# COLD WEATHER CONCRETING

## **WHAT** is Cold Weather?

Cold weather is defined as a period when the average daily temperature falls below 40°F [4°C] for more than three successive days. These conditions warrant special precautions when placing, finishing, curing and protecting concrete against the effects of cold weather. Since weather conditions can change rapidly in the winter months, good concrete practices and proper planning are critical.

## **WHY** Consider Cold Weather?

Successful cold-weather concreting requires an understanding of the various factors that affect concrete properties.

In its plastic state, concrete will freeze if its temperature falls below about 25°F [-4°C]. If plastic concrete freezes, its potential strength can be reduced by more than 50% and its durability will be adversely affected. Concrete should be protected from freezing until it attains a minimum compressive strength of 500 psi [3.5 MPa], which is about two days after placement for most concrete maintained at 50°F [10°C].

Low concrete temperature has a major effect on the rate of cement hydration, which results in slower setting and rate of strength gain. A good rule of thumb is that a drop in concrete temperature by 20°F [10°C] will approximately double the setting time. The slower rate of setting and strength gain should be accounted for when scheduling construction operations, such as form removal.

Concrete in contact with water and exposed to cycles of freezing and thawing, even if only during construction, should be air-entrained. Newly placed concrete is saturated with water and should be protected from cycles of freezing and thawing until it has attained a compressive strength of at least 3500 psi [24.0 MPa].

Cement hydration is a chemical reaction that generates heat. Newly placed concrete should be adequately insulated to retain this heat and thereby maintain favorable curing temperatures. Large temperature differences between the surface and the interior of the concrete mass should be prevented as cracking may result when this difference exceeds about 35°F [20°C]. Insulation or protective measures should be gradually removed to avoid thermal shock.

## **HOW** to Place Concrete in Cold Weather

Recommended concrete temperatures at the time of placement are shown below. The ready mixed concrete producer can control concrete temperature by heating the mixing water and/or the aggregates and furnish concrete in accordance with the guidelines in ASTM C 94.

| Section Size, minimum dimension, inch [mm] | Concrete temperature as placed |
|---|---|
| less than 12 [300] | 55°F [13°C] |
| 12 - 36 [300 - 900] | 50°F [10°C] |
| 36 - 72 [900 - 1800] | 45°F [7°C] |

Cold weather concrete temperature should not exceed these recommended temperatures by more than 20°F [10°C]. Concrete at a higher temperature requires more mixing water, has a higher rate of slump loss, and is more susceptible to cracking. Placing concrete in cold weather provides the opportunity for better quality, as cooler initial concrete temperature will typically result in higher ultimate strength.

Slower setting time and strength gain of concrete during cold weather typically delays finishing operations and form removal. Chemical admixtures and other modifications to the concrete mixture can accelerate the rate of setting and strength gain. Accelerating chemical admixtures, conforming to ASTM C 494—Types C (accelerating) and E (water-reducing and accelerating), are commonly used in the winter time. Calcium chloride is a common and effective accelerating admixture, but should not exceed a maximum dosage of 2% by weight of cement. Non-chloride, non-corrosive accelerators should be used for prestressed concrete or when corrosion of steel reinforcement or metal in contact with concrete is a concern. Accelerating admixtures do not prevent concrete from freezing and their use does not preclude the requirements for concrete temperature and appropriate curing and protection from freezing.

Accelerating the rate of set and strength gain can also be accomplished by increasing the amount of portland cement or by using a Type III cement (high early strength). The relative percentage of fly ash or ground slag in the cementitious material component may be reduced in cold

NOTE:

**Please refer to page 170 for more informations**