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TECHNICAL TOPIC:

Cold Weather Concreting Basics

BOTTOMLINE:

Cold weather slows the cement/water reaction (cement hydration process) which in turn increases the set time of freshly placed concrete. The National Ready Mixed Concrete Association (NRMCA) discusses a good rule of thumb that a 20 degree drop in concrete temperature will approximately double the concrete setting time.

How to reduce the set time in colder temperatures:

Usually problems occur during the fall of the year, when unexpected cold nights occurs. Air temperatures, subgrade temperatures, concrete stockpile temperatures, and of course fresh concrete temperatures all drop.

The cold subgrade temperatures coupled with possible variations in slab thickness create a non-uniform/spotty set. Concrete in contact with this cold subgrade sets slower because the subgrade is drawing the warmth away from the concrete. This lowers the concrete temperature, slowing the cement hydration. At the surface, which is exposed to the sun and wind we can see both warming effects and drying actions…both leading to lower relative humidity, which is not necessarily good and can create problems.

In cold weather, and because of the slower set, concrete bleeds for a longer period of time. Bleed water continues to travel up from the slower setting, plastic, lower portion of the slab as the top surface may be setting or drying. If the surface is crusting over, due to the drying action, it may appear to be ready for finishing, but in reality the concrete is still bleeding. Water gets trapped just under the sealed surface possibly leading to surface defects such as blisters and delamination.

Operating a power float over a crusted surface can cause the "body" of the slab to "roll". This has sometimes been referred to as a "jello-like" slab. This can result in a wavy, sometimes cracked surface. Further, if the finisher waits until the underlying concrete sets…it may be too late to produce an acceptable smooth, hard, durable surface.

Regarding strength and durability:

Concrete needs to be protected from freezing temperatures until it has reached 500 psi before being exposed to its' first freeze thaw cycle, which is a minimum time of the first night…but more likely about 2 days after placement at about 50 degrees. This is said to be enough strength for the concrete to withstand one freeze cycle.

The NRMCA further states that "Concrete in contact with water and exposed to freezing and thawing, even if during construction, should be air entrained. Newly placed concrete is saturated with water (from the mixing process) and should be protected from cycles of freezing and thawing until it has attained a compressive strength of at least 3500 psi."

A note about freeze-thaw:

Here in the northern portion of Alabama as well as in central and north Georgia, it is not unusual to have several cycles of freezing and thawing throughout the winter months. We see the overnight temperatures dip into the teens or low 20's followed by warming trends in the upper 30's and 40's during the day. This constitutes one freeze-thaw cycle. When the water in concrete freezes, it expands by about 9%. As the water/ice expands it creates internal pressures within the concrete that can, and usually will, exceed the developed tensile strength of the concrete. Multiple freeze-thaw cycles can result in internal cracking and disruption or failure of the bond between the cement paste and aggregates. Eventually, the result is concrete cracking, scaling, and crumbling.

How to reduce the set time in colder temperatures:

- Add cement to the mix design. For example, and simply stated; order a 4000 psi mix as opposed to a 3000 psi mix. This is about 100 pounds of cement/cementitious material.
- Specify the use of hot water to increase the concrete temperature.
- Incorporate the use of an accelerating admixture in the mix.
- Reduce the relative amount of flyash or ground slag in the mix.
- Reduce the slump/water content in the mix as low as practical (an addition of 1 to 2 gallons of water to the mix to increase the slump, as reported by the NRMCA, increases the set time by as much as 2 Hours).
- Avoid cold subgrades.
- Adequately insulate the concrete after placement to retain heat and to ensure acceptable curing temperatures.
- Water curing is not recommended when freezing temperatures are expected. Use membrane curing compounds or plastic sheets.