PDHonline Course S128 (1 PDH)

Hot Weather Concreting

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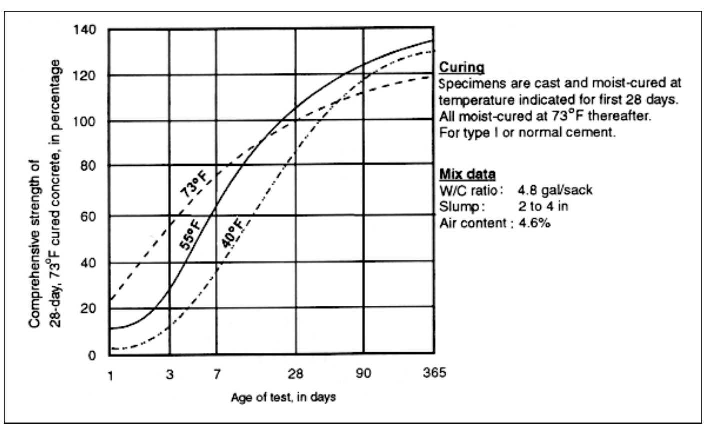
Definition of Hot Weather Concreting:

Any combination of high air temperature, low relative humidity and wind velocity that adversely affects the quality of fresh or hardened concrete. Because it is impractical to recommend a maximum limiting temperature due to the many variables involved, it is advised that at some temperature between 75°F and 100°F, there is a limit at which favorable conditions do not exist. Typical concrete temperatures for various relative humidity's that pose the potential for the formation of plastic shrinkage cracking are as follows:

Concrete Temperature F°	Relative Humidity %
105°	90%
100°	80%
95°	70%
90°	60%
85°	50%
80°	40%
75°	30%

In general, the table on the previous slide indicates the maximum concrete temperature and combined humidity above which the limiting rate of evaporation exceeds 0.2 PSF/hour assuming a wind speed of 10 MPH and a difference of temperature between concrete and air of 10° F. It is extremely important to realize that concrete mixed, placed and cured at elevated temperatures normally develops higher early strengths than concrete produced and cured at normal temperatures, but at 28 days or later, strengths are generally lower.



Source: Free-Ed.net

Undesirable Hot Weather Effects:

Plastic State

1. Increased water demand: Required water necessary to produce a 1" change in slump is 2.5% up to 80°F, and 4.5% at 120°F.
2. Increased rate of slump loss and corresponding tendency to add water at job site: An increase in concrete temperature of 20°F will decrease slump by about 1".
3. Increased rate of set resulting in greater difficulty with handling, finishing, curing and formation cold joints.
4. Increased tendency for plastic cracking: Plastic shrinkage cracking occurs whenever the rate of evaporation is greater than the rate at which water rises to the surface of the recently placed concrete.

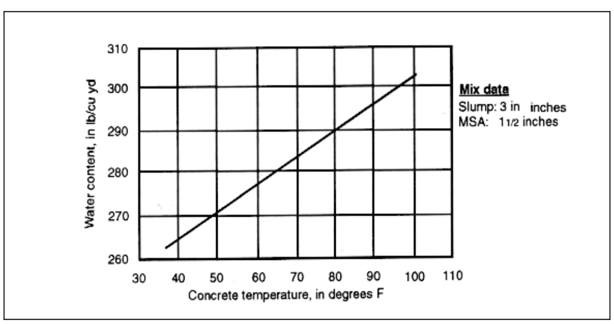
Hardened State

1. Decreased strength resulting from higher water demand and increased temperature level.
2. Increased tendency for drying shrinkage and differential thermal cracking.
3. Decreased durability.
4. Decreased uniformity of surface appearance.

Effects of Concrete Components:

Water:

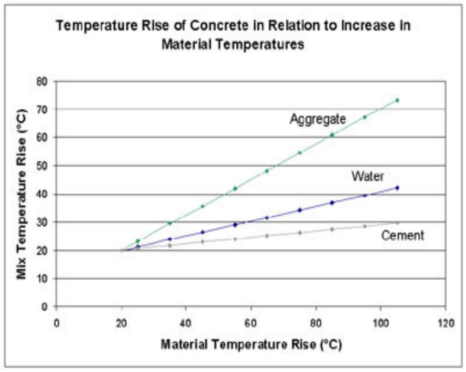
High water temperatures cause higher concrete temperatures. As the temperature of concrete increases, water demand increases and strength decreases for concrete with the same consistency. The addition of extra water to offset this effect, without correction for the effect on the water-cement ratio, will further adversely affect the quality of the concrete. Higher water content of a mix decreases the strength, durability, water tightness and other related properties of concrete. Mixing water has the greatest effect per unit weight of any of the ingredients on the temperature of concrete since it has a specific heat between four to five times that of cement or aggregate. The temperature of water is also easier to control than other components. A change in water temperature of 3.5°F will effect a 1°F change in concrete temperature.



Source: Free-Ed.net

Cement:

Hot cement results from heat generated mechanically during the manufacturing process. This heat is lost slowly while the product is stored, particularly during the hot summer months. Therefore it is common for cement temperature to be as much as 130°F above the desired concrete temperature. A change in cement temperature of 8°F will affect a 1°F change in concrete temperature. A maximum limit of 170°F should be used on cement temperature prior to mixing.



Source: PCA

Aggregates:

Since the greatest portion of concrete is aggregate, reduction of aggregate temperature brings about the greatest reduction in concrete temperature. A change in aggregate temperature of 2°F will affect a 1°F change in concrete temperature.

Source: JFE Mineral Company

Admixtures:

All of the following types of ASTM 494 chemical admixture have been found beneficial in offsetting some of the undesirable characteristics of concrete placed during hot weather. All the following admixtures may be used in varying portions and in combination with other admixtures. Type B (Retarding), Type D (Water-Reducing), Type G (High Range Water-Reducing and Retarding; "Superplastizer"): These admixtures effectively retard the setting time of concrete. Type B and D admixtures do not retard slump loss and may in fact increase somewhat the rate of slump loss. Water reducing and retarding admixtures reduce the water requirements of concrete and therefore offset the increase in water requirements resulting from elevated concrete temperatures. Type D admixtures increase the early bleeding of non-air entrained concrete and are therefore helpful in preventing drying of the top surface of concrete placed at high temperatures. However, if conditions are such that crusting of the surface occurs, subsequent bleeding may cause scaling.

TABLE 1: ASTM C 494 Descriptions of Admixture Types

Type	Purpose
A	Water-reducing admixtures
B	Retarding admixtures
C	Accelerating admixtures
D	Water-reducing & retarding admixtures
E	Water-reducing & accelerating admixtures
F	Water-reducing, high-range & accelerating admixtures
G	Water-reducing, high-range & retarding admixtures

Source: NPCA

Effects of Mixing and Delivery:

Batching and Mixing:

The length of haul from a ready mix plant may exaggerate the effects of hot weather concreting. This condition can be further affected by the color of paint used on the ready mix truck. Based on a one hour delivery time during the summer months, concrete in a white drum will be about 2.5°F cooler than that mixed in a red drum and .5°F cooler than that delivered in a cream colored drum. It has also been found that spraying the outside of the mixing drum, as a means to minimize concrete temperature, provides only a marginal benefit in the reduction of temperature.

Source: Gulf Atlantic Equipment

Placing and Curing:

Due to the rapid slump loss of concrete placed in hot weather, preparations must be made to place, consolidate and finish the concrete at the fastest possible rate. Strain on vibrating equipment is also greater during hot weather, so provisions should be made for an ample supply of stand by vibrators. Formwork and concrete delivery systems (mixers, belts and pump lines) are susceptible to excessive heat during the summer months and should be shielded or cooled prior to coming in contact with the concrete. The maximum depth of each lift of concrete will be shallower in hot weather to assure coverage with the previous layer and prevention of cold joints. Scheduling concrete placement to begin in the late afternoon will improve the placing conditions. Concrete placed during the early morning may attain undesirable high temperatures during the middle of the day. Flatwork is particularly susceptible to drying due to wind at low humidity's and should be properly protected or cured to help minimize the effects of the hot weather. Sometimes, re-vibration prior to floating will prevent the development of plastic-shrinkage cracking. When this type of cracking occurs prior to final set, the cracks may be closed by striking the surface each side of the crack with a float.

Source: Auburn University

Testing:

Precautions should also be taken to prevent the effects of hot weather on concrete test samples. Leaving samples exposed to hot sun, wind or dry air can seriously affect test results. Merely covering the top of a molded test cylinder is not sufficient in hot weather to prevent moisture loss and maintain standard temperatures. ASTM C31 requires that samples be maintained at temperatures between 60° and 80°F and loss of moisture be prevented from specimens for 20 ± 4 hours.

Source: Concrete Construction

Recommendations:

Since last minute improvisations are rarely successful, early preventive measures must be applied to prevent the adverse effects of hot weather on concreting operations. The following is a list of some of the recommended practices during hot weather concreting operations;

1. Use cold water or ice, as a part of the mixing water during reducing concrete temperatures because on melting alone it absorbs heat at the rate of 144 BTU/#. Ice is most effective when used in a crushed, shaved or chipped form and must be placed directly in the mixer as a part of the mixing water. Mixing should continue until all of the ice is completely melted.

2. Shade or continuously sprinkle with water aggregate stock piles in order to reduce their temperature prior to batching.

3. Limit the amount of mixing and agitating of the concrete. The number of revolutions at mixing speed in a ready mix truck should be held to 70, 100 or 125 at the most.

4. Addition of water should not be allowed at the job site other than that required initially to adjust to the specified slump, provided such addition does not exceed the limits of the specified water-cement ratio. Any later addition of water (retempering) should be prohibited as this will further aggravate the detrimental strength reductions experienced during hot weather.

5. Dampen subgrade and forms prior to placing concrete. Erect wind breaks or sunshades. Apply moisture after placing concrete via fog spraying or apply promptly a white pigmented curing compound (ASTM C 309 Type 2).