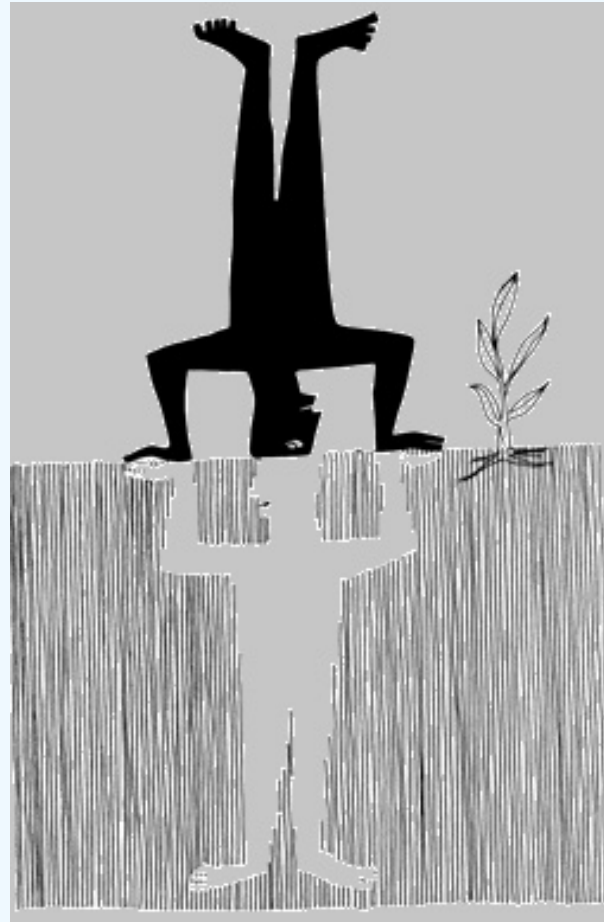


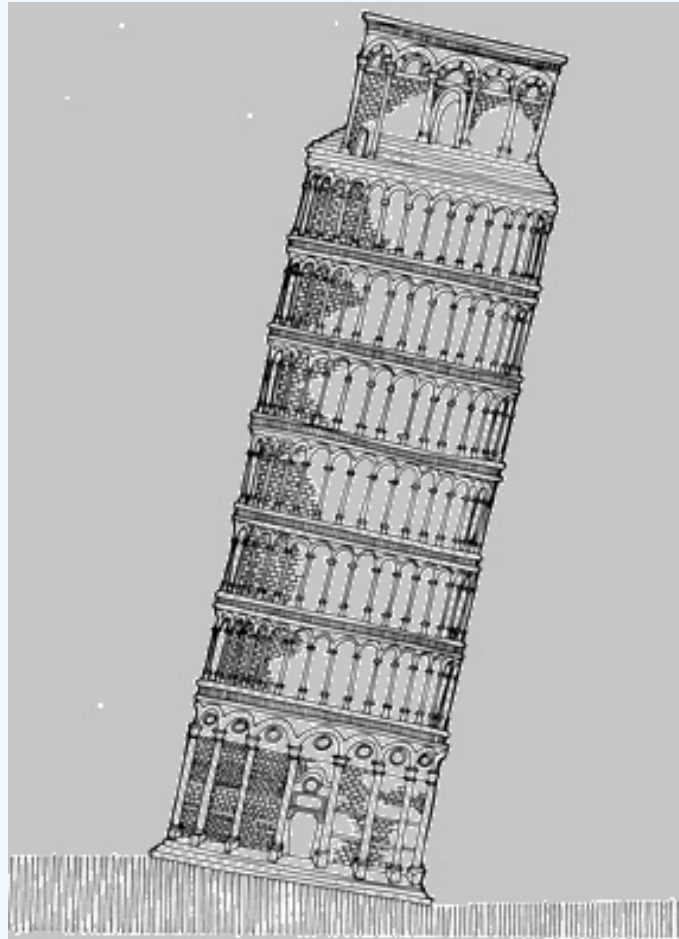
# The ground must push up as hard as the building pushes down

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# Leaning Tower of Pisa

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# Walls

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# Structural Considerations:

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- **Unreinforced**
- **Reinforced**
- **Veneered**

# Unreinforced

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- **Simple Construction**
- **Code of Hammurabi, 18th c. BC**
- **Strict Height Limitations**
- **Rule of Thumb**
  - *t equals h divided by 12 or*
  - *the thickness of the wall in inches is equal to the height of the wall in feet*

# Reinforced

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- **Masonry units, reinforcing steel grout and/or mortar combined to act together to resist forces**
- **The masonry units typically work as permanent form work for poured concrete**
- **Significant capacity for tensile as well as compressive stresses**

# Veneered

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- **A thin, usually single wythe, masonry non-load bearing wall attached to a substrate.**

# Unit Considerations:

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- **Single Wythe**
- **Multiple Wythe**
  - ***Similar Units***
    - *Common brick structures*
  - ***Composite***
    - *Brick / Block*
  - ***Cavity***
    - *Originated in England*
    - *Moisture resistant*
    - *Insulating*



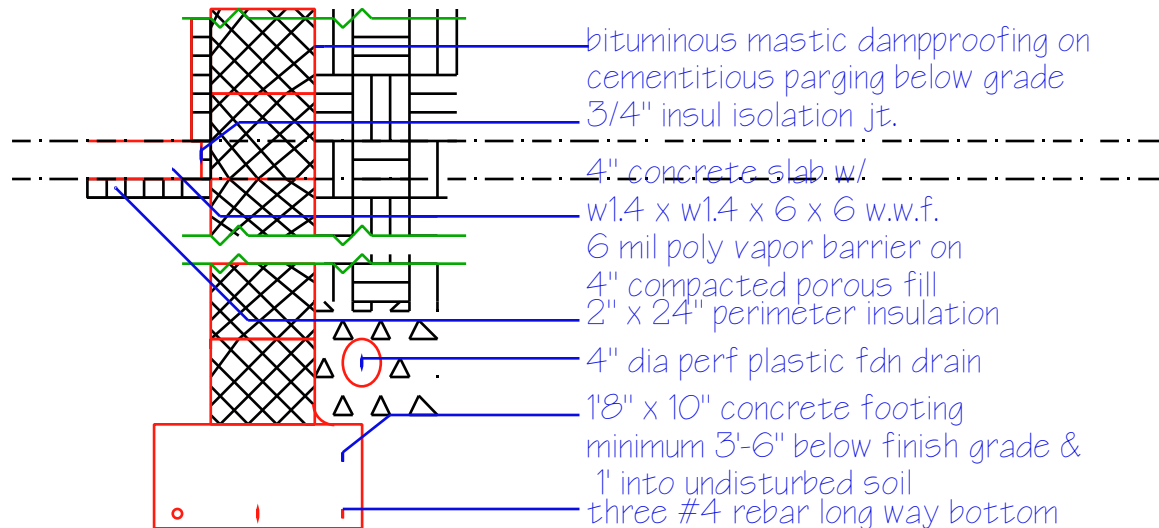
# Wall Sections

---

- **Typically 3/4" = 1'-0" scale**
- **Detailed blowups @ 1 1/2" or 3" scale**
- **Allows Investigation of the Placement of Wall Layers**
- **Don't forget plan sections!**



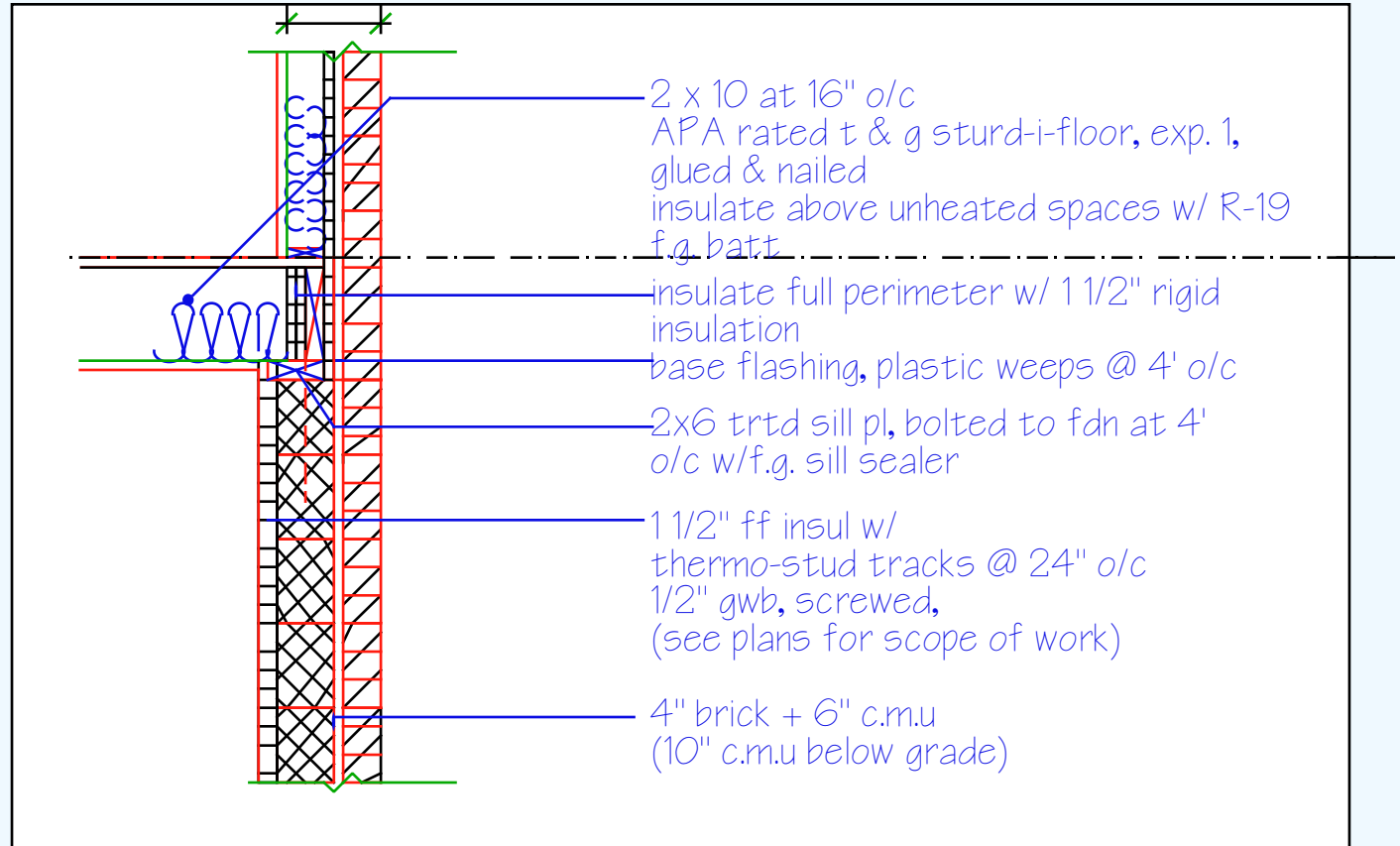
# Wall Section Basement



1

**FRONT / REAR BRICK  
VENEER WALL SECTION**

# Wall Section 1st Floor



# Masonry Walls

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# Wall Selection

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- **Structural Requirements**
  - *Height, etc.*
- **Interior Finish**
- **Exterior Finish**
- **Insulation**

# Masonry Openings

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# Masonry Must Be Supported Above Openings

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- **Opening requires spanning capability above**
- **Span creates bending stresses**
- **Bending stresses are a combination of tensile and compressive stresses**
- **Masonry has limited capacity for resisting tensile stresses**



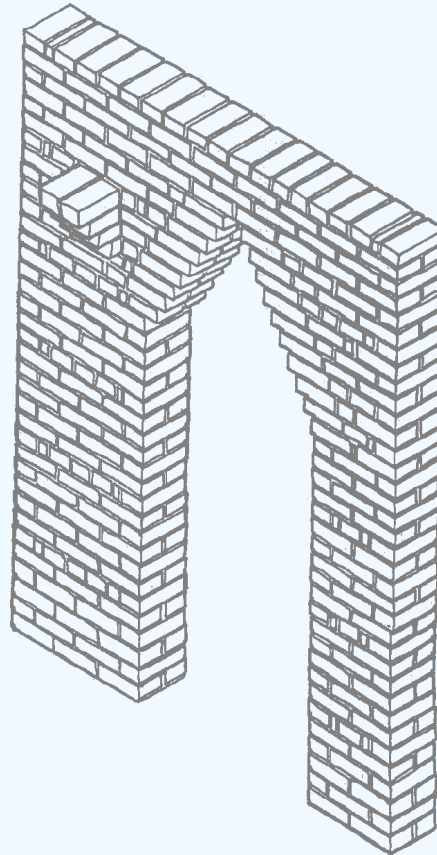
# Corbel and Arch Action in Masonry Walls

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- **Corbel** • a shelf or ledge formed by projecting successive courses of masonry
- **Arch** • a curved compressive structural member spanning openings or recesses

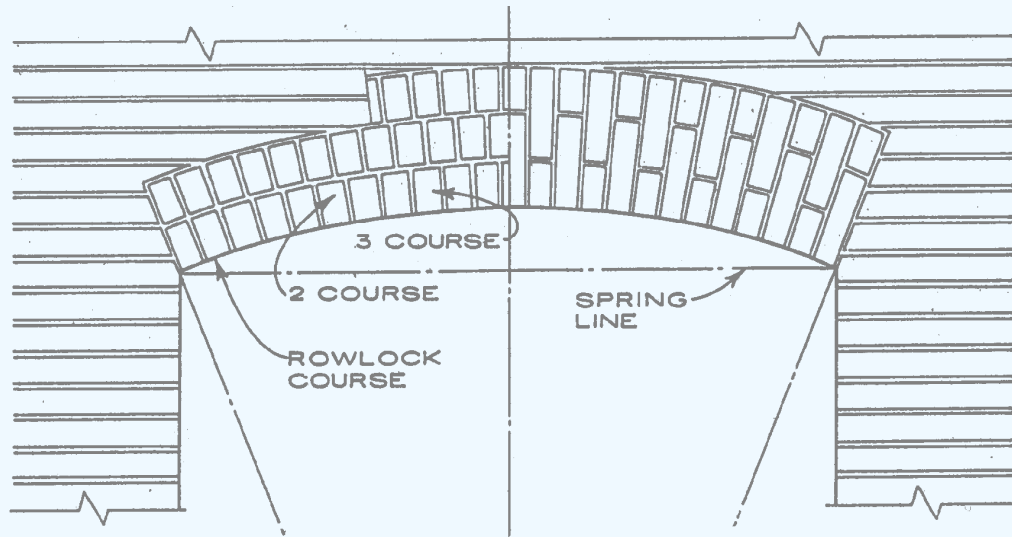
# Corbel

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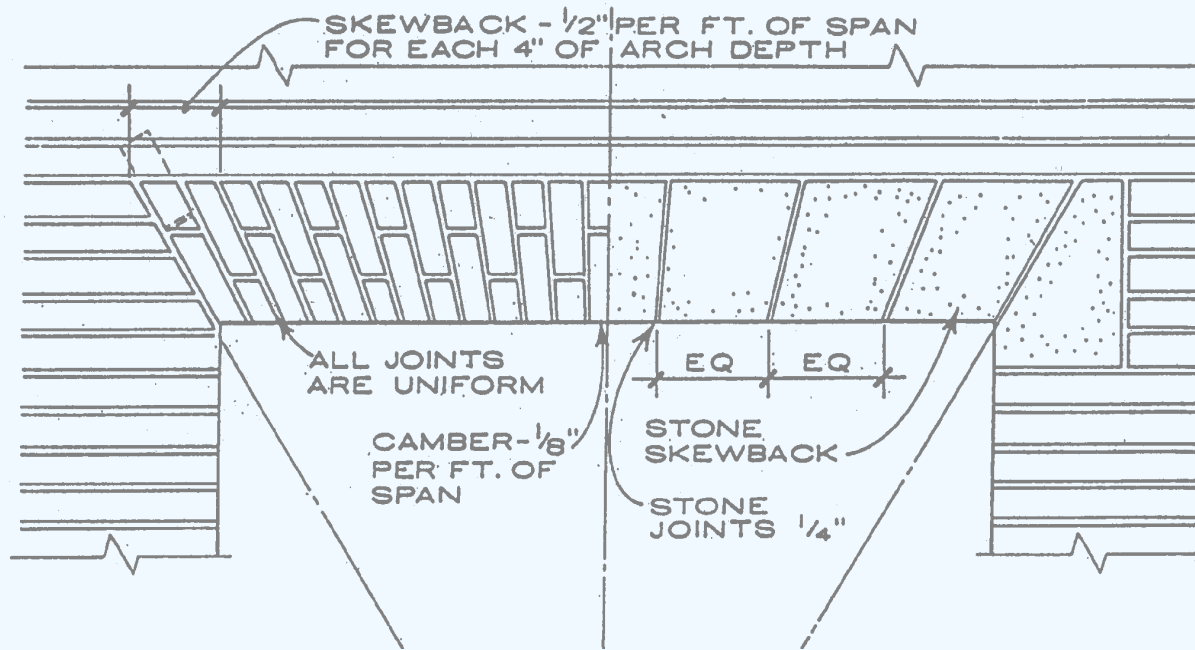


# Segmental Arch

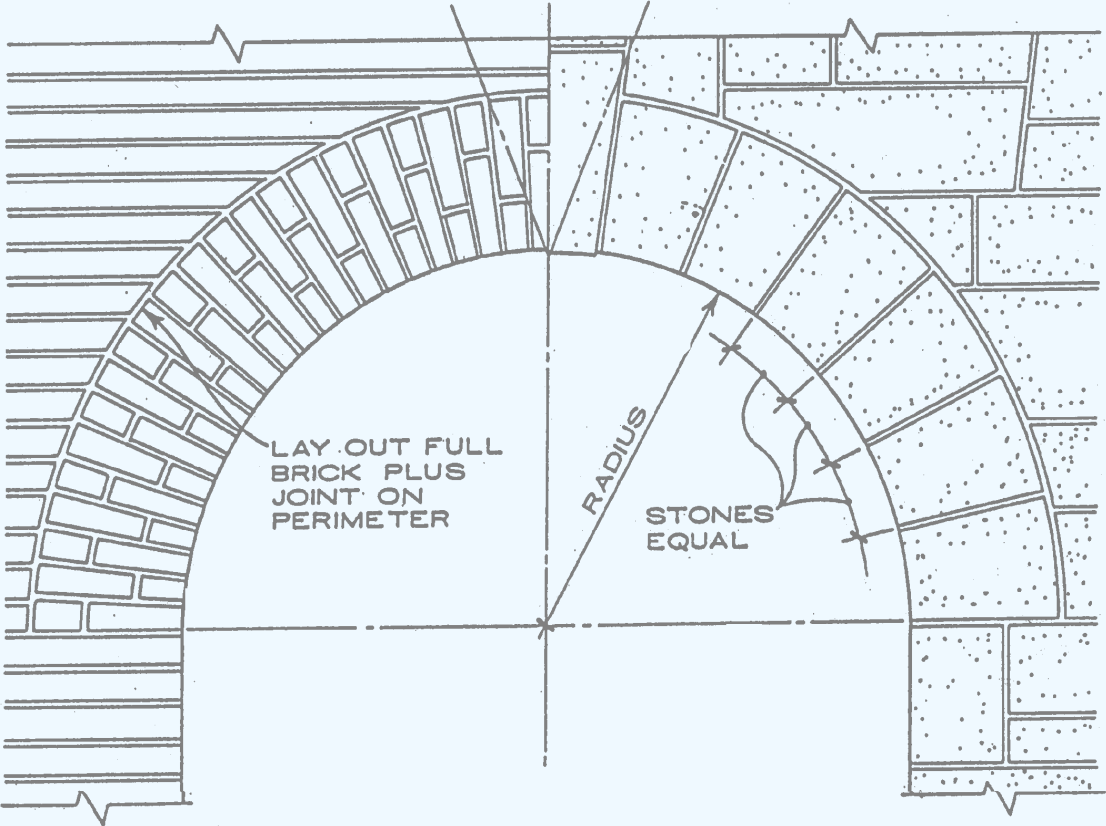
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# Jack Arch



# Roman Arch



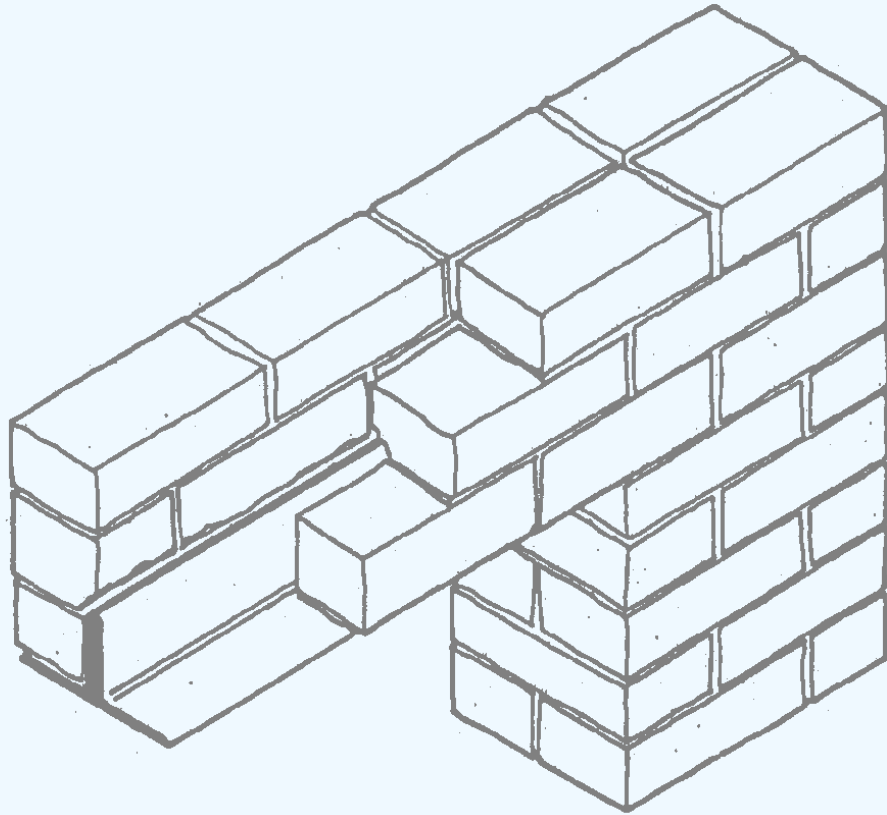
# Rectangular Openings Require a Lintel for Support of Wall Above

---

- **Loose Steel Angles**
  - *One per 4" wythe*
  - *Long Leg Vertical*
- **Steel Beam with Bottom Plate**
  - *4" Width Plus Thickness of Masonry Supported*
- **Lintel Blocks**
  - *Same Thickness as Wall*
  - *Steel Reinforcing Embedded in Concrete*
  - *Requires Temporary Support*
- **Precast Concrete or Stone (limited)**

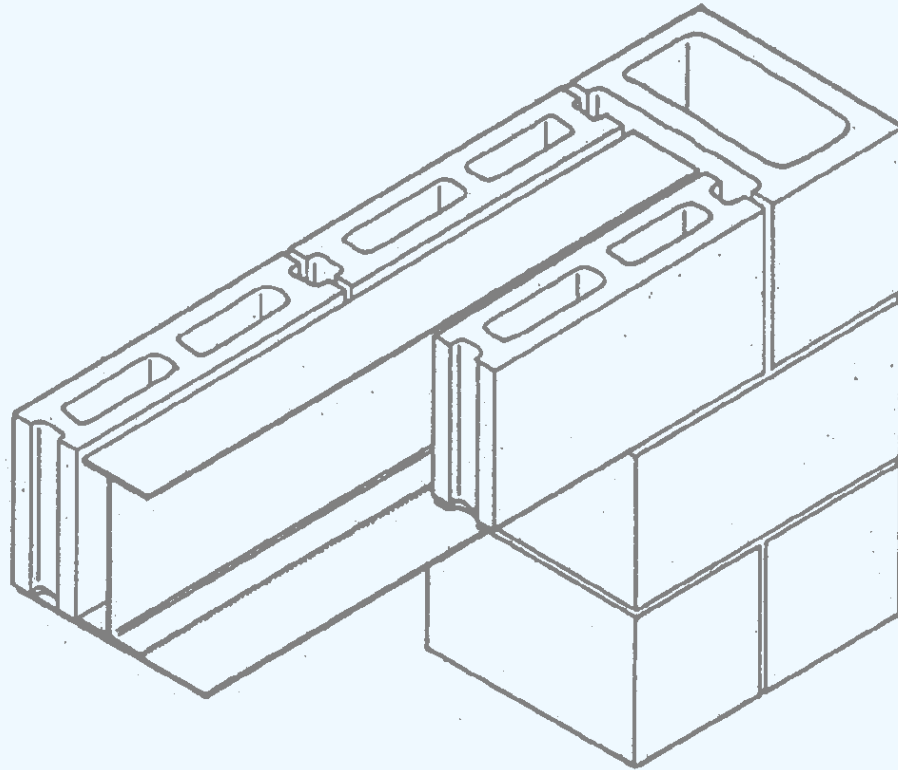
# Loose Steel Angles

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# Steel Beam

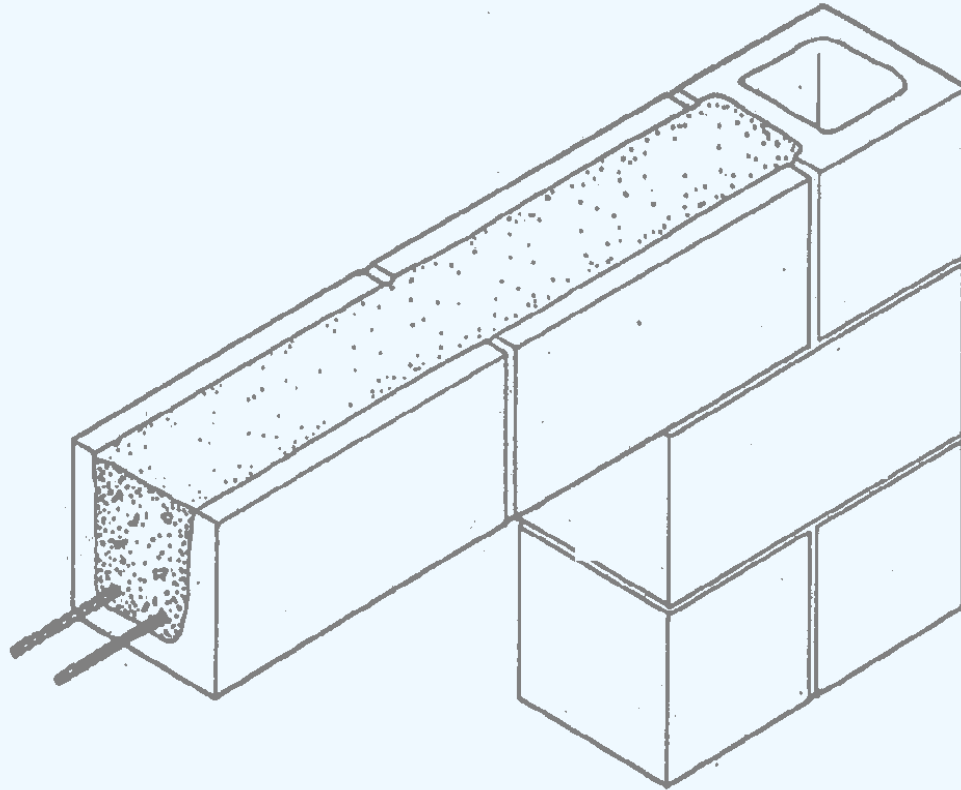
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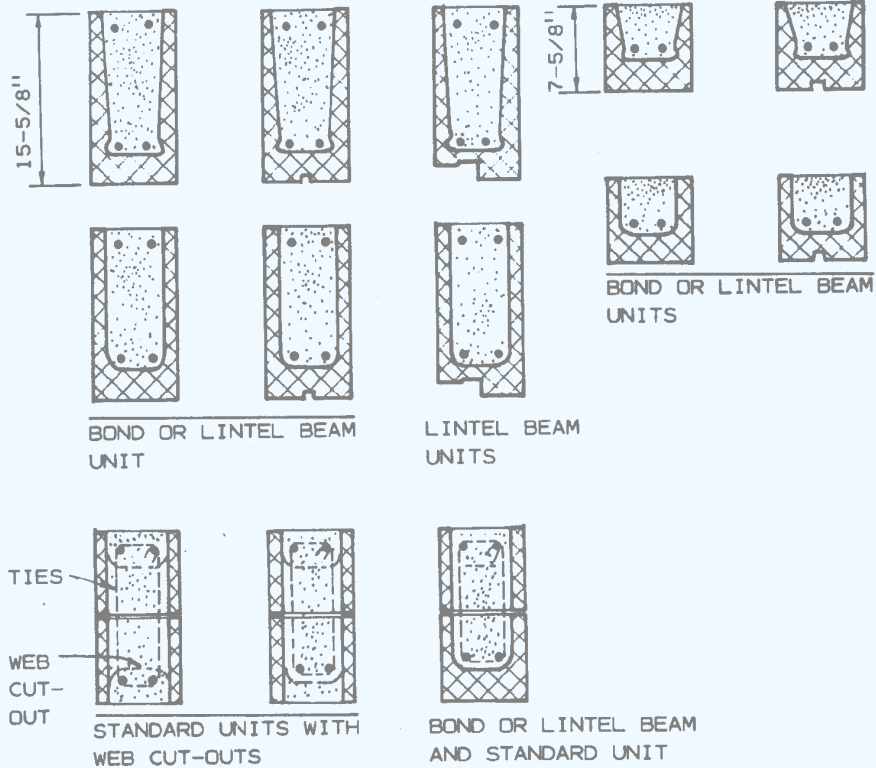


# Lintel Blocks

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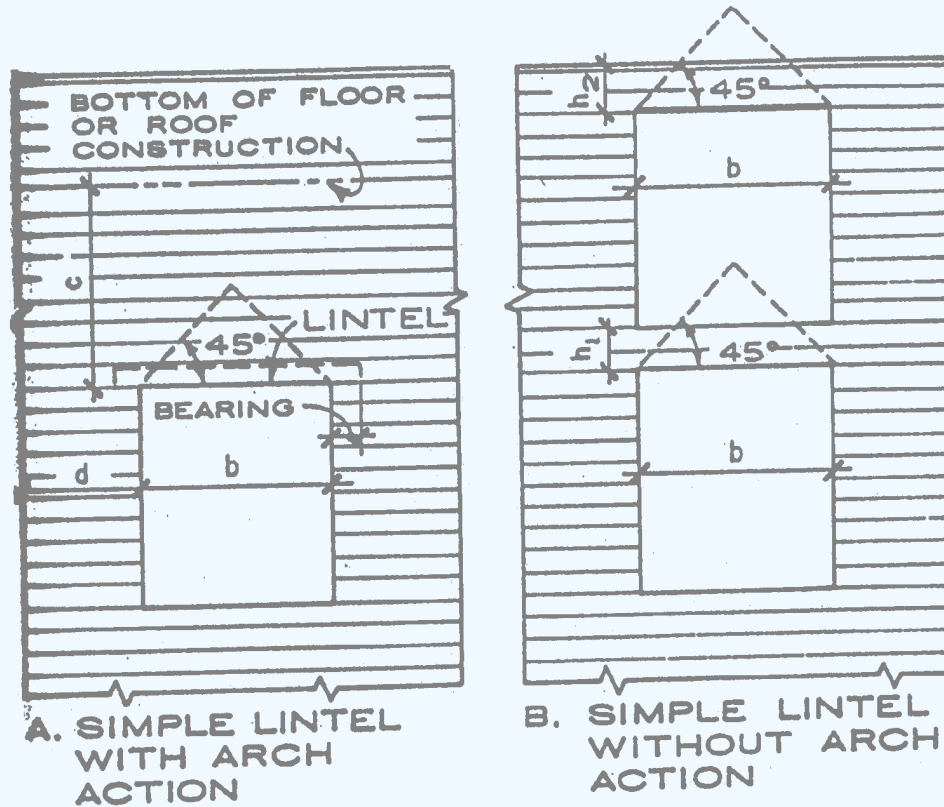
# Types of Lintel Blocks



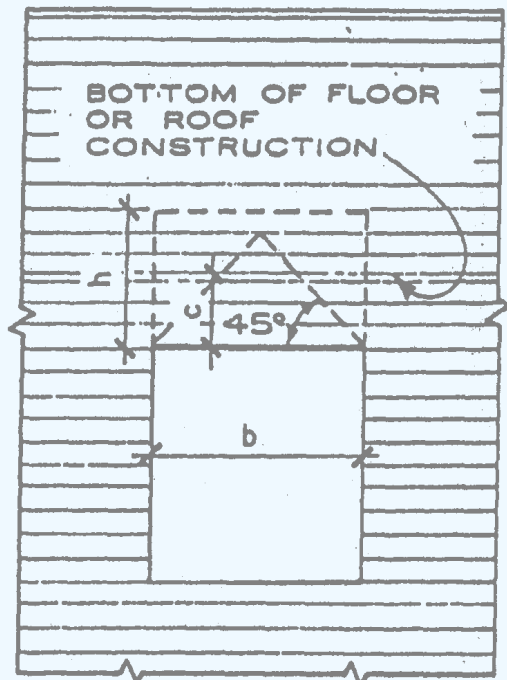
# Precast Concrete

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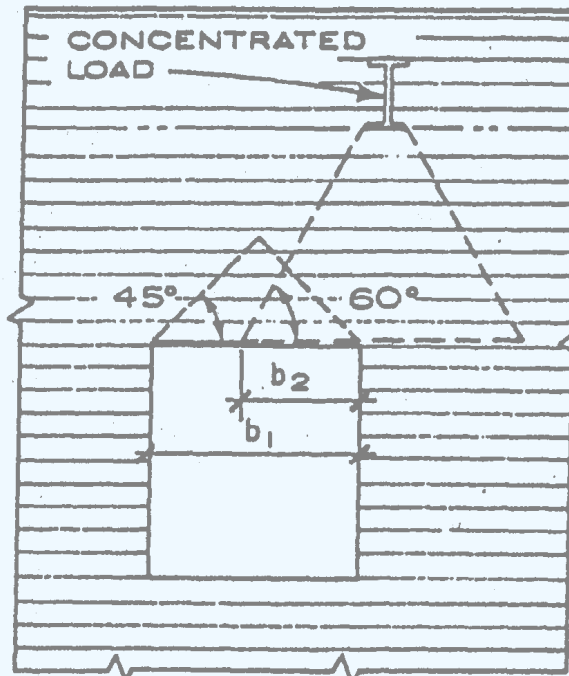
# Analyze Load Condition Above Opening • Simple



# Analyze Load Condition Above Opening • Concentrated

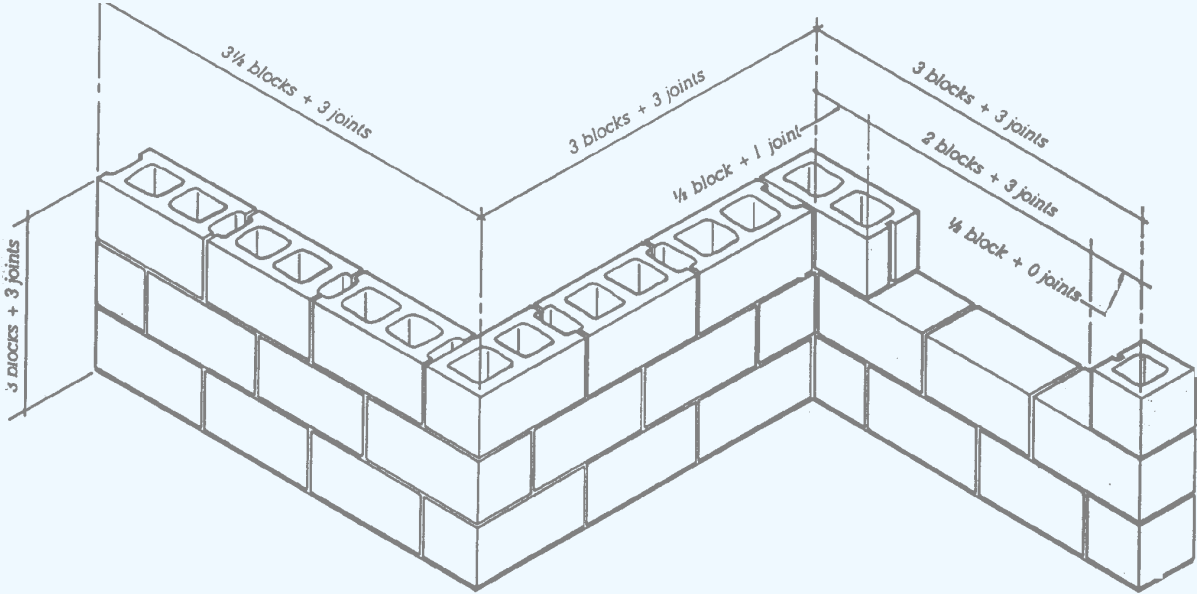


C. LINTEL WITH UNIFORM FLOOR LOAD



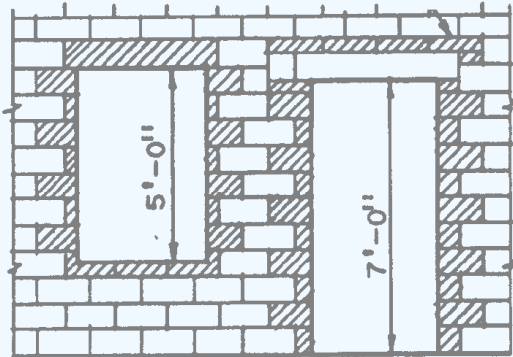
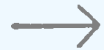
D. LINTEL WITH CONCENTRATED STRUCTURAL LOAD

# Dimensional Coordination of Wall Length(s)

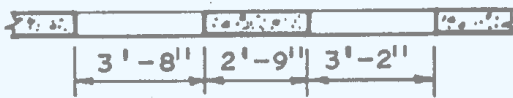


# Dimensional Coordination of Opening Locations

WRONG

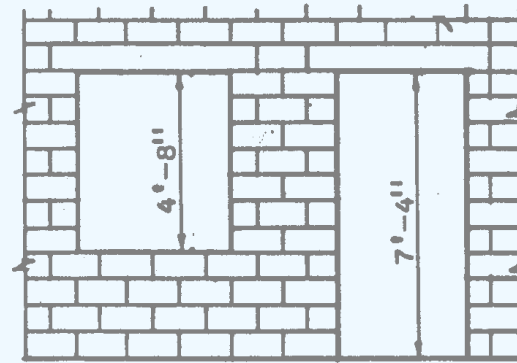


ELEVATION

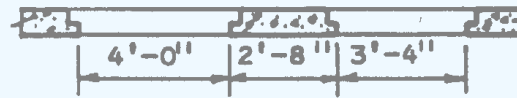


PLAN

RIGHT



ELEVATION



PLAN

# Controlling Movement in Masonry Walls

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# Cracking Results from Restrained Movement

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- **Temperature**
- **Moisture Content**
- **Overloads on Structure**
  - *Dead Load*
  - *Live Load*
  - *Impact*
  - *Vibration*
- **Settlement**

# Solutions

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- **Control Moisture**
- **Horizontal Reinforcement**
- **Control Joints**

# Moisture Control

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- **By Specification**
- **By Proper Care on Jobsite**
- **Proper Detailing**

# Horizontal Reinforcement

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- **Joint Reinforcement**
- **Bond Beams**

# Joint Reinforcement

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- **Prefabricated, galvanized steel wires for embedment in horizontal mortar joint**
- **8" ~ 24" o/c**

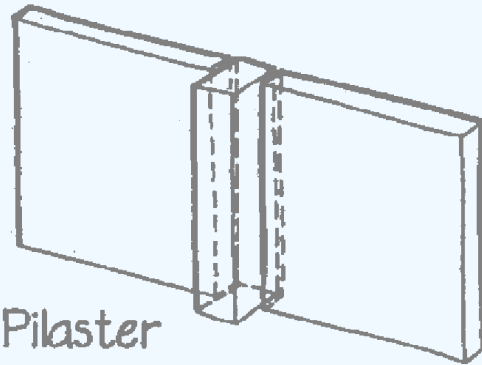
# Control Joints

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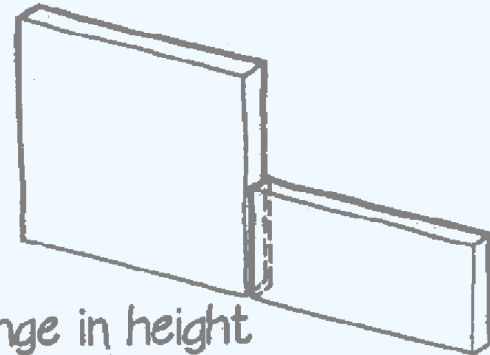
- **Changes in Wall Height or Thickness**
- **At Construction Joints in Foundation, Floors and Roof**
- **At Chases and Recesses**
- **At Abutment to Wall and Columns**
- **At Return Angles in L-, T- or U-shaped Structures**
- **At One or Both Sides of an Opening**

# Control Joint Locations

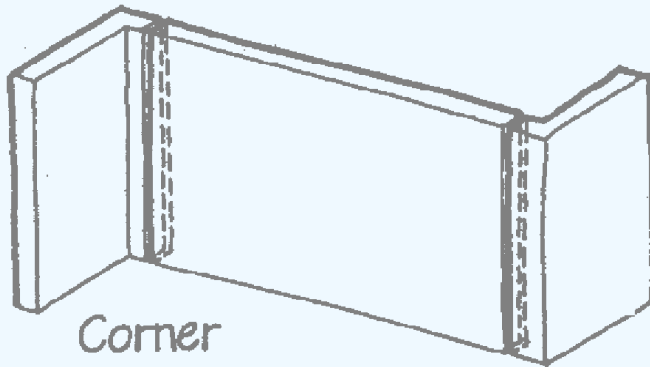
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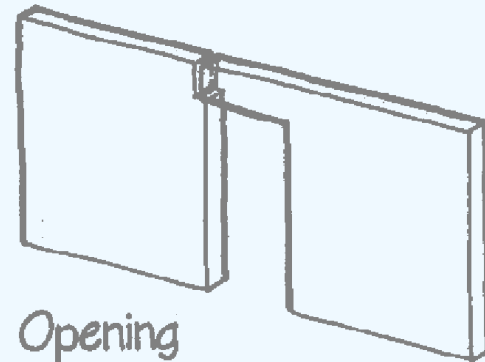
Pilaster



Change in height



Corner



Opening

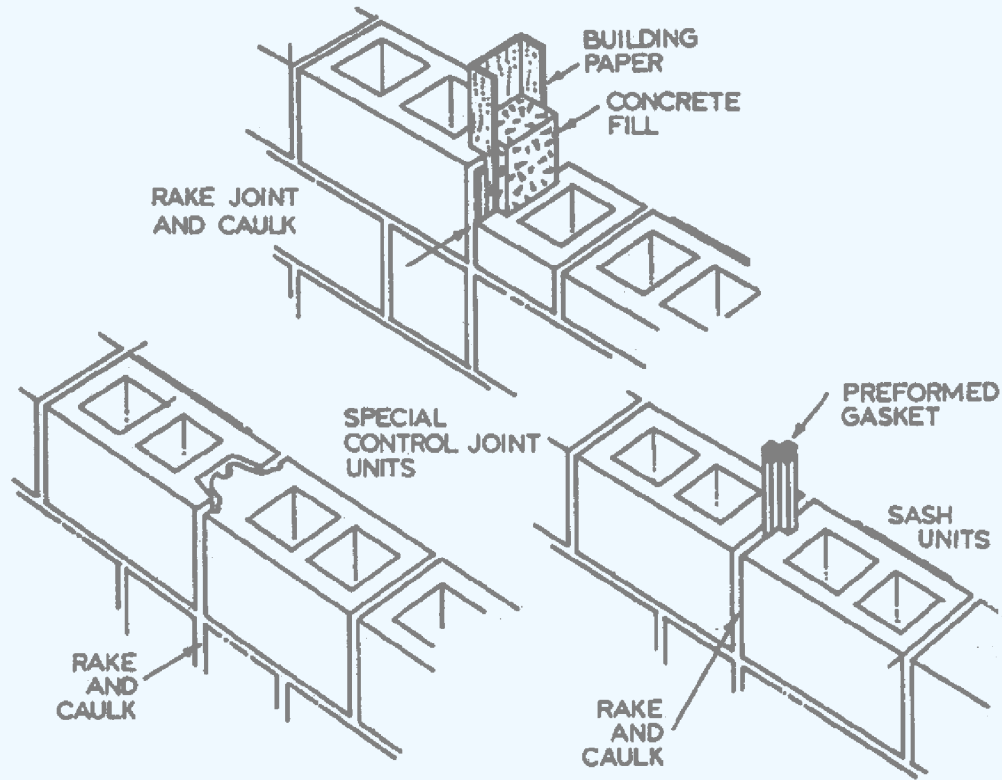
# Control Joints as a Function of Panel Size

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- **Assuming Horizontal Joint Reinforcing at 16" o/c**
- **Less Than 3 x the Panel Height**
- **Less Than 50'**

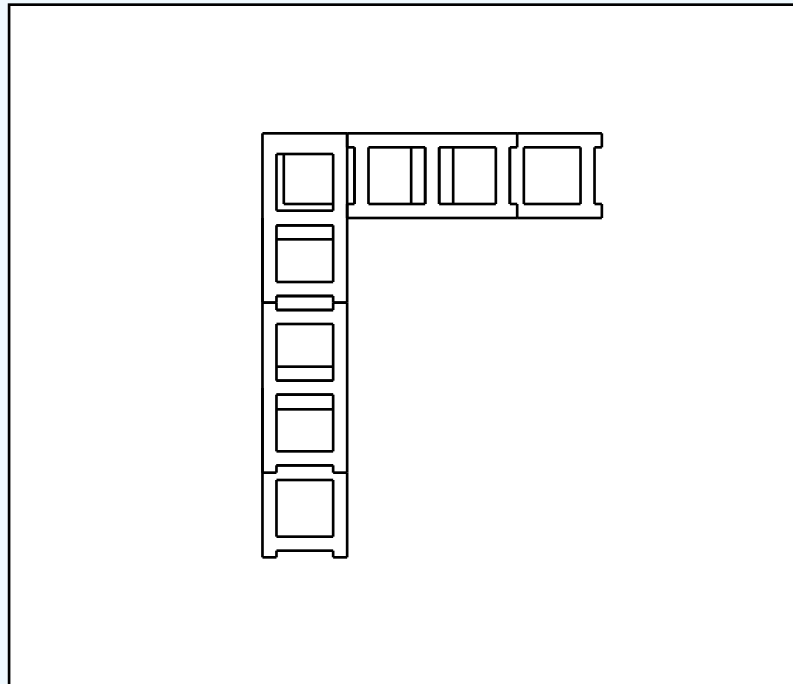


# Control Joint Details in Block



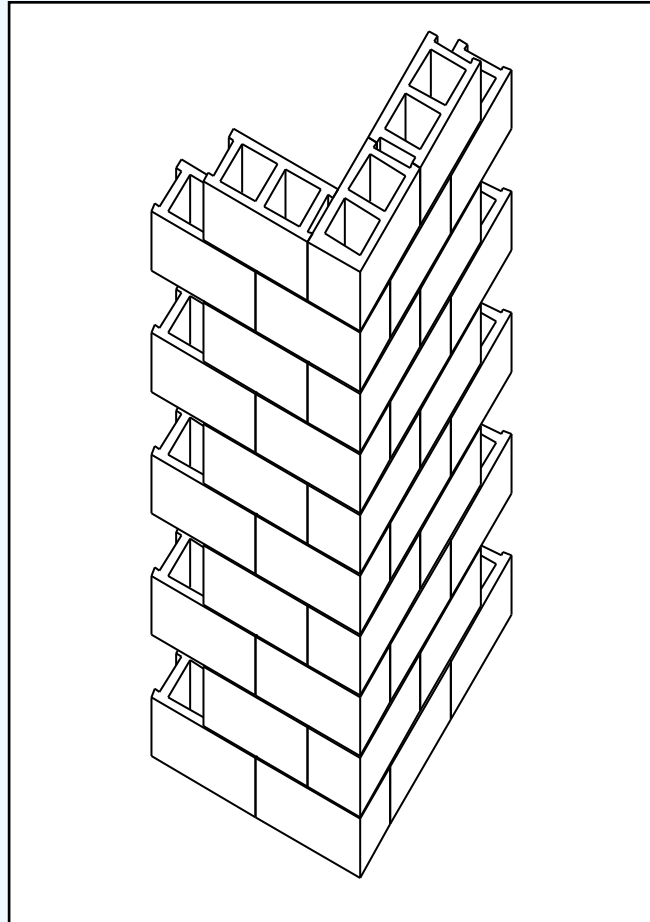
# 8" CMU Corner

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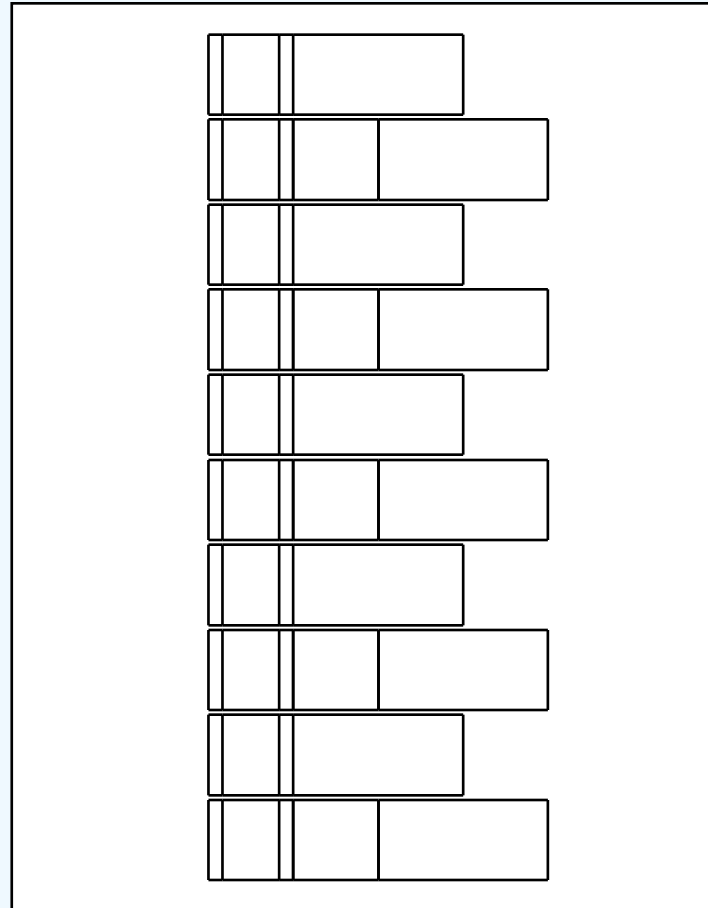
# 8" Axo

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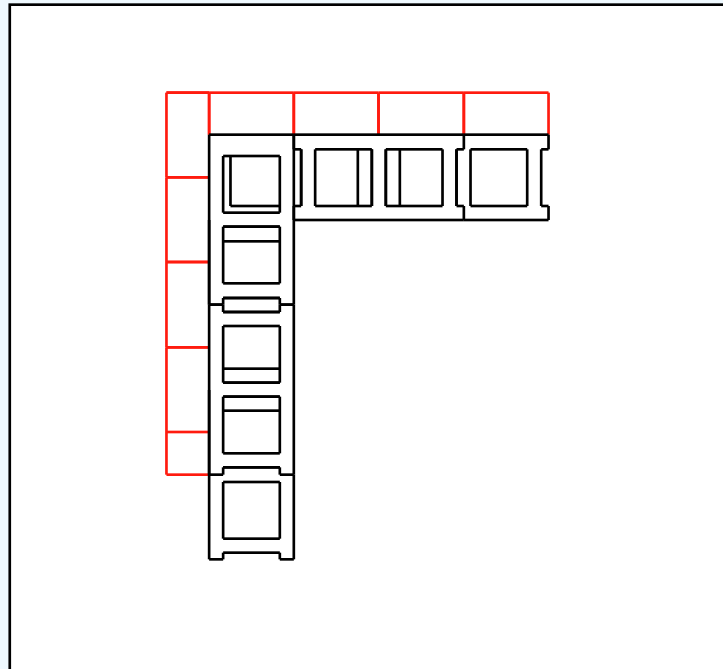
# 8" Section

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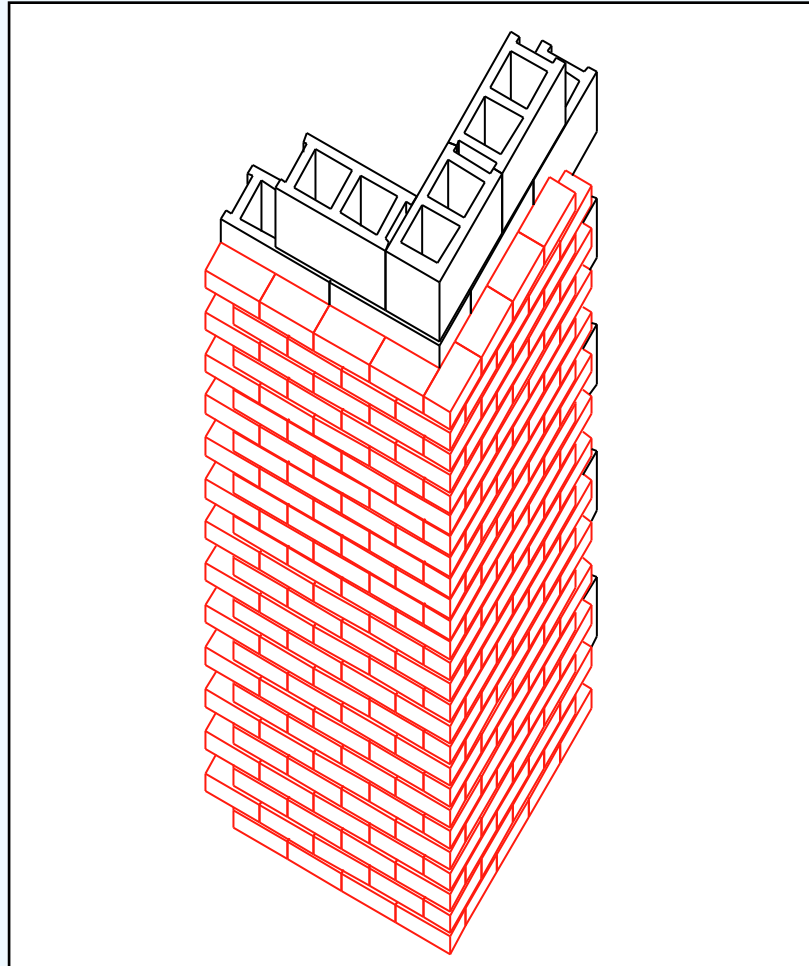
# 12" Composite Corner

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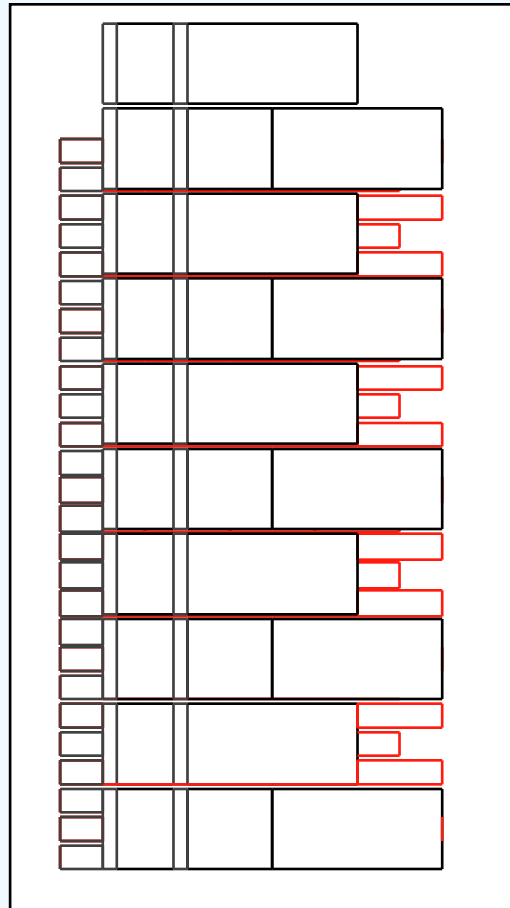
# 12" Axo

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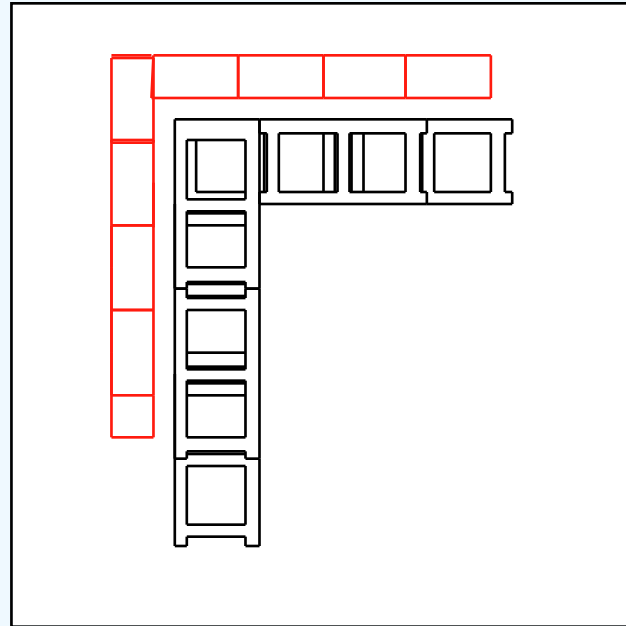
# 12" Section

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# 14" Cavity Corner

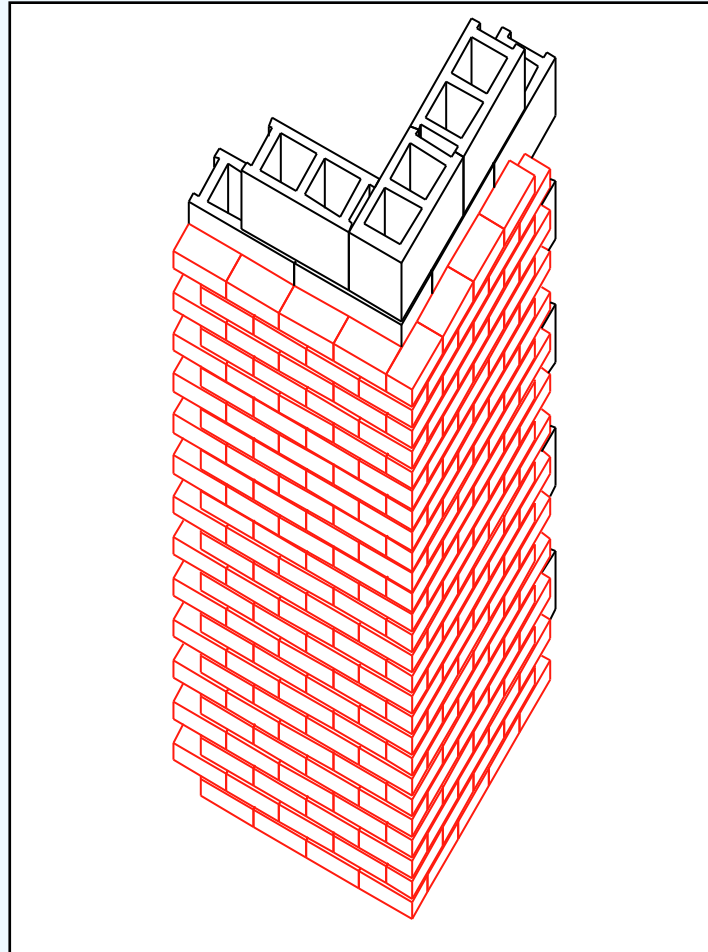
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# 14" Axo

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# 14" Section

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