Cold Weather Concreting

CONCRETE ONTARIO
Ready Mixed Concrete Association of Ontario

Weather conditions can have a dramatic effect on both the setting time and concrete placing, finishing and protection systems that must be followed for proper concrete placement. As per CSA A23.1, Cold weather concreting conditions are defined as:

- When the air temperature is 5°C or lower.
- Or when there is a probability that the temperature may fall below 5°C within 24 hours of placing the concrete.

General procedures for cold weather concreting include:

- Removing all ice and snow from the subgrade or formwork.
- Ensuring that all materials and equipment needed for adequate protection and curing are on hand before the concrete placement.
- Protection equipment shall include heated enclosures, coverings, insultation or a suitable combination of these methods.
- Supplying the necessary supplemental heat required to ensure that forms, subgrades, and reinforcing steel is maintained a minimum temperature of 10°C well prior to the concrete placement.
- Ordering concrete with a temperature between 10°C – 25°C.
- Concrete should be ordered using the lowest practical water slump since this will reduce bleeding and setting times. Chemical admixture can still be used to improve the workability of the concrete.
- Chemical admixtures and mix design modifications can be used to offset the slower setting times and strength gain of concrete during cold weather conditions. Considerations should be given to ordering concrete that will obtain higher early strengths.
- Concrete temperature must be maintained at a minimum of 10°C for the full curing period as is defined by CSA A23.1 Tables 2 & 19.
- The surface of the concrete should not be allowed to dry out while it is still plastic since this may cause plastic shrinkage cracking. The longer set times encountered during cold weather combined with the effects of hot dry air from heaters being blown along the top surface of the concrete significantly increase this risk.
- Wet curing methods are typically not recommended during cold weather conditions since the concrete will not have a sufficient time period to air dry before the first freeze/thaw cycle.
- The possibility of thermal cracking, which is caused by large temperature differences between the surface and the interior of the concrete, must be considered when the heating supplied during the curing period is going to be suspended. Protection shall not be removed until the temperature differential indicated in CSA A23.1 Table 20 has been achieved.

Special care should be taken with concrete test specimens used for the acceptance of the concrete. The initial test specimens shall be stored in a controlled environment that maintains the temperature at 20 ± 5°C as per CSA A23.1/.2 requirements.

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CSA A23.1:19 Table 19

Allowable curing regimes (see Clause 4.1.1.1.1, 7.7.1, 7.7.2.1, 7.8.9, 8.12.2, and Table 2)		
Curing Type	**Name**	**Description**
1	Basic Curing	3 d at ≥ 10 °C or for the time necessary to attain 40% of the specified strength.
2	Additional curing*	7 d total at ≥ 10 °C and for the time necessary to attain 70% of the specified strength.
3	Extended wet curing	A wet-curing period of 7 d 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. See Clause 1.3.13.*

Notes:
(1) Curing of plant production of precast concrete shall be as set out in CSA A23.4.
(2) Concrete should be allowed to air-dry for a period of at least one month after the end of the curing period, before exposure to de-icing chemicals.
(3) The rate of compressive strength gain in concrete is significantly reduced below 10 °C.

CSA A23.1:19 Table 20

Maximum permissible temperature differential between concrete surface and ambient to minimize cracking - wind up to 25 km/h

(see Clauses 7.1.2.5 and 7.5.3 and Figure D.2.)

	Maximum permissible temperature differential, °C				
	Length to height ratio of structural elements *				
Thickness of Concrete, m	0 †	3	5	7	20 or more
< 0.3	29	22	19	17	12
0.6	22	18	16	15	12
0.9	18	16	15	14	12
1.2	17	15	14	13	12
> 1.5	16	14	13	13	12

* Length shall be the longer restrained dimension and the height shall be considered the unrestrained dimension

† Very high, narrow structural elements such as columns.

Caution regarding the use of portable gas fired heaters

Plastic concrete exposed to a carbon dioxide source (CO_2) during the concrete placing, finishing and curing period will develop a soft, chalky, carbonated surface (known as dusting). Carbon Dioxide is an odourless and colourless gas that is heavier than air and is produced by all forms of combustion. Typical sources include open flame heaters (stacks must be vented to outside), and internal combustion engines (e.g. on trucks, power trowels, concrete buggies, etc.). Precautions **must** therefore be taken to properly vent the placement area.

Source:
1. Table 19 & 20, **CSA A23.1:19/CSA A23.2:19 Concrete materials and methods of concrete construction/Test methods and standard practices for concrete.** © 2019 Canadian Standards Association
2. Ontario Building Code – 2012, Ontario Ministry of Municipal Affairs and Housing – Housing Development and Buildings Branch
3. RMCAO Concrete Digest, Second Edition
4. Concrete in Practice #27 – Cold Weather Concreting, National Ready Mixed Concrete Association

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