Cold Weather Concreting

Dry cast concrete production - what to know as temperatures fall

Concrete professionals know that weather can have a big impact on concrete production. Here's a short primer on low and freezing temperature challenges.

Cement hydration basics

Concrete is made up of aggregates (sand and stone), cementitious materials and water. The chemical reaction between cement and water is called hydration. The cement hydration reaction slows down as it gets colder, and speeds up as it gets hotter.

The business model of manufactured concrete products producers is based on efficiency, and typically requires kilns or curing chambers to raise the internal temperature of units to speed up the cement hydration reaction and meet production quotas, particularly in cooler weather.

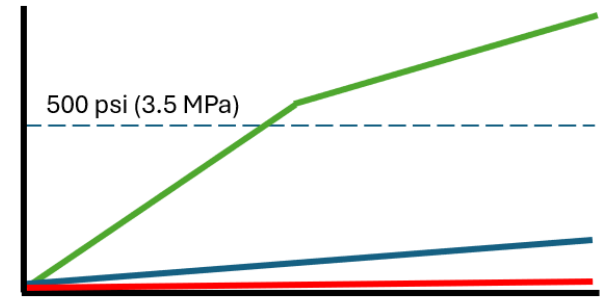
In general, for dry cast concrete, cold weather measures should be implemented when concrete temperatures fall below 55° F (13° C) for more than 3 days.

What happens to fresh concrete when it freezes?

- If the concrete temperature drops to 32° F (0° C) or below, and freshly made concrete freezes before reaching an initial strength of 500 psi (3.5 MPa) the cement hydration reaction is fatally compromised and the concrete will never gain strength.

What happens to concrete made below 55° F (13° C)?

- At 55° F (13° C) the cement hydration reaction begins to slow significantly.
- If the concrete temperature falls below 40° F (5° C) the hydration reaction basically comes to a halt, and strength gain stops. The cement hydration reaction will start up again when the concrete temperature rises above 50° F (10° C).



Controlled curing, ready to ship around 7 days
Curing too cold < 55° F (13° C) very slow strength gain
Frozen before sufficient strength gain, will never gain strength

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Why can slower cement hydration be a good thing for production?

In some ways, concrete production can be easier when temperatures drop:

- The amount of time that concrete can be held in the hopper increases.
- There is more time to move concrete through the machine before the mix feed and flow slow down, making it easier to fill the molds and compact the mix properly.
- Improved compaction means fewer interconnected voids in the mix. This translates to increased density and reduced absorption, which in turn improves product quality and durability in freeze-thaw environments.

What can go wrong with cold weather production?

The general rule of thumb for concrete is that for every 20° F (approx 10.5° C) drop in temperature, set time will double and early strength gain will be much lower.

What this means is that concrete units that are manufactured and placed in the yard at 40° F (5° C) will essentially stop hydrating until temperatures rise and restart the hydration process.

- **Controlled curing** is important to ensure that units gain sufficient strength prior to handling. It is important that kiln temperature and humidity are optimized to ensure that 1) internal concrete temperatures exceed 55° F (13° C) and 2) the units are cured for a sufficient time at the given conditions for the units to reach desired strength and structural integrity.
- The amount of time for concrete units to reach minimum strength for packaging depends on many factors including initial concrete temperature, volume and type of cementitious materials, admixtures, and temperature and humidity in the kiln or curing chamber.
- Even in cold weather, concrete can gain sufficient strength to allow handling after just one day, however, the cement hydration reaction is still in the early stages. The hydration phase that is responsible for ultimate compressive strength can take up to a week to get started - assuming conditions are optimal. If temperatures are too cold, the concrete may remain porous, with excessive moisture migration pathways, for extended periods. This can increase the potential for efflorescence.
- The ability of units to meet ASTM C140 28 day strength requirements can also be compromised if the units have not fully cured and developed the intended strength by that time.

An under-appreciated risk of placing under-cured units outside in cold weather is the increased risk of **efflorescence when the units warm up in the Spring**. Cold temperatures slow down the cement hydration reaction, leading to extended periods spent in hydration phases that are higher calcium hydroxide generators. Of course, calcium hydroxide is a primary contributor to efflorescence production. When warmer weather and moisture occur in the Spring, there may be more calcium hydroxide available in these units for efflorescence production.

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What can we do to mitigate the negative effects of cold weather?

- Keep raw materials as warm as possible. Cover aggregate bins to avoid snow and ice accumulation on the piles.
- Use an accelerating admixture, like **ProCast™ 330,** to speed up the cement hydration reaction, and allow units to gain sufficient strength before handling or exposure to cold conditions. Your ACM Technical Services Representative can advise you on whether an accelerating admixture is a good solution, and how to incorporate an accelerating admixture into your mixing sequence.
- Allow extra time for curing.
- Raise the temperature in the kiln to ensure that concrete is cured at a minimum temperature 55° F (13° C).
- Close the kiln doors to allow optimal temperature and humidity conditions to prevail. Sounds obvious, but we are constantly surprised at how many facilities expect kilns to function properly with the doors open!
- Avoid "shocking" the units with sudden changes of temperature and humidity. This can occur when units are moved from the warmer kiln to cooler outside without sufficient time to equilibrate with ambient conditions. We recommend venting the kiln if possible, or storing units inside for a few hours after exiting the kiln. This allows units to be moved outside only when they are cool and dry.

When is it too cold to make concrete?

Good question! With proper processes, infrastructure and equipment in place it is possible to produce concrete in very cold ambient conditions. However, there are significant raw material, capital equipment and production issues that must be addressed first.

For most producers, 55° F (13° C) ambient temperatures for more than 3 days are a commonsense place to start with cold weather concreting practices.

How can I learn more about controlled curing?

ACM has a Learning Center on our website with many tools to help dry cast producers with daily production needs. We have free learning tools, available 24/7 on our Learning Center.

- **Concrete 101 – Controlled Curing.** A 15 minute video on the basics of controlled curing.

Use the QR code to access our Learning Center

Who can I contact if I have questions?

Your Technical Services Representative can assist you with questions about all aspects of concrete technology. Please reach out to them directly, or call our office number below.

Contact

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