

Concrete Construction Precautions during Cold Weather

Overview

The current American Concrete Institute (ACI) – ACI 306R-10 definition of cold-weather is conditions when the air temperature has fallen to, or is expected to fall below 40 degrees Fahrenheit during the protection period. The protection period is defined as the time required to prevent concrete from being affected by exposure to cold weather. The Portland Concrete Association (PCA) states it is critical that concrete reach a minimum strength of 500 pounds per square inch (psi), upon which it is generally considered to have sufficient strength to resist expansive forces and damage associated with freezing water. Water expands up to 9% of its volume when it freezes. If concrete freezes before achieving adequate strength, ice formation in the cement paste matrix causes irreparable loss in strength – up to 50 percent of ultimate strength.

ACI prescribes the following minimum concrete temperature be maintained:

50 degrees Fahrenheit – most slabs, pavements, sections less than 12” thick.

50 degrees Fahrenheit – most beams, columns, walls, sections 12” to 36” thick.

The Project Supervisor, or his designated representative, should consult with the ready-mix producer on an agreed strategy for concreting in cold weather – addressing the possibility of using heated aggregates, increasing the cement content, or adding an accelerating admixture to achieve the proper concrete temperature at delivery, and at critical times during the cold weather curing period. Handling of concrete test cylinders, on site, should be in agreement with the expectation of the testing agency representative. All information should be made known to the Project Officer.

Basic Tips for concreting in cold weather include:

- Air entrainment is required if the concrete is to be exposed to freeze-thaw conditions during and/or after placement.
- Concrete should not be allowed to freeze during at least the first 24 hours after being placed. Protecting new concrete walls and columns by allowing forms to remain in place and adding sheeting is a good start to prevent freezing, but checking concrete temperature is still required.
- Subgrade should be compact, not frozen, and free of snow, ice, and frost. Cover the subgrade with insulated blankets a few days prior to concrete placement. A firm, stable subgrade would avoid serious settlement and cracking problems that

would occur to a new concrete slab placed on frozen subgrade. Cold ground may even cause “crusting” – the top part of concrete sets, while the bottom remains slow to set.

- PCA recommends columns, beams, slabs, cast-in-place walls, have a minimum curing period of seven days for ambient temperatures above 40 degrees Fahrenheit. ACI recommends the concrete be observed to reach at least 70% of specified strength level (often achieved in 7 days of curing), and be kept above 50 degrees F. Laser temperature infrared thermometers are valuable for obtaining concrete temperature and assessing when additional action must be taken to assure the concrete stays above 50 degrees Fahrenheit. For most small projects, the above criteria are reasonable, and will not adversely impact the project.
- One potential major disruption to a project is below anticipated concrete test cylinder strength. As mentioned in the second paragraph, it is important for the Project Officer to work with the Project Supervisor and the representative of the concrete testing agency to assure that all parties know/agree on the handling of the cylinders, location/construction of the test cylinder storage locker, conditions of storage, and when the cylinders will be moved to the test lab. Too often, a lack of planning of these steps and achieving agreement, result in one or more low cylinder breaks. Historically, after many job experiences, it turns out when this “chain of actions” was not done as agreed, concrete cylinder breaks test under the anticipated strength at scheduled cylinder interval testing. Consequently, additional concrete testing of as-built construction is required to assure all parties there is no problem with the in-place concrete. This subsequent testing results in project delay and the unpredictable cost impact of actions that will be required to convince the owner, the concrete is safe.

References:

1. www.concrete.org American Concrete Institute (ACI) – ACI 306R-10 definition of cold-weather concreting.
2. www.cement.org Portland Cement Association “What Happens When Concrete Freezes.”
3. www.ConcreteNetwork.com “Precautions Before Placing Concrete in the Cold.”
4. www.flyash.com Headwaters Resources
5. www.cemexusa.com Cemex United States

