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# Design Strategies for Architectural Stone Masonry

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# Design Strategies for Architectural Stone Masonry


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# The Oldcastle APG **Family of Brands**

**Building Materials Holding Company**

Dublin, Ireland


Oldcastle APG
Oldcastle Infrastructure
Oldcastle Building Envelope
Oldcastle Materials

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**North America's Largest Concrete Building & Hardscapes Manufacturer**

Atlanta, GA

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**Architectural & Commercial Building Products**

Atlanta, GA





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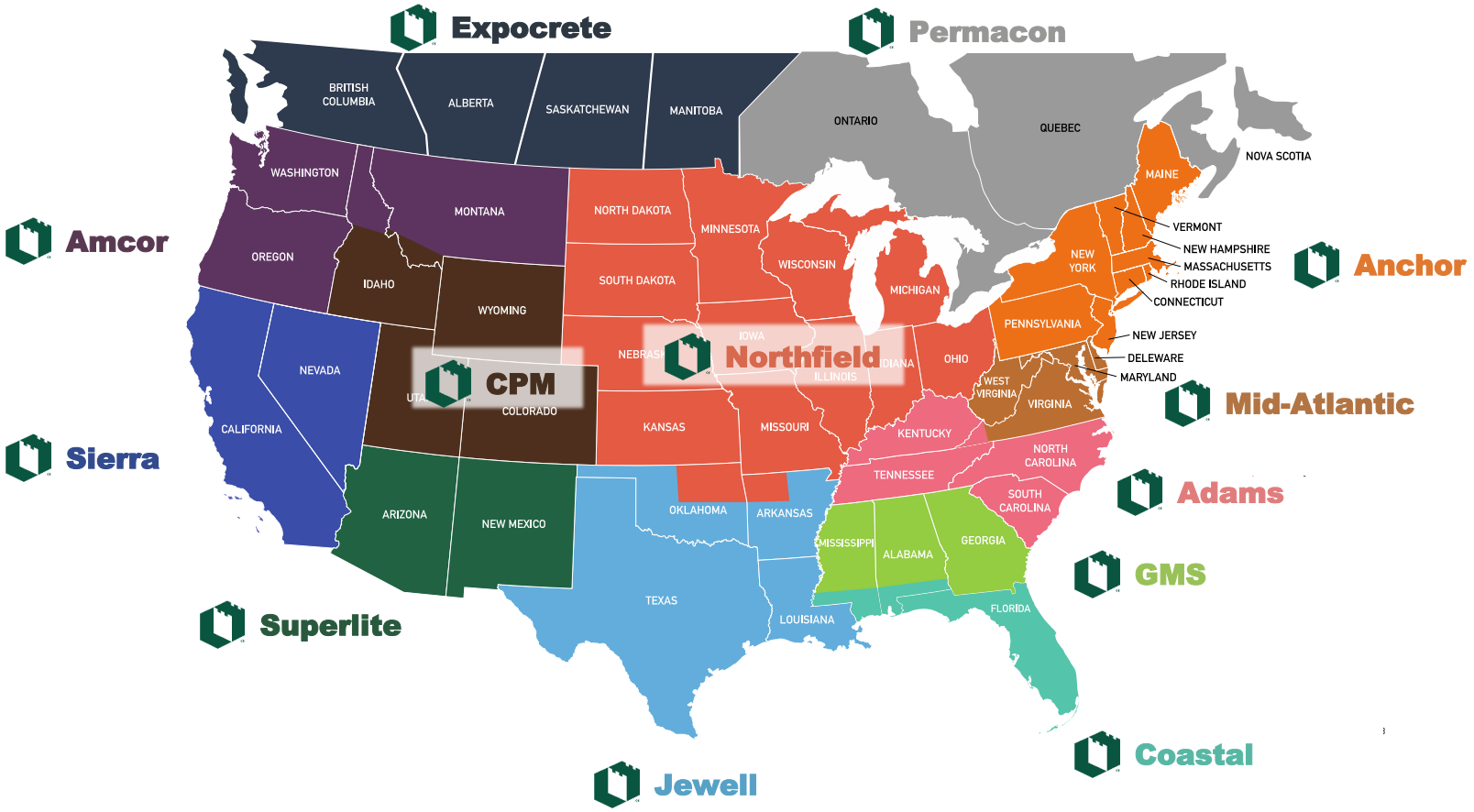
# National Reach, **Local Support**

**186**
Locations

**6,000+**
Employees

**ONE**
Oldcastle APG



# Questions?

***Your participation makes our presentation better!***

Post questions in Q & A – we'll answer them as fast as we can!

We've added dedicated times for questions in presentation

If we run out of time – we'll stick around to answer questions after the presentation

If we still can't get to them all – we'll answer everything in a follow-up e-mail to all registered attendees


# *Design Strategies for Architectural Stone Masonry*

Program: ECH-DSAM

AIA/CES: 1 LU/HSW Credit

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# Learning Objectives:

**Learning Objective** #1:
Gain a better understanding of Indiana Limestone through its history; its inherent performance characteristics that have made this the product of choice. Moreover, natural stone has transformed what was a localized industry into multiple stone options used in building construction today.

**Learning Objective #2:**
Discuss the performance criteria and overall sustainable design options of Architectural Stone Masonry regarding strengths, low moisture characteristics and durability and how these qualities effect the overall building envelope's resiliency.

**Learning Objective #3:**
Understand the different manufacturing methods of stone masonry products that not only offers an economical and aesthetically pleasing weather-resistant exterior stone cladding, but how the manufacturing process develops a fire resistant and safe component to the exterior envelope.

**Learning Objective #4:**
Demonstrate proper detailing methods and good construction practices to help mitigate moisture intrusion, avoid cracking, and provide an overall resilient structure.

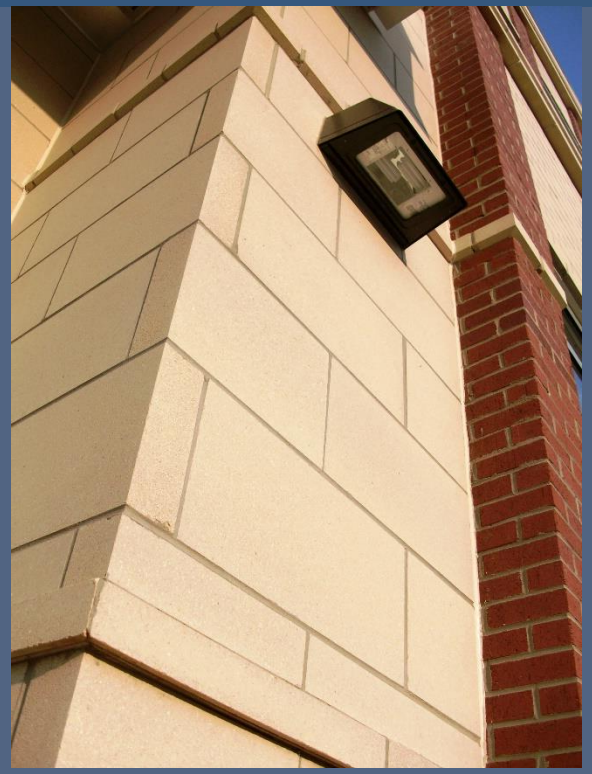
# Public Facility: Cast Stone

*Library Addition- Farmville, NC*

# Residential: Cast Stone/Limestone

*Nikolas Residence- Raleigh, NC*

# Commercial Building: Architectural Stone



*Crescent State Bank- Raleigh, NC*

# Commercial Landscape: Architectural Stone


*Waterstone Development- Hillsborough, NC*

# Commercial Site: Architectural Stone

*Beechleaf- Raleigh, NC*

# Residential: Calcium Silicate

*Luxury Apartments , Canada*

# Health Care: Calcium Silicate


*Children's Northwest- Arkansas*

# Why Stone Masonry?


Permanent, Good Quality
& Low Maintenance


Unique Applications


Easily manipulated into
various textures, shapes, and sizes

It all started with Indiana Limestone….

Standard Buff

Silver Buff

Rustic Buff

Standard Gray

Full Color Blend

Grade:

Select-

Fine grained stone. Has controlled minimum of inclusions and veining.

Standard-

Average to large grained stone. Permits an average amount of inclusion and veining.

Rustic-

Large to coarse grained stone Permits an above average amount of inclusions and veining.

*Source: Indiana Limestone Company*
*https://www.indianalimestonecompany.com/products/limestone-blocks/*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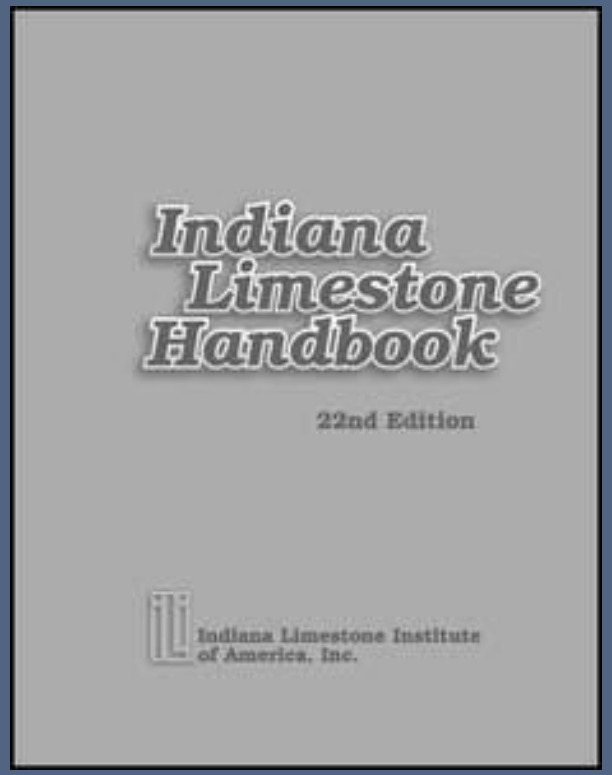
# Specifying Indiana Limestone

Follow guidelines in The Indiana Limestone Institute Handbook.

Specify a description of the stone including the quarry, grade, color, and finish.

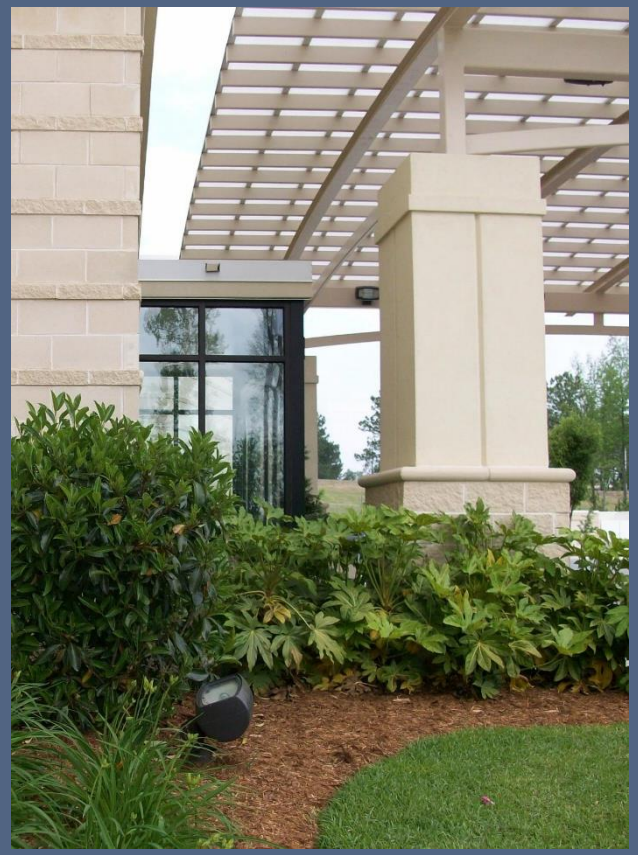
ASTM 568- Standard Specifications for Limestone Dimensioned Stone

**<u>Several tests to confirm performance:</u>**
ASTM C97 Absorption and Bulk Specific Gravity
ASTM C99 Modulus of Rupture
ASTM C170 Compressive Strength
ASTM C241 Abrasion Resistance of Stone Subjected to Foot Traffic
ASTM C880 Flexural Strength of Dimensioned Stone



# Other Stone Options

Cast Stone



Architectural Stone

Calcium Silicate

Architectural Precast

# Defining Cast Stone

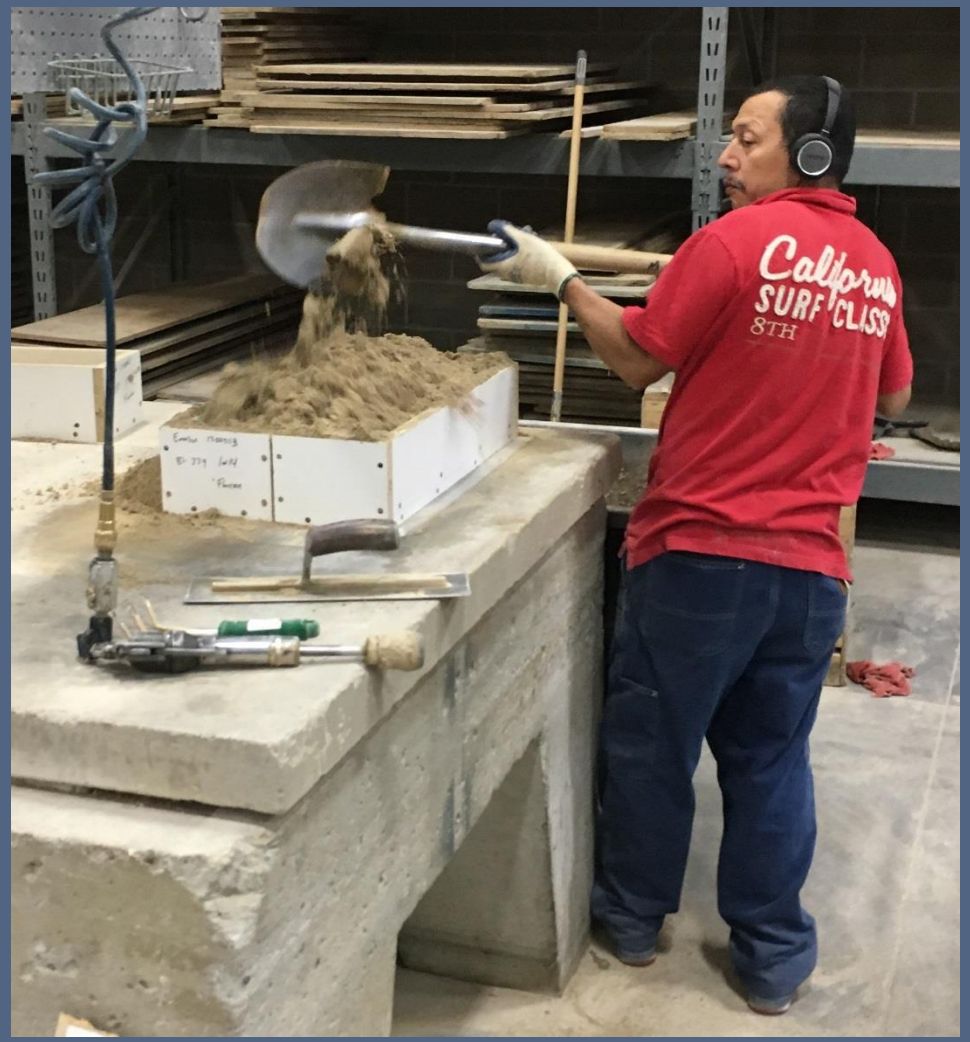
- 1.4. Definitions
- Cast Stone - a refined architectural concrete building unit manufactured to simulate natural cut stone, used in unit masonry applications.
  - Dry Cast Concrete Products – manufactured from zero slump concrete.
    - Vibrant Dry Tamp (VDT) casting method: Vibratory ramming of earth moist, zero- slump concrete against a rigid mold until it is densely compacted.
    - Machine casting method: manufactured from earth moist, zero-slump concrete compacted by machinery using vibration and pressure against a mold until it becomes densely consolidated.


(Resource: http://www.caststone.org/specifications.htm)

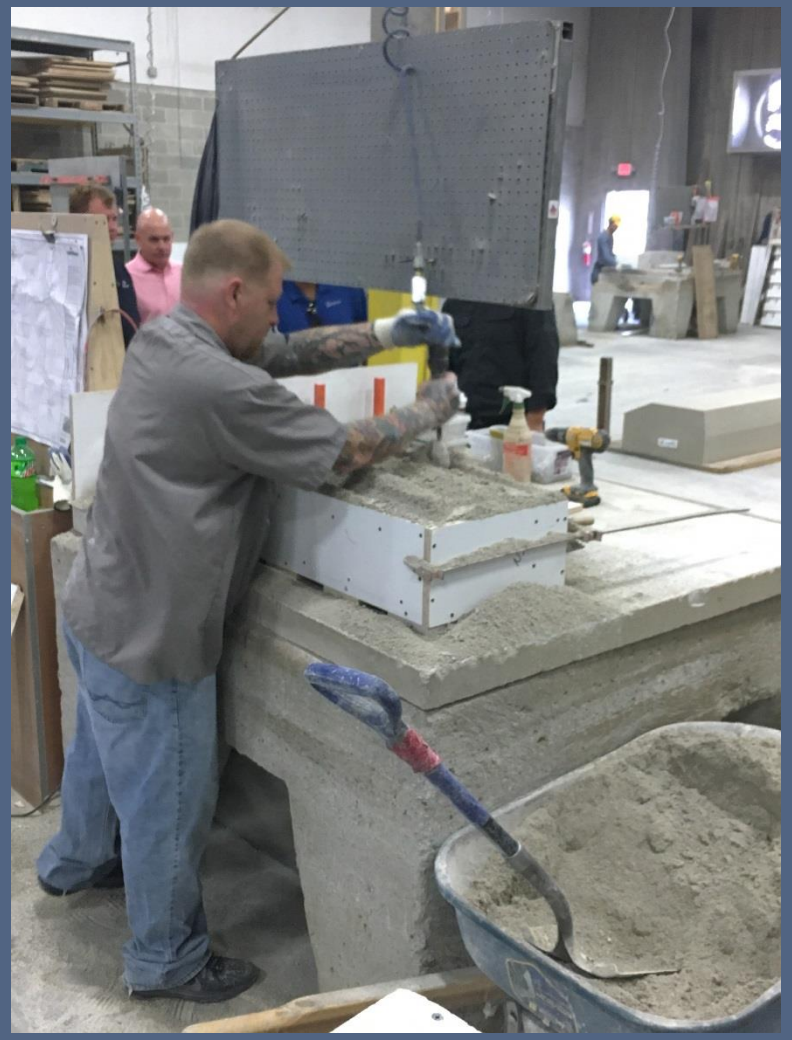

# Cast Stone Sophisticated Equipment


# Cast Stone- Molds for Custom Shapes

# Cast Stone- Custom Shapes

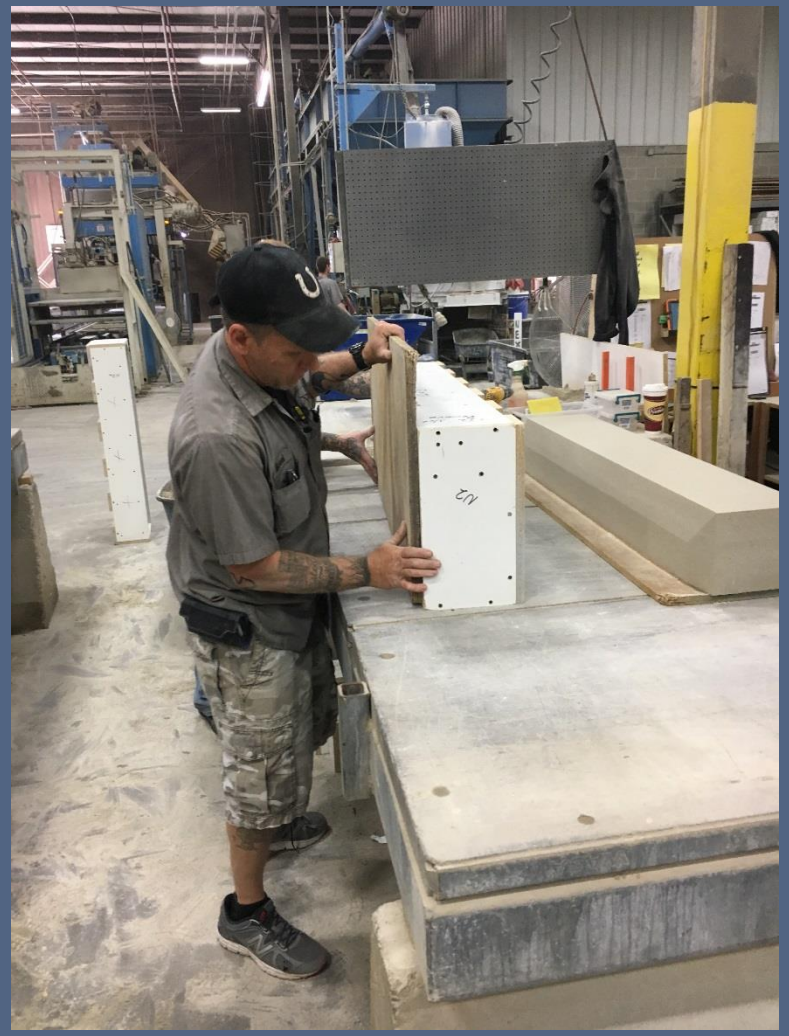


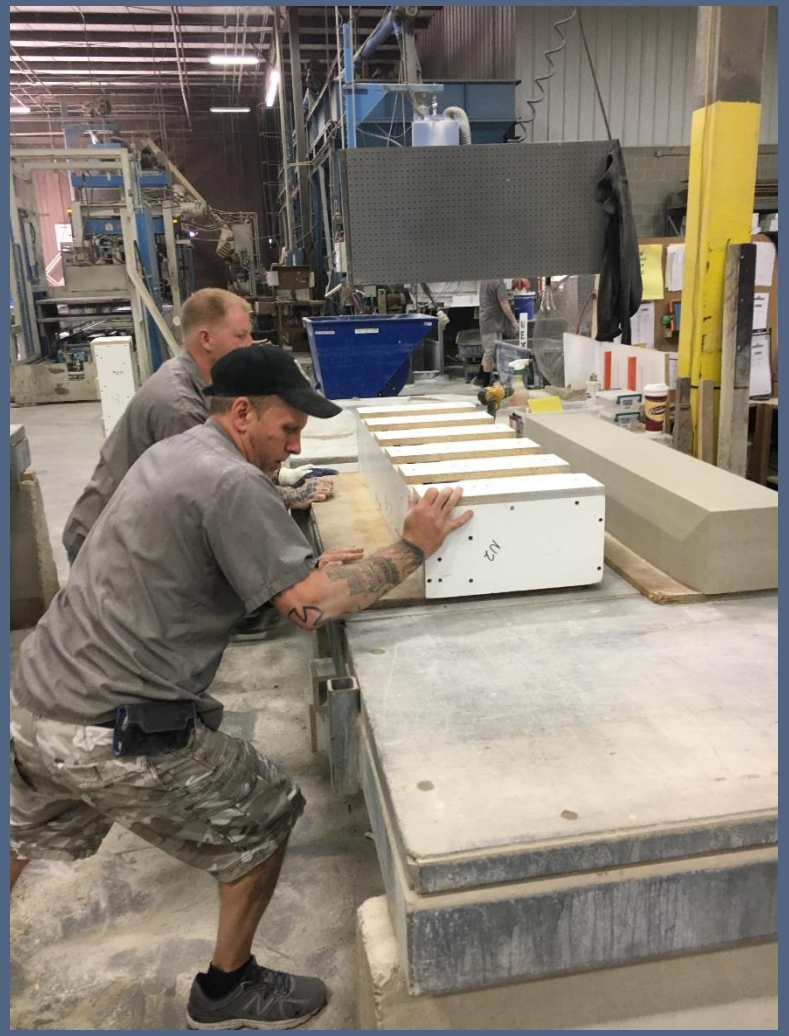

*Zero Slump Cement Placed into the Mold*



*Cement is Vibrated/ Tamped*

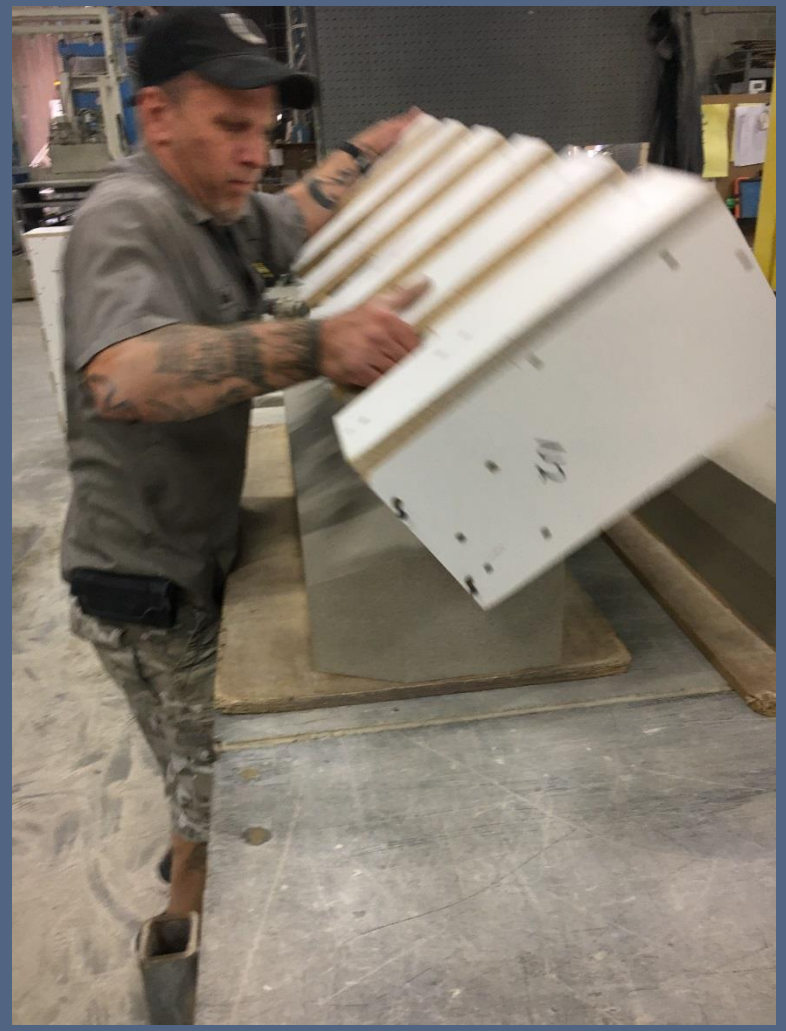
# Cast Stone- Custom Shapes



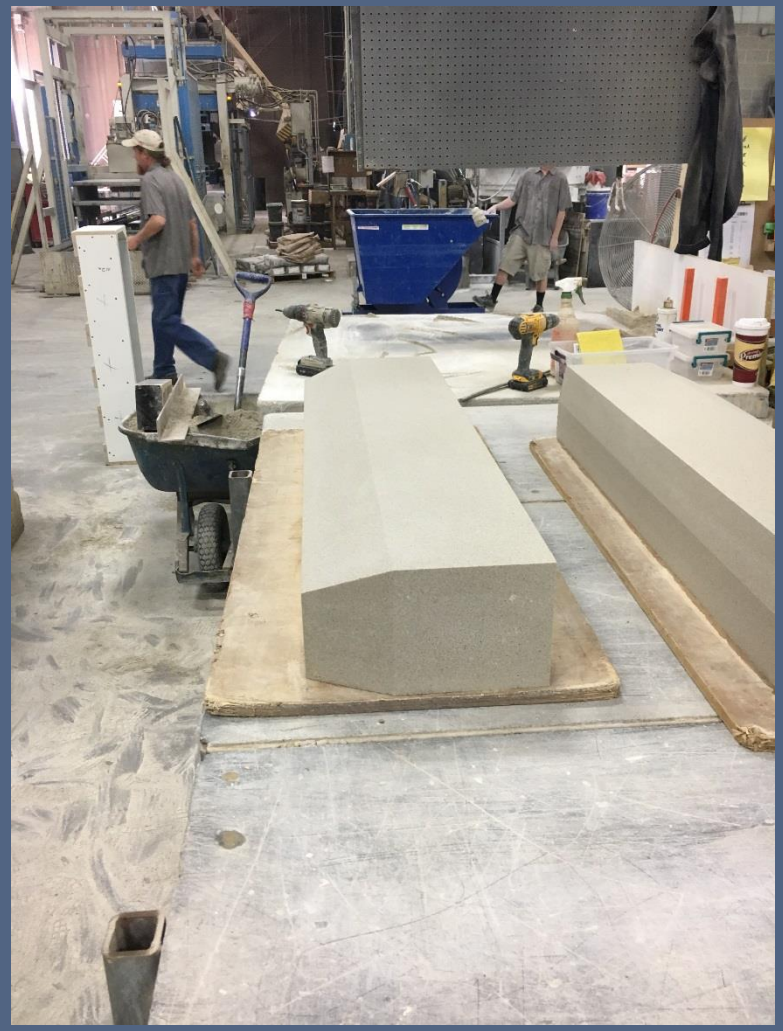


*Stripping Shapes from the Custom Mold*

# Cast Stone- Custom Shapes

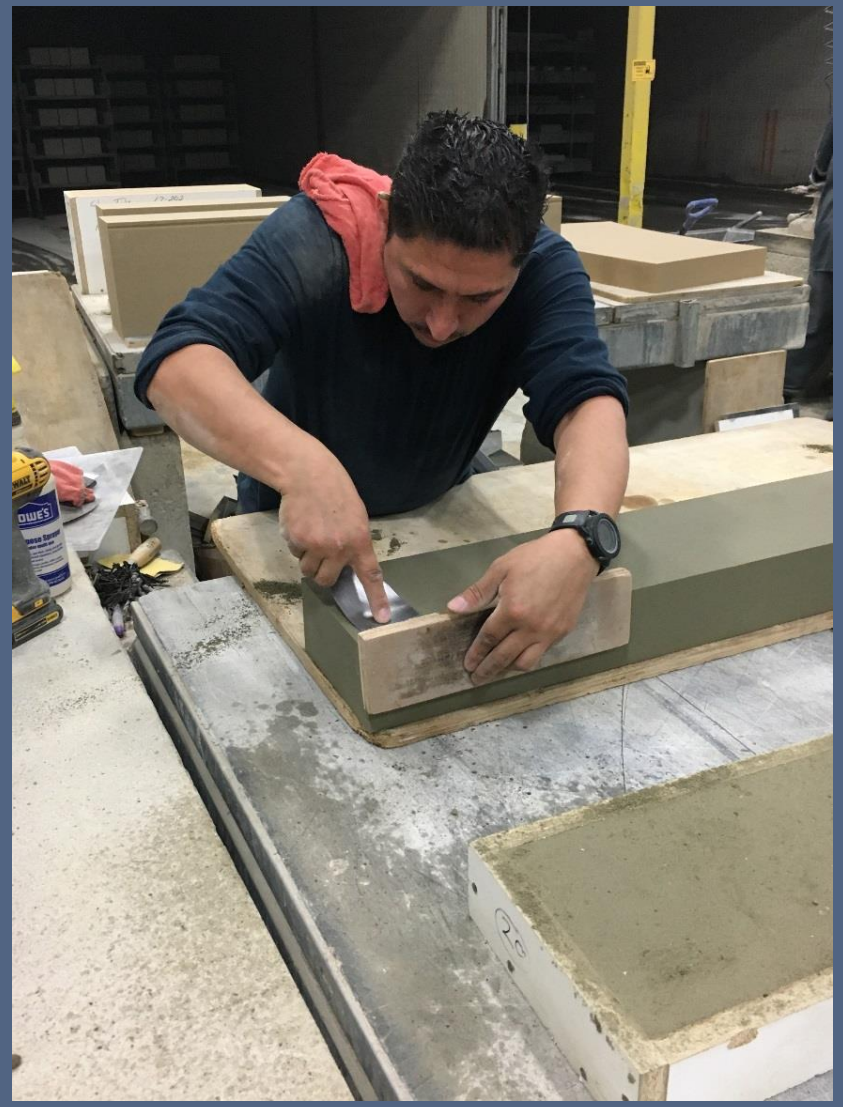


*Mold is Removed*



*Finished Product*

# Cast Stone- Custom Shapes



- Visually Inspected
- Fine Tune any Imperfections
- Labor Intensive

*Craftsmen correct any imperfections during final inspection*

# Cast Stone- Flexibility

# Cast Stone vs Architectural Stone

*Cast Stone*

Cast Stone vs Architectural Stone:

- **Architectural stone** is an economical stone product made from crushed aggregates like limestone, sand and cement that offers the look and feel of natural limestone.
- **Architectural stone** is a high-density, water-resistant masonry product that can be used above grade, at grade or even below grade.

*Architectural Stone*

# Cast Stone vs Architectural Stone

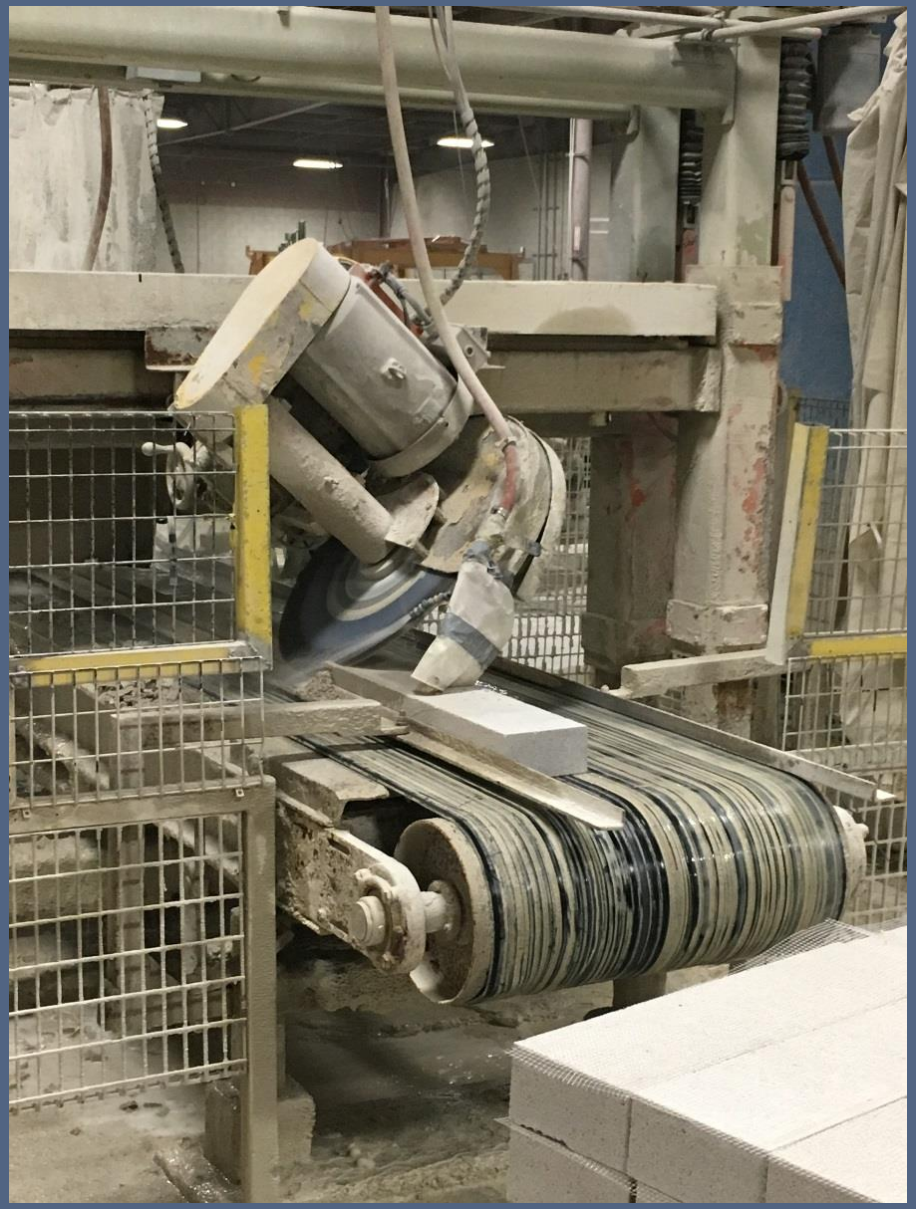

*Cast Stone*

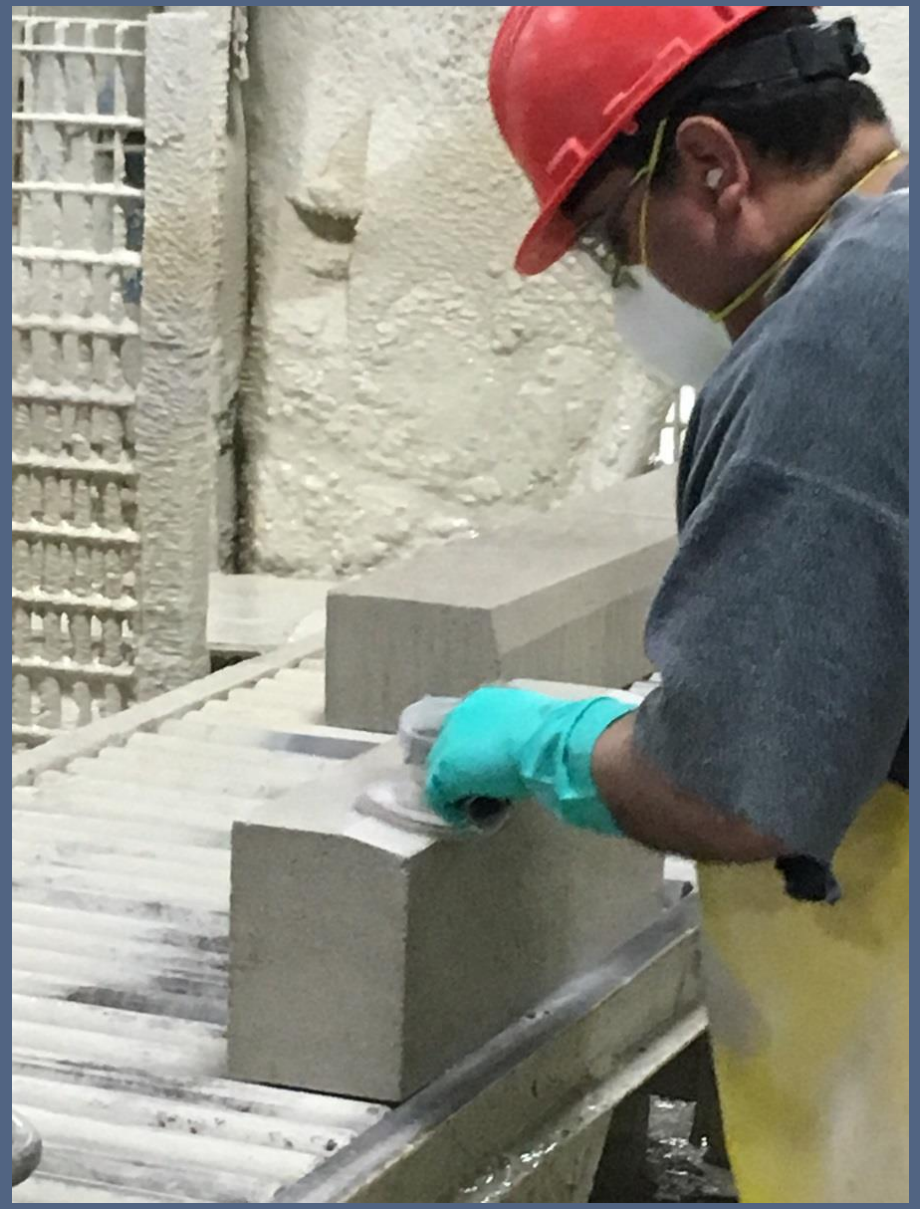

*Architectural Stone*

# Architectural Stone

- Manufactured in Large Blanks
- Faces Manipulated to Create Shapes
- Repetition is Good – Economy of Scale

# Architectural Stone- Customized Fabrication





# Architectural Stone

# Architectural Stone


FDC

# Architectural Stone- Standardized Fabrication

- Standard sized elongated units
- Full bed depth units
- Same unit for facades and corners

# Calcium Silicate

- Masonry units are produced from sand and silica which is mixed with hydrated lime and other elements.
- The no-slump mixture is then pressed into modular-sized molds and cured in an autoclave.
- Calcium silicate contains no Portland cement.

# Calcium Silicate

- The appearance of masonry rising directly from grade can be a desirable design element for many designers.

- By employing common sense precautions one can effectively prevent moisture from adjacent elements wicking into the masonry at grade.

# Calcium Silicate


# Calcium Silicate

- Variety of Textures
- Primarily as architectural veneer facing
- Calcium Silicate units must comply with ASTM C73
- MW Grade at 3,500 psi with maximum 14% absorption
- SW grade at 5,500 psi with 11.5% maximum absorption.
- No freeze thaw durability requirement

# Dry Cast vs. Wet Cast Manufacturing

## Dry Cast (architectural/cast stone)

- 6 % Moisture
- Sand aggregates
- Releasing Molds
- Repetitious units

https://www.youtube.com/watch?v=F6auoqql5D8

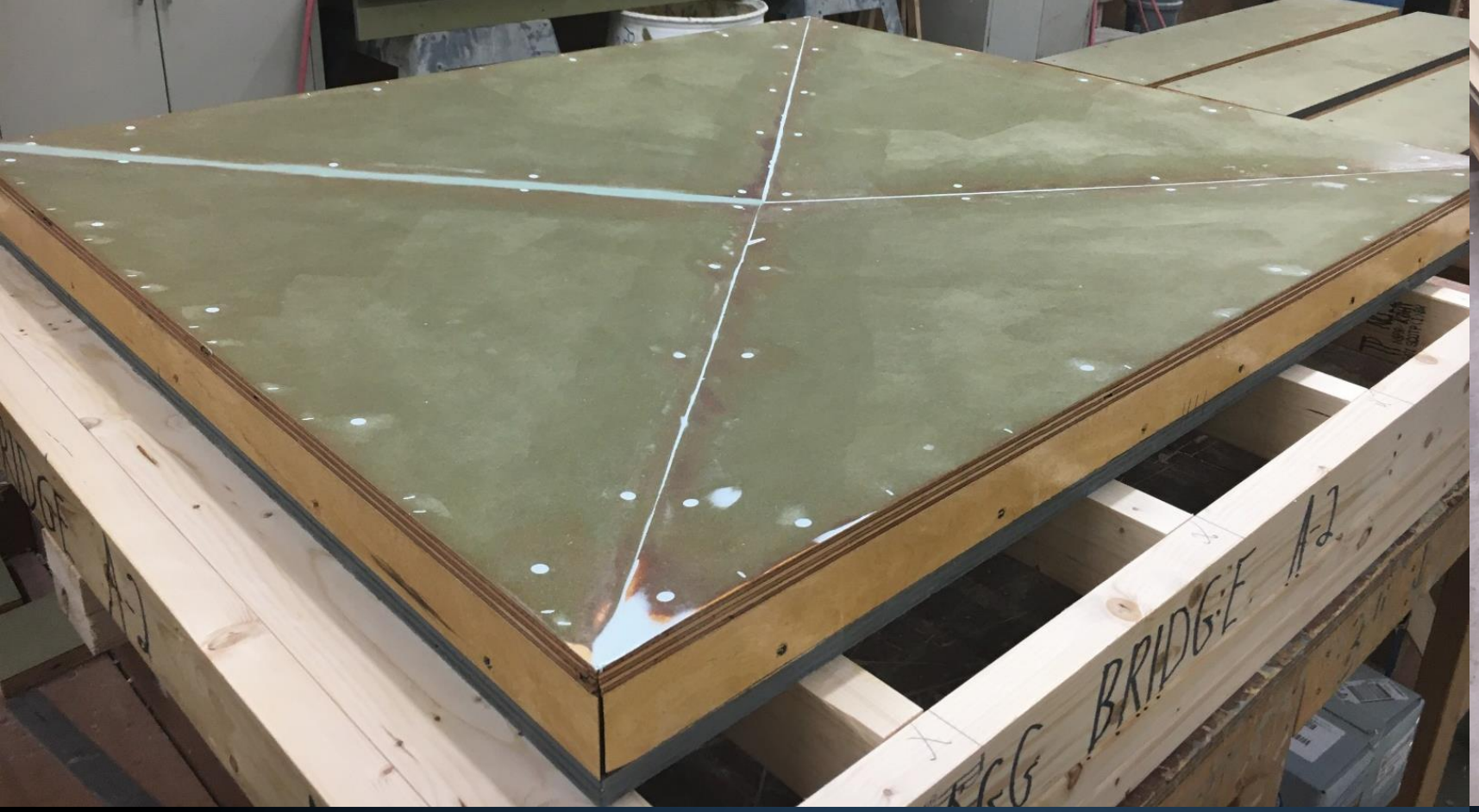
## Wet Cast (Architectural Pre- Cast)

- 33 % Moisture
- Pebble aggregates
- Wood or Metal Molds
- Large units


https://www.youtube.com/watch?v=27dGZREgcwQ&index=9&list=PLVvyuMEI05J6Dlzy6A20S0e2KVW00IfPf



# Architectural Pre-Cast Manufacturing




# Architectural Pre-Cast Manufacturing

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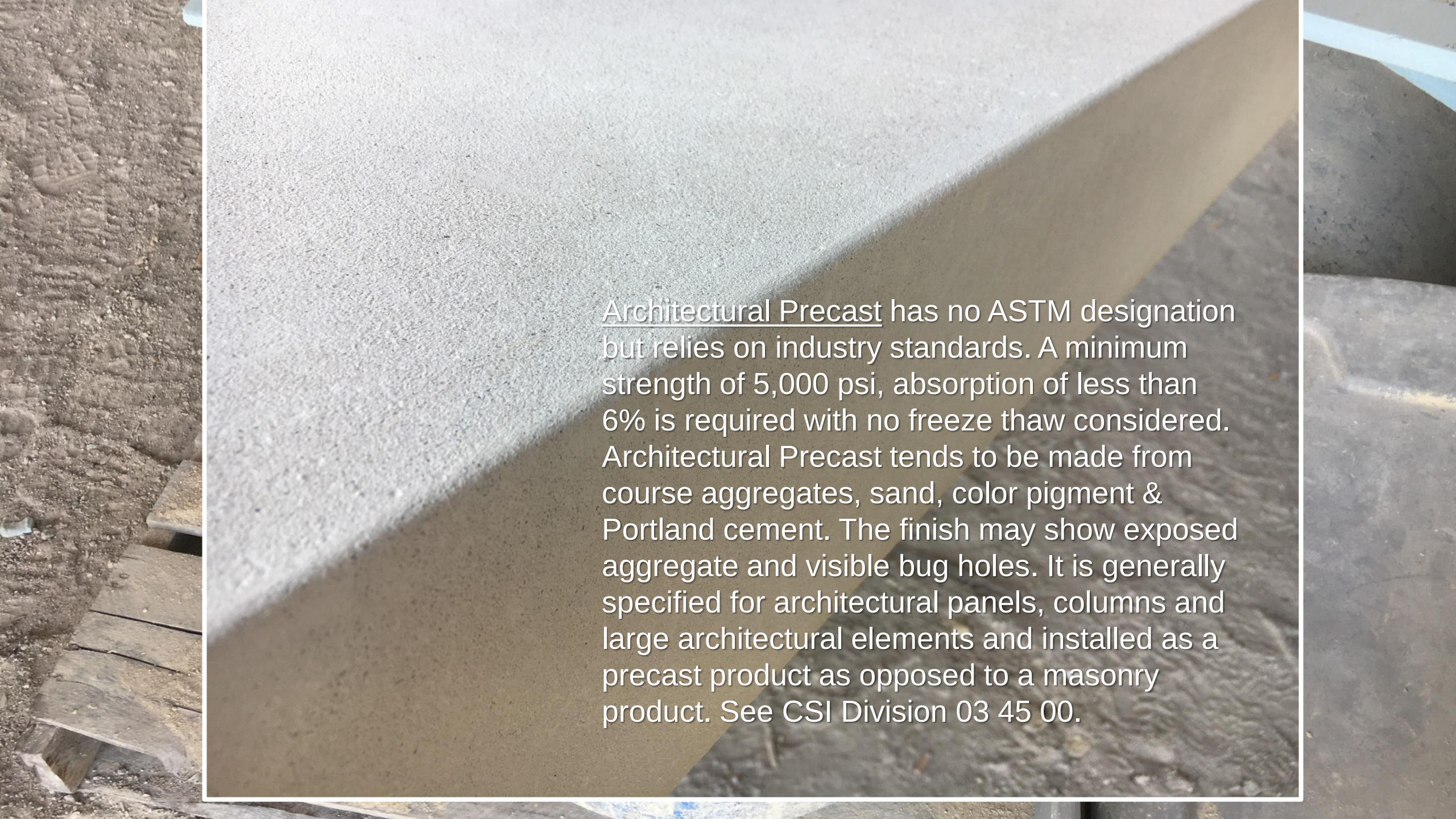


Architectural Precast has no ASTM designation but relies on industry standards. A minimum strength of 5,000 psi, absorption of less than 6% is required with no freeze thaw considered. Architectural Precast tends to be made from course aggregates, sand, color pigment & Portland cement. The finish may show exposed aggregate and visible bug holes. It is generally specified for architectural panels, columns and large architectural elements and installed as a precast product as opposed to a masonry product. See CSI Division 03 45 00.

# *Specifying Stone Masonry Units*

| | Limestone Units | Cast Stone Units | Architectural Masonry Stone Units | Calcium Silicate Units | Architectural Precast Units |
|---|---|---|---|---|---|
| Specification: | ASTM C-568 | ASTM C-1364 | ASTM C-90 | ASTM C-73 | N/A |
| Compressive Strength: | 4000 psi Minimum Med. Density | 6500 psi Minimum | 2000 psi Minimum NW Density | 5500 psi Minimum Grade SW | 5000 psi Minimum |
| Absorption: | 7.5% Maximum | 10% Maximum | 10.4% Maximum | 11.5% Maximum | 2.18% Maximum |

How do they compare?

# What Type of Stone?

*The Beauty of Natural Stone with the Advantage of Concrete Masonry*

# What Type of Stone?

# What Type of Stone?

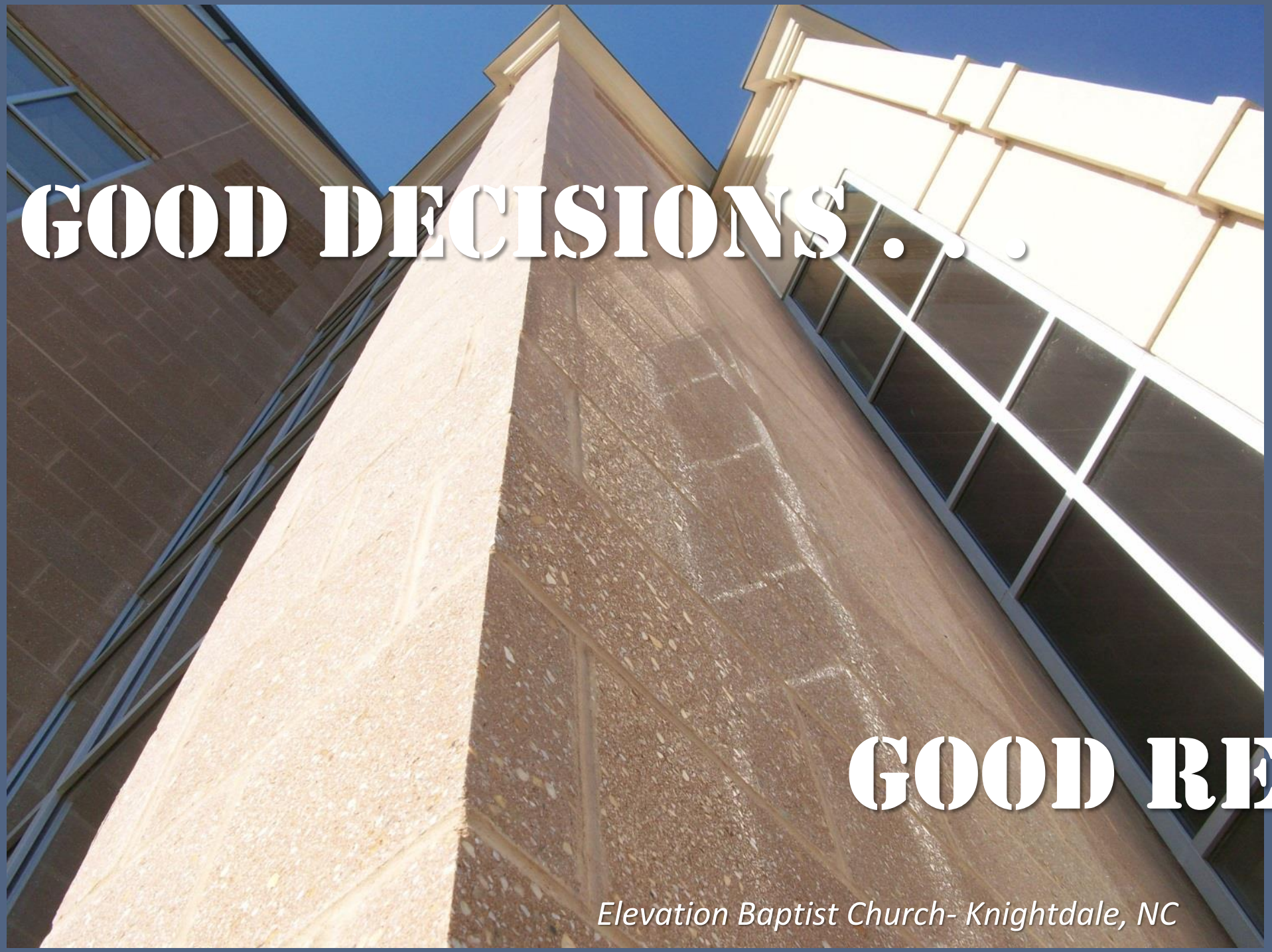
*Courtesy of 3D Limestone*

# What Type of Stone?

*Photo courtesy of P & D Precast*

# What Type of Stone?

*Beckford Tower- New York City*


GOOD DECISIONS . . .
GOOD RESULTS
Elevation Baptist Church- Knightdale, NC

# Important Criteria!

**Masonry is a system of**

**Components.**

- **Cracking**
- **Moisture Mitigation**

# What Causes Movement?

- Temperature changes
- Shrinkage or restraint
- Excessive deflection, structural overload and settlement
- Permanent Movement - Carbonation
- Differential Movement (most important)

Control Joints are essentially vertical separations built into the wall to reduce restraint and permit longitudinal movement.

Cracking is NOT a product issue and usually not a structural concern but more of an aesthetic  issue, that is preventable!

# Strategy

**Differential Movement**

All masonry materials have some degree of movement and may move in opposite directions.  Therefore your walls must accommodate this change.

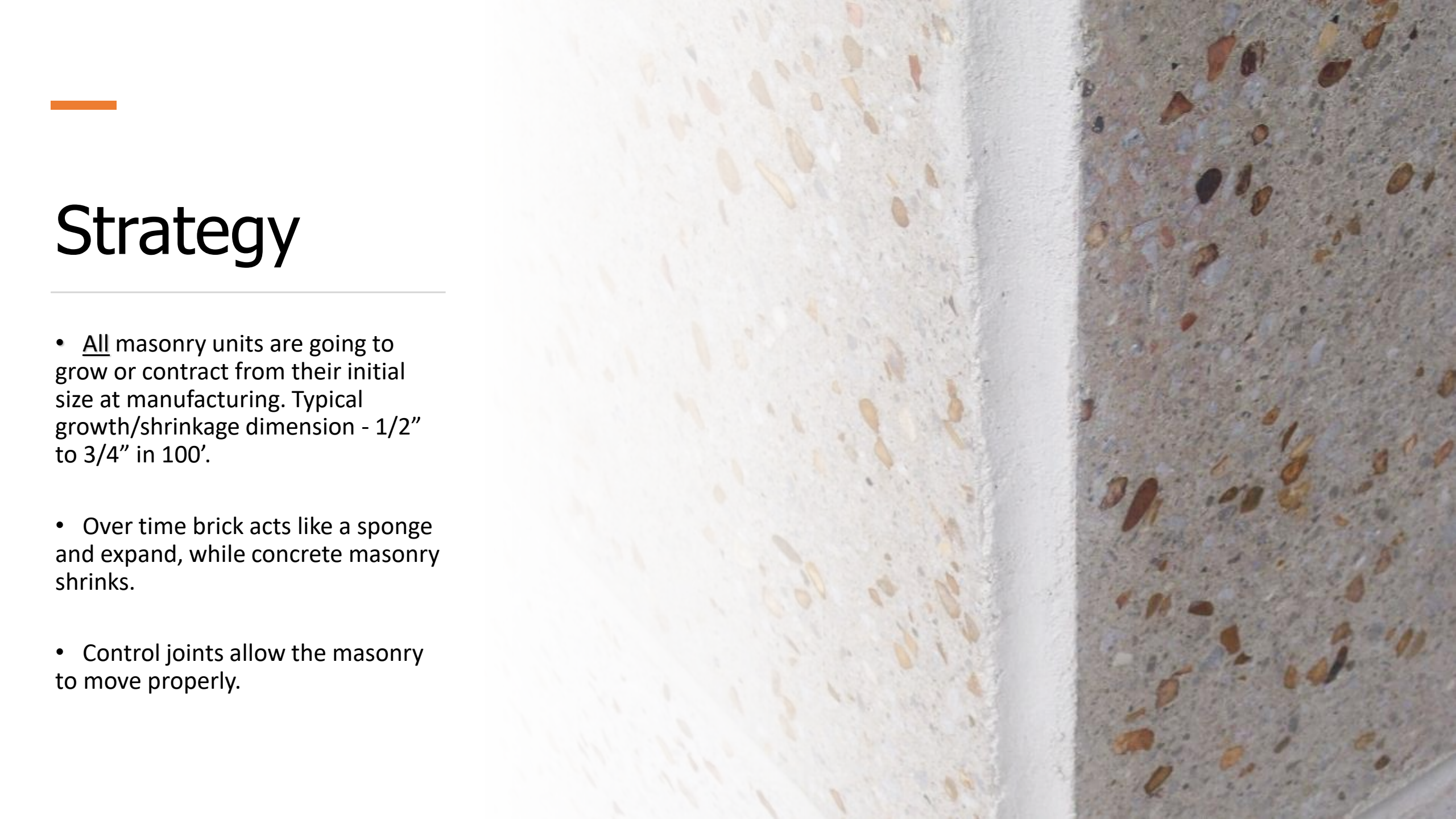

*Crescent State Bank- Raleigh, NC*

# Strategy

- All masonry units are going to grow or contract from their initial size at manufacturing. Typical growth/shrinkage dimension - 1/2” to 3/4” in 100’.

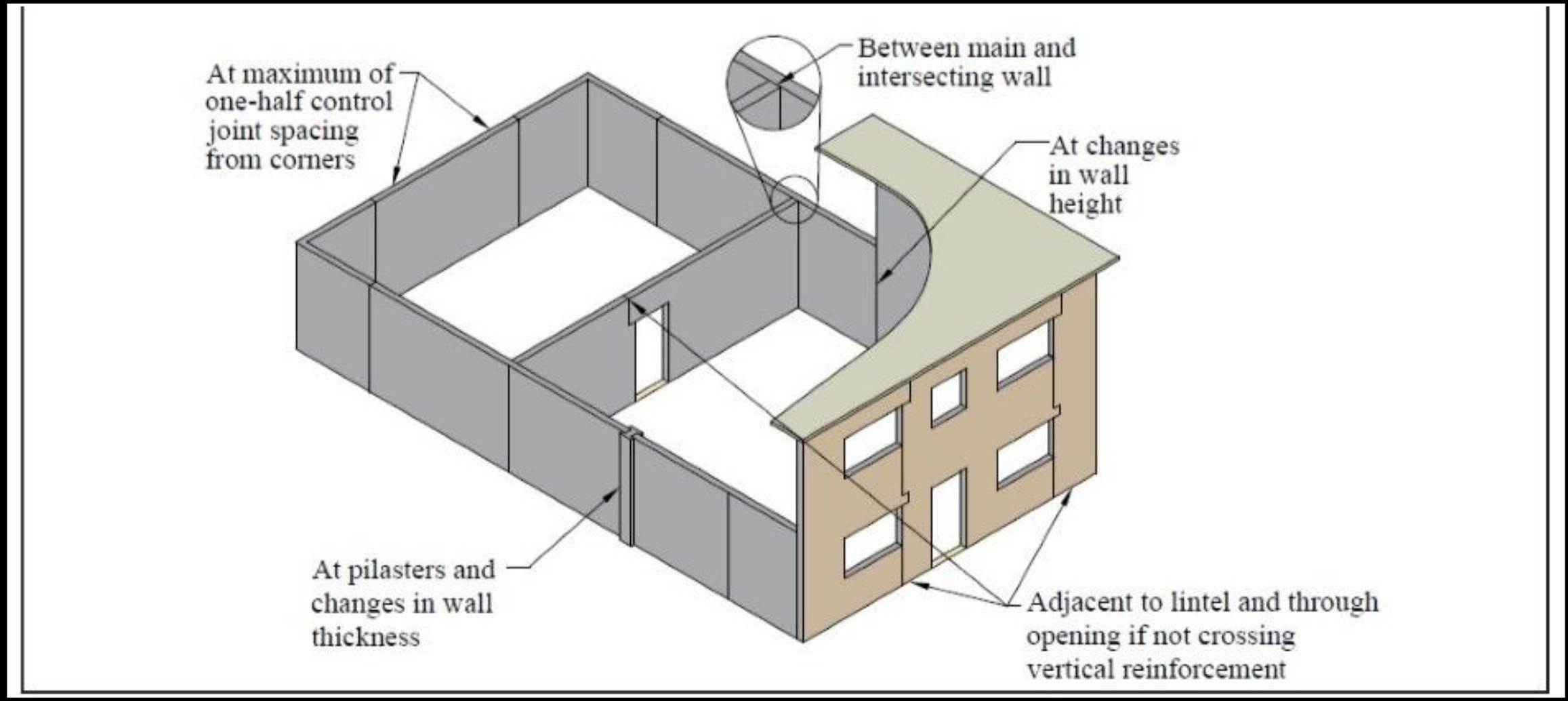
- Over time brick acts like a sponge and expand, while concrete masonry shrinks.

- Control joints allow the masonry to move properly.



# Crack Control Empirical Approach

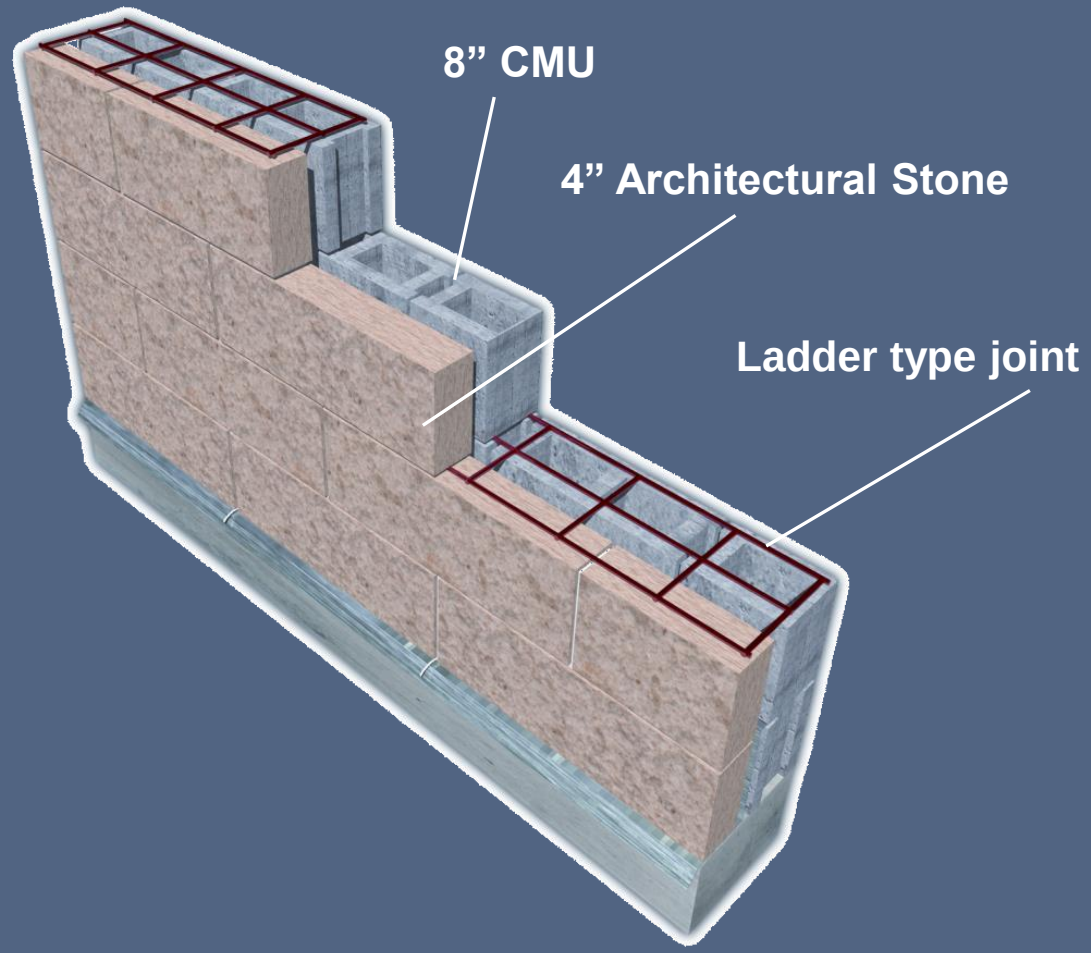
- Control Joint Locations
- No more than 25’ apart based on wall height
- Approx 2’-4’ from corner
- At inside corners especially at wall piers and columns
- At the side of any large opening or window
- At wall height changes

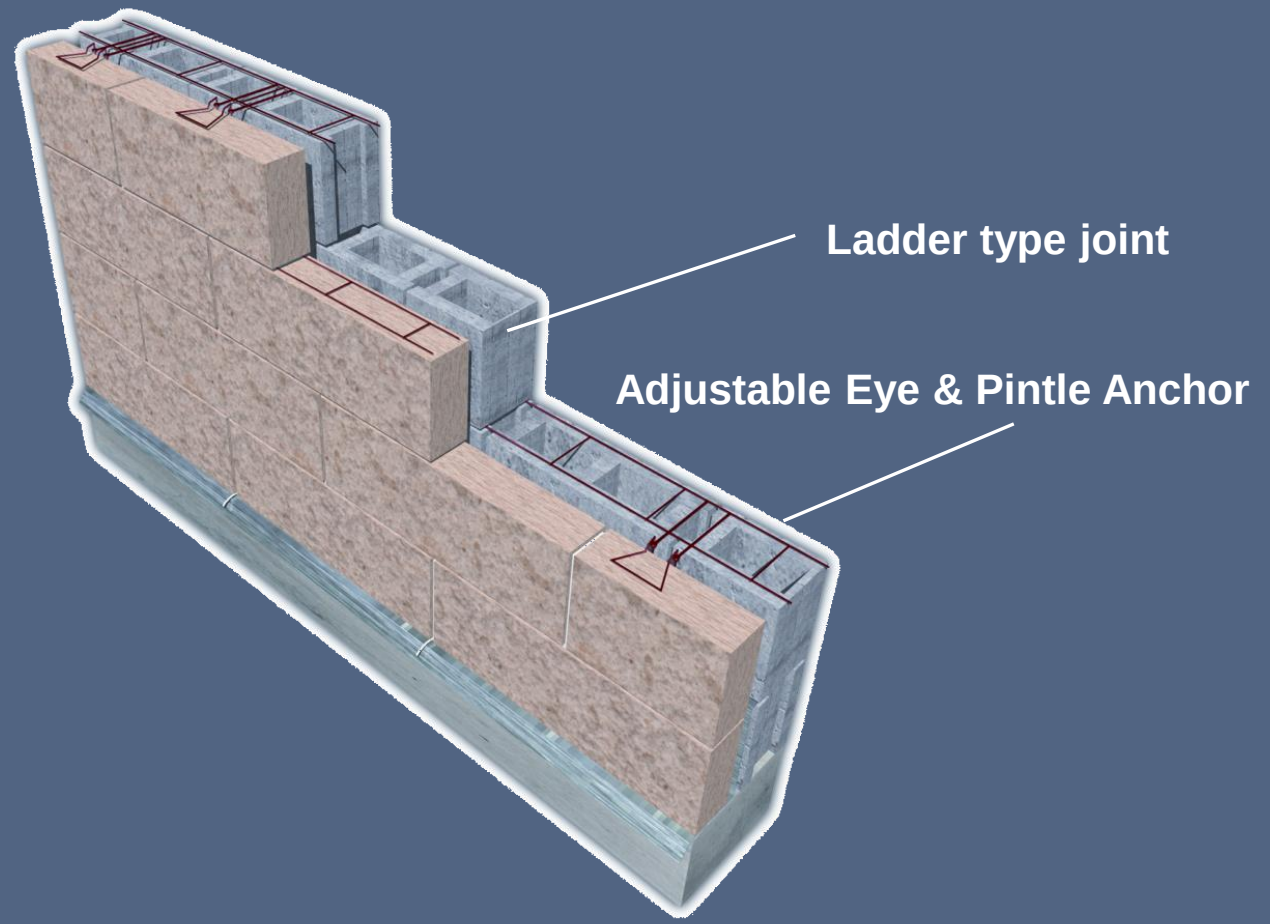



# Typical Control Joint Locations

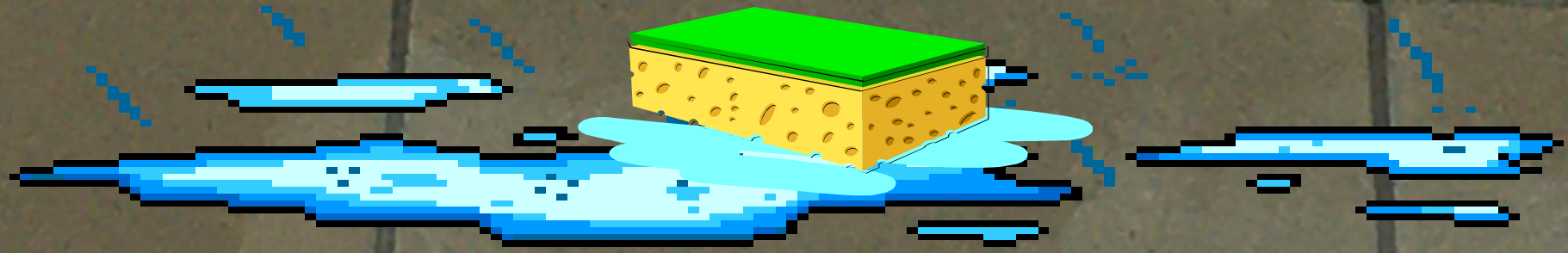
# Crack Control- Horizontal Joints

Continuous horizontal joint reinforcement is recommended in exterior wythe every 16”.  When using 12” or 16” tall units install every course.



# Mitigating Moisture



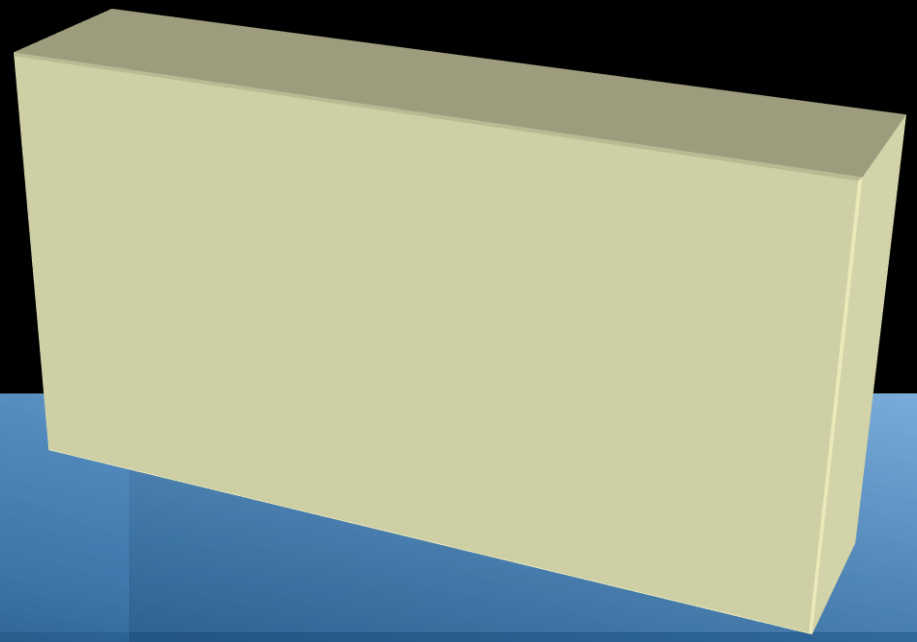

# *Mitigating Moisture Issues*

# Moisture Control: A System's Approach

**Designing walls with moisture penetration in mind:**

- 1st line of defense - Veneer
- 2nd line of defense - Cavity
- 3rd line of defense - Flashing and Weeps
- 4th line of defense - Back-up Wall

- Choose the right product for the right project
- Integral water repellent can enhance the performance for many of the products.
- Stone units should be protected from moisture during construction; it reduces efflorescence issues.



# 1st line of Defense - Veneer

# Integral Water Repellent

With IWR

Without IWR

Water-REPELLENT doesn’t make it Water-PROOF

# 2nd line of Defense – Open Cavity

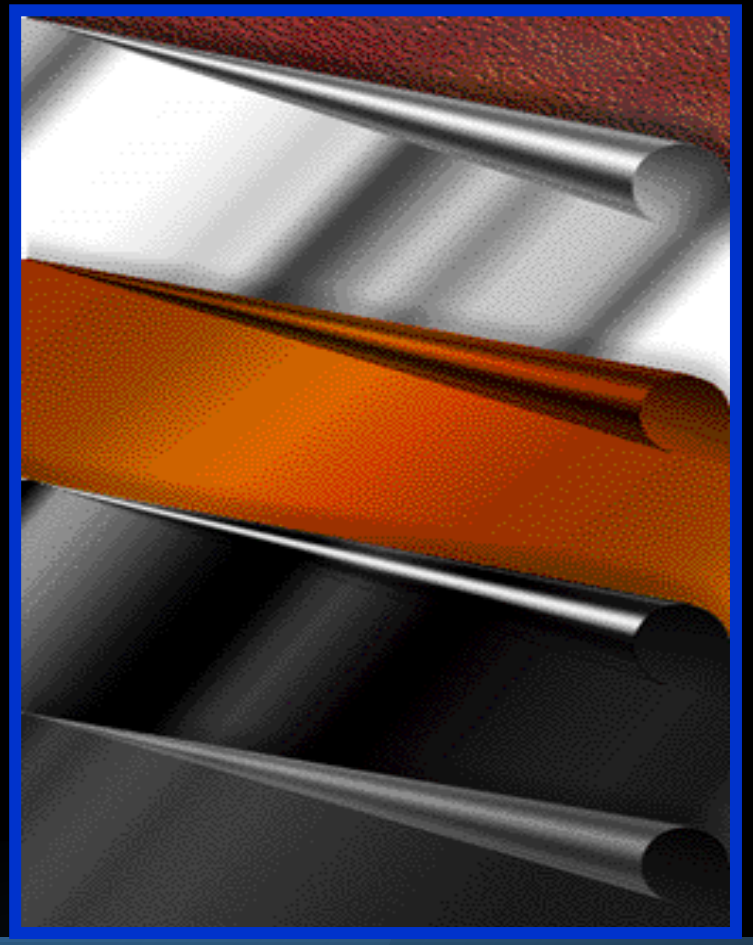
# Mortar Accumulation Protection

Cavity Drainage Mats are available from a variety of manufacturers.

Best not to have mortar droppings in the cavity, but hard to avoid.

## Various Types to Choose From

- Metals
- Copper Composites
- Loose Laid/PVC
- Self-Adhering Membranes



# 3rd line of Defense – Flashing & Weeps

# Are all the Components Compatible?

| FLASHINGS | AIR BARRIERS & INSULATIONS | | | | | |
|---|---|---|---|---|---|---|
| | Spray Polyurethane Foam | Liquid Applied Asphaltic Air Barrier | Liquid Applied Acrylic Air Barrier | Membrane Applied Asphaltic Air Barrier | Polystyrene Foam Insulation | Maximum Warranty |
| Asphaltic copper fabric | | | | | | None |
| Non-asphaltic copper fabric | | | | | | **Lifetime** |
| Stainless Steel fabric | | | | | | **Lifetime** |
| Copper Drainage Plane | | | | | | **Lifetime** |
| EPDM | | | | | | 10 years |
| PVC | | | | | | 5 years |
| PVC KEE Self Adhered | | | | | | 10 years |
| Peel & Stick | | | | | | 5 years |

**NOT COMPATIBLE**

**CAUTION**

**COMPATIBLE**

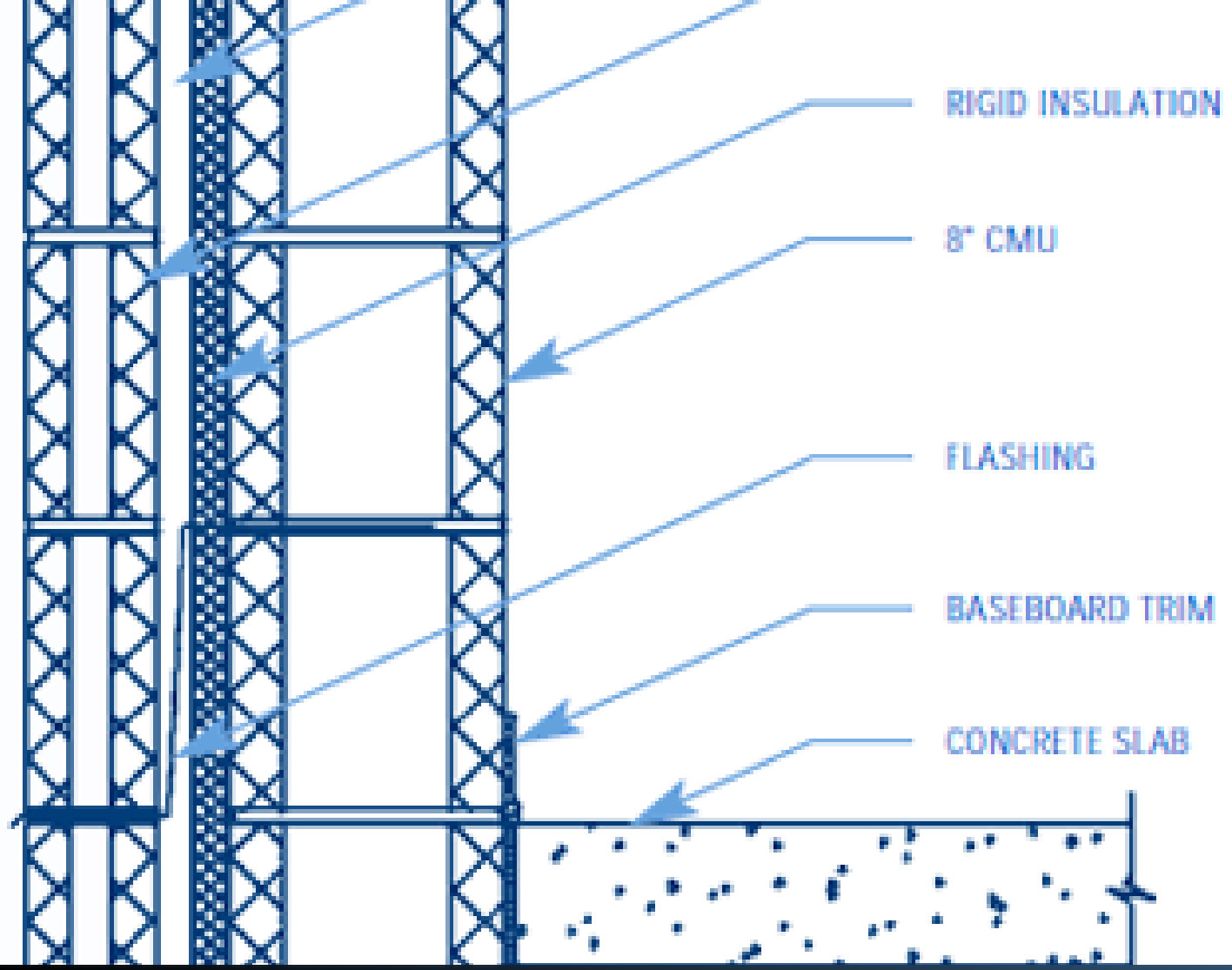
# Good Flashing Characteristics

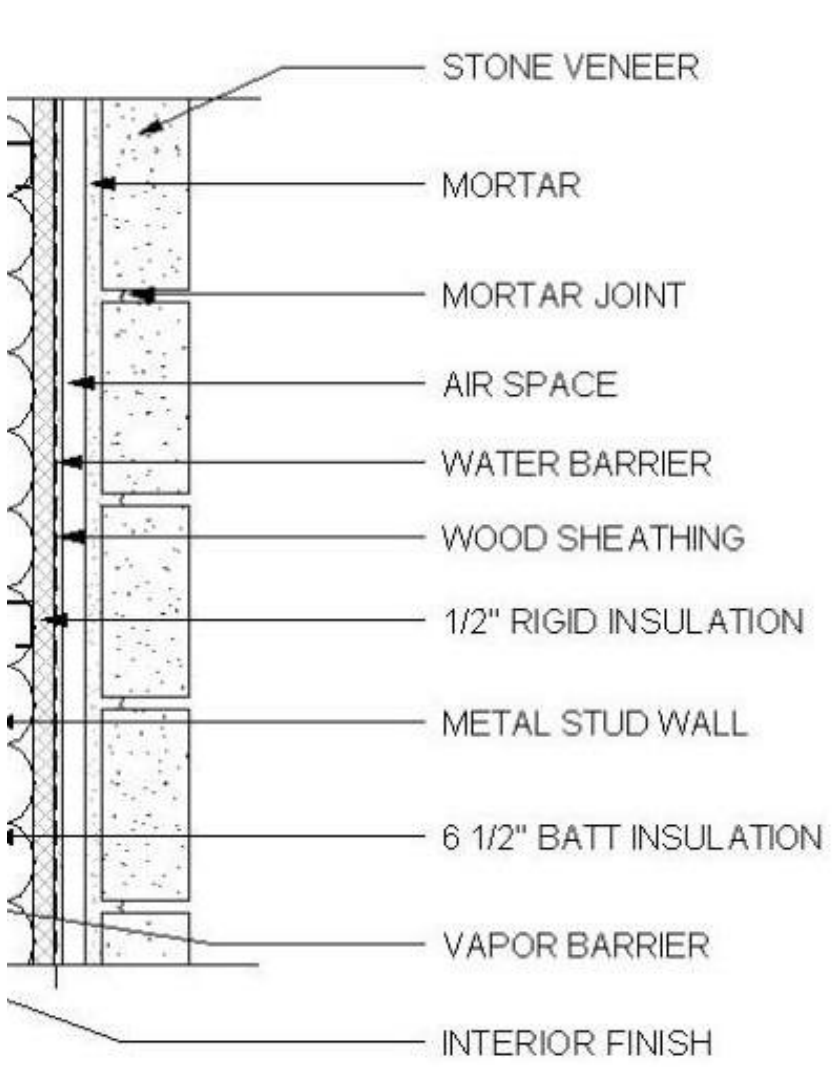
- Durable
- Continuously Water Resistant
- Complete System
- End Dams
- User Friendly

# Weep Holes and Vents

- Install weep holes and vents at proper intervals (24”- 32” O.C. and 2” high, above bed joints, typical)

- Located at courses above grade, above flashing, and at any water stops over windows, doors, and beams.




# 4th line of Defense – Back Up Wall

# Importance of  a Field Panel

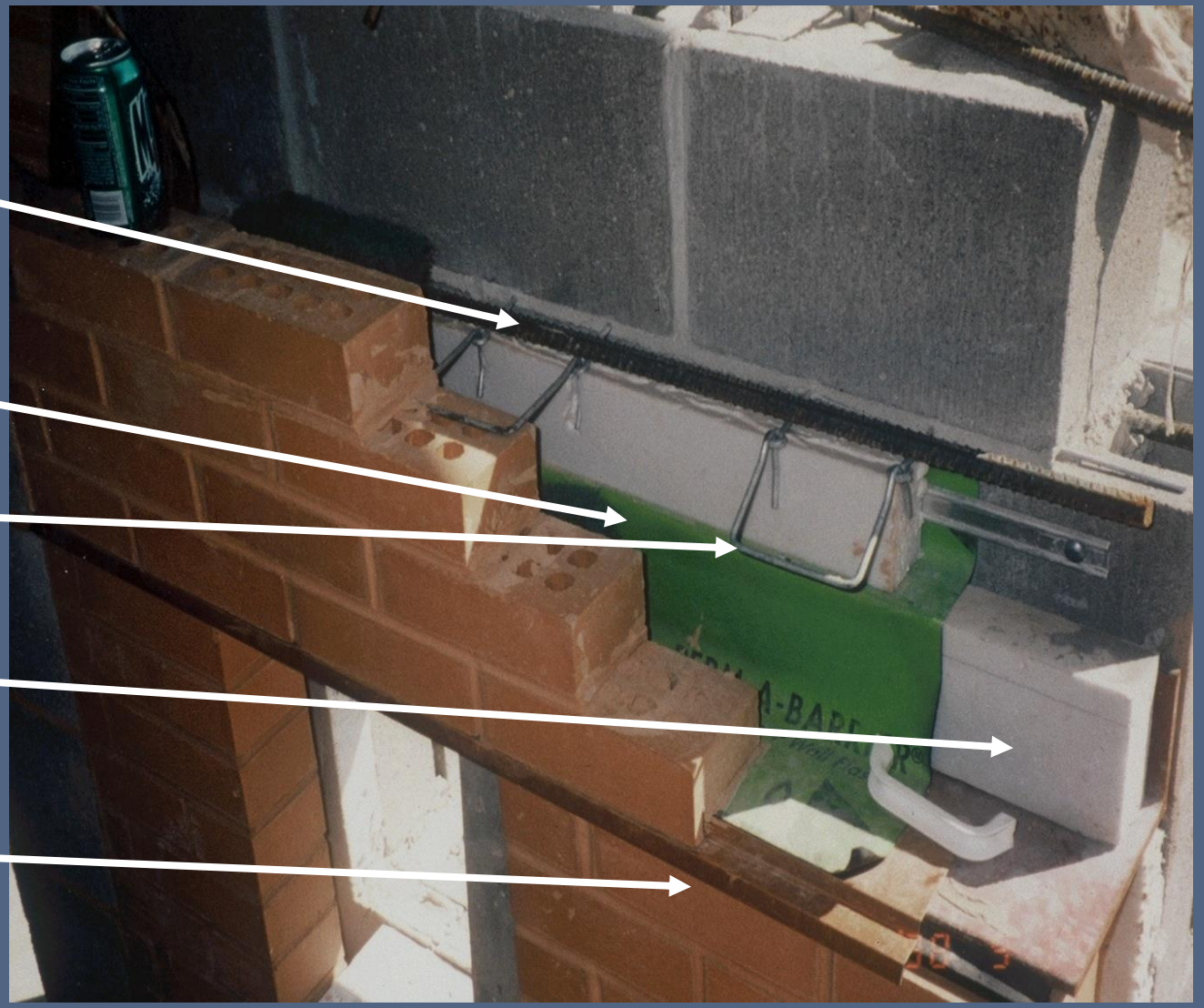
Termination Bar

Flashing

Anchors

Insulation

Drip Edge



# Key Takeaways

- General overview of how Indiana Limestone is quarried, milled, and fabricated to create veneer stones, carvings, and other ornamental shapes.
- Brief review of several common masonry stone options available in the market today and how their reliable performance criteria make them products of choice.
- Highlighted different manufacturing processes for Cast Stone and Architectural Stone and how veneer and custom shapes are fabricated.
- Proper design considerations and detailing to mitigate moisture intrusion and unsightly aesthetic movement cracks in masonry stone veneers.

# Masonry is a Great Choice!

ECHELON™

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