

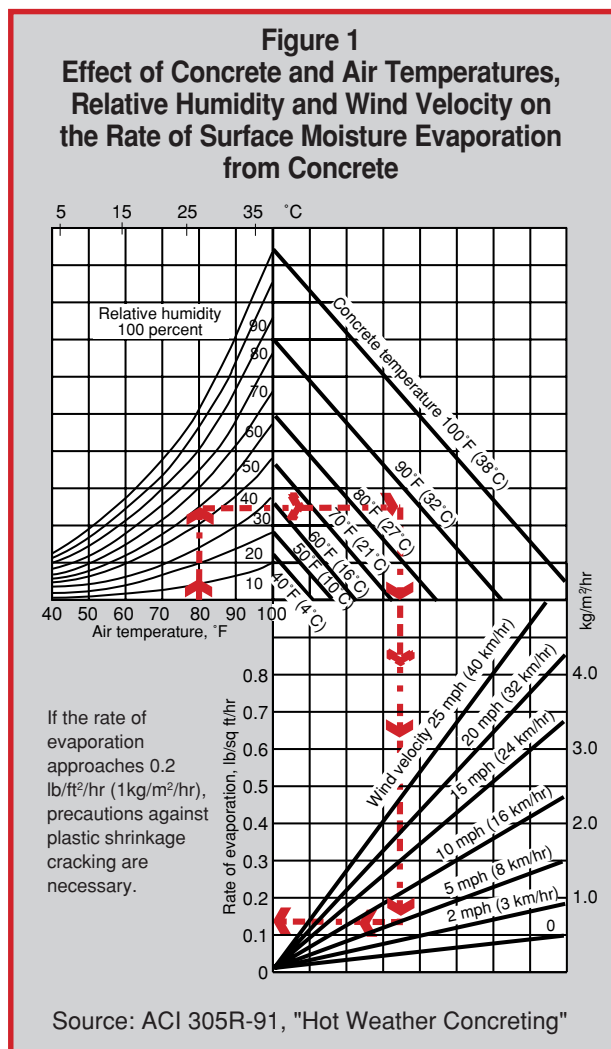
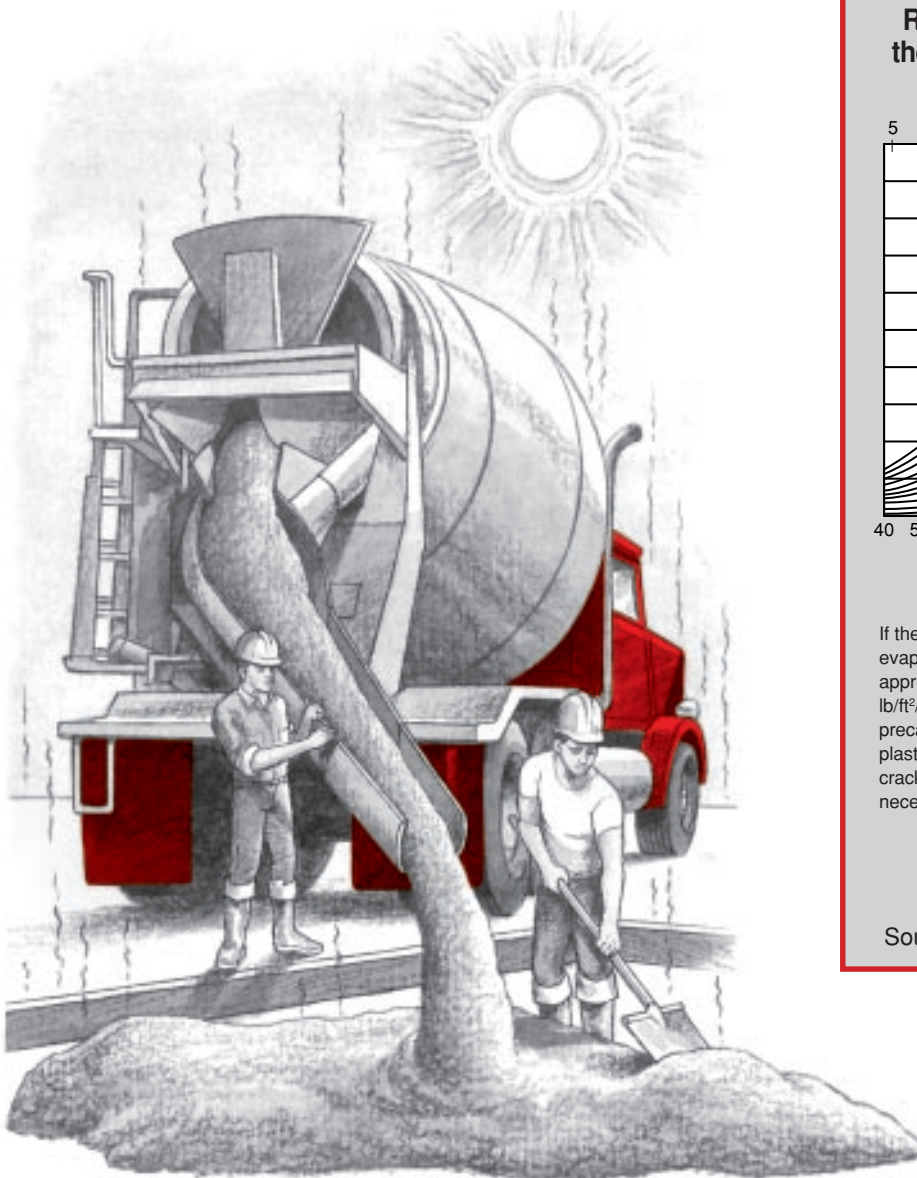


Successful

# HOT WEATHER CONCRETING

*HOT WEATHER can lead to many problems in mixing, placing, and curing of concrete that can have an adverse affect on its properties and service life. This guide has been developed by Master Builders, Inc. to assist the entire construction team (owners, specifiers, contractors, and ready mixed concrete producers) in the design, manufacture, delivery, placement and curing of quality concrete in HOT WEATHER.*

ACI Committee 305 defines hot weather as any combination of high ambient temperature, high concrete temperature, low relative humidity, wind velocity and solar radiation. The effects of high temperature, solar radiation and low relative humidity on concrete may be more pronounced with increases in wind velocity (see Figure 1), and can lead to rapid evaporation of moisture, which is the primary cause of plastic shrinkage cracks in concrete.



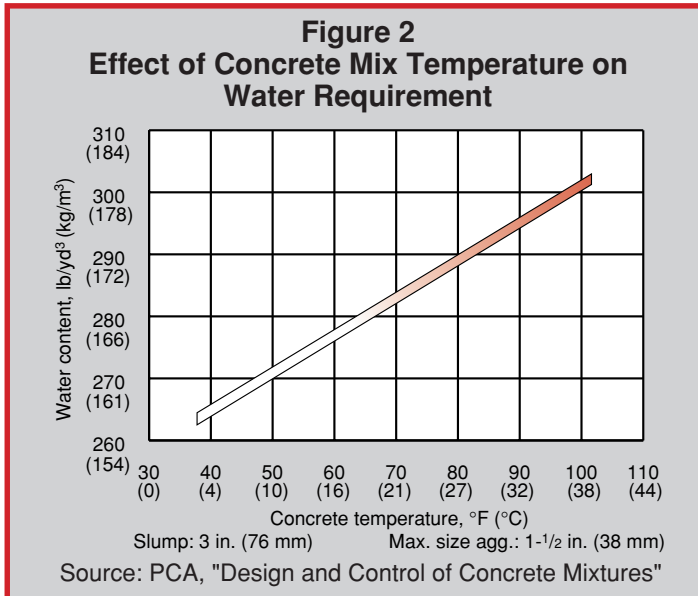
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Construction Chemicals

## Potential Problems

The potential problems of hot weather can occur at any time of the year in warm tropical or arid climates and generally occur during the summer season in other climates. Problems associated with freshly-mixed concrete placed during hot weather conditions include increased:

- **water demand (see Figure 2)**
- **rate of slump loss**
- **tendency for retempering**
- **rate of setting (see Table 1)**
- **difficulty in handling, placing, compacting and finishing**
- **occurrence of plastic shrinkage cracking**
- **amount of air-entraining admixture to entrain air**
- **need for early curing**



**Table 1**  
**Setting Time of Concrete at Various Temperatures**

Temperature	Approximate Setting Time
100 °F (38 °C)	1-2/3 hours
90 °F (32 °C)	2-2/3 hours
80 °F (27 °C)	4 hours
<b>70 °F (21 °C)</b>	<b>6 hours</b>
60 °F (16 °C)	8 hours
50 °F (10 °C)	10-2/3 hours
40 °F (4 °C)	14-2/3 hours

In hardened concrete, hot weather can increase:

- **drying shrinkage and differential thermal cracking**
- **permeability**

and decrease:

- **compressive and flexural strength**
- **durability**
- **watertightness**
- **uniformity of surface appearance**

ACI 305-91 report on, "Hot Weather Concreting", states that "concrete can be produced in hot weather without maximum limits on placing temperatures and will perform satisfactorily if proper precautions are observed in proportioning, production, delivery, placing and curing. As part of these precautions, an effort should be made to keep concrete temperature as low as practical."

## Concrete Temperature Control

Concrete temperature at the time of mixing is influenced by temperature, specific heat and quantity of its ingredients. The approximate temperature of concrete can be calculated from the following equation:

$$T = \frac{0.22(T_a W_a + T_c W_c) + T_w W_w + T_{wa} W_{wa}}{0.22(W_a + W_c) + W_w + W_{wa}}$$

where T = temperature of freshly-mixed concrete  
T<sub>a</sub>, T<sub>c</sub>, T<sub>w</sub>, T<sub>wa</sub> = temperature of aggregates, cement, added mixing water and free water on aggregates, respectively.

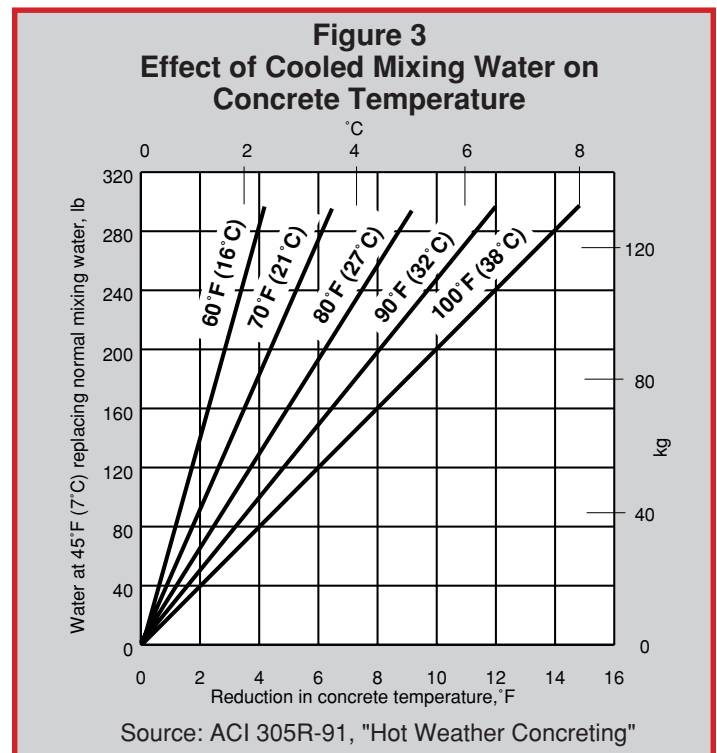
W<sub>a</sub>, W<sub>c</sub>, W<sub>w</sub>, W<sub>wa</sub> = weight of aggregates, cement, added mixing water, and free water on aggregates, respectively.

The temperature of concrete can be reduced 1 °F (0.5 °C) by reducing:

- **cement temperature by 8 °F (4 °C)**
- **water temperature by 4 °F (2 °C) (see Figure 3)**
- **aggregate temperature by 2 °F (1 °C)**

Of all concrete-making materials, water is the easiest to cool, and using ice as part of the mixing water will help reduce the concrete temperature. The amount of ice used must be included as part of the mix water and should not exceed the established water-cementitious materials ratio. The following measures will further help to control concrete temperature at the time of batching or during the hydration process:

- **sprinkling and spraying of aggregates**
- **shade storage of aggregates**
- **use of liquid nitrogen**
- **use of fly ash/slag cement**
- **use of set controlling admixtures**  
(**POZZOLITH®**, **POLYHEED®**, **RHEOBUILD®**, **DELVO® Stabilizer**, **DELVO® ESC**)
- **use of an evaporation reducer (CONFILM®)**



The use of slower setting cements may improve the handling characteristics of concrete in hot weather. A 10 °F (5 °C) to 15 °F (8 °C) temperature rise per 100 lb (45 kg) of cement occurs from cement hydration. The temperature increase from cement hydration is directly proportional to its cement content.

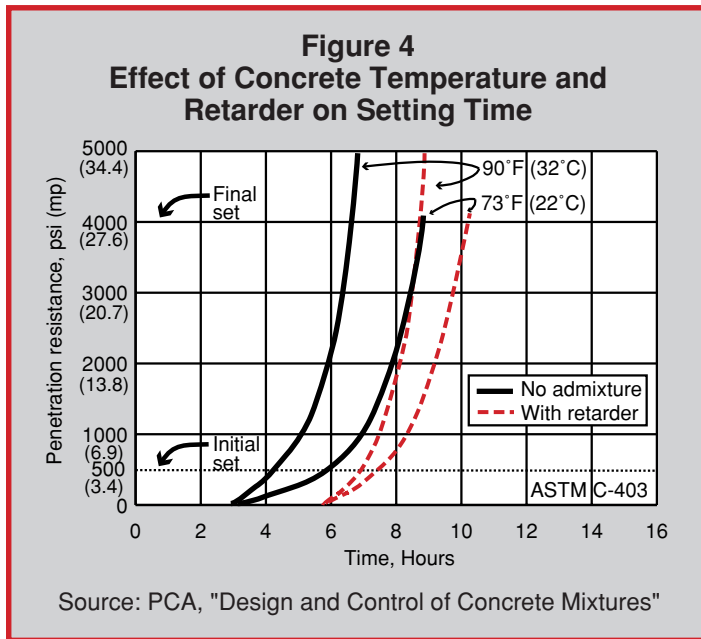
Fly ash, other pozzolans and ground granulated blast-furnace slag are used as partial replacements for portland cement and impart a slower rate of setting and strength development to concrete, both of which are desirable in hot weather concreting.

The requirements to achieve good results in hot weather concrete placing and curing are no different than those for other seasons. Concrete should be placed where it will remain and in shallow layers to allow adequate vibration; use sunscreens, shades, wind breaks, cure and protect from moisture loss; place at times to escape the heat of day.

### Chemical Admixtures

Chemical admixtures conforming to ASTM C 494 Types B, Retarding; D, Water-reducing and retarding and G, High-range water-reducing and retarding, are beneficial for concrete placed during hot weather. Benefits obtained from these admixtures include:

- lower water demand - minimum 5%
- improved workability during placing
- slower rate of setting time (see Figure 4)
- lower rate of heat evolution
- increased compressive strength



In addition, Type G admixtures also provide a minimum of 12% water reduction and extended slump retention of rheoplastic concrete - slump > 7 in. (175 mm).

Master Builders, Inc. offers a complete family of retarding admixtures that conform to ASTM C 494 requirements.

Typical performance data is as follows:

Product	ASTM C 494 Designation	Dosage fl oz/cwt (mL/100 kg)	Setting Time Retardation vs. Plain Concrete (h:min)
<b>POZZOLITH 100 XR</b> Conventional water-reducing and retarding admixture	B & D	2 (130)	+2:30
		5 (330)	+8:55
<b>POLYHEED RI</b> Mid-range water-reducing and retarding admixture	B & D	6 (390)	+1:38
		12 (780)	+4:49
<b>RHEOBUILD 716 I</b> High-range water-reducing and retarding admixture	B & G	11 (720)	+1:00**
		13 (850)	+3:20**
<b>DELVO Stabilizer</b> Hydration control admixture (Liquid)	B & D	2 (130)	+0:45
		6 (390)	+2:00
<b>DELVO ESC</b> Hydration control admixture (Dry Formulation)	B & D	4 (260)* (1/4 puck)	+2:15**

\*1 DELVO ESC PUCK = 16 fl oz (470 mL) of Liquid DELVO Stabilizer

Your Master Builders sales representative will help you select the formulation that best serves your needs.

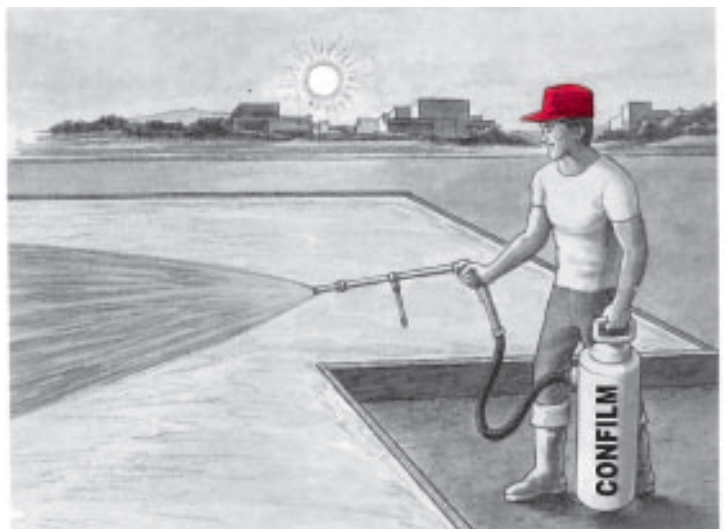
### Miscellaneous Products

Polypropylene synthetic fibers (**Fibermesh**\*) reduce the formation of plastic settlement and shrinkage cracks. In addition, these fibers:

- reinforce against plastic shrinkage crack formation
- hold cracks together
- reinforce against abrasion
- are compatible with all surface treatments

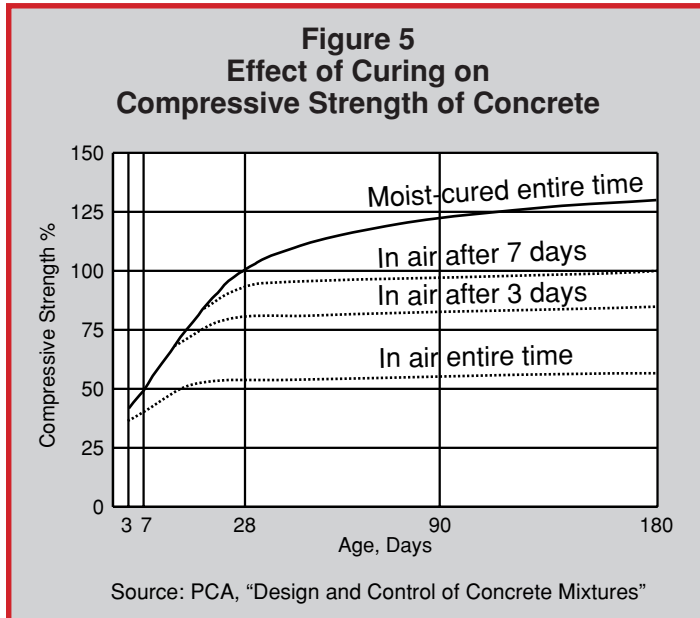
The use of an evaporation reducer (**CONFILM**) will enhance the quality of the concrete. This monomolecular film:

- reduces surface moisture evaporation
- reduces crusting, plastic shrinkage cracks
- increases amount of surface handled per finisher
- reduces overall finishing costs
- is **NOT** a finishing aid
- is **NOT** a curing compound for concrete



## Curing

Curing is the maintenance of a satisfactory moisture content and temperature in concrete during its early stages so that desired properties may develop (see Figure 5). The minimum recommended curing period is 7 days. Inadequate curing can cause plastic shrinkage cracking and impair strength development and durability.



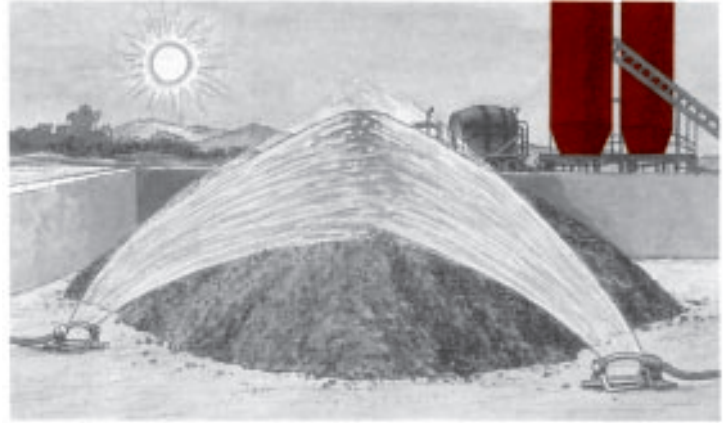
Methods of curing include:

1. Moist curing (ponding, continuous sprinkling and fogging)
2. Wet coverings (wet burlap, etc.)
3. Impervious paper and plastic sheets - white curing sheets
4. Membrane-forming curing compounds

## Solutions

Strength, durability and other desired properties of concrete can be obtained in hot weather through the use of the following techniques:

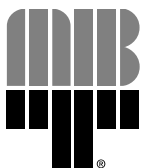
- use of cool concrete ingredients
- avoiding prolonged mixing of concrete materials
- protection of materials and equipment from hot weather
- good scheduling (plan hot weather placements)
- proper testing techniques (e.g. ASTM C 31)



## Summary

Hot weather difficulties are chiefly caused by high concrete temperatures and rapid evaporation of water from concrete. These conditions adversely affect the quality of concrete since the rate of setting is accelerated, strength is reduced and cracks may occur in either the plastic or hardened state. Curing is more critical and air-entrainment more difficult to attain in hot weather, and field strength specimens are affected in the same manner as the concrete in place. If all precautions and recommended ACI (American Concrete Institute) concreting practices are followed, successful hot weather concreting can be achieved.

**Master Builders, Inc. has the products and technical expertise to assist the entire construction team (owners, specifiers, contractors, and ready mixed concrete producers) in the design, manufacture, delivery, placement and curing of quality concrete in **HOT WEATHER**. For further information or assistance, contact your local Master Builders sales representative or by phoning our Customer Service Department.**



**Master Builders, Inc.**

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