

# Technology in Practice

## What, Why & How?



### TIP 18 - Managing Concrete Temperature for Specified Requirements

*This TIP provides guidance to concrete producers on managing temperature of freshly mixed concrete to comply with specification limits or for quality reasons. In this TIP The term “initial concrete temperature” refers to the temperature of freshly mixed concrete.*

#### WHAT is the Concern with Concrete Temperature?

A high initial concrete temperature can require a higher water content for target slump. A higher mixing water content results in a lower strength, increase in permeability, and greater shrinkage. A high initial concrete temperature can result in lower entrained air content at a specific air-entraining-admixture dosage. A high initial concrete temperature coupled with a high ambient temperature will lead to increased slump loss, reduced set times, higher early-age strength, and lower later-age strength. A high initial concrete temperature also increases the potential for higher temperature rise in hardened concrete in the early period after it is placed. This can increase the potential for delayed-etching formation and associated durability problems. In mass concrete members (typically defined as structure where the minimum dimension is greater than 36 in.), a high initial concrete temperature will lead to high temperatures at the core and a greater tendency for a large temperature differential between the core and the surface that can result in thermal cracking.

A low initial concrete temperature can result in unacceptable setting time in cool weather. Lower initial concrete temperature can impact the rate of strength gain and can impact the contractor’s schedule. Significant reductions in ultimate strength, up to about 50%, can occur if fresh concrete is frozen.

From a quality perspective, variations in concrete temperature, by more than 10°F, can cause variation in fresh and hardened concrete properties. Changing mixing water content due to variable concrete temperatures will increase the standard deviation of strength test results. This will increase the required average strength of concrete mixtures (as per ACI 301). Variations on workability, setting time, and rate of strength gain will impact the ability of the contractor to properly finish concrete and perform scheduled construction activities.

The concrete producer can manage production processes to target a consistent concrete temperature to minimize the impact of these factors. Supplementary cementitious materials and admixtures can be used when developing concrete mixtures for optimum performance in hot and cold weather and for mass concrete applications. This TIP focusses only on temperature control of fresh concrete to comply with specified limits.

#### HOW is Concrete Temperature Specified?

There is no limit for temperature of fresh concrete as delivered in hot weather in ASTM C94. ACI 301 and ACI 305.1 state a maximum temperature of 95°F that can be modified by the project specification. Higher temperature limits are permitted based on mixture evaluation or local practice. ACI 305R provides a procedure for evaluating the rate of slump loss for a concrete mixture. The producer should target a temperature lower than the specified maximum to account for temperature rise between 1 to 5°F during delivery. Factors impacting this temperature rise are the color of the mixer drums, radiant heat, and delivery time.

In cold weather, ACI 306R recommends temperature limits for concrete. These are indicated in Table 1 and vary depending on minimum dimension of the member being constructed. Thinner sections have higher minimum temperature requirements to account for less heat that can be retained. Minimum temperature limits as placed and maintained apply to concrete as delivered. Specifications ACI 301, 306.1 and ASTM C94