Cold Weather Concrete in SOUTHERN Colorado

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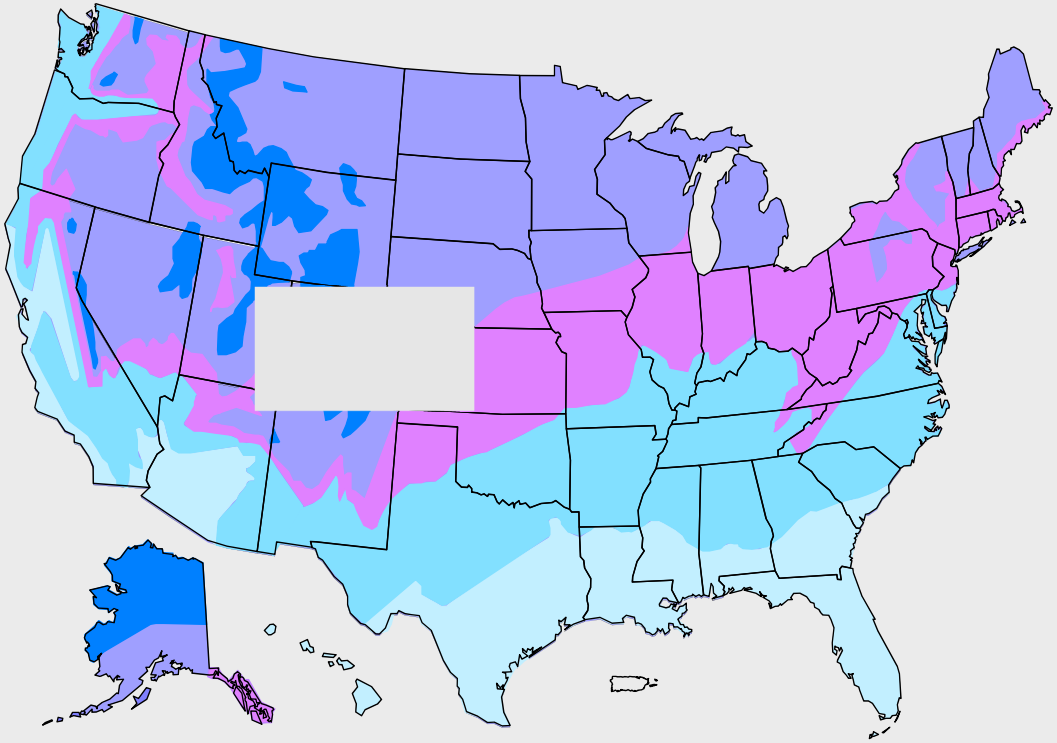
If you went camping, hiking, or hunting, would you want to be **prepared and protected** from the elements?

Or unprepared and unprotected?


CONCRETE FEELS THE SAME WAY!
Why is it important?
What are some problems?
How to prevent and protect?

U.S. FREEZE / THAW ZONE MAP



Annual average number of days temperatures fall below 32 °F (0 °C)

- Less than 30
- 30 to 90
- 91 to 150
- 151 to 210
- More than 210

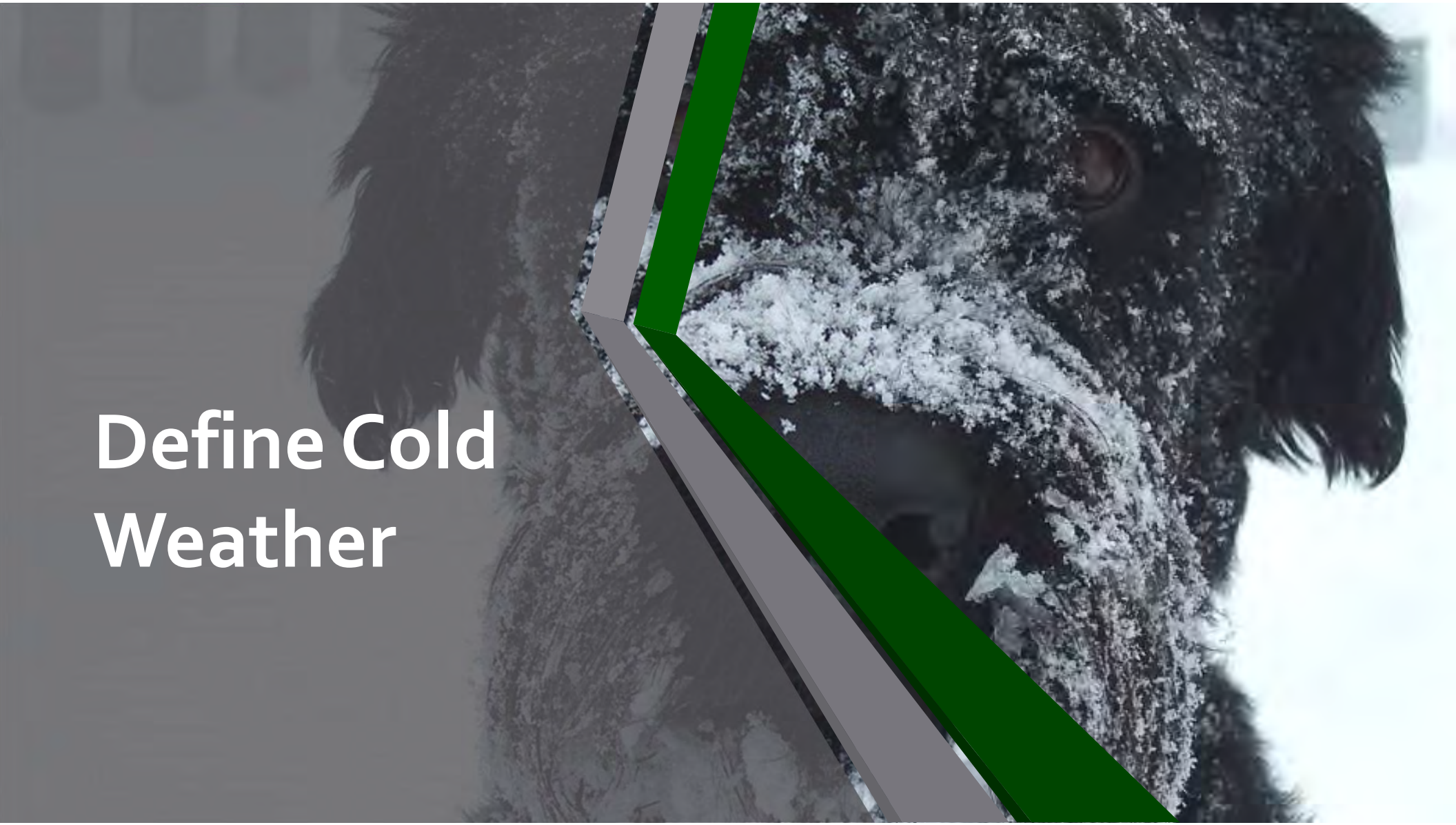
Strength in Numbers


Columbine
Walden
Craig
Fort Collins
Steamboat Springs
Rangely
Hot Sulphur Springs
Loveland
Greeley
Haxtun
Sterling
Holyoke
Brush
Fort Morgan
Akron
Yuma
Wray
Longmont
Boulder
Thornton
Glenwood Springs
Vail
Rifle
Denver
Centennial
UNITED STATES
Clifton
Leadville
Fairplay
Grand Junction
Aspen
Joes
Burlington
Limon
Hugo
Buena Vista
Delta
Orchard City
Colorado Springs
Cheyenne Wells
Montrose
Gunnison
COLORADO
Nucla
Salida
Canon City
Eads
Telluride
Ouray
Westcliffe
Pueblo
Ordway
Las Animas
Dove Creek
Silverton
Creede
Saguache
Rocky Ford
Lamar
Del Norte
La Junta
Cortez
Monte Vista
Walsenburg
Durango
Alamosa
Springfield
Southern Ute I.R.
Pagosa Springs
Trinidad

Why is it Important in Colorado?

- Seasonal weather conditions
- Daily temperature fluctuations
- High/strong winds
- Higher elevations

Define Cold Weather



What is Cold Weather?

Period of 3 consecutive days

Average daily temperature is <40°F

Air temperature is not > 50°F for 1/2 of 24 hours

Placement control

Prevent damage from freezing at early stages

Limit rapid temperature changes

Provide protection consistent with serviceability of structure

Strength in Numbers

Some EXCITING, Completely TECHNICAL stuff!

Strength in Numbers

Effects on Concrete

- Slows Cement Hydration
  - A 10°F drop delays setting approximately 2–2½ hours
    - EXAMPLE – If the set time is 6 hours at 75°F, it will be over 10 hours at 55°F
  - Concrete needs to…
  - (1) Set – Plastic to Solid State
  - (2) Harden – Gains Strength

Strength in Numbers

Effects on Concrete

- Slows Cement Hydration
- Slows Initial Setting Time
  - Concrete should be protected from freezing at an early age – **for the first 48 hours** – until it achieves a compressive strength of at least 500 psi
  - Up to 50% strength reduction can occur if concrete freezes before reaching 500 psi

Strength in Numbers

Effects on Concrete

- Slows Cement Hydration
- Slows Initial Setting Time
- Slows Overall Strength Gain
  - Compressive strength development will be delayed up to 60% in cold weather…
  - Meaning, if design strength is **3000 psi** in 7 days @ 75°F (for 4000 psi mix), in cold weather, UNPROTECTED, compressive strength at 7 days could be as low as **1200 psi**.

Strength in Numbers

Effects on Concrete

- Slows Cement Hydration
- Slows Initial Setting Time
- Slows Overall Strength Gain
- Danger of Freezing
  - Water begins to freeze in capillaries of concrete at 28°F *(air temperature)*
  - Water expands up to 9% of its volume when it freezes, causing cracks in the concrete matrix
    - Use an air-entrained concrete mix

Strength in Numbers

Before Placement

- Materials
  - Use of an accelerator
    - Water reducers?
- Minimize water in the mix
- Heated aggregates and water (NEVER exceed 140°F)
- Mix design
  - Use air entrained concrete
  - Use a type III cement or High-Early (HE) strength cement
  - Use additional 100-200 LB/cy add type I cement

Chemical Accelerators

Use with caution/understanding

Non Chloride (or Corrosive) Accelerators (NCA)

- Required in reinforced concrete or by spec
- Follow manufacturer's dosage guide

Calcium Chloride (CC)

- Only in non-reinforced concrete
- Can increase potential for corrosion and sulfate attack
- Speeds hydration, which increases heat

Strength in Numbers

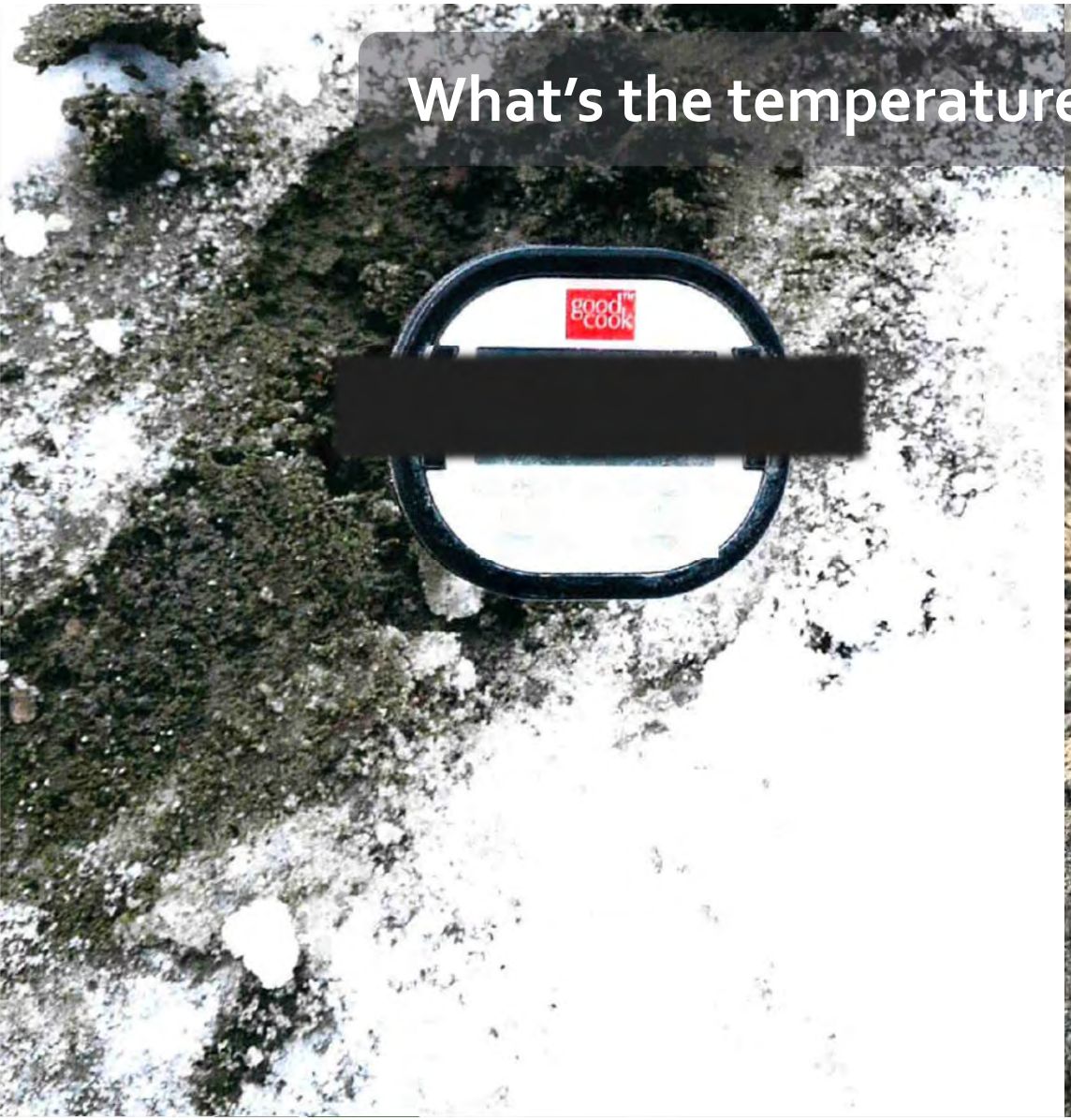
Placement Conditions

- Schedule appropriately
- Place concrete at the lowest practical slump
- Remove snow, ice and frost from subgrade & contact surfaces (including reinforcing steel and forms)
- Insulate and/or heat subgrade and contact surfaces
  - Subgrade freezes deeper than the top inch exposed to weather
  - Control temperature of reinforcing and forms
- Use of maturity meters to monitor

Concrete should NEVER be placed on a frozen subgrade

Improper use or no use at all…

What's the temperature of my subgrade?



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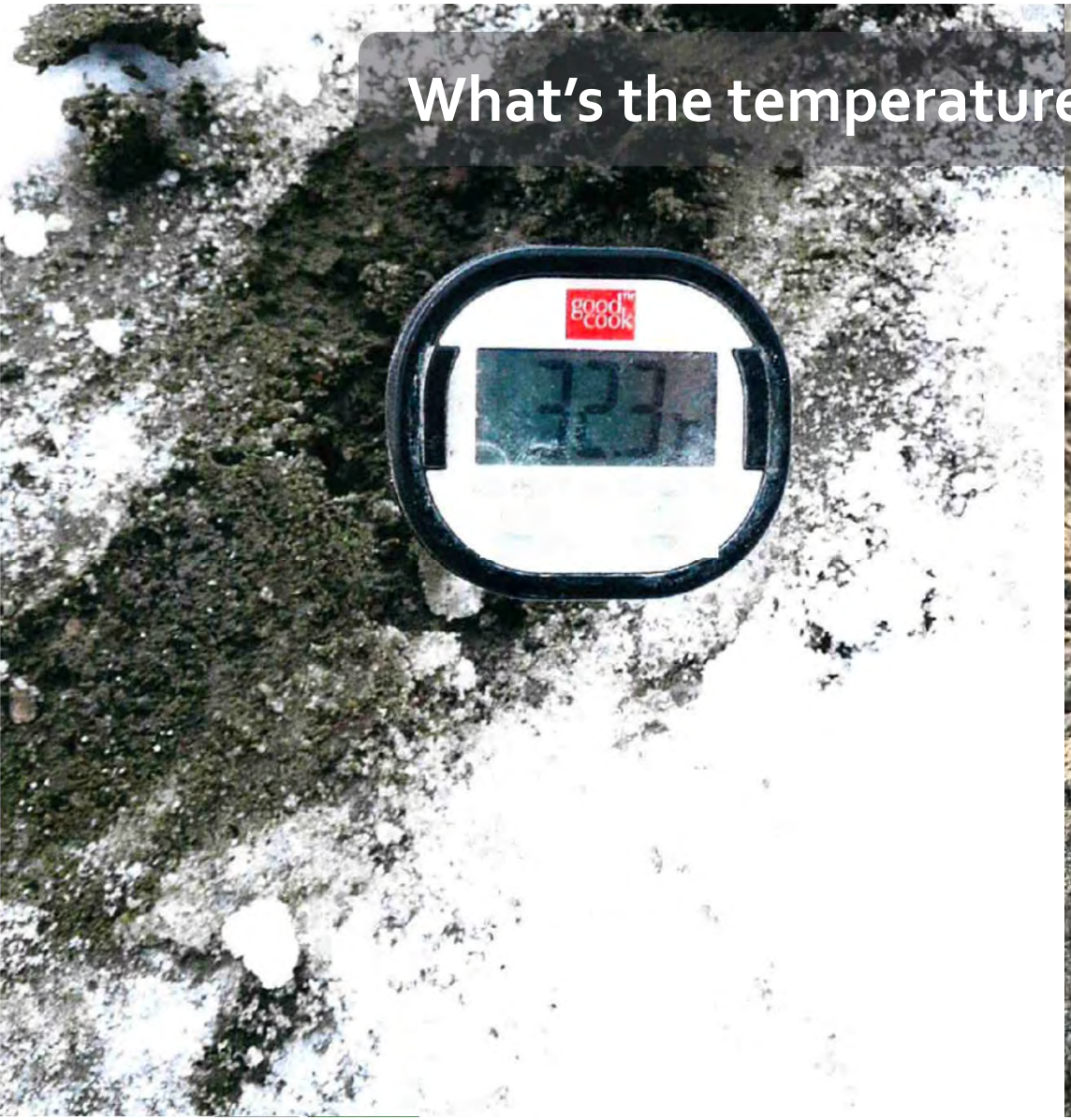


Pop Quiz!

What is wrong with these placements?

Strength in Numbers

Pop Quiz!

What should be expected after placement?

Strength in Numbers

Pop Quiz!

What other considerations should be made on-site?

Strength in Numbers

Pop Quiz!

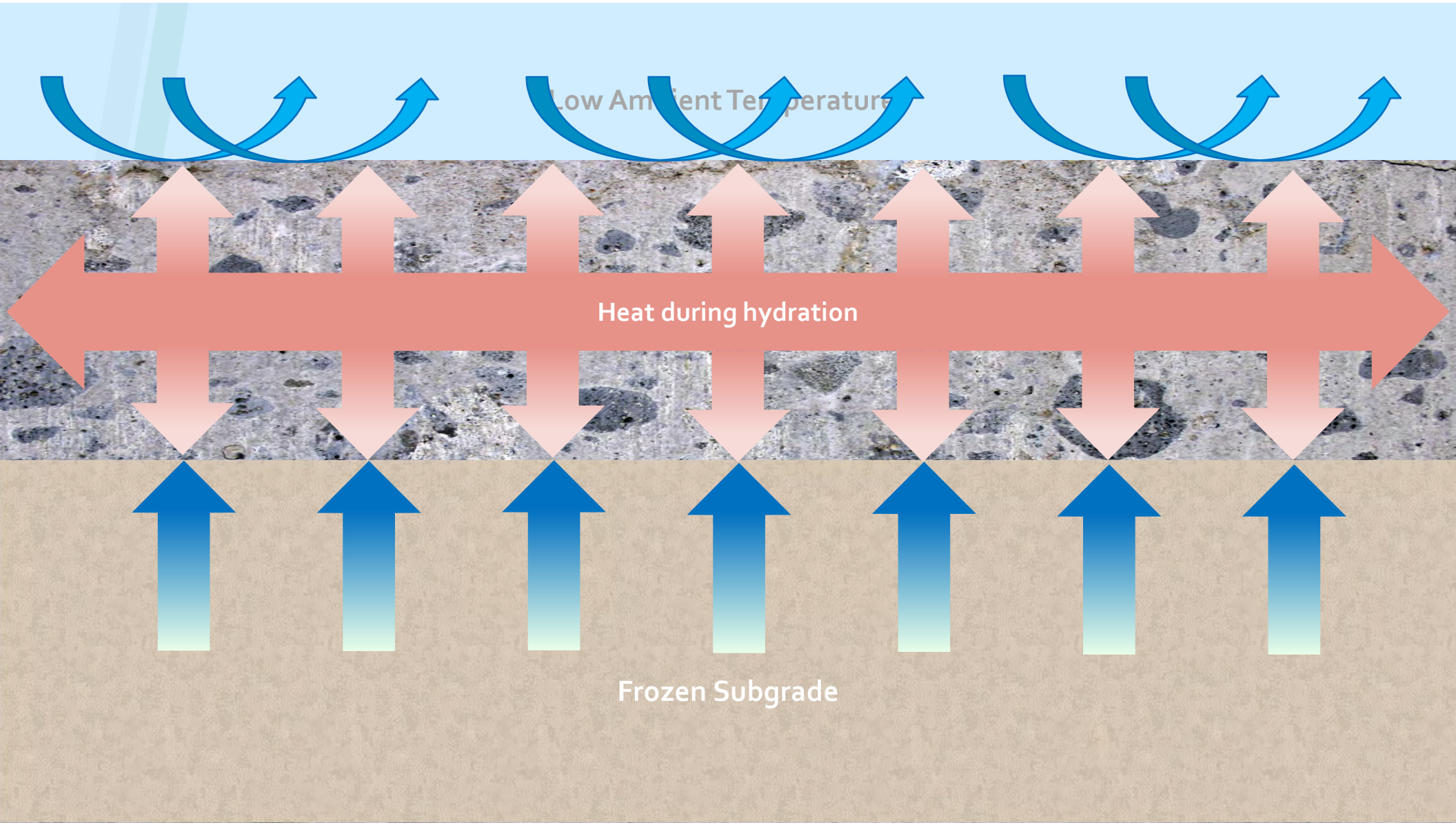
What happened to the concrete at placement?

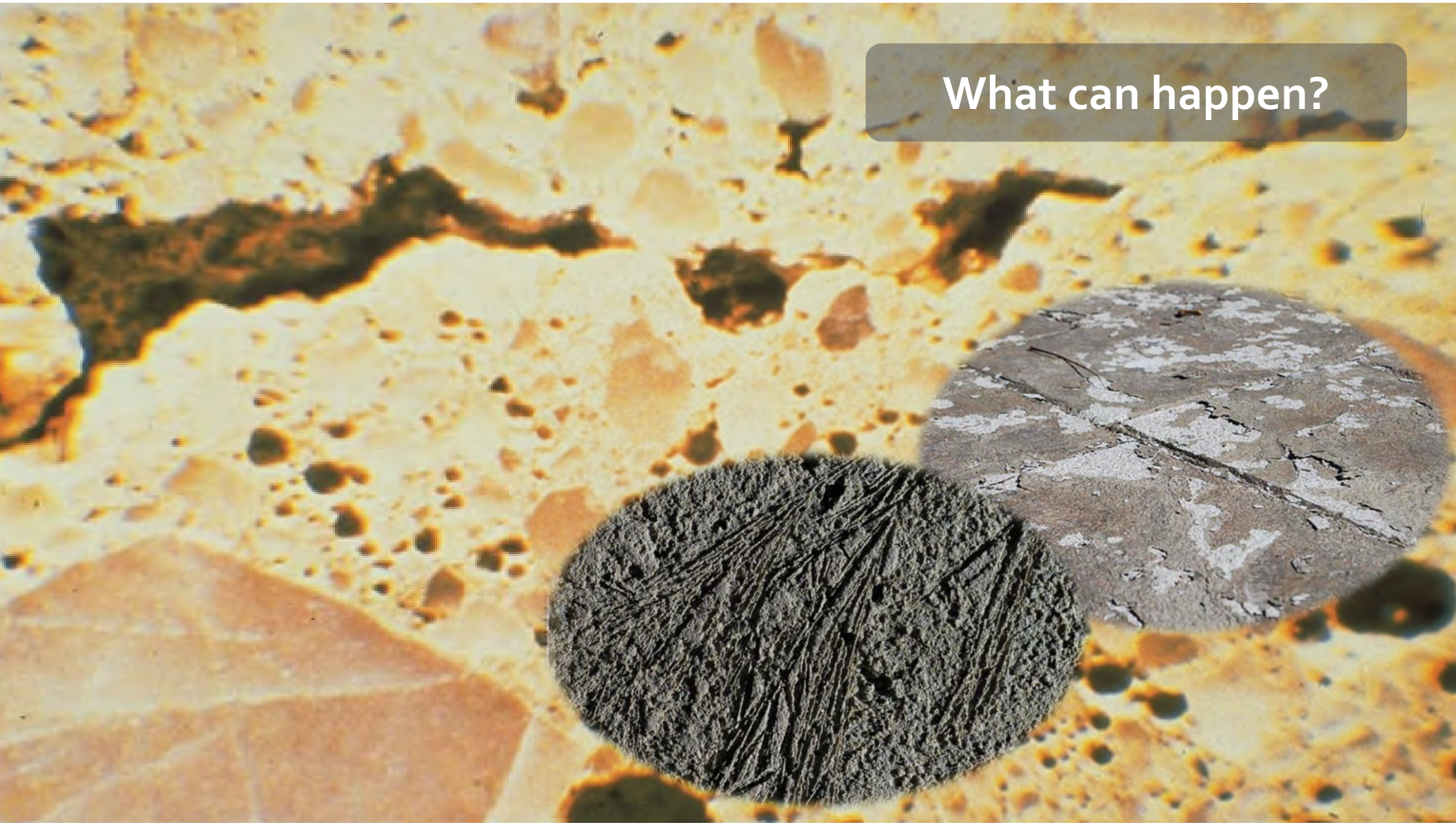
Strength in Numbers

Pop Quiz!

Will there be any long-term affects?

Strength in Numbers


Low Ambient Temperature
Heat during hydration
Frozen Subgrade


What can happen?

Curing Conditions and Time

- Provide protection immediately after concrete placement
- Don't allow concrete to freeze when saturated
- External heating source
- If dry heat is used, curing compound should be considered
- Don't water cure in the winter

Strength in Numbers

Protection

- Cover concrete surfaces with insulated blankets, tarps, or straw covered with plastic sheeting to retain heat generated by hydration process
  - Corners & edges are most susceptible to heat loss
- Enclosures may be needed, depending on ambient and site conditions

Strength in Numbers

On the worst days…

Strength in Numbers

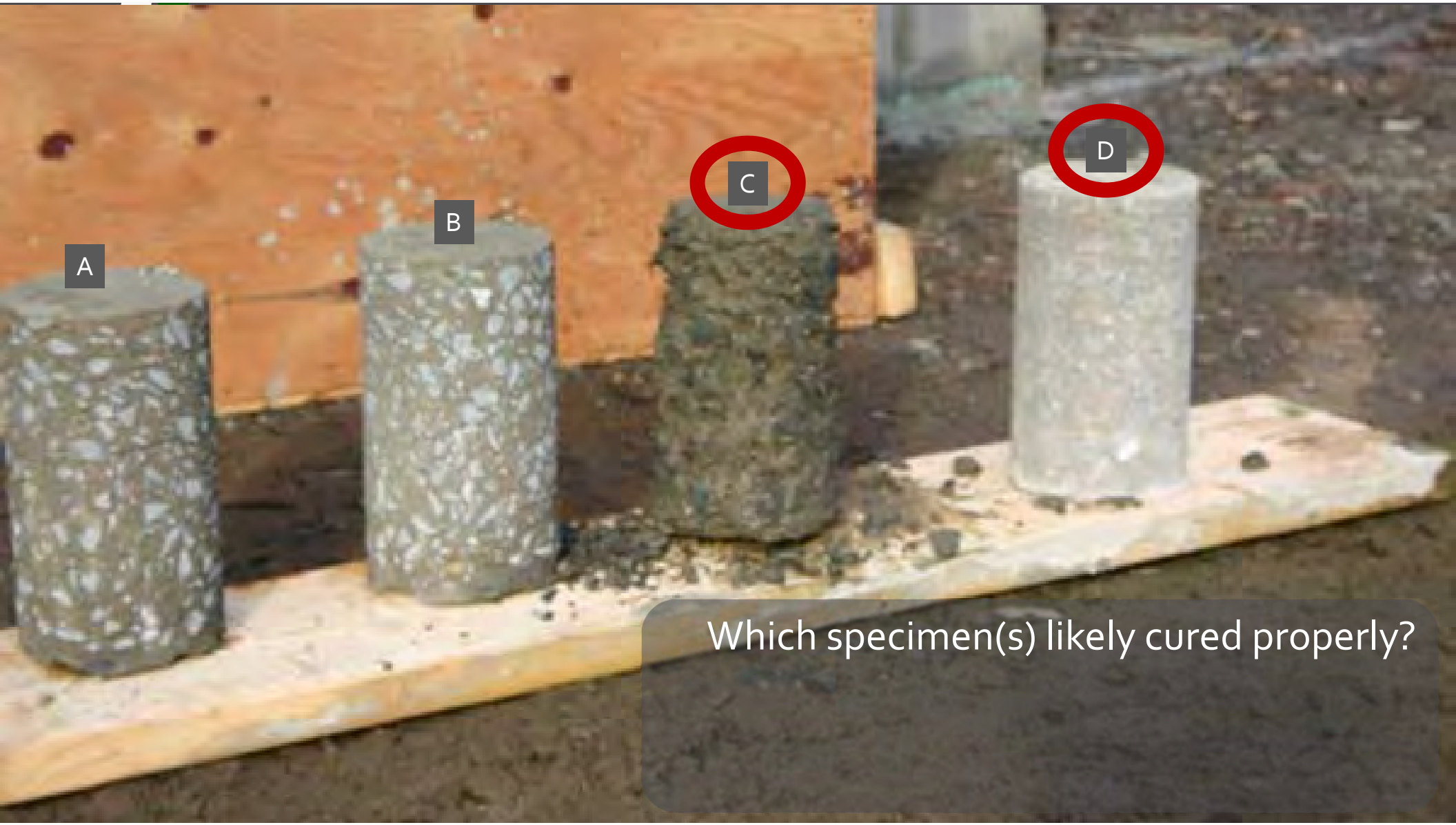
Quality Control and Assurance

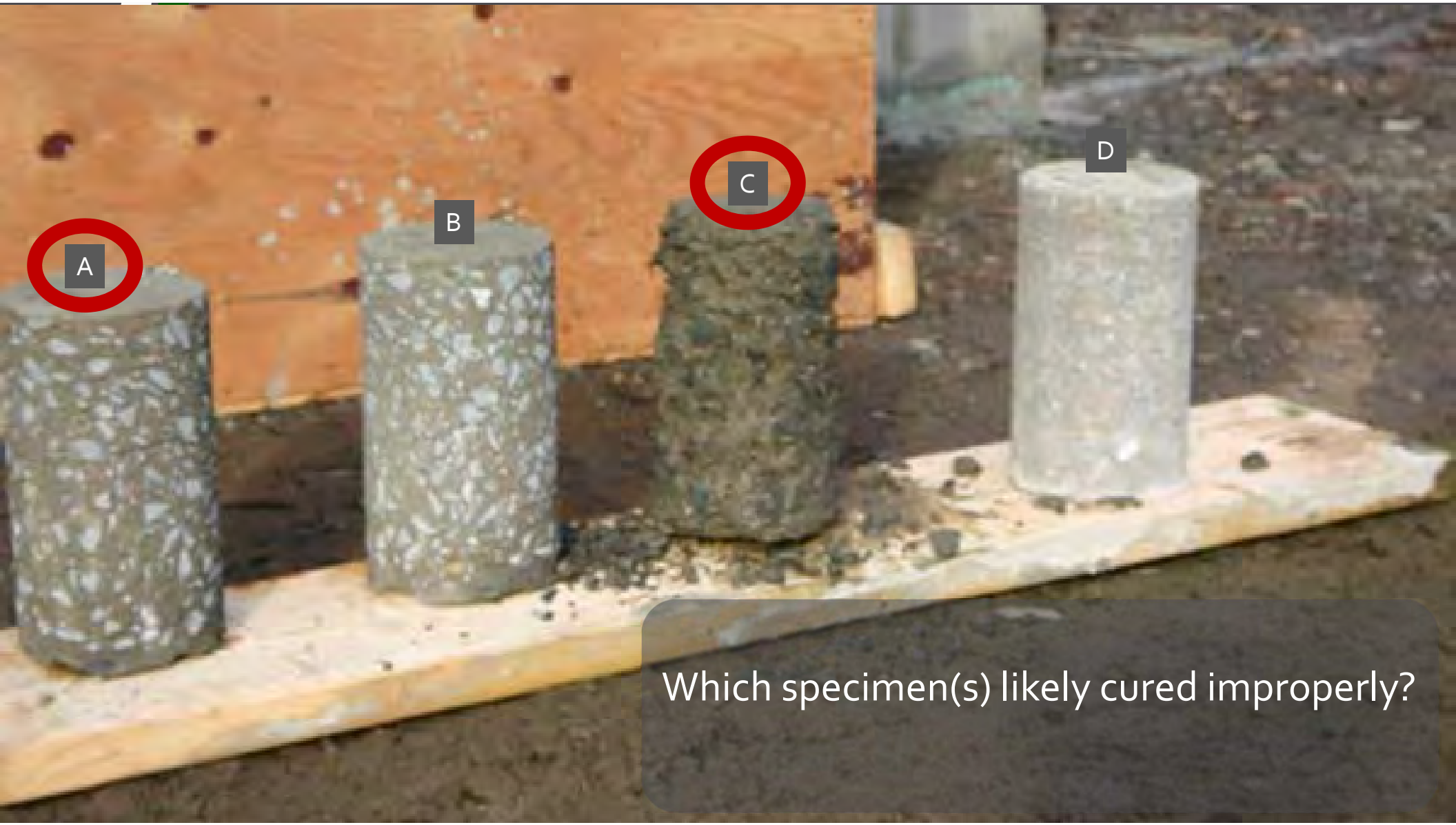
- Initial curing of specimens
  - Location **Where?**
  - Storage **How?**
  - Temperature monitoring **Range?**
- Protection for field cured specimens
  - NOT for acceptance




Strength in Numbers

crmca
Colorado Ready Mixed Concrete Association


A
B
C
D
Which specimen(s) likely cured properly?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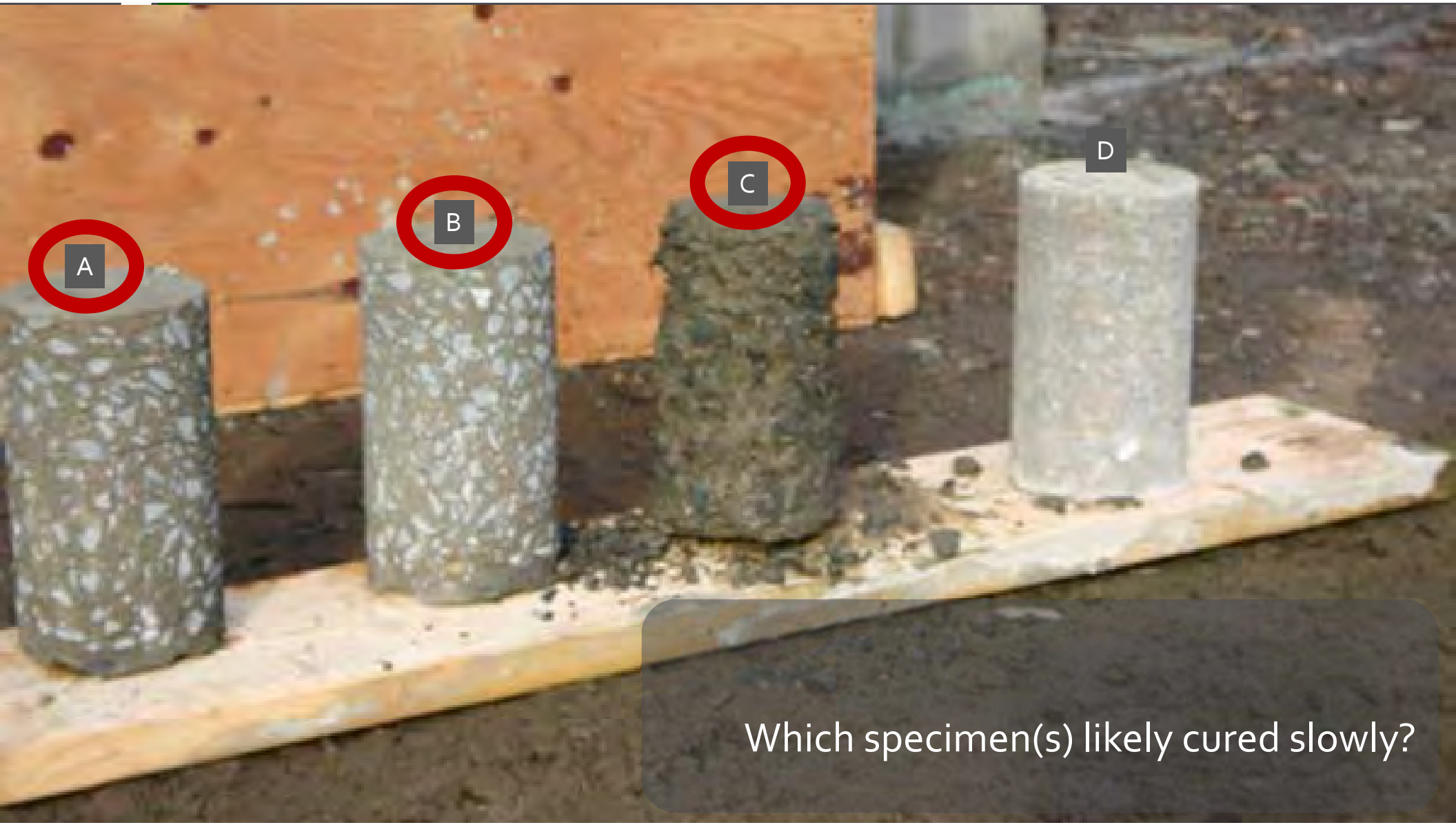
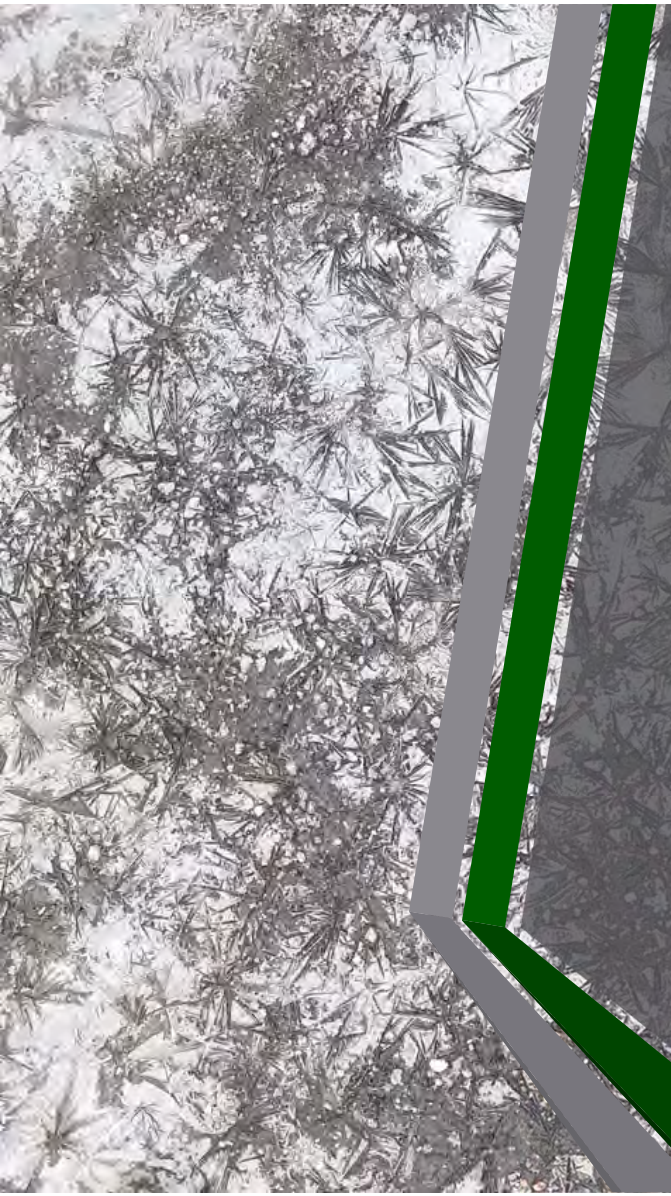

A
B
C
D
Which specimen(s) likely cured slowly?



Prevention

- Prevent concrete from freezing at an early age (first 24-48 hours)
- Assure concrete reaches strength prior to loading or form removal
- Maintain normal curing conditions
- Limit rapid temperature changes
- Provide protection consistent with the intended serviceability of the structure

It Takes Teamwork

- Plan ahead
- Be prepared
- Be concerned
- Schedule work
- Instruct and inspect

Conversation, not Confrontation!

Strength in Numbers

Bottom Line

- A drop in concrete temperature of 20°F will DOUBLE the setting time.
- Plan, plan, plan

"I'm sure the contractor will understand"

~ No One...EVER!

Question?

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