Cold Weather Best Practices

- 3 consecutive days in which the average daily temperature drops below 40°F is considered cold weather (ACI)
- Any 24 hour duration in which the temperature is above 50°F for 12 hours is no longer considered cold weather (ACI)
- When cold weather is expected while concreting, preparations must be made to ensure quality concrete

Effects of Cold Weather Concreting

- 50% reduction of ultimate strength of the concrete if it freezes within the first 24 hours (Can’t be repaired)
- Thermal cracking caused by a rapid change in concrete temperature (Thermal shock)
- Delayed set time
- Temperature curling of concrete pavement

Best Pre-Pour Practices

- Plan and be prepared!
- Look at the upcoming weather forecast to determine if low temperatures are expected
- Hold a pre-pour conference
  - TDOT, the contractor, and the concrete producer should participate
  - Discuss actions that should be taken by all parties to ensure quality concrete.
Best Practice Guide

Cold Weather Concreting
Best Practices

Best Pre-Pour Practices

Concrete Producer:
- Submit a cold weather mix design for approval
- Use Type III cement or use an extra 100-200 lbs/C.Y. of Type I cement (high-early strength concrete)
- Avoid use of fly-ash and slag
- Use a Type C (Accelerator) chemical admixture
- Use a Type E (Water reducer & Accelerator) chemical admixture
- Heat materials
  - Uniformly heat aggregates and water before mixing.

Heating Concrete Materials

Best Pre-Pour Practices

Contractor:
- Schedule pour for the warmest part of the day
- Surfaces to be cast against should be free from ice and snow
- Insulate the subgrade prior to pouring
- Have materials available on-site to protect the concrete from cold weather

Clean off snow/ice from reinforcement bars

Best Pre-Pour Practices

Inspector:
- Check the air temperature (501.11 & 604.12)
  - Temperature must be 35°F and rising to begin mixing and concreting operations
  - Mixing and concreting operations shall discontinue when temperatures reach 40°F and falling.
- Concrete may be poured at temperatures below 35°F, if authorized by the engineer in writing.
  - Water and aggregates at time of mixing must be between 70°F and 150°F. (Plant inspector can check)

Ensure thermometer is calibrated and working properly!

Heating the ground with hydronic heat pipes

<table>
<thead>
<tr>
<th>Temperature</th>
<th>°F</th>
</tr>
</thead>
<tbody>
<tr>
<td>35°F and rising</td>
<td>35°F</td>
</tr>
<tr>
<td>40°F and falling</td>
<td>40°F</td>
</tr>
</tbody>
</table>

10 AM: 32°F  | 1 PM: 35°F  | 2 PM: 36°F  | 3 PM: 39°F  | 4 PM: 40°F  | 5 PM: 41°F  |
| 11 AM: 33°F  | 12 PM: 34°F | 1 PM: 35°F  | 2 PM: 36°F | 3 PM: 39°F  | 4 PM: 40°F  |
| 12 PM: 34°F  | 1 PM: 35°F  | 2 PM: 36°F  | 3 PM: 39°F  | 4 PM: 40°F  | 5 PM: 41°F  |
| 1 PM: 35°F   | 2 PM: 36°F  | 3 PM: 39°F  | 4 PM: 40°F  | 5 PM: 41°F  |
Cold Weather Concreting
Best Practices

Best Practices During the Pour

- **Contractor:**
  - Provide a cure box for initial curing of concrete cylinders for up to 48 hours.
  - Temperature in the cure box shall be maintained by heating and cooling as necessary and shall range between:
    - 60°F-80°F for mixes with design strength below 6000 psi
    - 68°F-78°F for high early strength mixes (≥6000 psi)

- **Inspector:**
  - Monitor concrete temperature (501.11 & 604.12)
    - 50°F-90°F at time of placement
    - 60°F-100°F if authorized to pour below 35°F

Best Post-Pour Practices

- **Inspector:**
  - Record the maximum and minimum temperature surrounding the fresh concrete daily

- **Contractor:**
  - Provide cold weather protection of fresh concrete if ambient temperature is expected to drop below 35°F (604.24)
    - Air surrounding the fresh concrete must be maintained at a temperature between 45°F-80°F for 120 hours (5 days)
    - Furnish a maximum-minimum thermometer for temperature documentation
Cold Weather Concreting
Best Practices

Best Post-Pour Practices

- Contractor:
  - Acceptable cold weather protection:
    - Insulation blankets
    - Heated enclosures
  - Caution with heated enclosures
    - When using combustion heaters, there must be sufficient ventilation for safety as well as to protect concrete from carbonation
    - Place heaters in a manner to prevent overheating or over drying select areas of the fresh concrete

- Carbonation led to the deterioration

Heated Enclosures

- Cracks Resulting from Thermal Shock

- Contractor:
  - Removal of forms and falsework (501.19 & 604.19)
    - In cold weather, vertical forms shall remain in place until concrete has set sufficiently to withstand damage when forms are removed.
    - Falsework may be removed from concrete structures after 21 calendar days or 7 days in which the temperature has not fell below 40°F.
  - Avoid thermal shock! (rapid temperature change)