10 COLD WEATHER TIPS FOR STRUCTURAL CONCRETE

1. Properly air-entrained exterior structural concrete should not be subjected to multiple freezing and thawing cycles in a saturated condition before developing a **COMPRESSIVE STRENGTH OF 3,500 psi**. If surface defects are a concern, a compressive strength of 4,500 psi needs to be achieved.

2. **FROZEN SUBGRADE** can cause the concrete to freeze as well as cause finishing and durability issues. The subgrade should be free of snow and ice and have a temperature no greater than 20°F cooler than the concrete being placed.

3. **MINIMIZE RAPID TEMPERATURE CHANGES**, particularly before the concrete has developed sufficient strength to withstand thermal stresses, which can cause cracking. Gradually remove insulation and other protection methods so that the concrete surface temperature decreases no more than 50°F for concrete 12” or less in thickness in a 24 hour period.

4. The use of **HIGH EARLY STRENGTH CONCRETE OR ACCELERATING CHEMICAL ADMIXTURES** is recommended during cooler temperatures to increase the speed of hydration and mitigate free water within the concrete from freezing. Avoid using calcium chloride as an accelerator if the concrete contains steel reinforcement. Accelerating admixtures must not be used as a substitute for proper curing and frost protection.

5. **TEST CYLINDERS** for normal strength concrete must be cured at an initial curing temperature of 60 to 80°F. Cure boxes, blankets or other curing methods must be used in order to comply with ASTM specifications. ASTM C31 also requires that cylinders must be initially cured in an environment free of evaporation and be stored for no longer than 48 hours prior to being taken to the laboratory for final curing and testing.

6. To keep your project on schedule, consider using **CONCRETE MATURITY** to determine the in-place concrete strength in lieu of field cure cylinders. Concrete maturity is the relationship between concrete temperature, time, and strength gain. It is measured through the use of in-place sensors.

7. **DO NOT USE UNVENTED HEATERS**. Carbon dioxide from unvented fossil fuel heaters can cause carbonation of the concrete. Carbonation can result in craze cracking and a soft, chalky surface that will dust under traffic.

8. Allow ample time for **BLEED WATER** to dissipate before concrete finishing. Trapping or finishing bleed water into the concrete can cause higher water-cementitious materials ratios at the surface and may lead to scaling and/or blistering.

9. **PROPER CURING** procedures must be followed immediately after finishing is completed. This includes maintaining proper moisture and temperature conditions.

10. **MONITOR CONCRETE TEMPERATURES** at concrete corners and edges. They are vulnerable to freezing as temperatures are usually more difficult to maintain in these locations.
The American Concrete Institute (ACI) 306R-16, “Guide to Cold Weather Concreting” states that cold weather concreting exists when the air temperature has fallen to or is expected to fall below 40°F during the protection period. This document also defines the protection period as the amount of time recommended to prevent concrete from being adversely affected by exposure to cold weather during construction.

The objectives of a cold weather protection plan are to:

- Prevent damage to concrete due to early-age freezing. Concrete can withstand a single cycle of freezing when it has obtained a compressive strength of 500 psi in a dry condition. At 50°F, most well-proportioned concrete mixtures reach this strength within 48 hours.
- Ensure that the concrete develops the required strength for safe removal of formwork and for safe loading of the structure.
- Maintain curing conditions without using water curing. During cold weather, water curing may reduce the resistance to freezing and thawing when protection is removed.
- Limit rapid temperature changes, particularly before the concrete has developed sufficient strength to withstand induced thermal stresses. Rapid cooling of concrete surfaces or large temperature differences between the exterior and interior can cause cracking and reduce the strength or durability of the concrete member.
- Provide protection consistent with the durability of the structure during its design life. Surfaces and corners must be protected from freezing, dehydration, and cracking from overheating due to inadequate protection, improper curing, or careless workmanship.

For more information on cold weather concreting practices, a copy of ACI 306R-16 is available for purchase at concrete.org. If you have questions or concerns about a mix design for your project, coarse aggregate selection or admixture packages, please contact your Cemstone Account Representative.
A cold weather plan is a team effort between Cemstone and the contractor. We each have responsibilities for executing the plan. Consider the items below in the plan.

- All formwork and subgrade should be free and clear of snow and ice. The temperature difference of the subgrade and fresh concrete should not be greater than 20°F.
- When temperatures are below 10°F, metallic embeds should be warmed prior to placement. Embeds with a cross-section 4 in$^2$ or greater should be warmed to at least 32°F. A heated enclosure or insulated concrete curing blankets may need to be used before the concrete is placed.
- The air temperature on the placement day must be determined. Table 1 below provides recommended concrete temperatures, based on the air temperature and member size.
- Concrete placed in cold weather conditions must be protected using a heated enclosure or insulating blankets. Table 2 below provides the recommended length of the protection period based on the use and exposure condition of the concrete member.

### Table 1: Recommended Concrete Temperatures

<table>
<thead>
<tr>
<th>Line</th>
<th>Air Temperature</th>
<th>Minimum Concrete Temperature as Placed and Maintained (°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>—</td>
<td>55°F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>50°F</td>
</tr>
<tr>
<td>2</td>
<td>Above 30°F</td>
<td>60°F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>55°F</td>
</tr>
<tr>
<td>3</td>
<td>0 to 30°F</td>
<td>65°F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>60°F</td>
</tr>
<tr>
<td>4</td>
<td>Below 0°F</td>
<td>70°F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>65°F</td>
</tr>
</tbody>
</table>

### Table 2: Length of Protection Period for Concrete Placed During Cold Weather

<table>
<thead>
<tr>
<th>Service Condition</th>
<th>Normal Set Condition, Days</th>
<th>Accelerated Set Concrete, Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>No load, not exposed</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>No load, exposed</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Partial load, exposed</td>
<td>6</td>
<td>4</td>
</tr>
</tbody>
</table>

*The contractor is responsible for informing Cemstone dispatch if higher concrete delivery temperatures are needed. Additional costs may apply. For colder weather, a greater margin in temperature is provided between concrete as mixed and required minimum temperature of fresh concrete in place.

Note 1: For Line 1, maximum placement temperature is minimum temperature in the table plus 20°F.

Note 2: For Lines 2-4, maximum temperature is minimum temperature in the table plus 15°F.

Note 3: For larger section sizes, consult Table 5.1 of ACI 306R-16.

Ref. Table 5.1 ACI 306R-16
RECOMMENDATIONS FOR PLACING CONCRETE IN COLD WEATHER CONDITIONS

CONCRETE MIXTURES

- The water-cementitious materials ratio (w/cm) should not exceed the recommendations within ACI 201.2R-16. All concrete that is subjected to freeze-thaw cycles while saturated in service should have a w/cm ratio no greater than 0.45.

- Use accelerating admixtures to increase the rate of hydration. Do not use calcium chloride (CaCl₂) accelerators or admixtures containing CaCl₂ for concrete with reinforcing steel as this can lead to corrosion. CaCl₂ admixtures may also darken the concrete color.

- Accelerating admixtures are not anti-freezing agents.

- Limit the use of supplementary cementing materials such as fly ash and slag, when early strength development is required.

REFERENCE: American Concrete Institute (ACI) 306-16 Guide to Cold Weather Concreting.

SLAB FINISHING

- It is recommended to use air-entrained concrete for saturated members that will be exposed to freeze-thaw cycles during construction, even if the member is not expected to be exposed to freeze-thaw cycles while in service.

- Avoid hard-trowel finishing air-entrained concrete greater than 3%. This can lead to surface blistering or other surface defects. Air-entrained concrete should not be specified for hard-trowel slab construction.

CURING

- Upon completion of finishing, concrete should be protected from drying, i.e. evaporation of moisture should be prevented. Subsequently, since fresh concrete is critically saturated, a drying period must occur after curing and before the concrete is exposed to freezing temperatures.

- Additional curing is generally not needed after protection is removed so long as the air temperature remains below 50°F and the relative humidity is above 40%.

REFERENCE: American Concrete Institute (ACI) 306-16 Guide to Cold Weather Concreting.
SLIP PREVENTION

25 lb bag Traction Grit Item# 105248
2,000 lb bulk bag Special Order

COLD WEATHER APPLICATION

Set Accelerator Item# 120376
Liquid Air Entrainment Item# 120377
Chapin® Spreader Item# 9370520
Critical Pavement Repair Item# 110301
AT-XP® Acrylic Adhesive Item# 9372424

HEATING SOLUTIONS

Premium Winter Curing Blanket Item# 9329832
R Series Nu-Way Torch Item# 9329272
Norseman™ 250 Heater Item# 9333540
Tradesman® 170 Ultra Heater Item# 9367430
Tradesman 400 Ultra Item# 9333539
6 mil Reinforced Poly Sheeting Stocked in sizes 10, 12, 16, 20, 24, 32, 40 and 60' wide by 100' long.

AC Series NU-WAY Torch Item# 9329270

COLD WEATHER PPE

MaxiFlex® Ultimate™ Gloves Size M-3XL
PowerGrab™ Thermo W Gloves Size M-2XL
ZXT BUCKLE OVERSHOE Size 6-17. Available at Eagan location only.

A. Full Zip Black Bottom Ripstop Soft Shell Jacket Size M-4XL
B. Zip Front Black Bottom Hoodie Size S-5XL

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