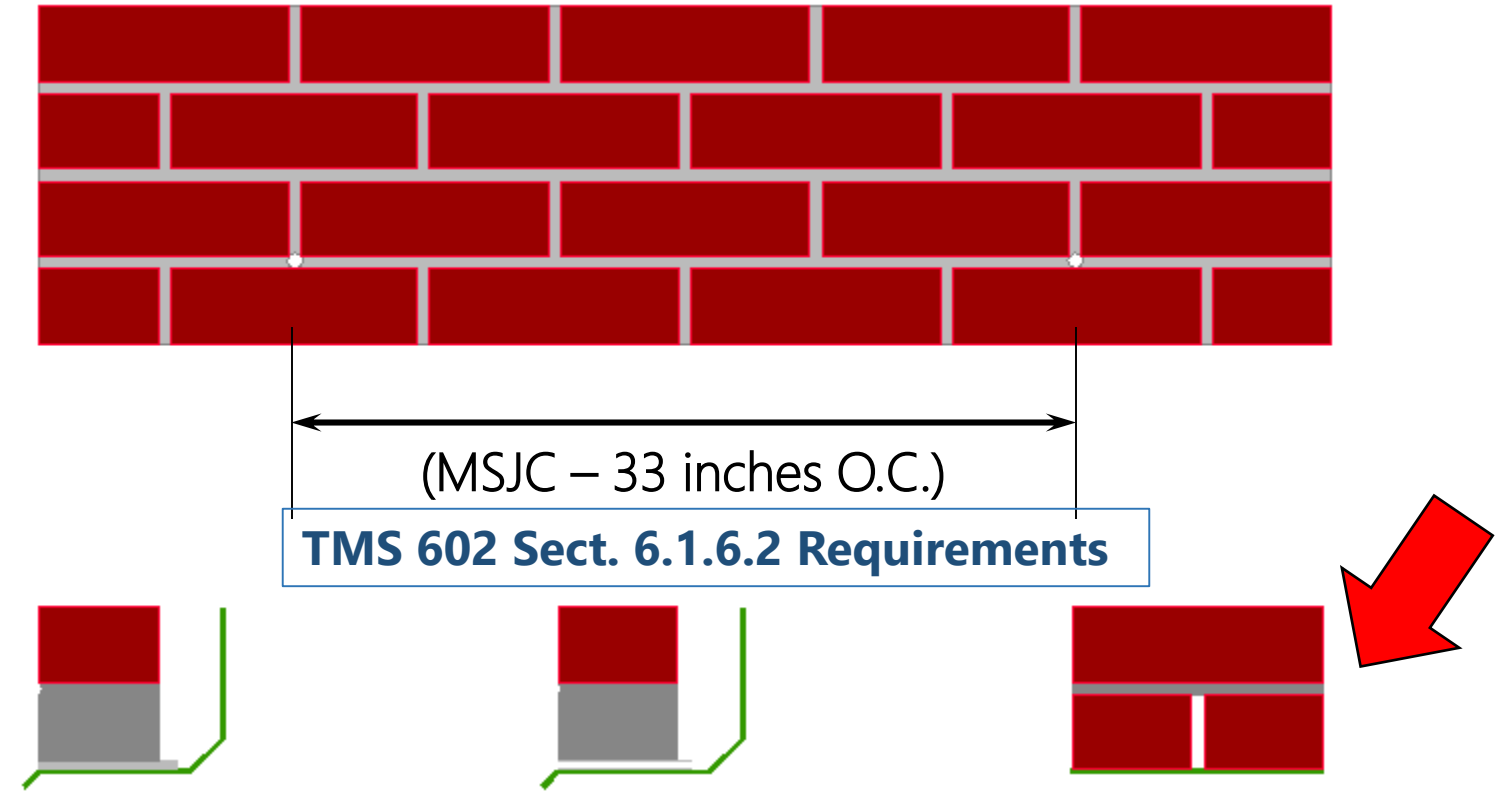
Collar joint must be completely filled

Water is absorbed by masonry or runs down to flashing and exits wall

WEEP HOLES

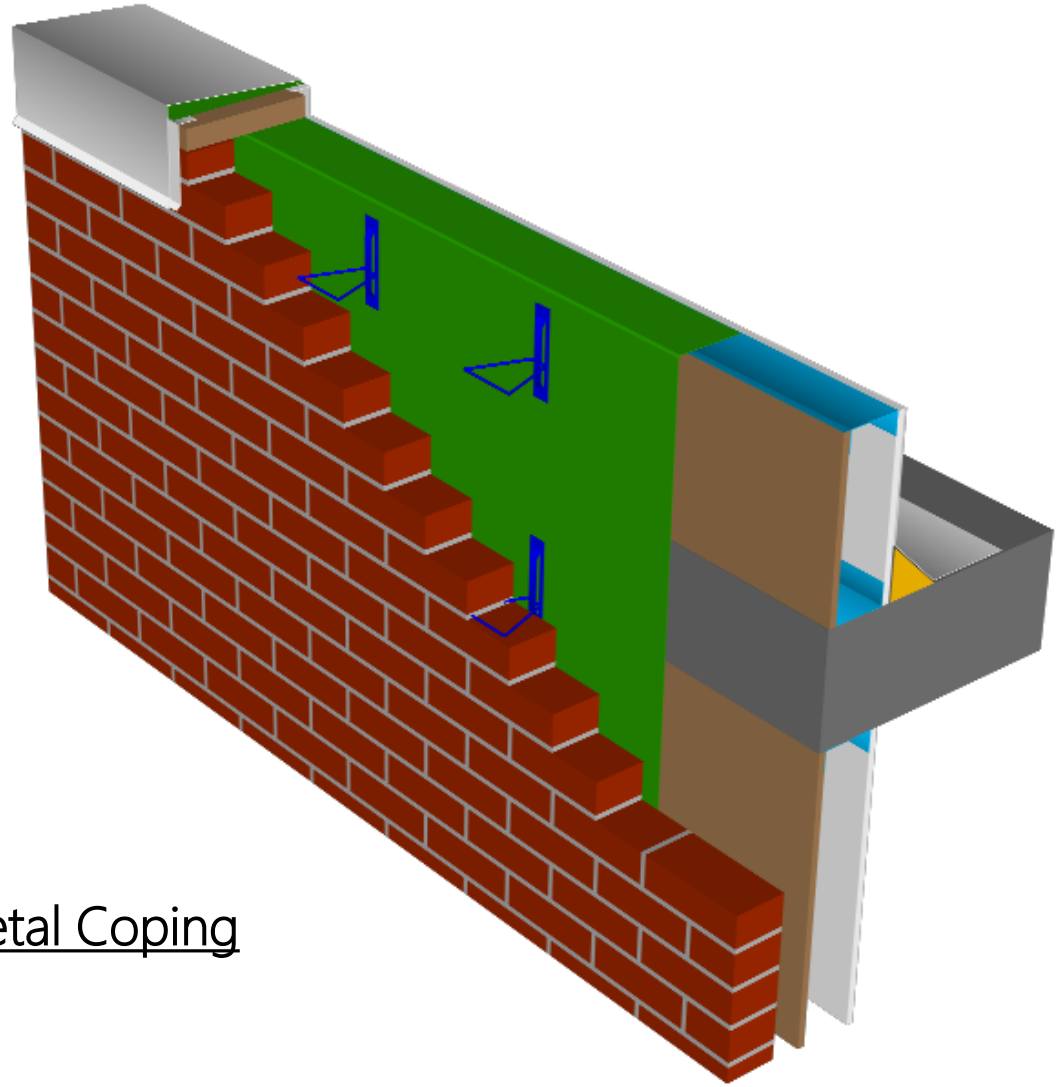
BIA Suggested Spacings

Weep Holes @ 24 " O.C., Wicks @ 16" O.C.



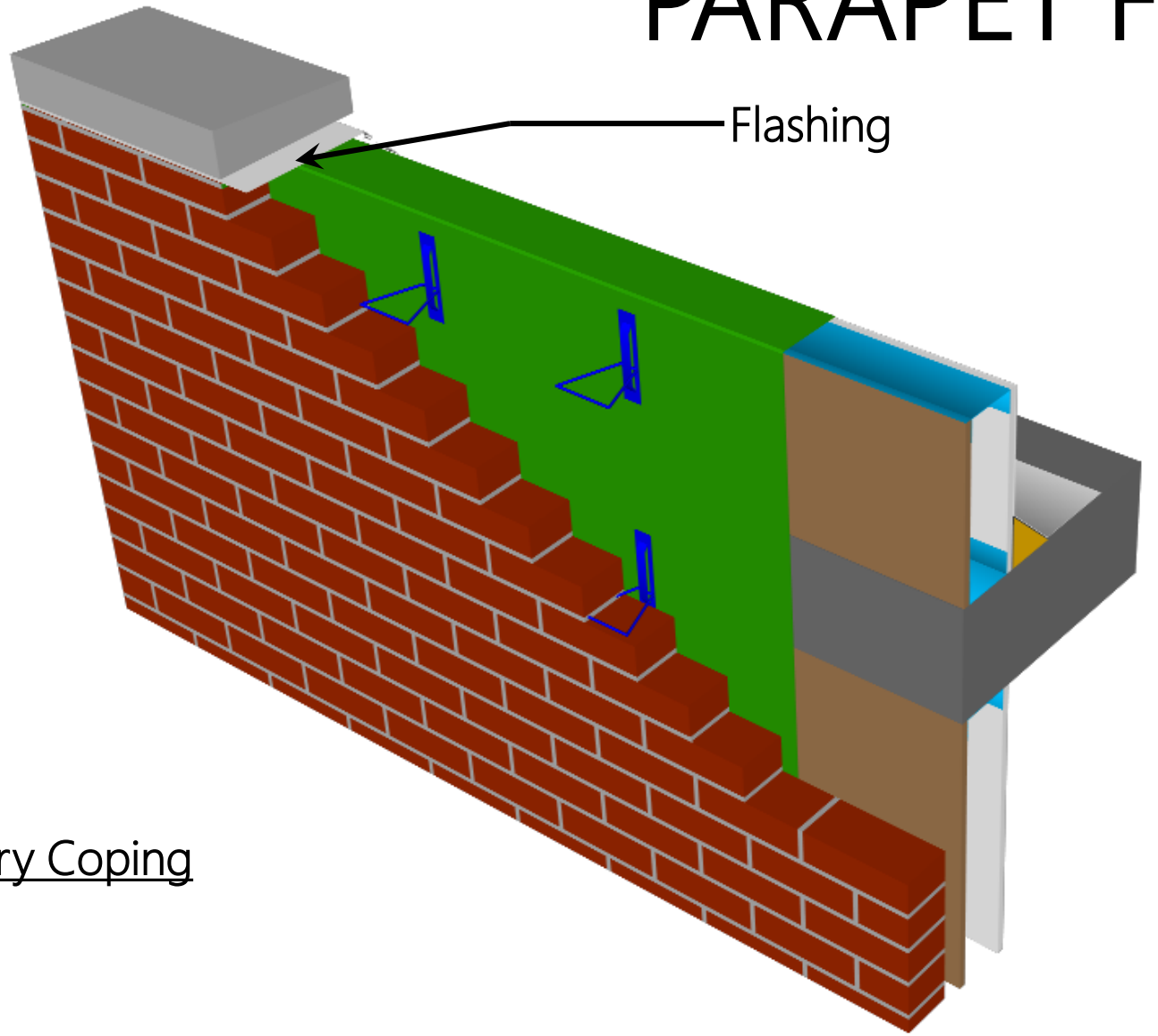
REQUIRED FLASHING LOCATIONS

PARAPET FLASHING



Prefinished Metal Coping

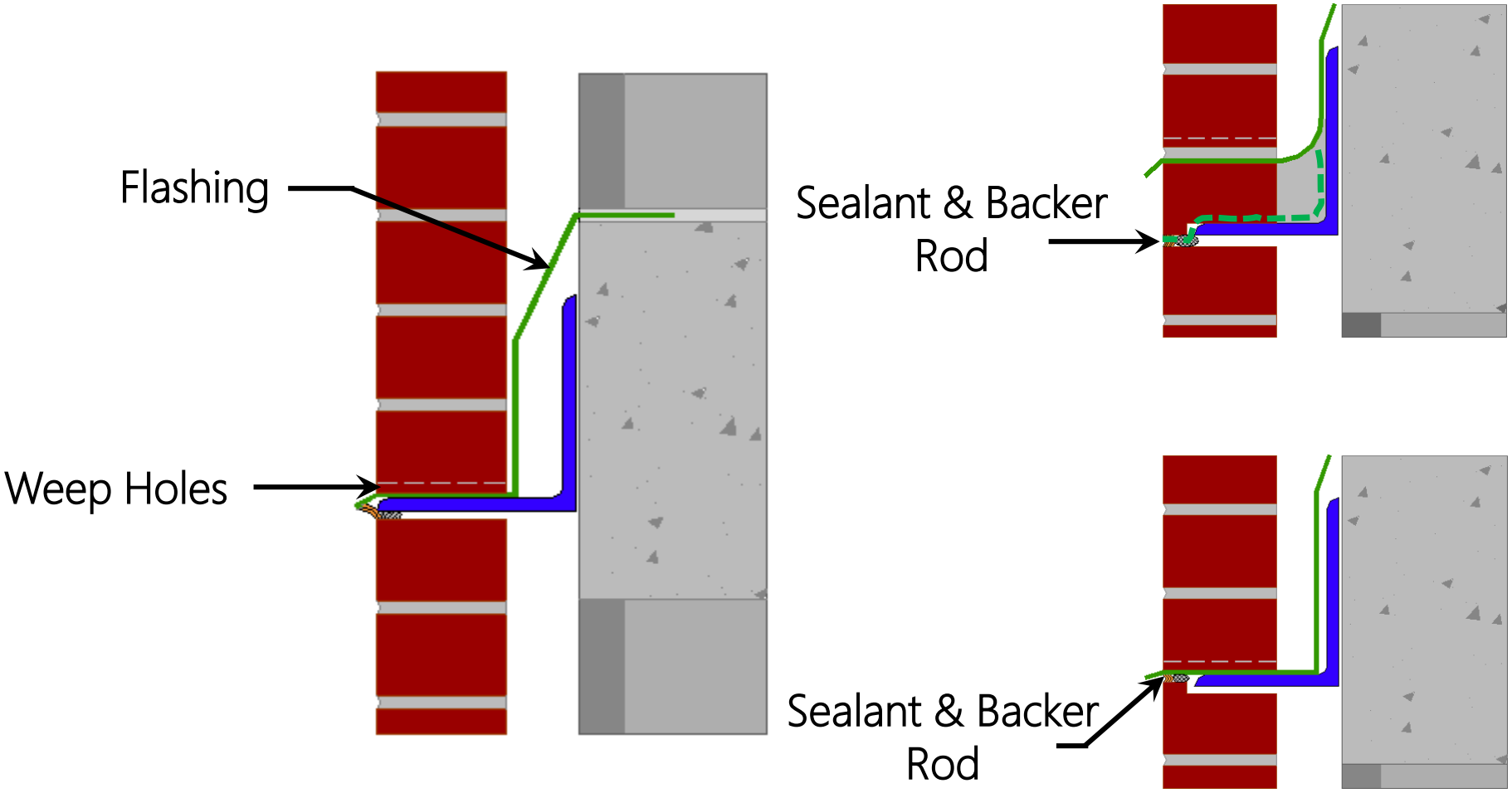
PARAPET FLASHING



Masonry Coping

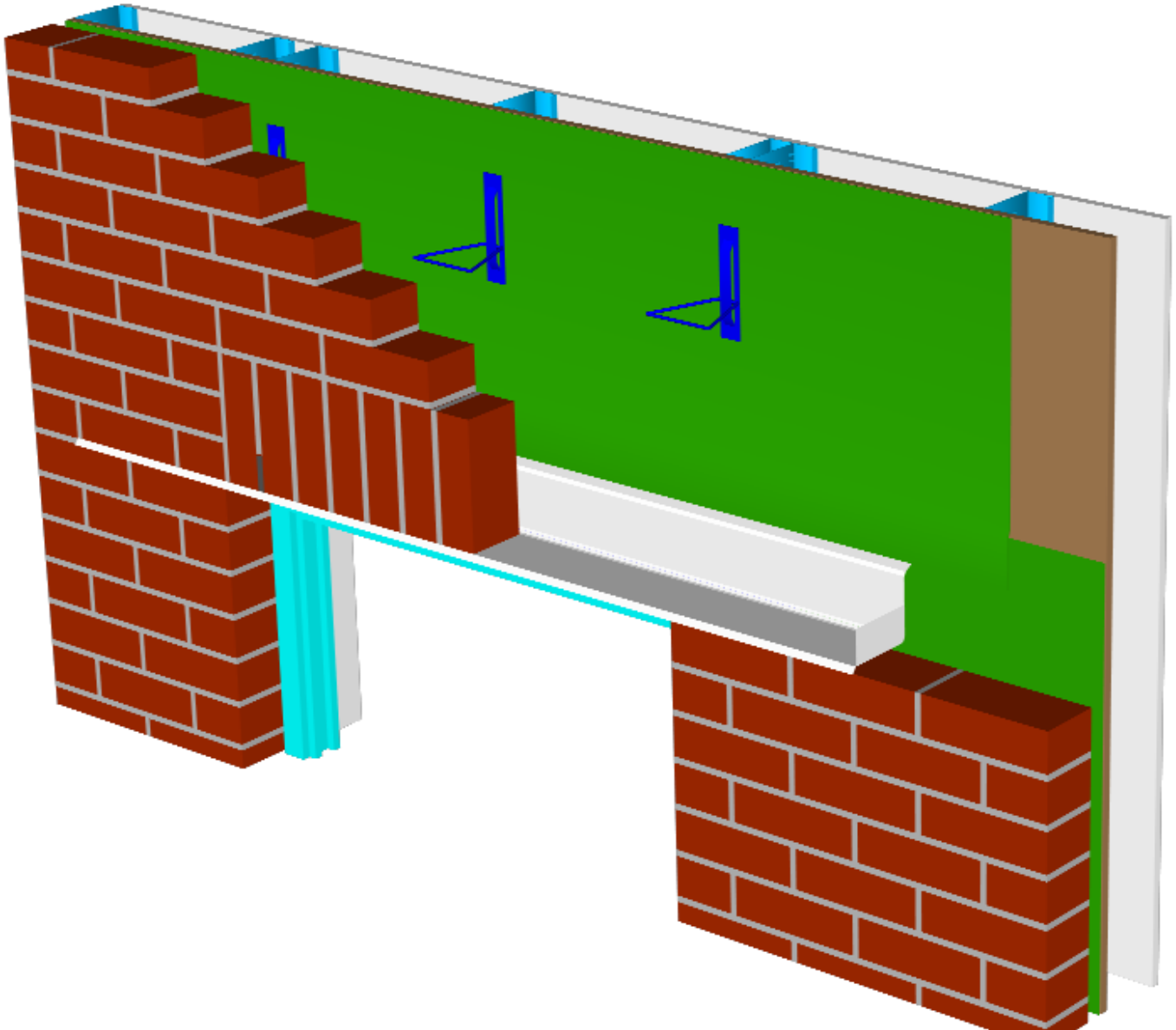
REQUIRED FLASHING LOCATIONS

SHELF ANGLE FLASHING

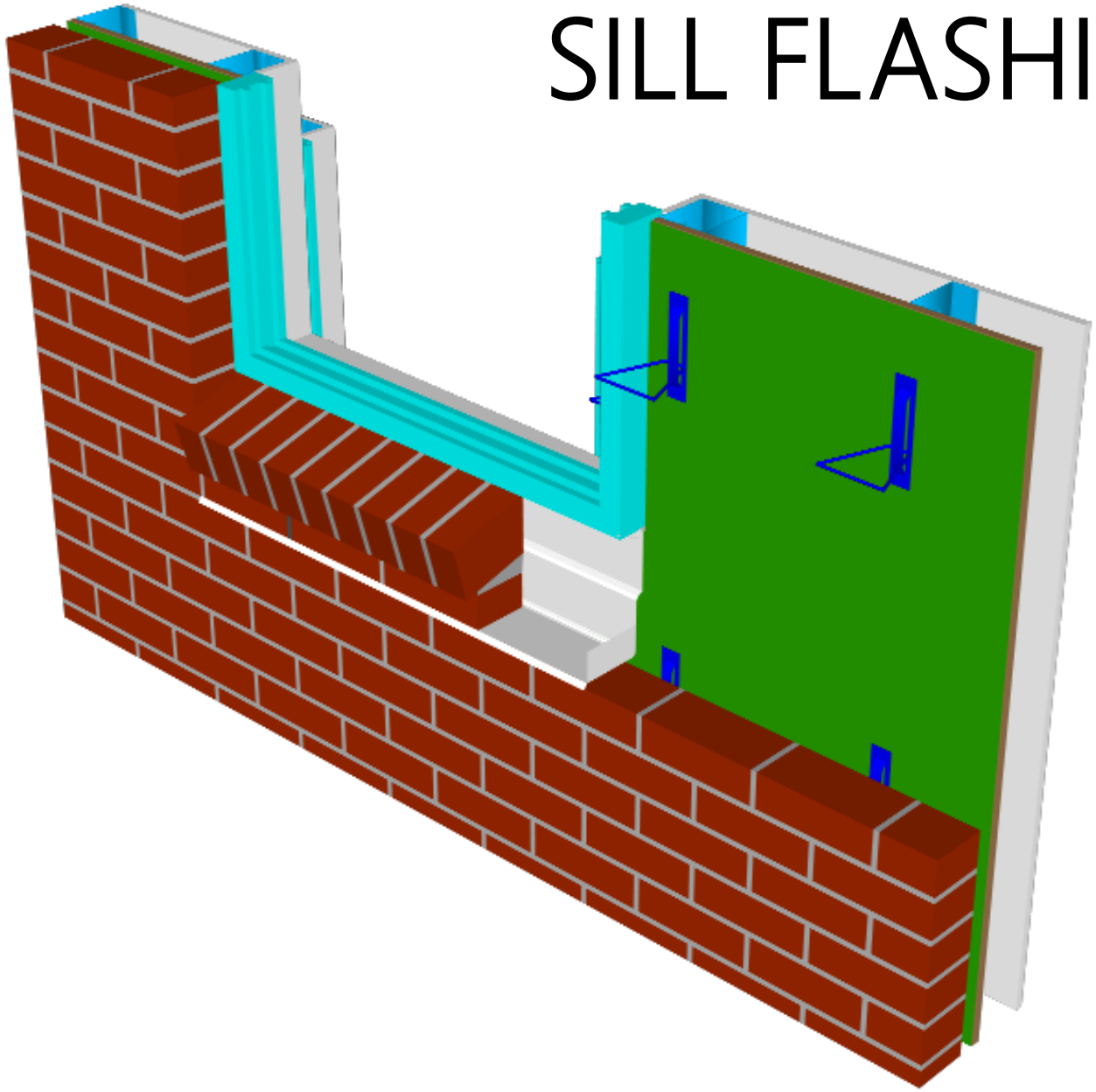


REQUIRED FLASHING LOCATIONS

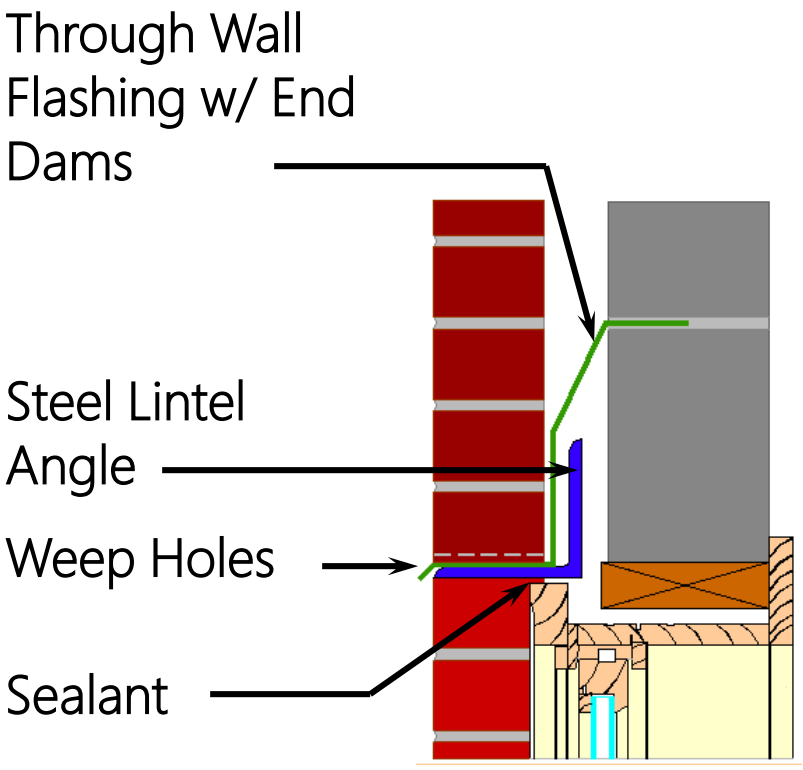
HEAD/LOOSE LINTEL FLASHING



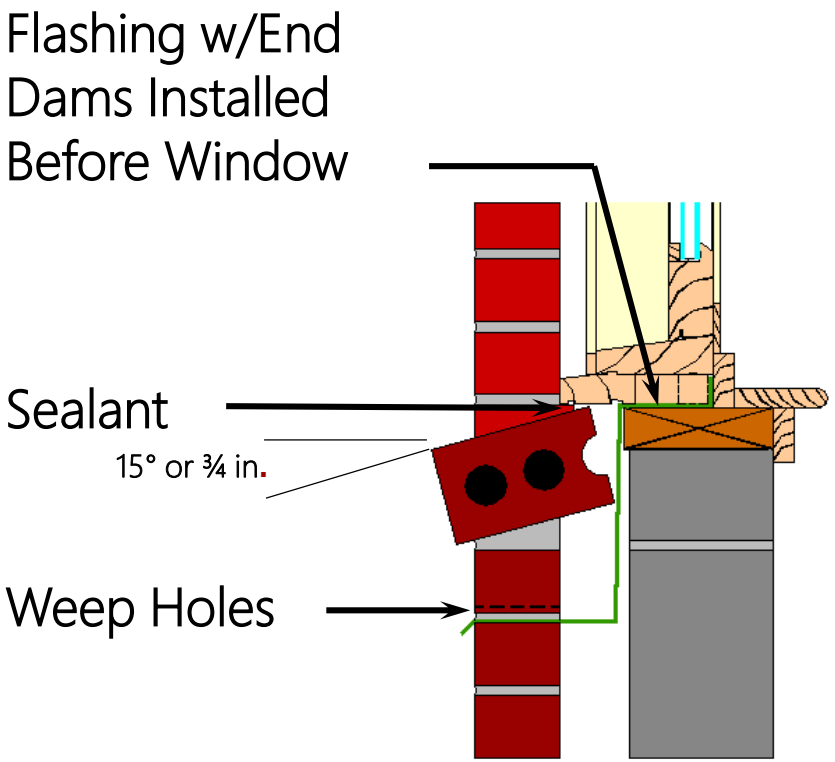
SILL FLASHING



WINDOW FLASHING

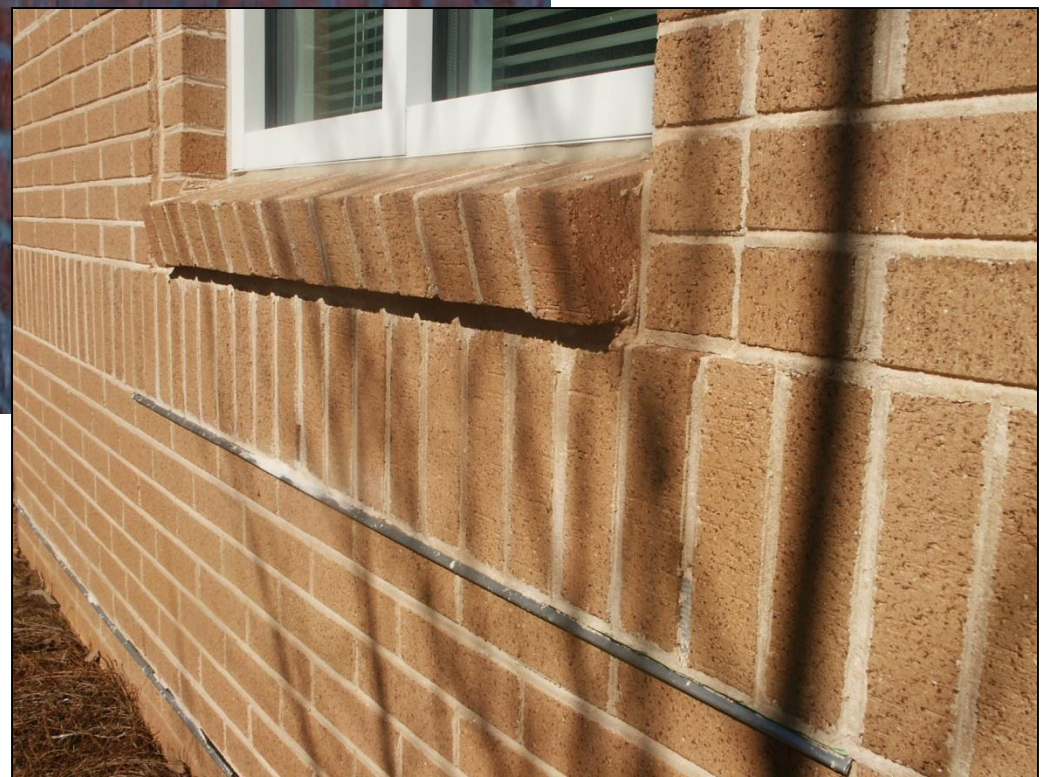


Window Head



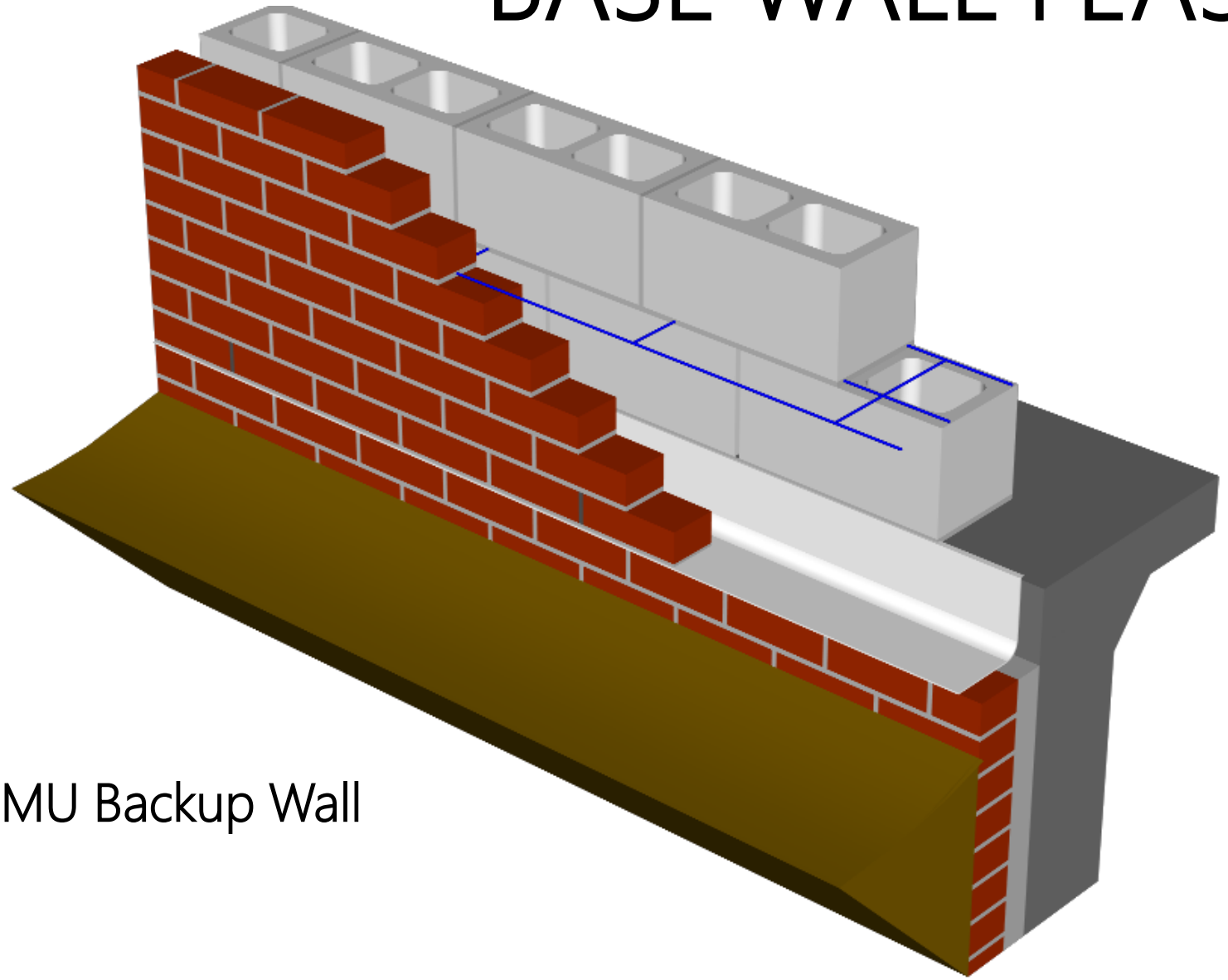
Window Sill

Window Sills- ¾" Slope Minimum



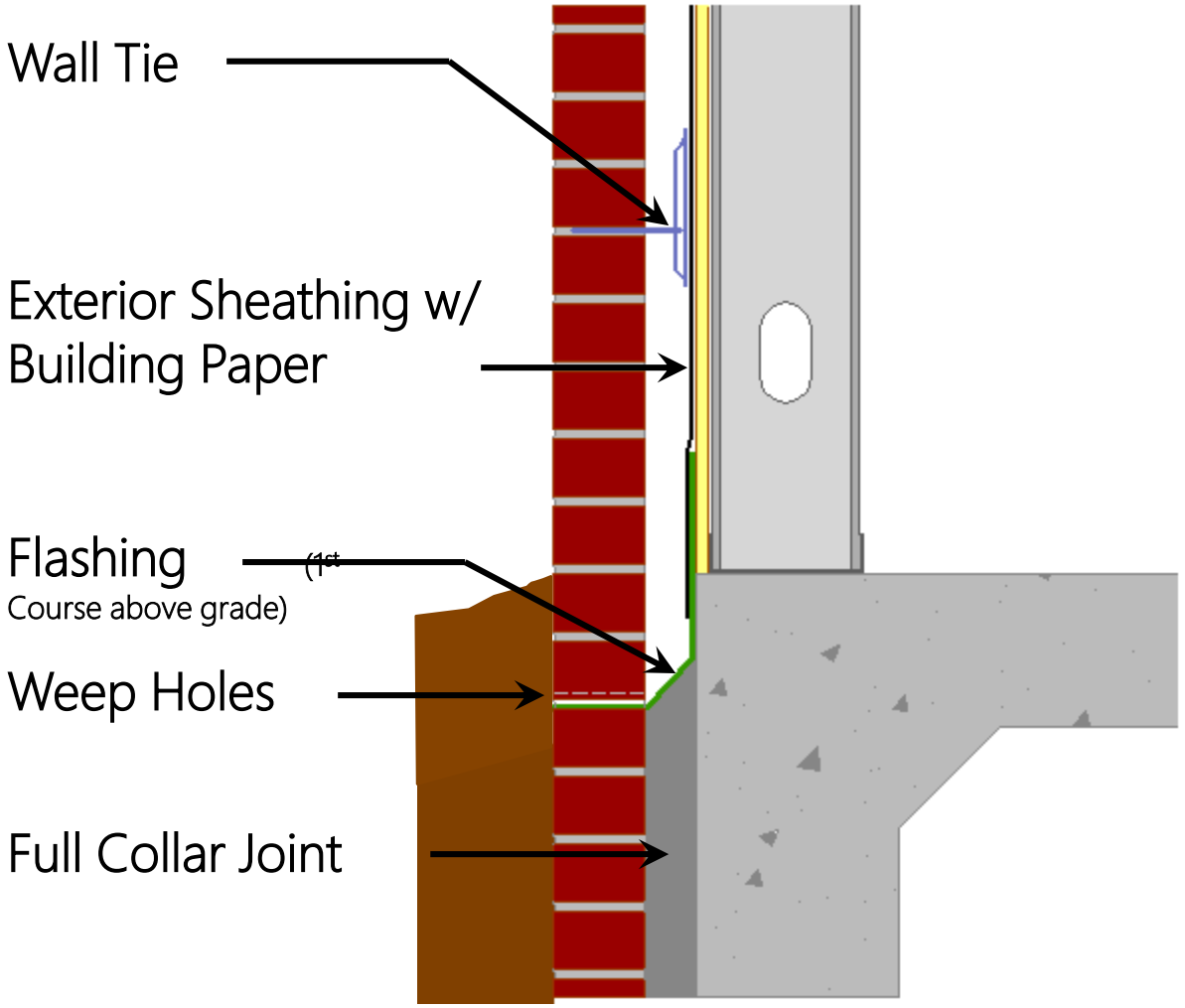
REQUIRED FLASHING LOCATIONS

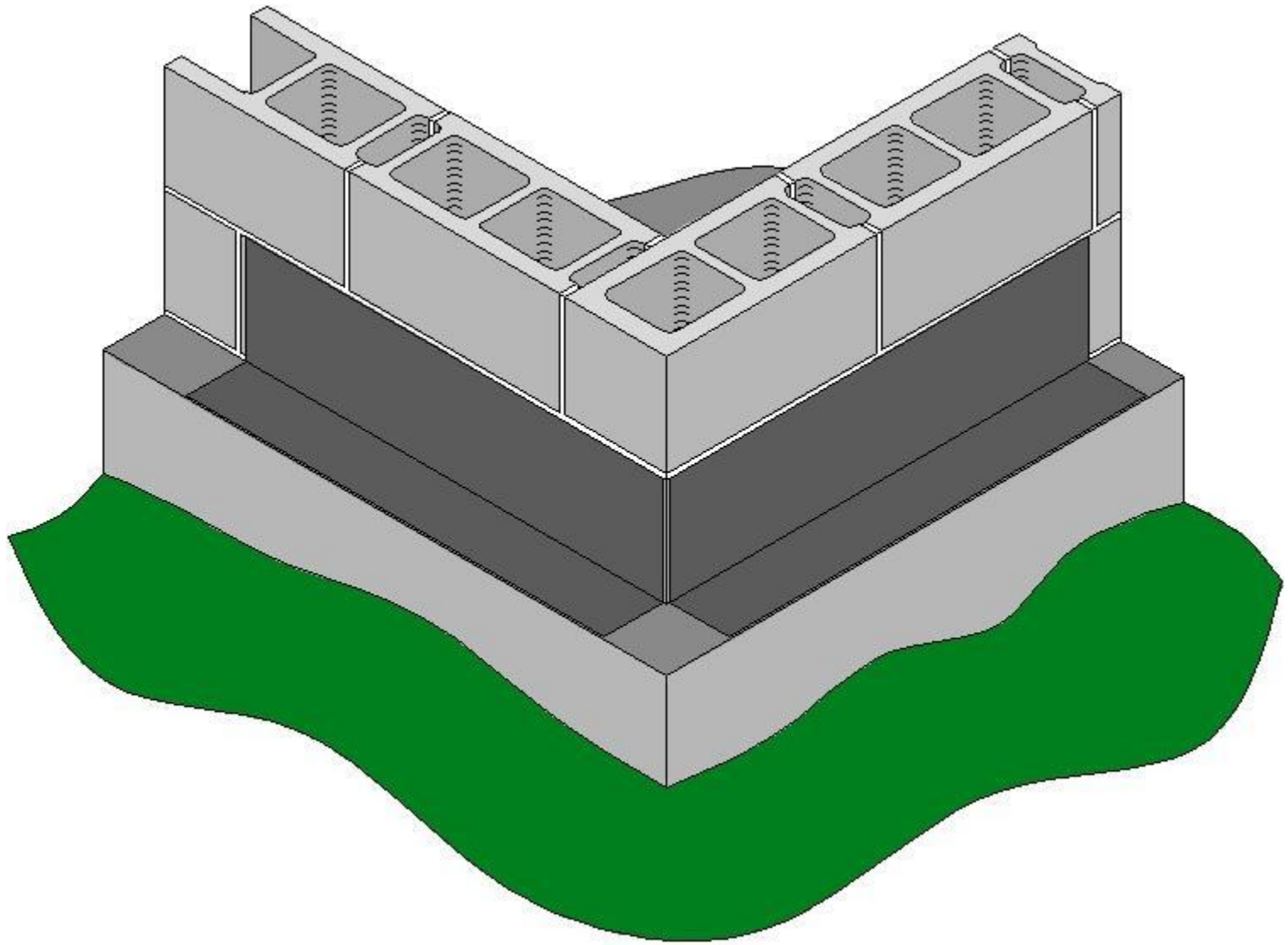
BASE WALL FLASHING

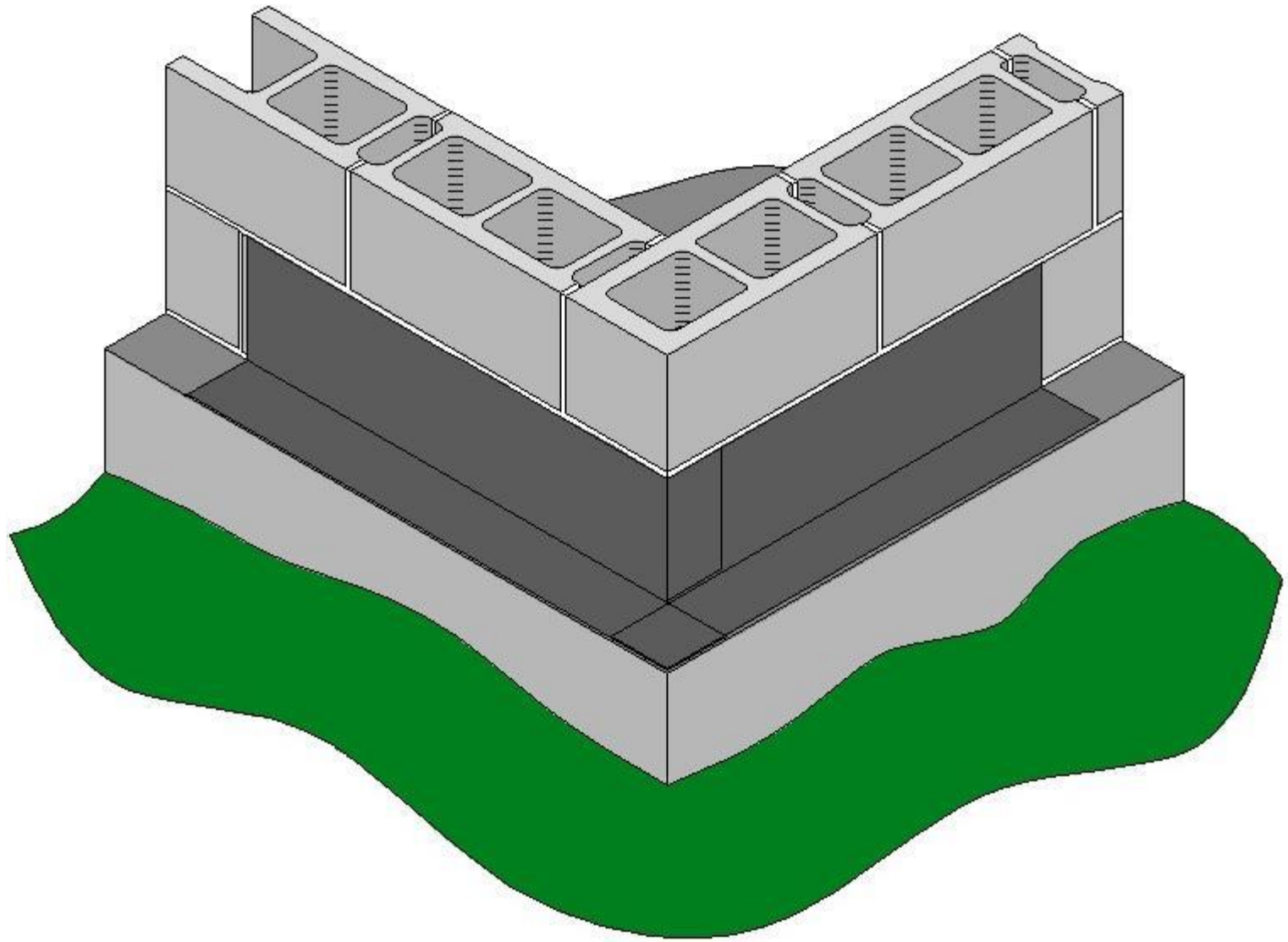


CMU Backup Wall

Through Wall Flashing







BRICK INDUSTRY ASSOCIATION
TECHNICAL NOTES on Brick Construction | 18A
1850 Centennial Park Drive, Reston, Virginia 20191 | www.gobrick.com | 703-620-0010 | November 2006

Accommodating Expansion of Brickwork

Abstract: Expansion joints are used in brickwork to accommodate movement and to avoid cracking. This *Technical Note* describes typical movement joints used in building construction and gives guidance regarding their placement. The theory and rationale for the guidelines are presented. Examples are given showing proper placement of expansion joints to avoid cracking of brickwork and methods to improve the aesthetic impact of expansion joints. Also included is information about bond breaks, bond beams and flexible anchorage.

Key Words: differential movement, expansion joints, flexible anchorage, movement, sealants.

SUMMARY OF RECOMMENDATIONS:

Vertical Expansion Joints in Brick Veneer:
- For brickwork without openings, space no more than 25 ft (7.6 m) o.c.
- For brickwork with multiple openings, consider symmetrical placement of expansion joints and reduced spacing of no more than 20 ft (6.1 m) o.c.
- When spacing between vertical expansion joints in parapets is more than 15 ft (4.6 m), make expansion joints wider or place additional expansion joints halfway between full-height expansion joints
- Place as follows:
  - at or near corners
  - at offsets and setbacks
  - at wall intersections
  - at changes in wall height
  - where wall backing system changes
  - where support of brick veneer changes
  - where wall function or climatic exposure changes
- Extend to top of brickwork, including parapets

Horizontal Expansion Joints in Brick Veneer:
- Locate immediately below shelf angles
- Minimum ¼ in. (6.4 mm) space or compressible material recommended below shelf angle
- For brick infill, place between the top of brickwork and structural frame

Brickwork Without Shelf Angles:
- Accommodate brickwork movement by:
  - placing expansion joints around elements that are rigidly attached to the frame and project into the veneer, such as windows and door frames
  - installing metal caps or copings that allow independent vertical movement of wythes
  - installing jamb receptors that allow independent movement between the brick and window frame
  - installing adjustable anchors or ties

Expansion Joint Sealants:
- Comply with ASTM C 920, Grade NS, Use M
- Class 50 minimum extensibility recommended; Class 25 alternate
- Consult sealant manufacturer's literature for guidance regarding use of primer and backing materials

Bond Breaks:
- Use building paper or flashing to separate brickwork from dissimilar materials, foundations and slabs

Loadbearing Masonry:
- Use reinforcement to accommodate stress concentrations, particularly in parapets, at applied loading points and around openings
- Consider effect of vertical expansion joints on brickwork stability

INTRODUCTION

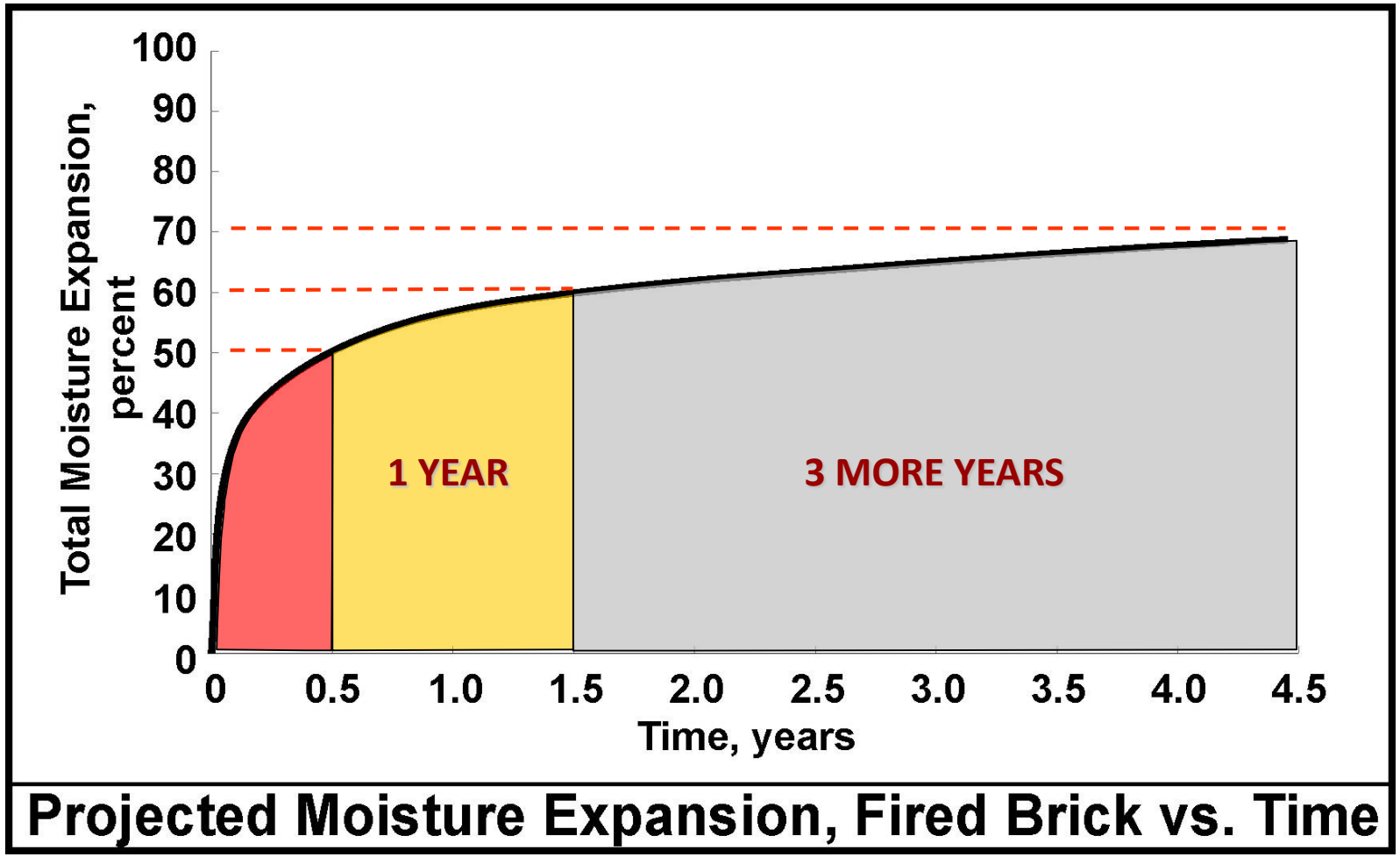
A system of movement joints is necessary to accommodate the changes in volume that all building materials experience. Failure to permit the movements caused by these changes may result in cracks in brickwork, as discussed in *Technical Note* 18. The type, size and placement of movement joints are critical to the proper performance of a building. This *Technical Note* defines the types of movement joints and discusses the proper design of expansion joints within brickwork. Details of expansion joints are provided for loadbearing and nonloadbearing applications. While most examples are for commercial structures, movement joints, although rare, also must be considered for residential structures.

TYPES OF MOVEMENT JOINTS

The primary type of movement joint used in brick construction is the expansion joint. Other types of movement joints in buildings that may be needed include control joints, building expansion joints and construction joints. Each of these is designed to perform a specific task, and they should not be used interchangeably.

EXPANSION JOINT DESIGN

Q: Where should I put the expansion joints on my building?



Projected Moisture Expansion, Fired Brick vs. Time

EXPANSION JOINTS

Spacing of Vertical & Horizontal Joints

$$S_e = \frac{w_j e_j}{(k_e + k_f + k_t \Delta T)\, 100}$$

S_e = spacing between expansion joints

w_j = width of expansion joint

e_j = extensibility of expansion joint material (~ 50%)

k_e = coefficient of moisture expansion (0.0003)

k_f = coefficient of freezing expansion (only if < -10°F and sat.)

k_t = coefficient of thermal expansion (0.000004/°F)

ΔT = temperature change in brickwork

EXPANSION JOINTS

Spacing of Vertical & Horizontal Joints

30 & 4

EXPANSION JOINTS

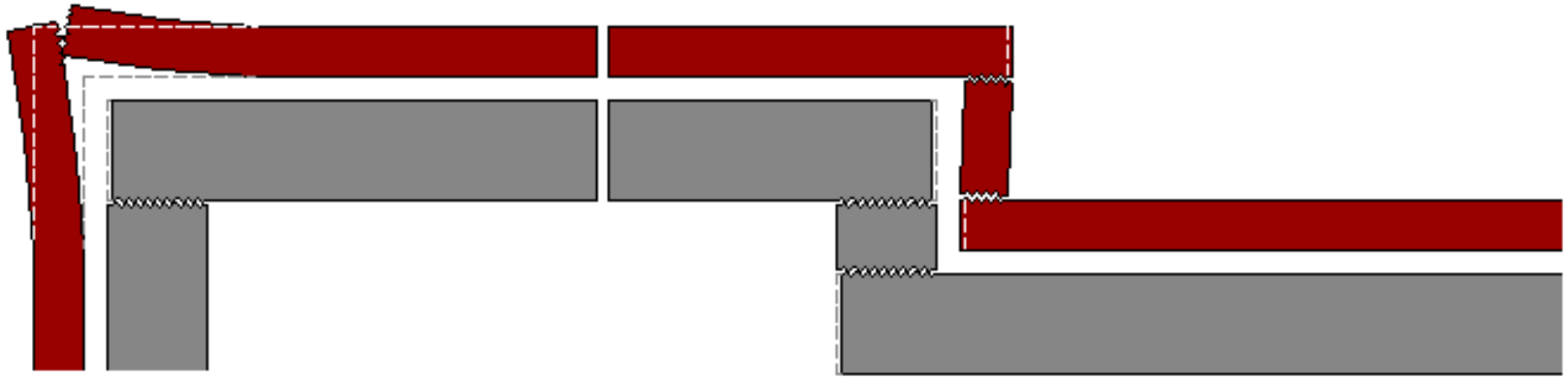
Spacing of Vertical & Horizontal Joints

30’ Run Max

4’ From Corner Max

MOVEMENT

	Brick	CMU
Permanent	0.05 %	- 0.035 %
Thermal	0.0004 %/°T	0.00045 %/°T

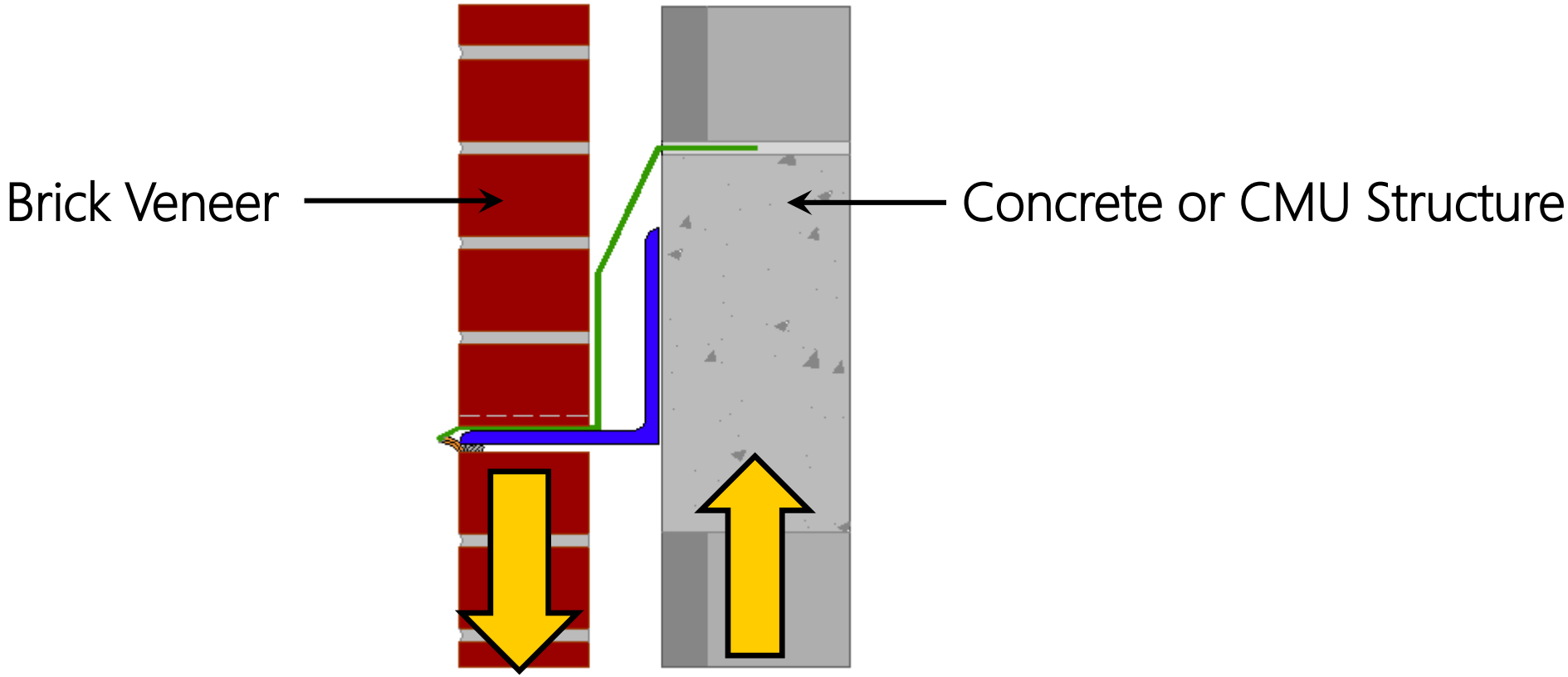


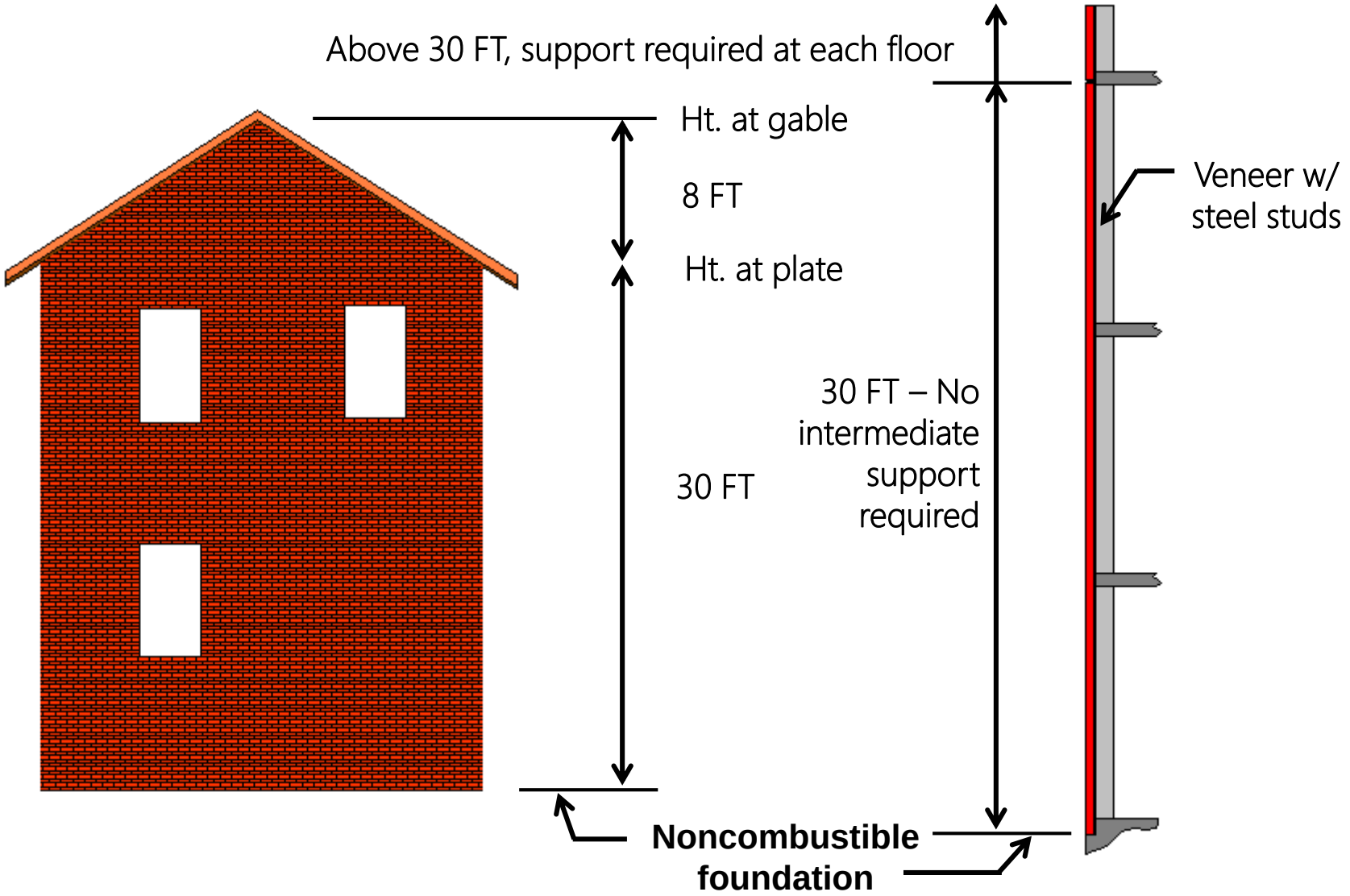
Example: 100 ft brick wall, 100°F Summer, 40°F Winter

Permanent	100 ft x 12 in/ft x .0005 =	0.6 in.
Thermal	100 ft x 12 in/ft x (100 - 40) x .000004 =	0.288 in.
TOTAL		0.888 in ≈ 7/8 in.

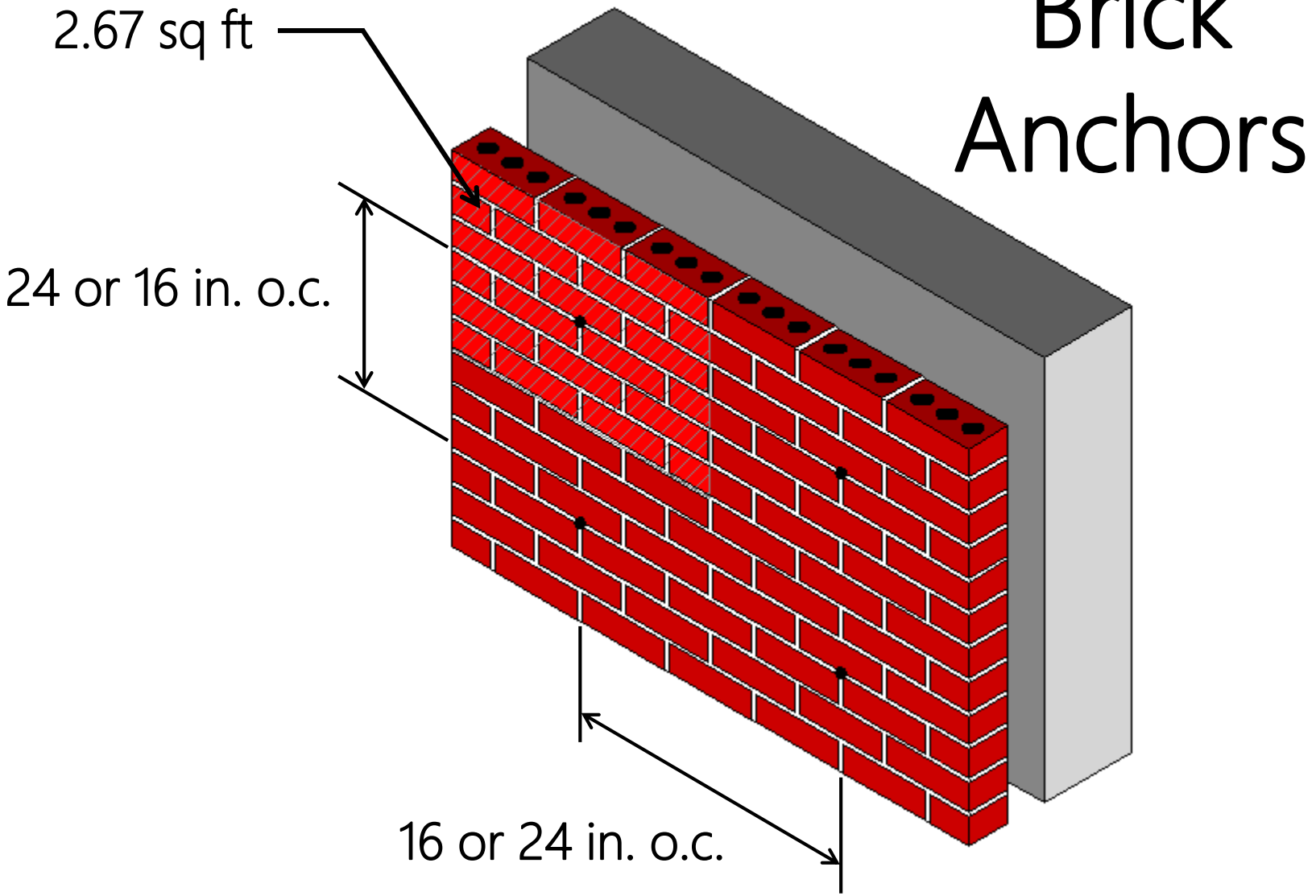
TYPICAL EXPANSION JOINT LOCATIONS

HORIZONTAL EXPANSION JOINTS

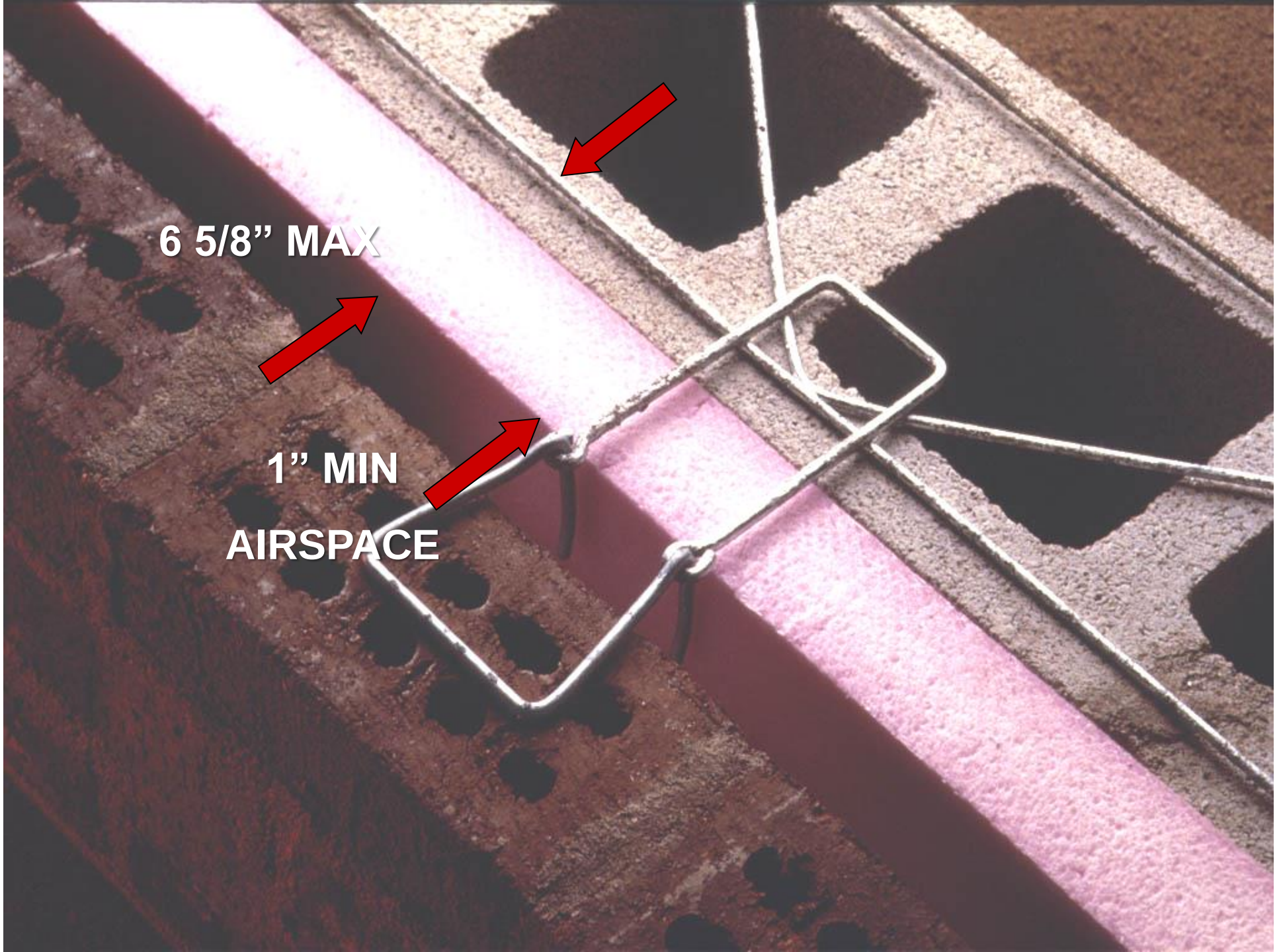



Above 30 FT, support required at each floor
Ht. at gable
8 FT
Ht. at plate
30 FT
30 FT – No intermediate support required
Veneer w/ steel studs
Noncombustible foundation

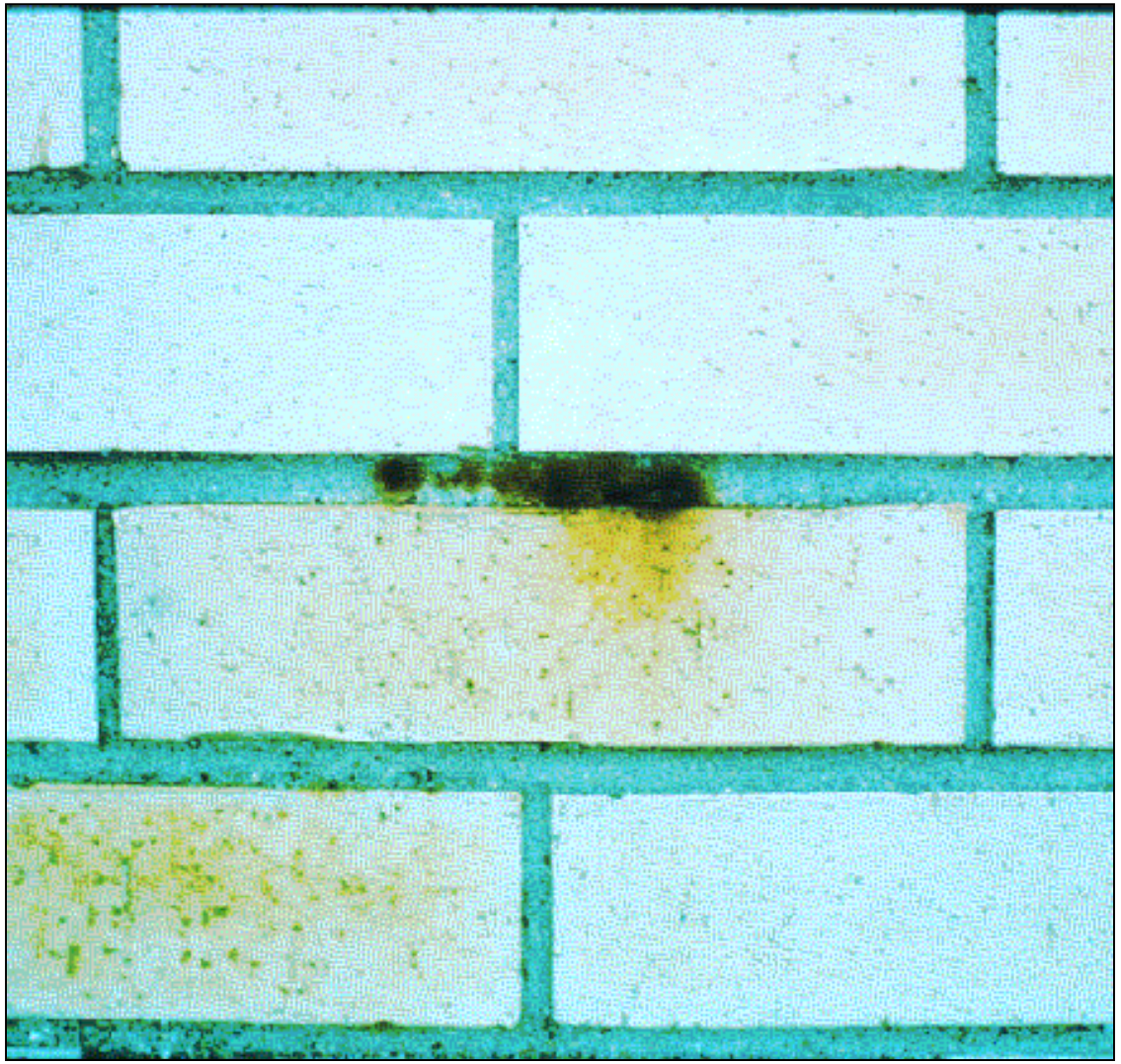
Brick Anchors



NOT APPROVED BY CODE FOR COMMERCIAL PROPETIES


6 5/8” MAX
1” MIN
AIRSPACE

...at least 5/8 in. (15.9 mm) mortar cover to the outside face.



Minimum Air Space

	FBC, Res	FBC, Bldg	TMS 402	BIA*
Wood Stud	1″		1″	1″
Steel Stud	1″		1″	2″
Concrete/ Masonry	1″		1″	2″

*Recommended


1
2
3

Masonry Best Practices

Sampling & Mock-ups

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SAMPLING & MOCK-UPS

Mini Panels – Qualifying color texture and scale (no older than 6 months)
Mortar sample - Color

Recent Run Sample – Natural material, can vary from run to run
Submittal Package – Test Reports and Letter of Certification
Budget $$ reviewed

Selection has been made & Project Bid

Jobsite Mock-up to establish product and workmanship standards using run sample of material

SAMPLING & MOCK-UPS

Jobsite Mock-up to establish product and workmanship standards

POTENTIAL PROBLEMS

1. Mock-up disappears – needs to stay up till project is finished
2. Mock-up not built to production standards…
    - Too perfect
    - Not Cleaned as specified
    - Special conditions not shown
        - Shapes
        - Windows and doors
3. Cleaned incorrectly
    - Clean to the weakest link

Masonry Best Practices

Questions

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Masonry Best Practices

Thank you!

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