CRACK CONTROL IN CONCRETE MASONRY WALLS

NCMA

PROGRAM # -- 0503 -01

Continuing Education Services

NATIONAL CONCRETE MASONRY ASSOCIATION

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Continuing Education Services

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This is Not proper Crack Control

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Causes of Concrete Masonry Cracks

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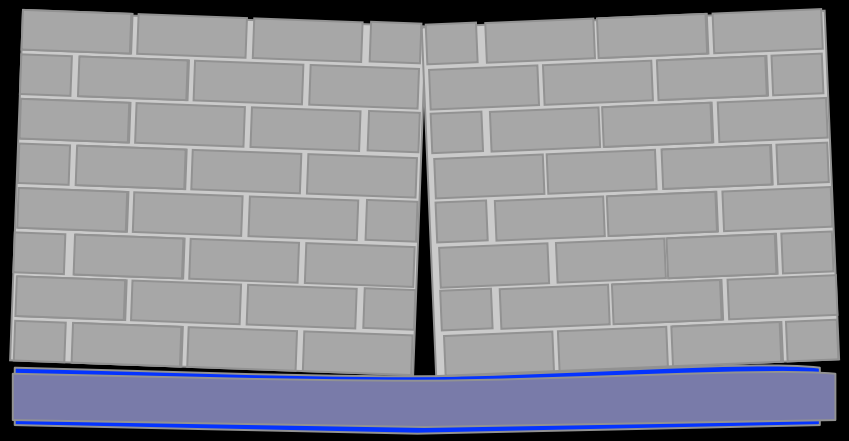
1. Excessive deflection
2. Structural Overload



TEK 10-1A

Causes of Concrete Masonry Cracks

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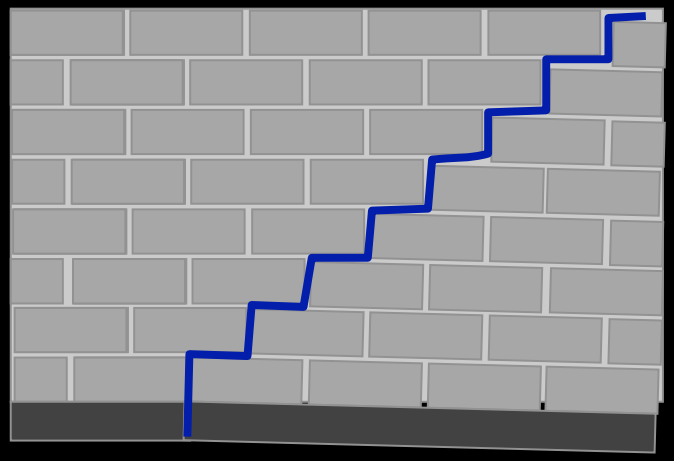
3. Differential settlement



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Causes of Concrete Masonry Cracks

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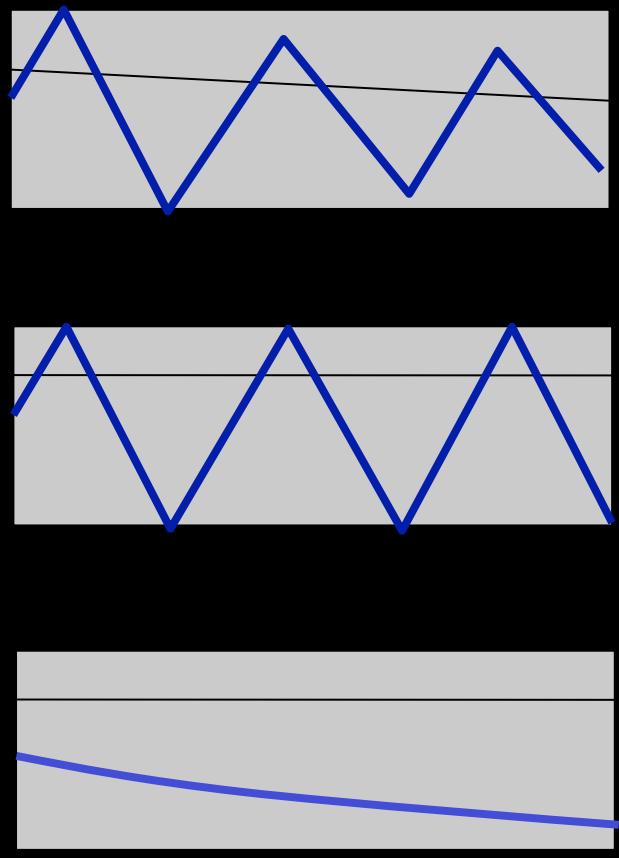
4. Shrinkage

- Moisture change
- Temperature
- Carbonation



General trend = shrinkage

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Shrinkage Cracking

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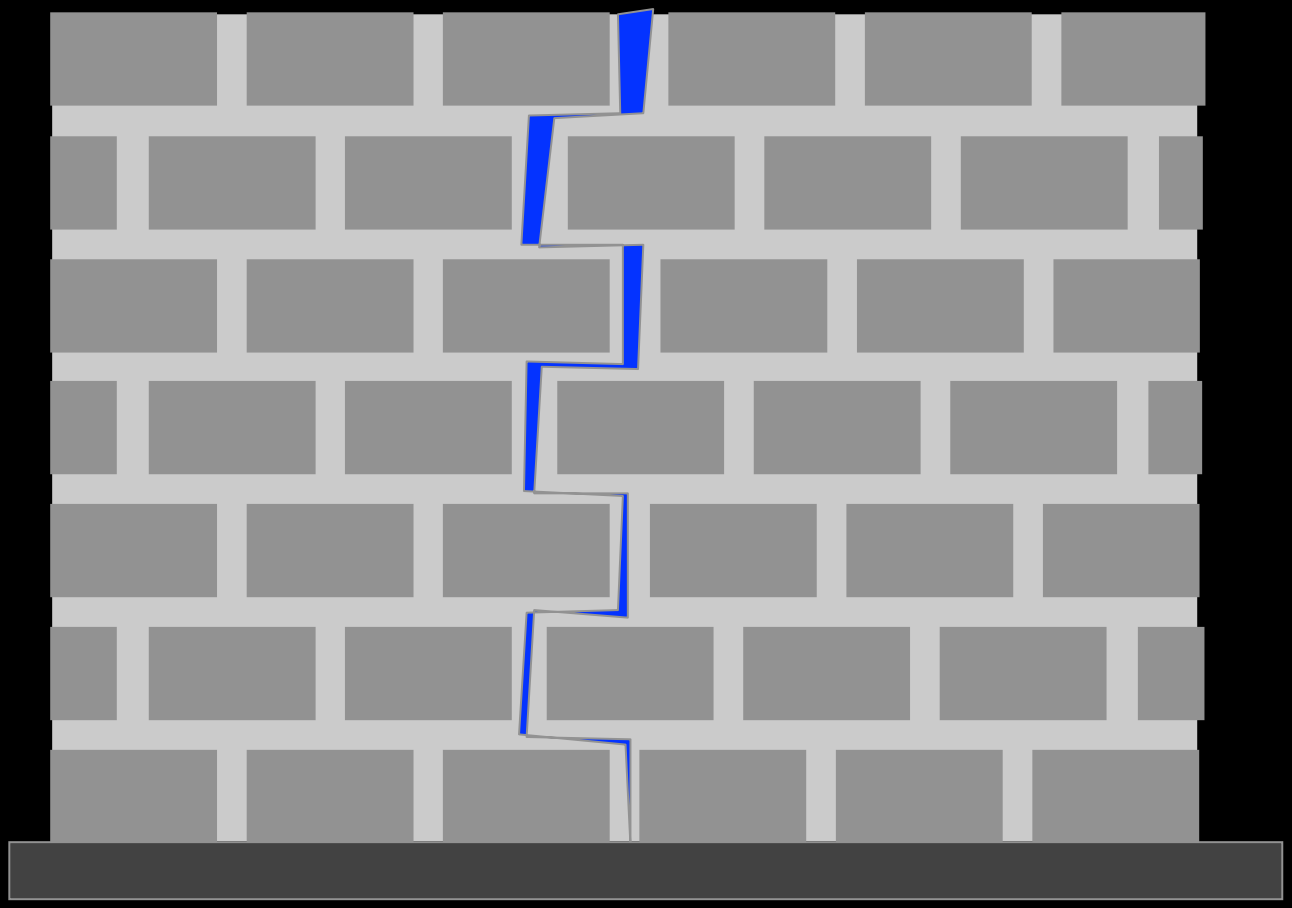

Restraint at bottom only

Shrinkage Cracking

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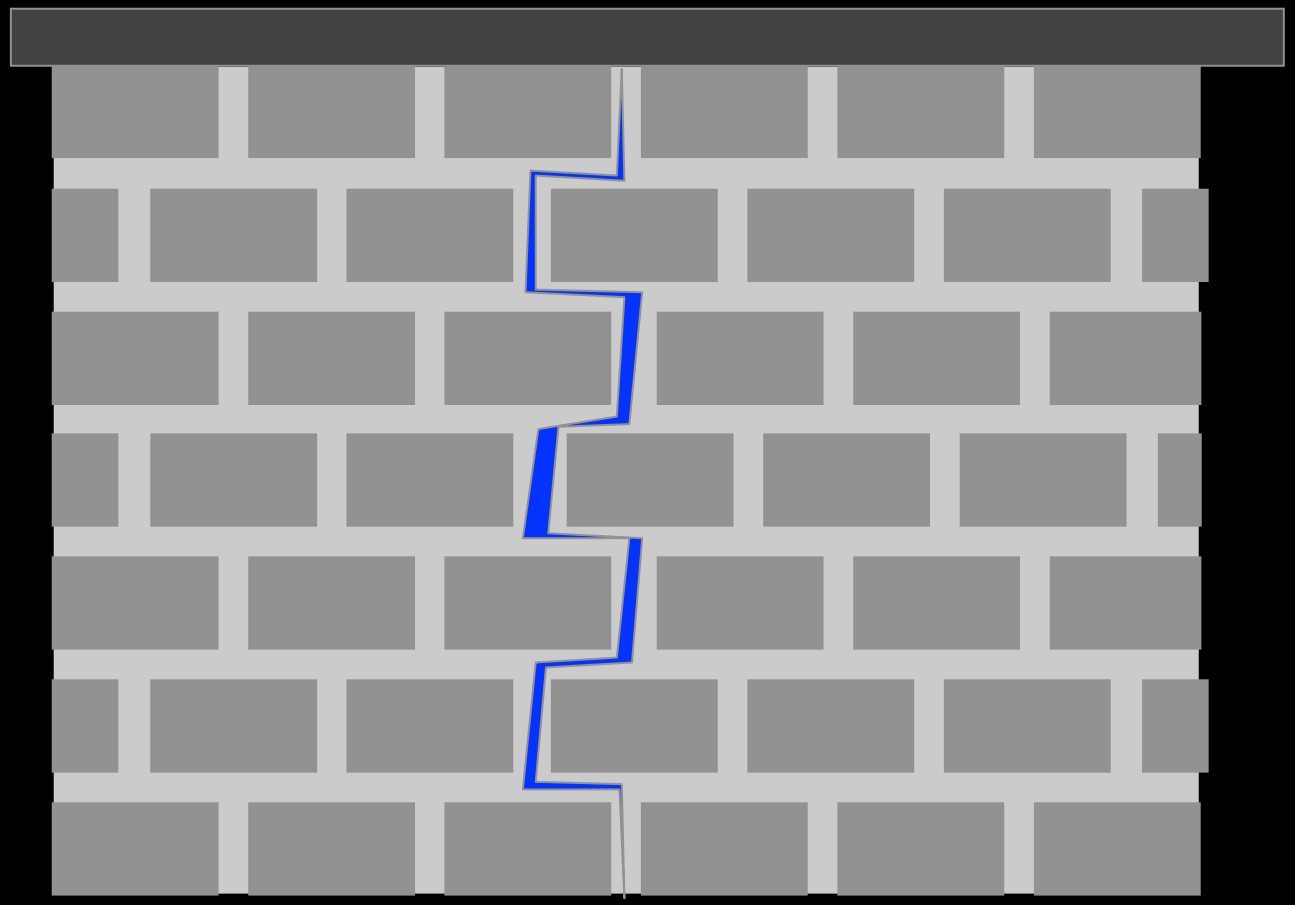

Restraint at top and bottom

Accommodating Movement

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- Control Joints
  - Used in concrete masonry construction
- Expansion Joints
  - Used with clay brick

Purpose of Control Joints

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- Relieve horizontal tensile stresses
- Reduce restraint and permit longitudinal movement
- Separate dissimilar materials

Goal of Crack Control Provisions

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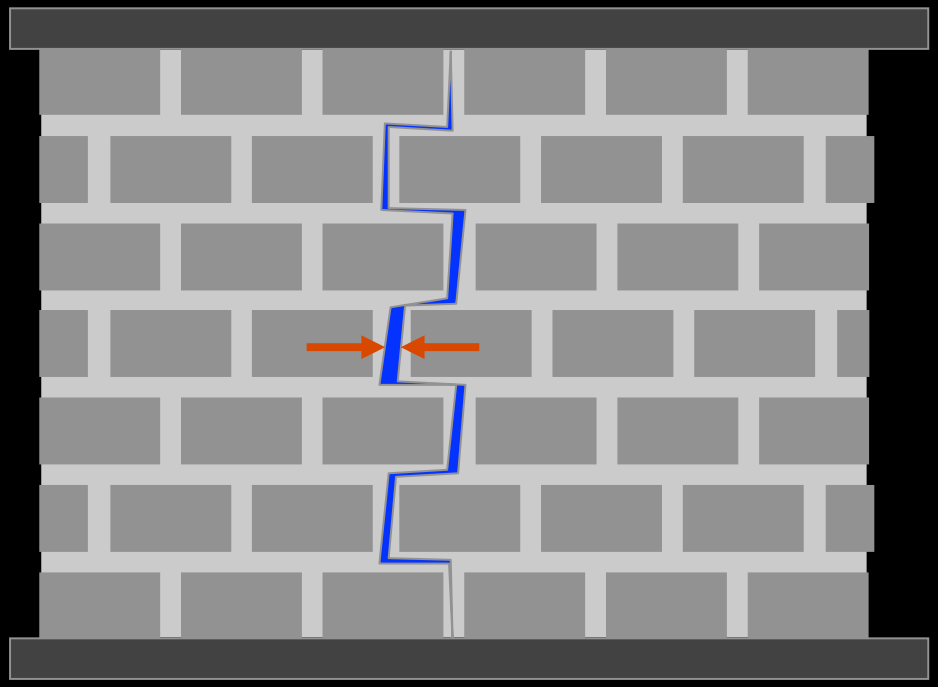

Restraint at top and bottom

Limit crack widths to less than 0.02 in (0.5 mm)

- able to be bridged by most coatings
- prevents water penetration

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Specifying Concrete Masonry Units

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- Included in C 90
  - Compressive Strength
  - Absorption
  - Dimensional Tolerances
  - Density Definitions
  - Linear Drying Shrinkage

C 90

Standard Specification for Loadbearing Concrete Masonry Units

TEK 1-1C

Specifying Concrete Masonry Units

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- **NOT** Included in C 90
  - Color
  - Texture
  - Density
  - Water Repellency
  - Fire Ratings
  - Thermal Properties
  - Sound Properties

Most architectural concrete masonry units are custom made. Work closely with producers to get exactly what you want.

ASTM

C 90

Standard Specification for Loadbearing Concrete Masonry Units

TEK 1-1C

Type I and Type II CMU

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3.1 Types - Two types of concrete masonry units are covered as follows:

3.1.1 Type I, Moisture-Controlled Units - Units designated as Type 1 shall conform to the requirements of this specification.

3.1.2 Type II, Nonmoisture-Controlled Units - Units designated as Type 2 shall conform to the requirements of this specification with the exception of Table 1.

This section was removed.
Does not appear in C 90-00 & later.

TEK 1-1C

Recommended Maximum Unit Moisture Content

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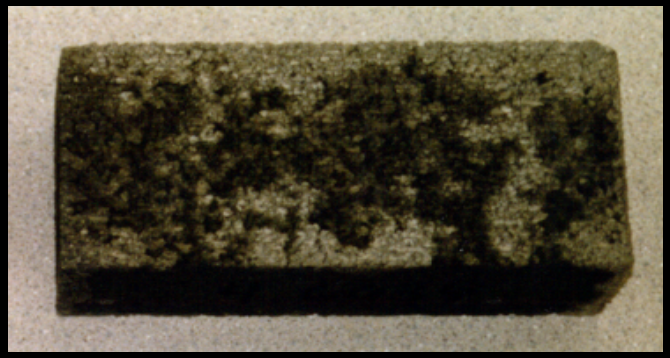
- When 50% or more of the surface area is observed to be wet, the unit is considered to be unacceptable for placement.
- Damp surfaces are not considered wet.
- Test procedure: The surface is considered wet if moisture is observed and the surface does not darken when free water is applied.



TEK 3-1C

Control Joint Spacing Recommendations

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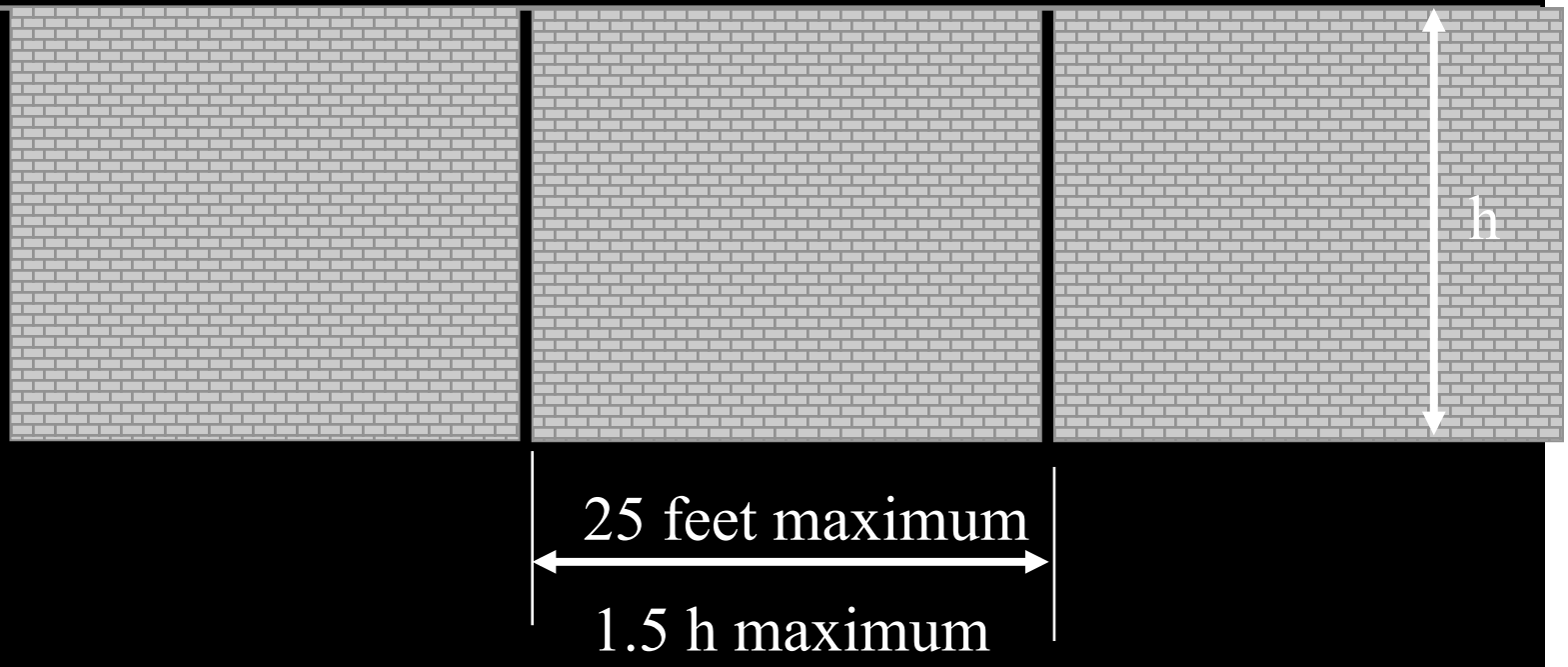

So, for h = 8 ft, spacing ≤ 12 feet

for h = 20 ft, spacing ≤ ~~30 feet~~ 25 feet

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Control Joint Spacing Recommendations

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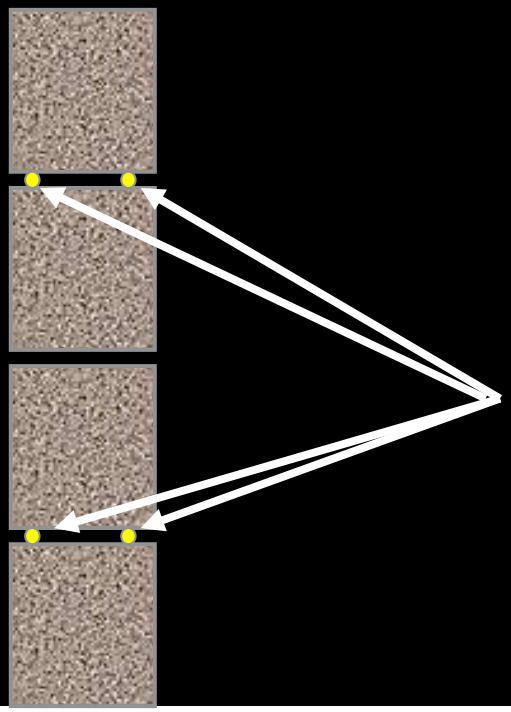
1. Control joint spacings are based on the use of horizontal reinforcement having an equivalent area of no less than 0.025 in^2 / ft of height to keep unplanned cracks closed.



$$\frac{\text{Sum of steel area}}{\text{height}}$$

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Control Joint Spacing Recommendations

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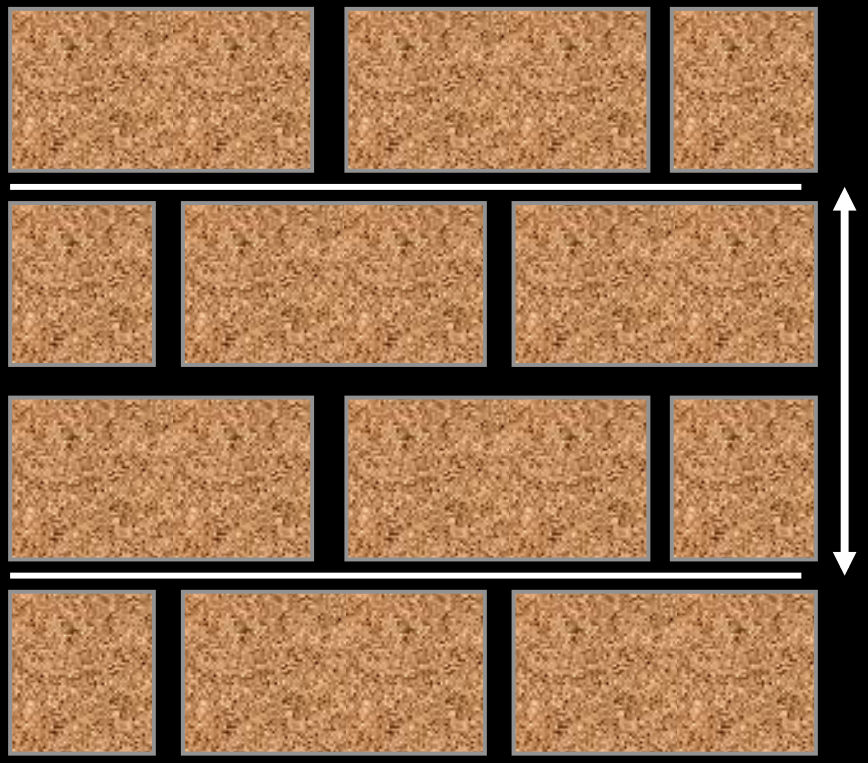
1. Control joint spacings are based on the use of horizontal reinforcement having an equivalent area of no less than 0.025 in^2 / ft of height.



i.e. 9 gage joint reinforcement every other course (16 in.) or….

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Control Joint Spacing Recommendations

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1. Control joint spacings are based on the use of horizontal reinforcement having an equivalent area of no less than 0.025 in^2 / ft of height.

…. by the use of bond beams and….

#3 bars at 48 in. (4 ft.)
#4 bars at 96 in. (8 ft.)
#5 bars at 144 in. (12 ft.)

TEK 10-2B

The Role of Reinforcement in Controlling Shrinkage Cracking

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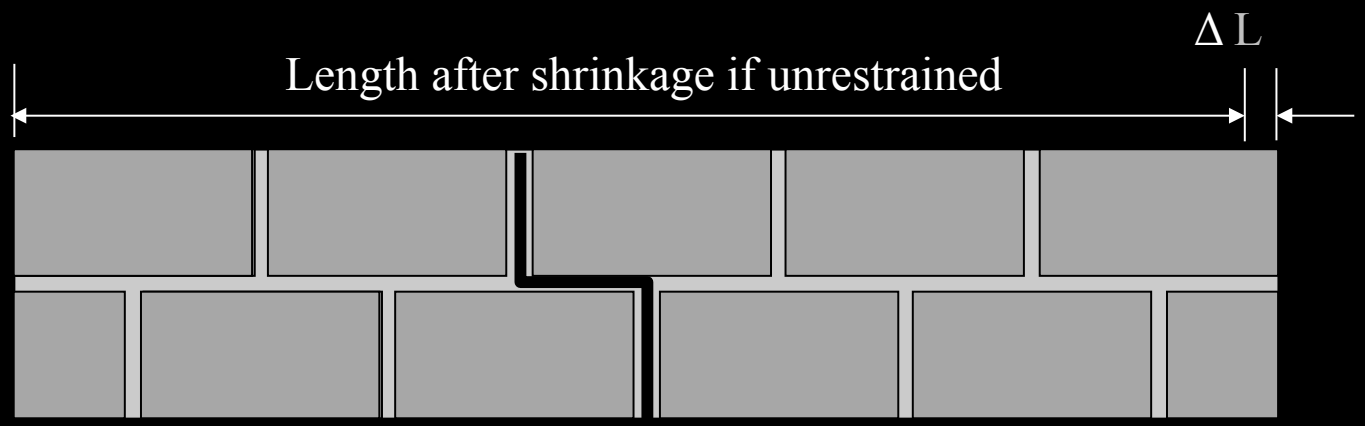
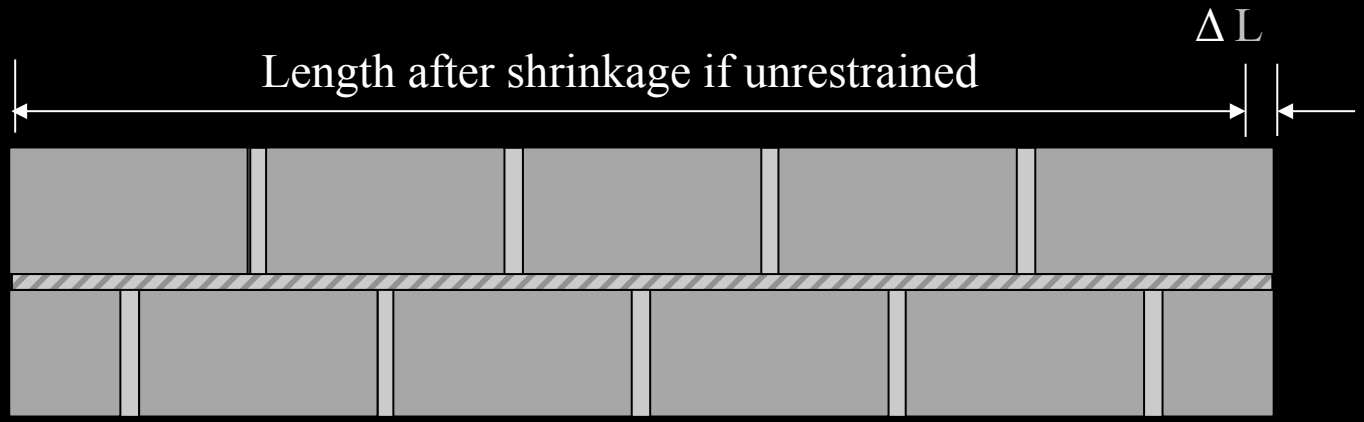


Without horizontal reinforcement



With horizontal reinforcement

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Joint Reinforcement

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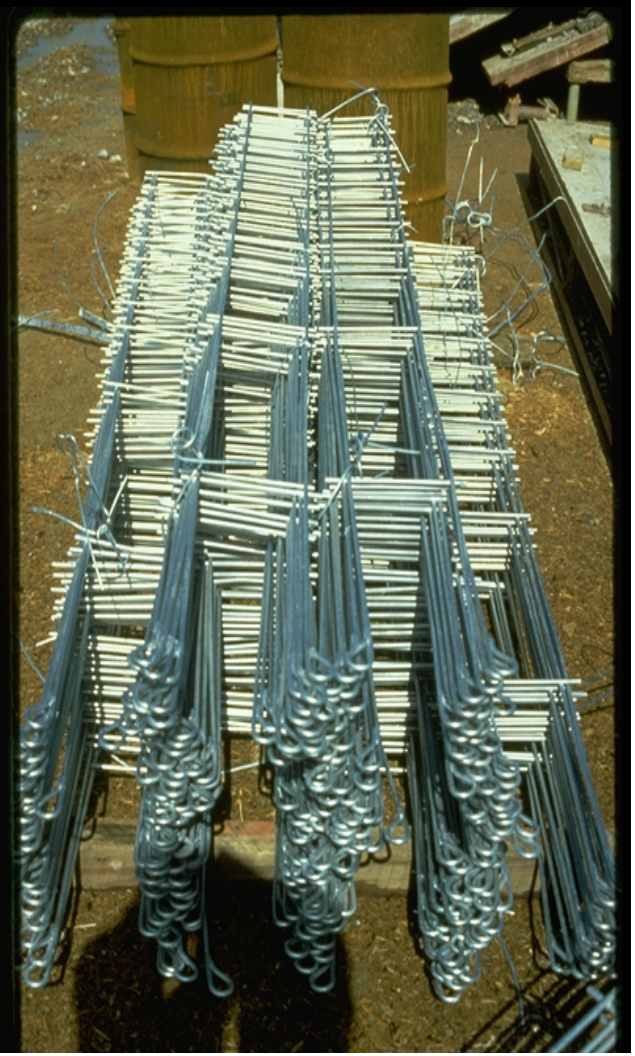
- Primary function - control wall cracking associated with shrinkage

- Secondary Functions
  - metal tie system for bonding
  - structural reinforcement where allowed by code



TEK 12-2B

Joint Reinforcement

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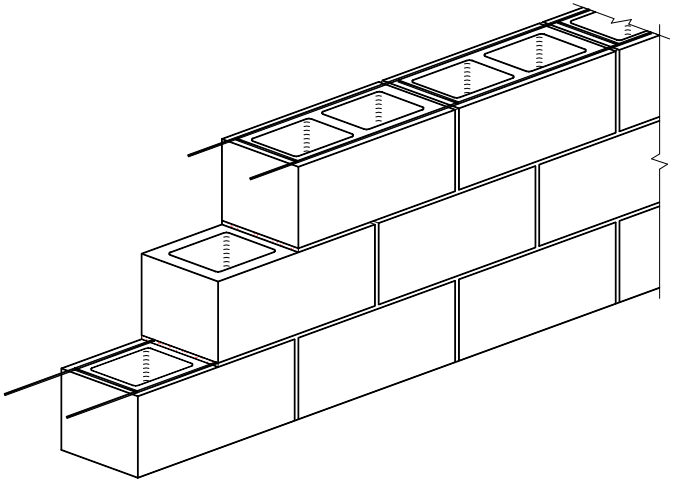
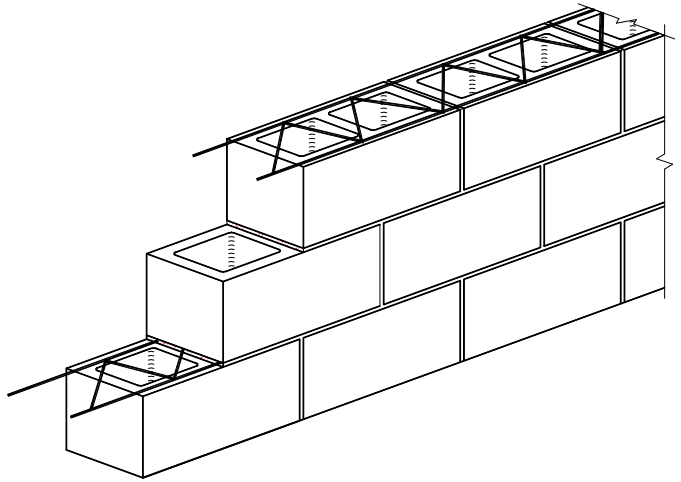
Consists of two or more longitudinal wires connected with cross wires forming a truss or ladder configuration



Ladder Type



Truss Type

Joint Reinforcement

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- Must be spliced a minimum of 6 inches per MSJC
- It is permissible to lay joint reinforcement on face shell and mortar over it.

Control Joints

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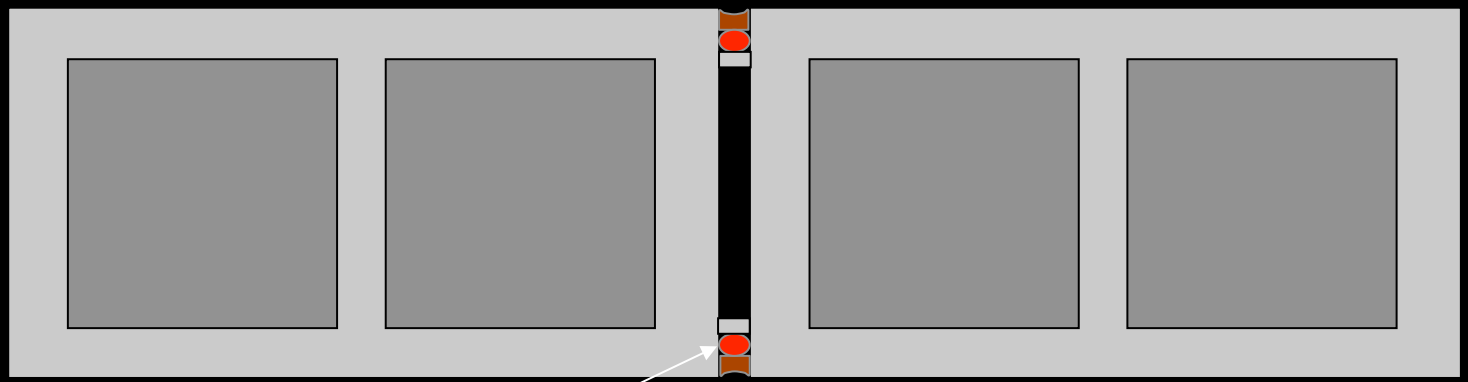

Backer rod in mortar joint raked out to a depth of at least 3/4”

Sealant

- polysulfide, urethane, silicone or epoxy. Avoid oil-based caulks or othe materials that dry out rapidly or do no bond effectively to masonry.

Types of Control Joints with Shear Resistance

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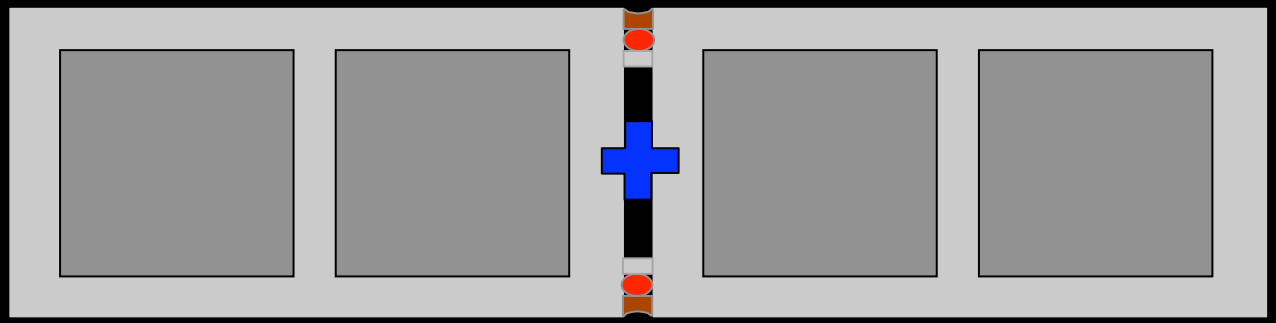
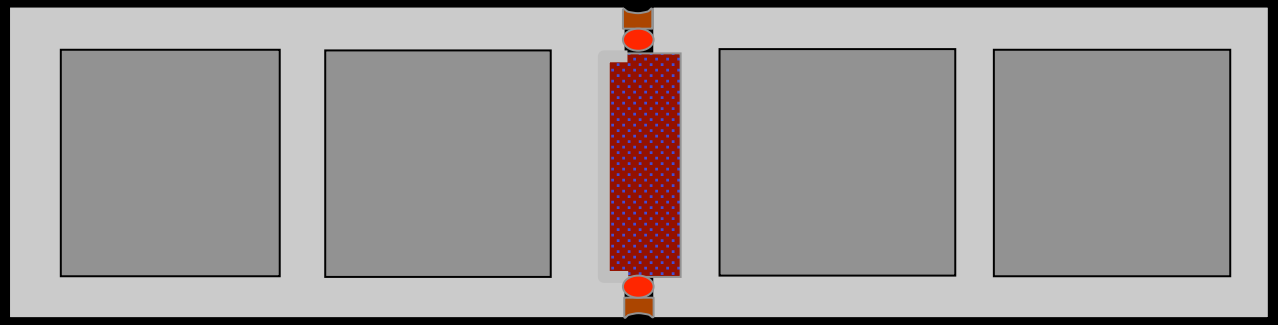
- Preformed gasket



- Grout shear key



TEK 10-2B

Types of Control Joints with Shear Resistance

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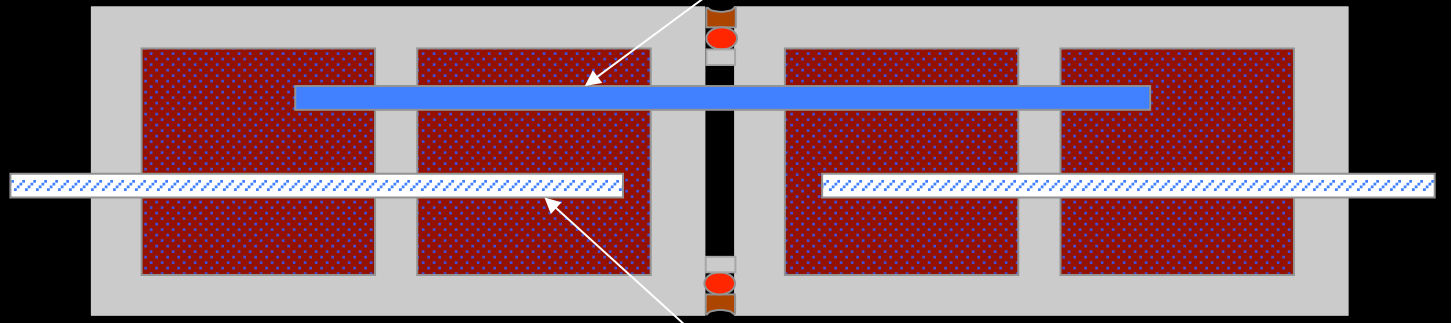
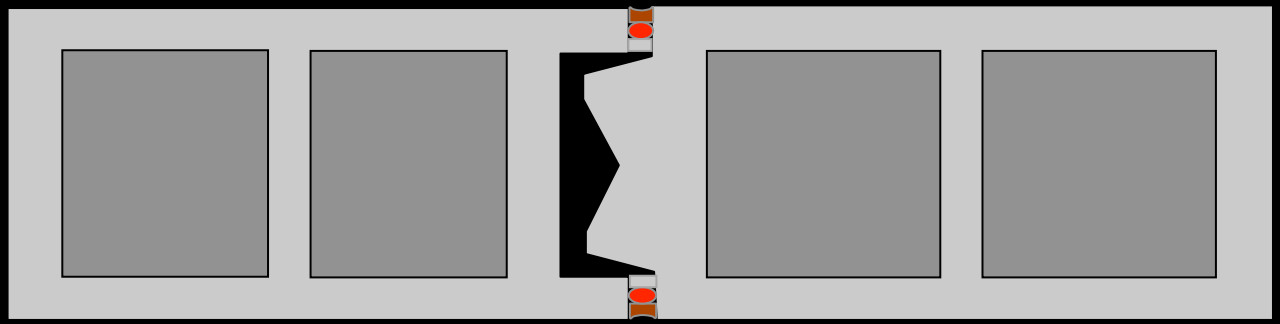
- Dowels



- Special unit shape



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Eliminating Control Joints With Reinforcement

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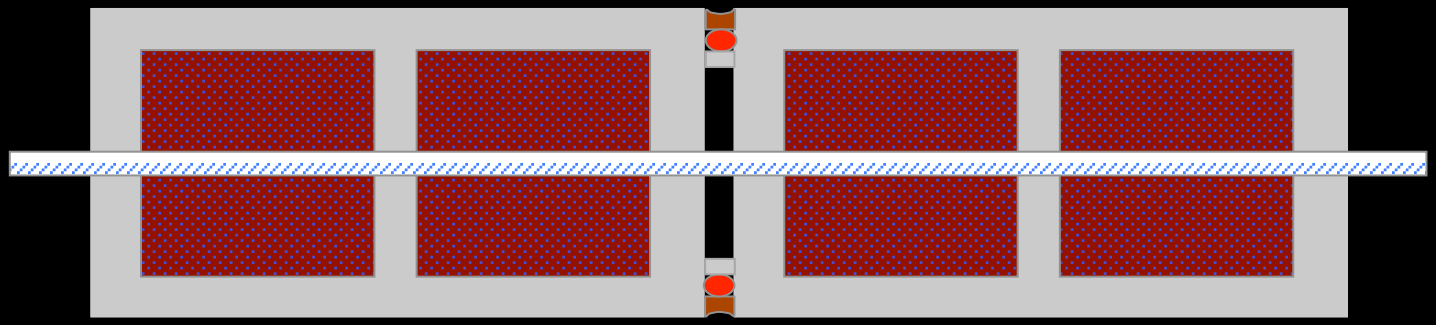

Control joints can be eliminated completely if enough horizontal reinforcement is provided.

ie., where $A_s \geq 0.002\ A_n$

Maximum reinforcement spacing for 8 in. CMU (not solid grouted):

#4 bar - 24 inches

#5 bar - 40 inches

#6 bar - 48 inches

TEK 10-1A & 10-3

4-hour Rated Control Joints

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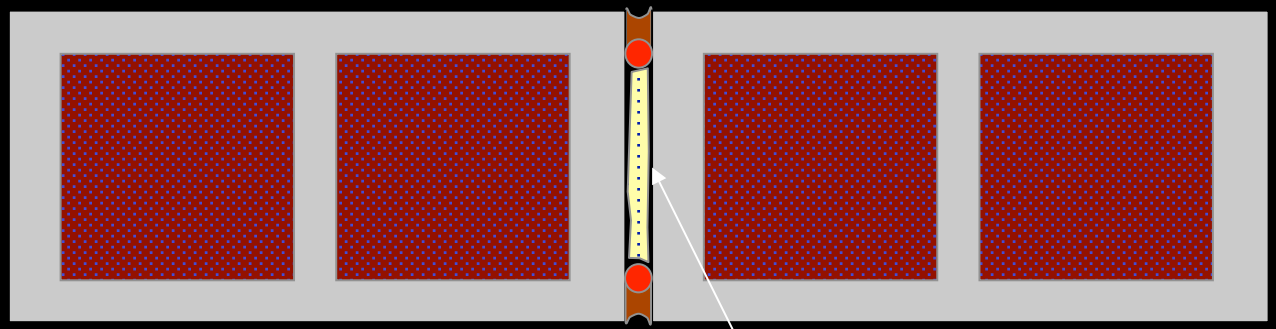

Ceramic fiber blanket

Note: Special unit shape and grout shear key type control joints are also rated 4 hours as long as they contain backer rod and joint sealant.

TEK 10-2B

Control Joint Locations

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- Typically use above grade in concrete masonry walls
  - Shrinkage cracks are an aesthetic rather than a structural concern
- Generally not used below grade
  - Less temperature and moisture variation

Control Joint Locations

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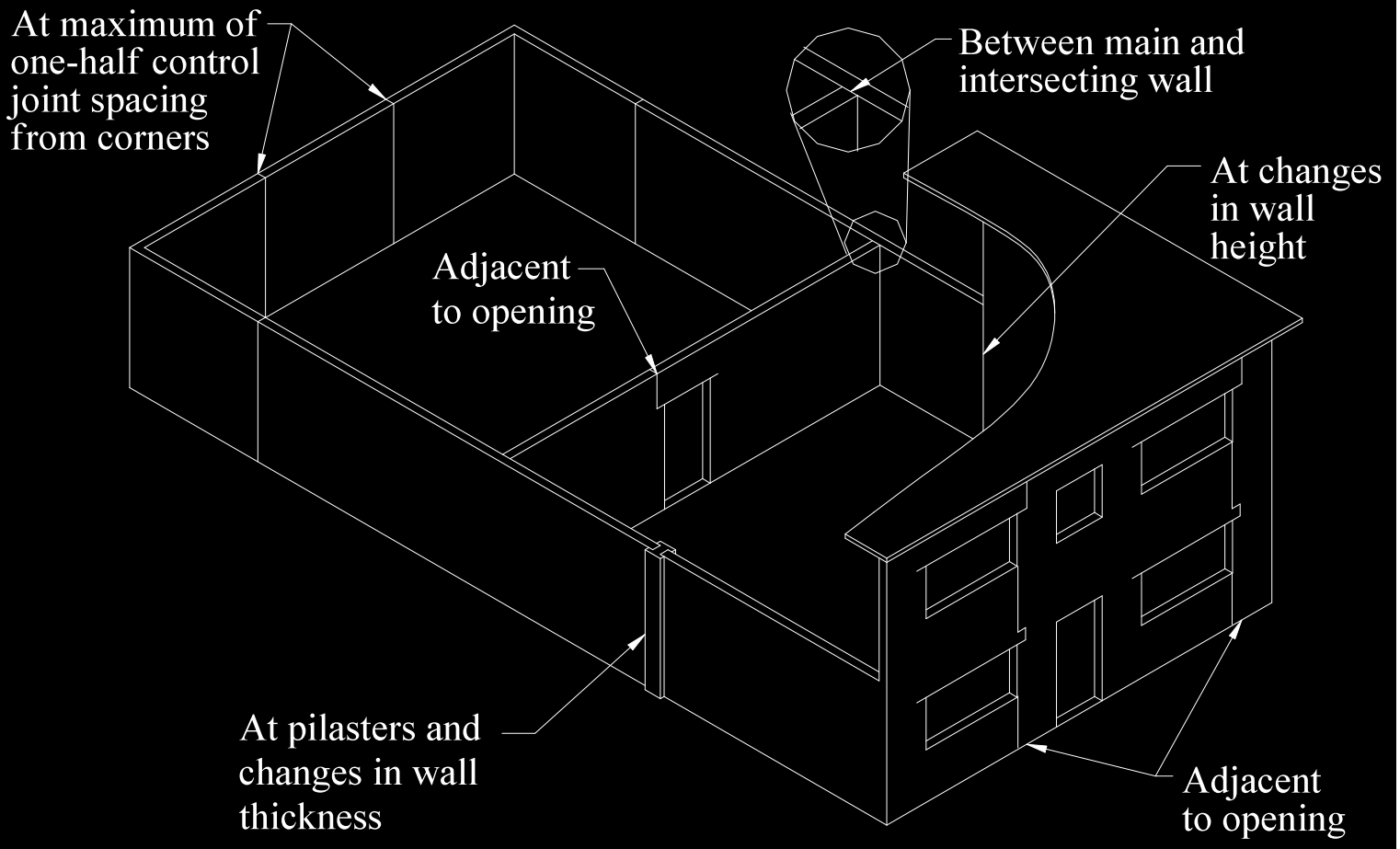

TEK 10-2B

Control Joints at Openings in Unreinforced Walls

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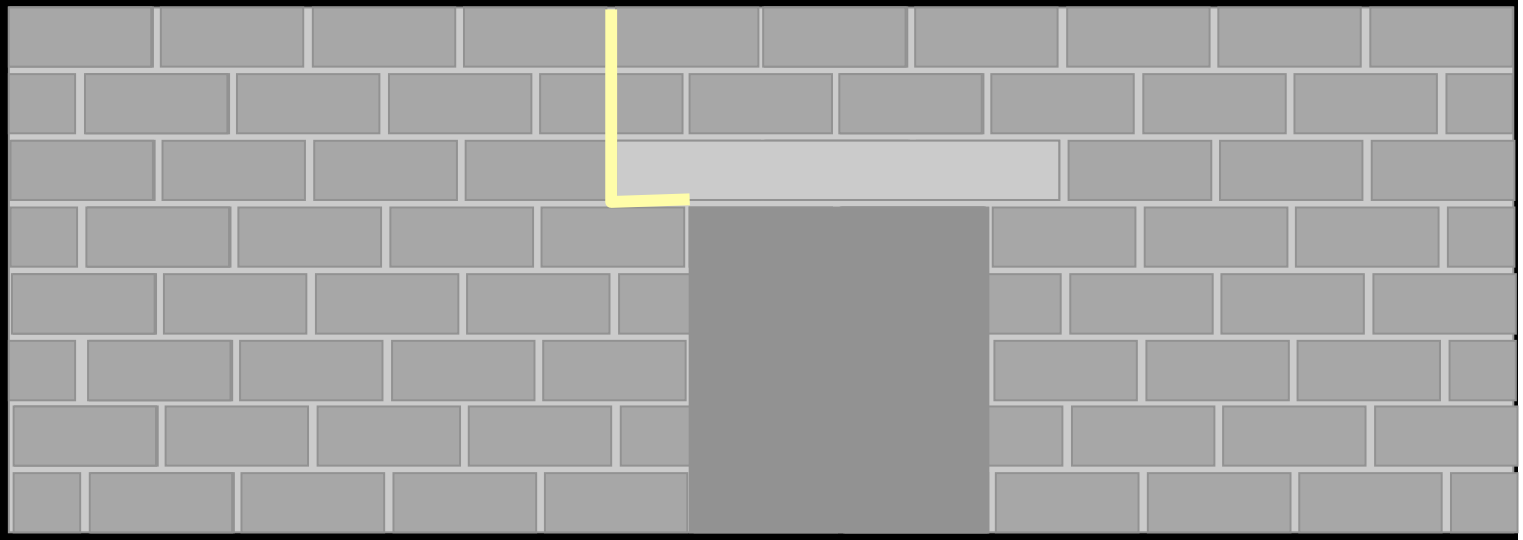
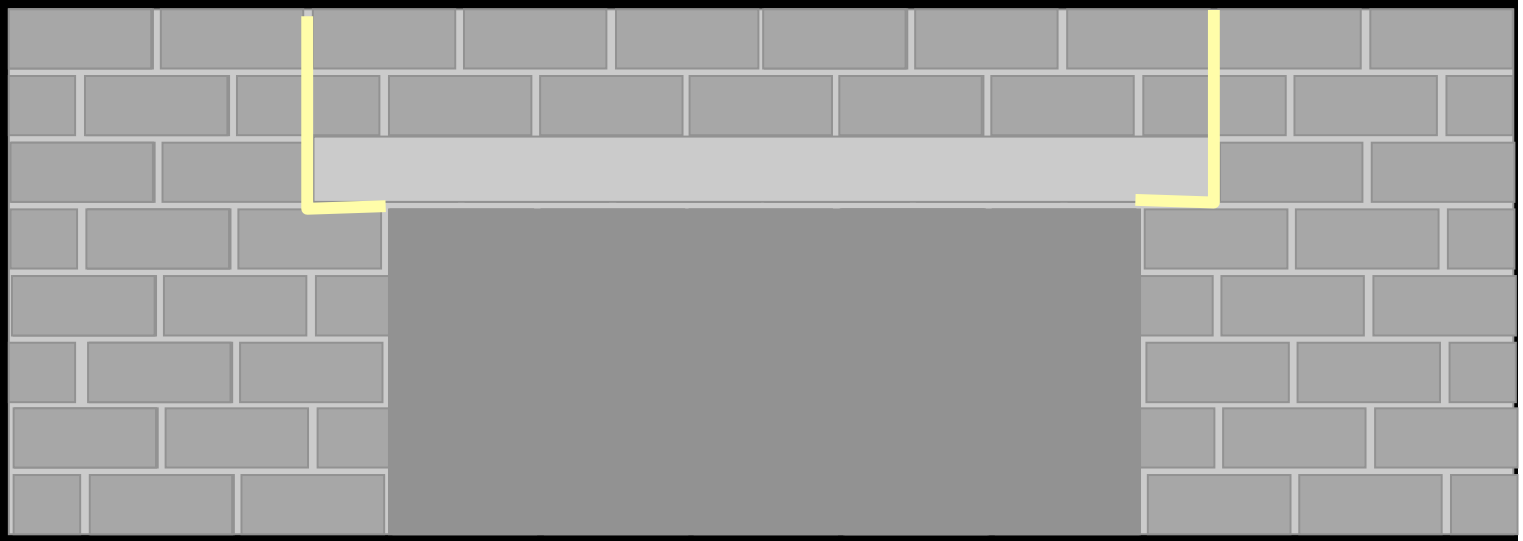


Openings less than 6 feet

TEK 10-2B

Control Joints at Openings in Unreinforced Walls

Continuing Education Services

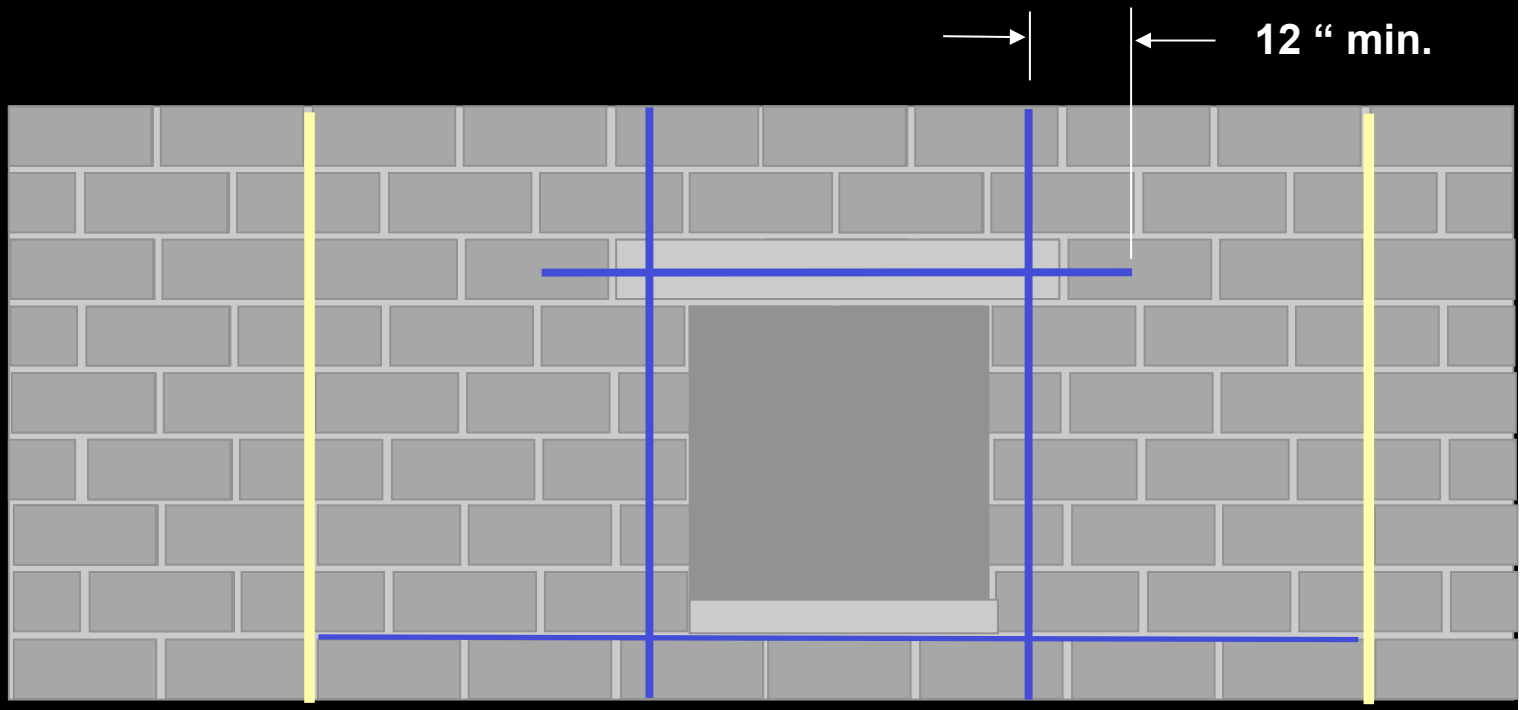


Openings more than 6 feet

TEK 10-2B

Control Joints at Openings in Reinforced Walls

Continuing Education Services



Preferred strengthening of opening with reinforcement - extending lintel reinforcement and joint reinforcement under the sill

TEK 10-3

Control Joints at Openings in Reinforced Walls

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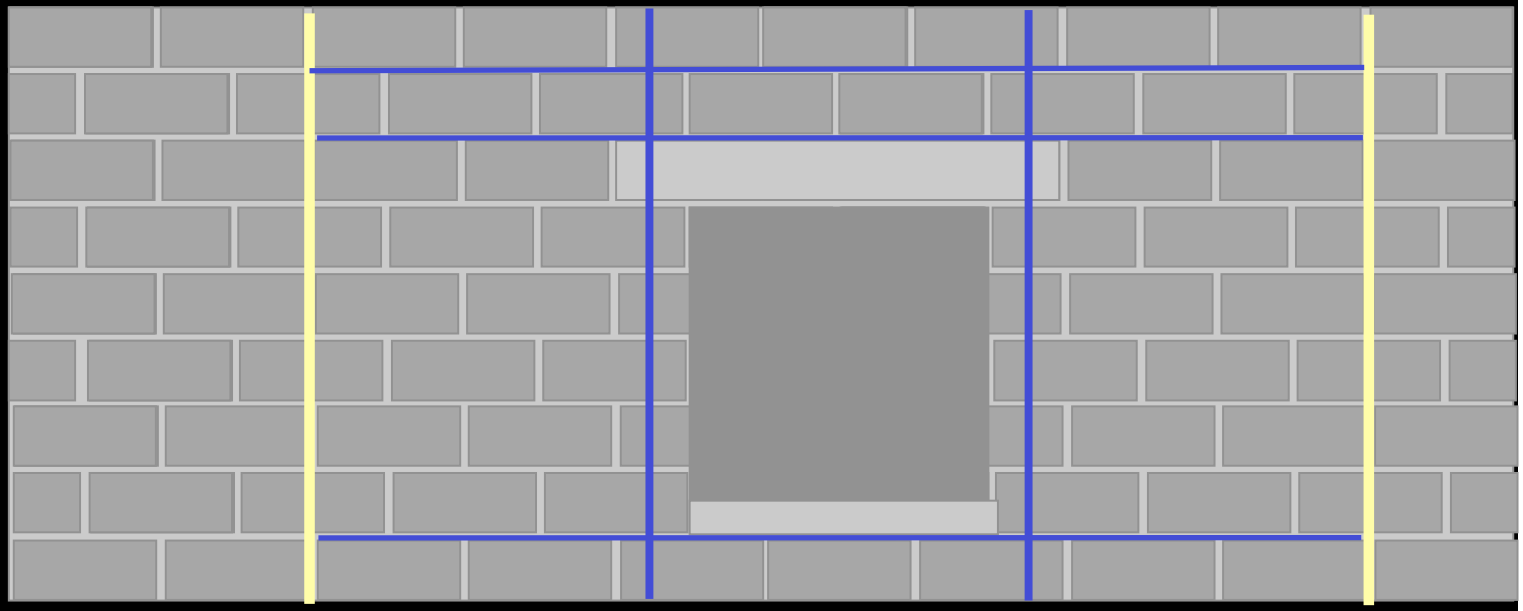

Opening strengthened with joint reinforcement first two courses over opening and under the sill

TEK 10-3

Control Joints for Multi-wythe Walls

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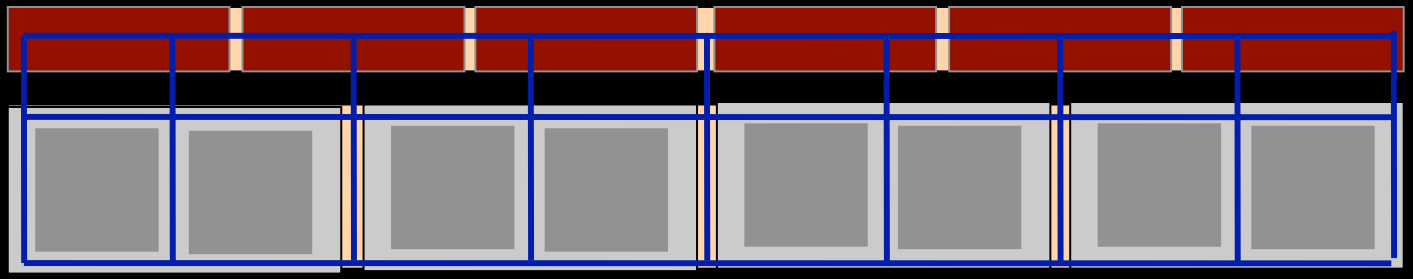
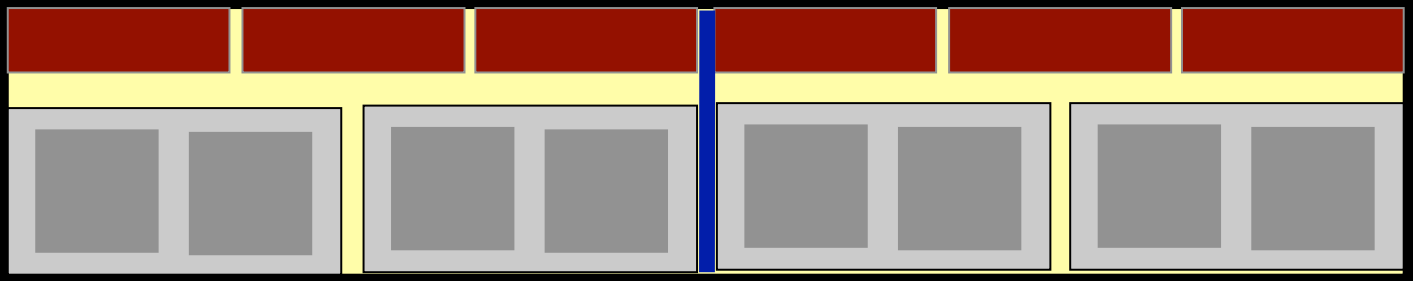
If wythes are unbonded...



…consider control joint requirements separately for each wythe

If wythes are bonded...



…continue control joints from back-up through face

TEK 10-1A

Impact of Mortar Strength

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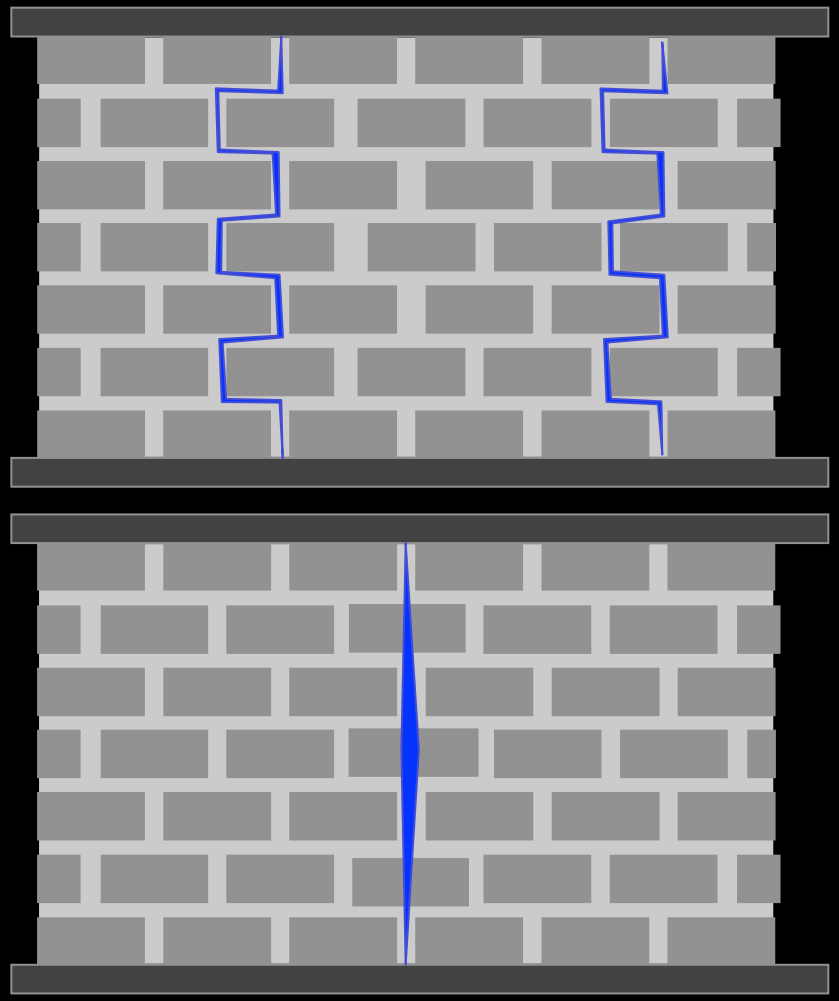
Weak mortar

Strong mortar



CMU Band in Clay Brick Veneer

Joint reinforcement w/ no slip plane

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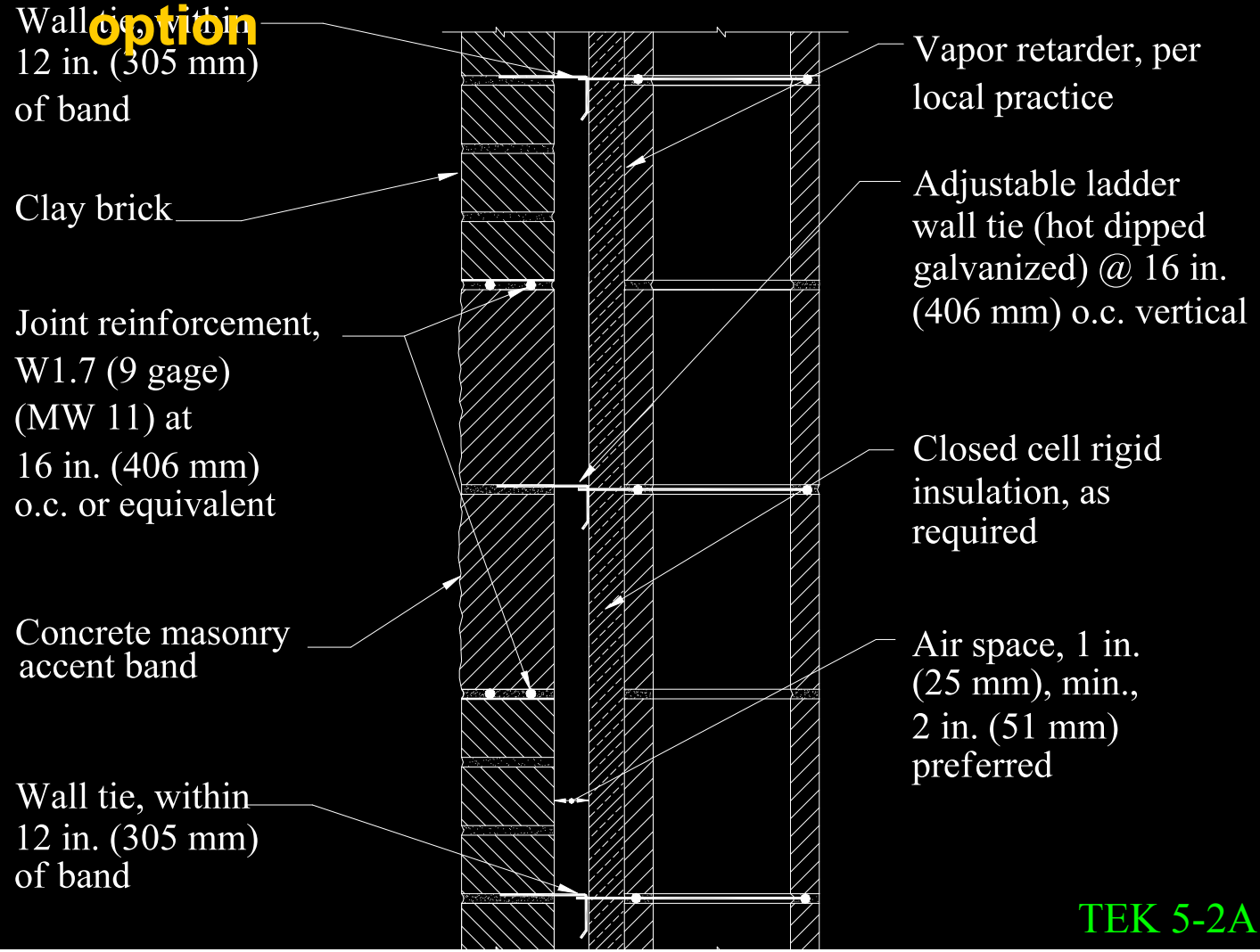

TEK 5-2A

CMU Band in Clay Brick Veneer

Slip plane top and bottom of band option

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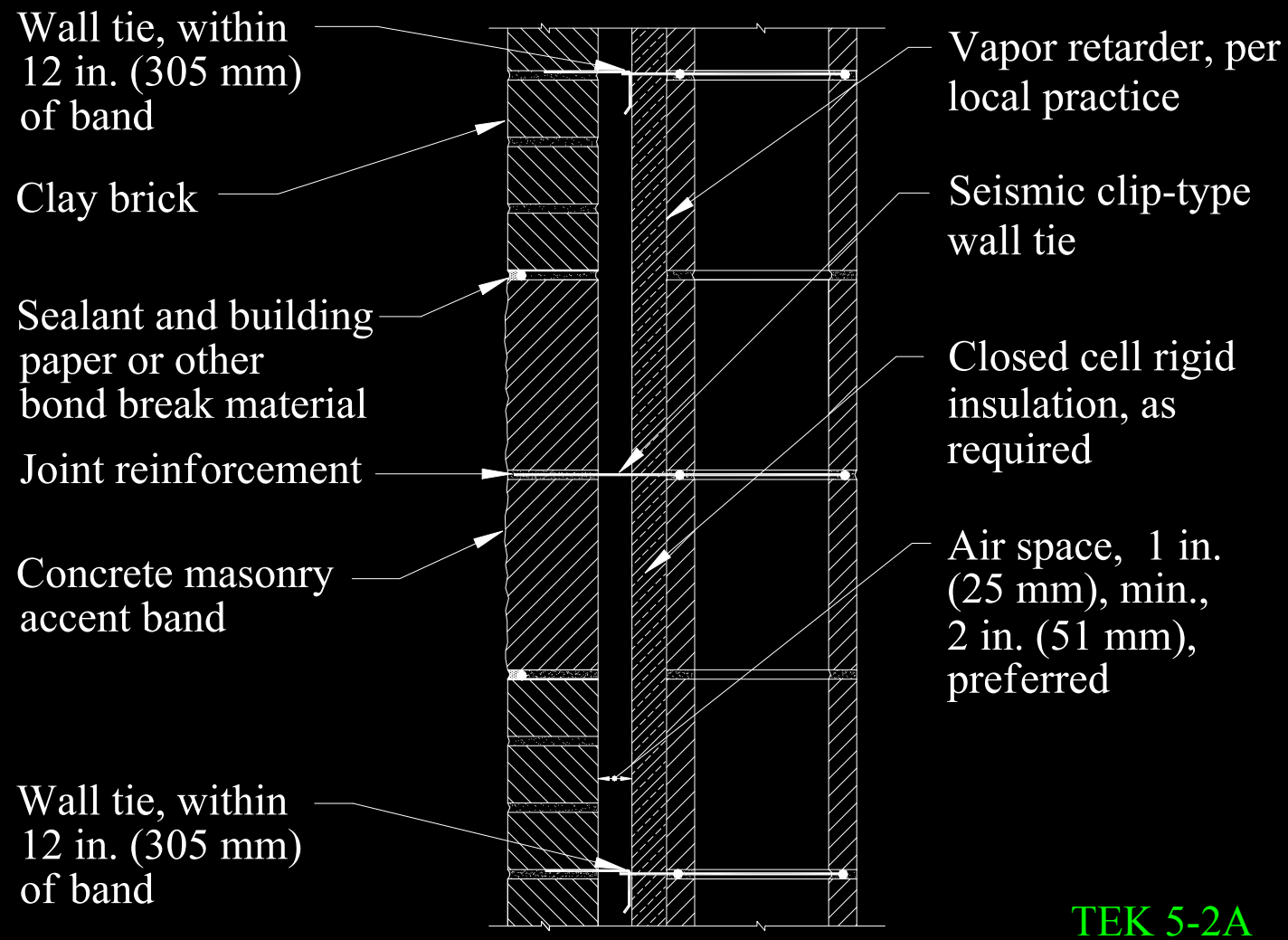

TEK 5-2A

Clay Brick Band in CMU Veneer

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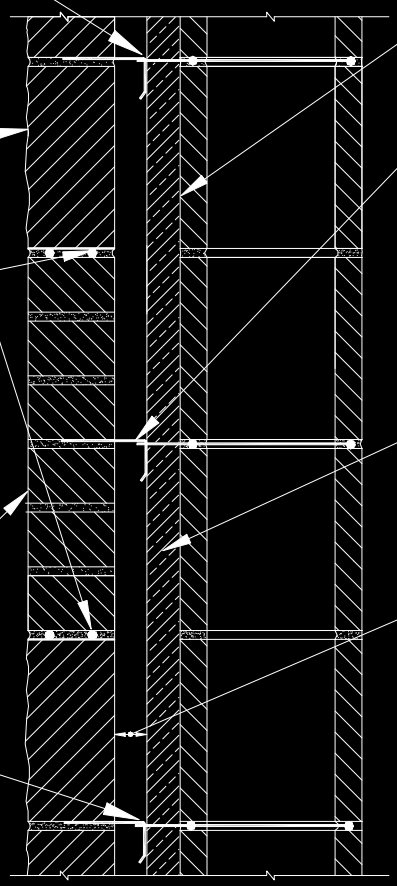

TEK 5-2A

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Summary

- **Better manage movement through masonry systems by**
  - **Proper design**
  - **Using MSJC installation standards**
  - **Proper location of control joints**
  - **Proper use of bond beams**
  - **Proper placement of joint reinforcement**