CONCRETE SASK

TECH TIP #26

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COLD WEATHER CONCRETING

WHAT is Cold Weather?

Cold weather is defined in CSA A23.1 as a period when the air temperature will be below 5°C within 24 hours of placement and adequate protection of the concrete is required, at a minimum of 10°C, for the duration of the curing period as defined by CSA A23.1, Tables 2 and 19.

Protection shall be provided by means of heated enclosures, coverings, insulation, or a suitable combination of these methods. In freezing temperatures, all curing water shall be removed from the surface at the end of the curing period.

Why consider Cold Weather?

Successful cold-weather concreting requires an understanding of the various factors that affect concrete properties. In its fresh state concrete freezes if its temperature falls below -4°C. The potential strength of frozen concrete can be reduced by more than 50% and it will not be durable. Concrete should be protected from freezing until it attains at least 40% of its specified strength. Concrete at a low temperature has a slower setting and rate of strength gain. A rule of thumb is that a drop in concrete temperature by 10°C will approximately double the setting time. These factors should be accounted for when scheduling construction operations, such as form removal.

Concrete that will be in contact with water and exposed to cycles of freezing and thawing 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 24.0 MPa. The reaction between cement and water, called hydration, generates heat. Insulating concrete retains heat and maintains favorable curing temperatures.

Temperature differences between the surface and the interior of concrete should be controlled. Thermal cracking may occur when the difference exceeds about 20°C. To avoid cracking of the concrete due to a sudden temperature change near the end of the curing period, the protection shall not be completely removed until the concrete has cooled to the temperature differential given in Table 20, CSA A23.1. For high-performance concrete, the maximum temperature differential for all structural components shall be 20 °C (Clause 8.2.2 of CSA A23.1).

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 and furnish concrete to comply.

Table 14, CSA A23.1 Permissible Concrete Temperatures at Placing		
Thickness of Section, m	Temperatures, °C	
	Minimum	Maximum
<0.3	10	32
≥0.3 - < 1	10	30
≥ 1 - < 2	5	25
≥ 2	5	20

Concrete at a higher temperature requires more mixing water, has a higher rate of slump loss, and is more susceptible to cracking. Concreting in cold weather provides the opportunity for better quality, as cooler initial concrete temperature will typically result in higher ultimate strength and improved durability.

In cold weather, slower setting time and rate of strength gain of concrete can delay finishing operations and form removal. Chemical admixtures and other materials can be used to offset these effects. Accelerating admixtures, conforming to ASTM C 494—Types C (accelerating) and E (water -reducing and accelerating), are commonly used.

Accelerating admixtures do not prevent concrete from freezing and their use does not preclude the requirements for appropriate curing and protection from freezing.

Concrete should be placed at the lowest practical slump. Adding water to achieve slump can delay setting time and prolong the duration of bleeding, thereby impacting finishing operations.

Adequate preparations should be made prior to concrete placement. Snow and ice should be removed and the temperature of surfaces and metallic embedments in contact with concrete should be at or above 5°C. This might require insulating or heating subgrades and contact surfaces prior to placement.

Materials and equipment should be in place to protect concrete from freezing temperature and for adequate curing, both during and after placement. Insulated blankets and tarps, as well as straw covered with plastic sheets, are commonly used measures. Enclosures and insulated forms may be needed for additional protection depending on ambient conditions. Corners and edges are most susceptible to heat loss. Fossil-fueled heaters in enclosed spaces should be vented for safety reasons and to prevent carbonation of newly placed concrete surfaces, which causes dusting.

The concrete surface should not be allowed to dry before it sets as this can cause plastic shrinkage cracks. Subsequently, concrete should be adequately cured. Water curing is not recommended when freezing temperatures are imminent. Use membrane-forming curing compounds or impervious paper and plastic sheets for concrete slabs.

Forming materials, except for metals, maintain and evenly distribute heat and provide adequate protection in moderately cold weather. In extremely cold temperatures, insulating blankets or forms should be used, especially for thin sections. Forms should not be stripped for 1 to 7 days depending on rate of strength gain, ambient conditions, and anticipated loading on the structure. Field-cured cylinders or non-destructive methods should be used to estimate in-place concrete strength prior to stripping forms or applying loads.

Removal of protective measures and formwork should not cause thermal shock to the concrete. Concrete test specimens used for acceptance of concrete should be carefully managed. In accordance with CSA A23.1/A23.2, cylinders should be stored in insulated containers, which may need temperature controls, to ensure that they are initially cured at 15°C to 25°C for the first 24 to 48 hours. A minimum/maximum thermometer should be placed in the curing box to maintain a temperature record of curing test

specimens at the jobsite.

Table 19 – Allowable Curing Regimes		
Curing Type	Name	Description
1	Basic Curing	3 days at ≥ 10°C for the time necessary to attain 40% of the specified strength
2	Additional Curing*	7 days total at ≥ 10°C for the time necessary to attain 70% of the specified strength
3	Extended Wet Curing	A wet curing period of 7 days at ≥ 10°C and for the time necessary to attain 70% of the specified strength. The curing types allowed are ponding, continuous sprinkling, absorptive mat or fabric kept continuously wet

*When using silica fume concrete, additional curing procedures shall be used.

References:

1. *CAN CSA A23.1-24/A23.2-24.*
2. *ASTM D4832, Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Cylindrical Test Specimens*