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LESSONS LEARNED:
Construction Engineering Services
OBSERVATIONS AND LESSONS FROM THE SCHOOL OF EXPERIENCE

COLD WEATHER CONCRETE (REVISITED)

Based on ACI 306R-88 (Reapproved 2002)

With the approach of winter, it is again time to remember cold weather concreting practices. Cold weather affects concrete in two ways. Hydration in concrete, the process of hardening, is a chemical reaction. When concrete is placed at cold temperatures, hydration can be slowed and even stop, affecting finishing and curing times. Secondly, concrete typically develops strength slowly over a period of several days. If the water in fresh concrete freezes before the concrete develops significant strength, the expanding ice in the concrete may cause small fractures that will prevent the concrete from ever reaching its full strength and reducing its long-term durability. So protecting your concrete early is important to providing a good quality product.

Construction Practices

The American Concrete Institute (ACI) has developed the following chart. It gives minimum concrete temperatures at time of placement as a function of thickness:

	Section Size, Minimum Dimension			
Minimum Concrete Temperature	<12 inches	12-36 inches	36-72 inches	>72 inches
	55° F	50° F	45° F	40° F

In addition to carefully monitoring the concrete temperature, formwork, reinforcing steel, subbase, subgrade, and any other items associated with the pour should be above 32° F to prevent concrete from freezing at the interface. Once the concrete has been placed, it must be maintained at a temperature above 50° F and moist for a specified period of time, usually at least 72 hours, to allow for adequate initial curing. The use of insulating blankets, heated mats, or heated enclosures may be necessary. Don't wait to the last minute to confirm that protective equipment and supplies are on site.

The handling of field-cured cylinders becomes especially critical during cold weather operations. When used to confirm suitable strength for formwork removal, post-tensioning, or steel erection, every reasonable effort must be made to ensure these cylinders receive the same temperature and moisture treatment as the concrete they represent.

Mix Design Considerations

It is often worth considering modifying concrete mix designs during the winter. Using higher strength mixes can lead to early strength gain and thereby allow faster formwork removal. Other suggestions to accomplish this include lower water/cementitious material ratios, adding additional cement, using an accelerating admixture, or using a Type III cement (high early strength).

The addition of calcium chloride has often been used in the past as an accelerating admixture, but caution is advised. The chloride in the concrete can increase the possibility of corrosion of the reinforcing steel. Many specification and code documents limit or completely prohibit the use of calcium chloride. Non-chloride accelerating admixtures are available.

Some of the common mineral admixtures such as slag or fly ash should also be reviewed in periods of cold weather. There are numerous advantages in using mineral admixtures, but they can also retard initial strength gain. This phenomenon tends to be more pronounced in cold weather, and an accelerating admixture may be required if the delayed strength gain impacts finishing or framework removal.

We hope this "Lessons Learned" will be helpful to you in planning for your next project.

Respectfully,
ECS Corporate Services, LLC