Hot weather concreting tips

Plan ahead to avoid problems caused by high temperatures and dry conditions

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Editorial Director

Placing, finishing, and curing concrete require extra care in hot weather. When temperatures rise above 80°F, fast setting, lower strengths, and cracking are all more likely. But these problems can be avoided by recognizing the causes and minimizing hot weather effects.

WHY HOT WEATHER CAN CAUSE PROBLEMS

When concrete temperature increases, more mixing water is required to produce the slump needed for placing. Figure 1 shows typical effects for a 3-inch-slump concrete made with 1½-inch-maximum-size aggregate. Rate of slump loss increases as well, increasing the chance that water will be added at the jobsite. Regardless of whether water is added at the plant or the jobsite, a higher water content increases shrinkage and a higher water-cement ratio reduces strength.

Because higher temperatures speed setting, handling and finishing are more difficult and cold joints are more likely. Plastic cracking also may occur during finishing when humidity is low or wind speed is high (Figure 2).

If concrete is air-entrained, hot weather makes control of air content more difficult. High temperatures reduce air content, requiring higher dosages of air-entraining admixtures.

Even if more cement is added to compensate for increased water demand, quality of the hardened concrete may suffer. Concrete cured at high temperatures gains early strength faster but at the expense of 28-day strength. There's also more cracking due to drying shrinkage and a greater possibility of thermal cracking, especially in mass concrete.

The key to success in hot weather concreting is planning and preparation. By carefully selecting concreting materials and construction methods, producers and contractors can avoid most problems.

CONCRETE PRODUCTION, DELIVERY, AND DISCHARGE

The first steps in controlling concrete temperature are taken at the batch plant. Lowering concrete temperature decreases water demand, slows slump loss, increases setting time, and reduces the chance of plastic shrinkage cracking.

- ❑ Minimize cement content by using water reducers and fly ash as a cement replacement. Also use the largest size and amount of coarse aggregate permitted by placing conditions.
- ❑ Use retarders to control fast setting and when long haul times are unavoidable. But carefully control the dosage, especially for flatwork. If too much retarder is used in concrete for slabs, the surface may crust over while the underlying concrete remains plastic. Finishers may start floating and troweling too soon, creating a wavy surface or trapping bleedwater beneath the surface.
- ❑ If a higher slump is needed, consider using third generation high-range water reducers instead of water to get the needed slump. These admixtures produce high slumps that last up to 2 hours. The high slump also reduces friction between aggregate particles during mixing, slowing heat buildup in the mixer drum during transit.
- ❑ Consider substituting Type II moderate heat cement for Type I normal cement. Avoid using Type III cement.
- ❑ Shade aggregate stockpiles and wet them to promote evaporative cooling that lowers concrete tem-

perature. Wetting with chilled water is even more effective, especially when humidity is high.

- ❑ In extremely hot weather or when concrete for massive structures is being produced, use chilled batch water, add ice as part of the batch water, or cool the concrete with liquid nitrogen.
- ❑ Time deliveries so placing delays don't cause long truck waiting periods. Discharge concrete as soon as possible after mixing.
- ❑ Limit mixing to 100 drum revolutions at the mixing speed designated by the mixer manufacturer. Use agitating speed for additional revolutions.
- ❑ For long hauls during hot, humid weather, consider delaying mixing until the truck reaches the jobsite. This requires loading the materials into the drum without rotating it and charging the cement last. If relative humidity is low, concrete can sometimes be hauled long distances after mixing even when air temperatures are high.
- ❑ Paint mixer drums white so they don't absorb as much solar heat.

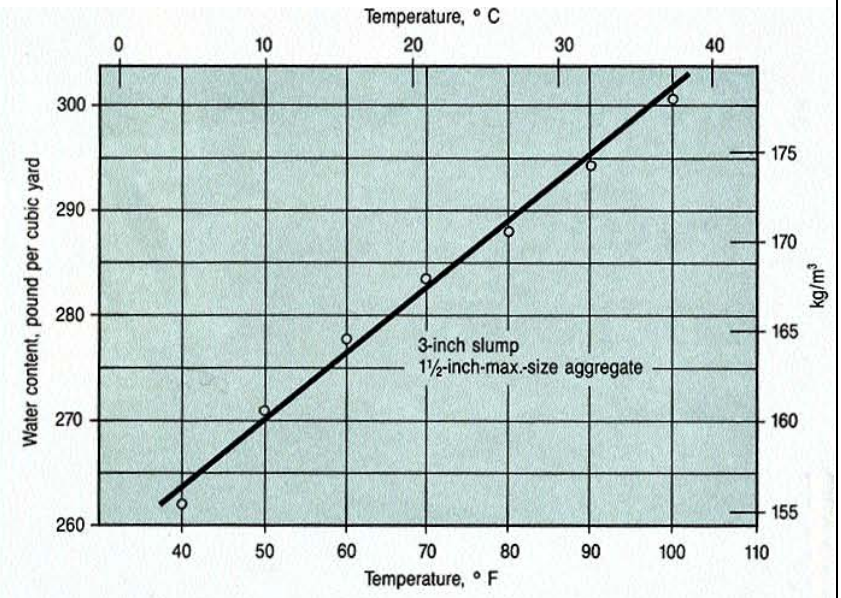

Figure 1. *At higher temperatures, more water is needed to produce a given slump. (Data from U.S. Bureau of Reclamation)*

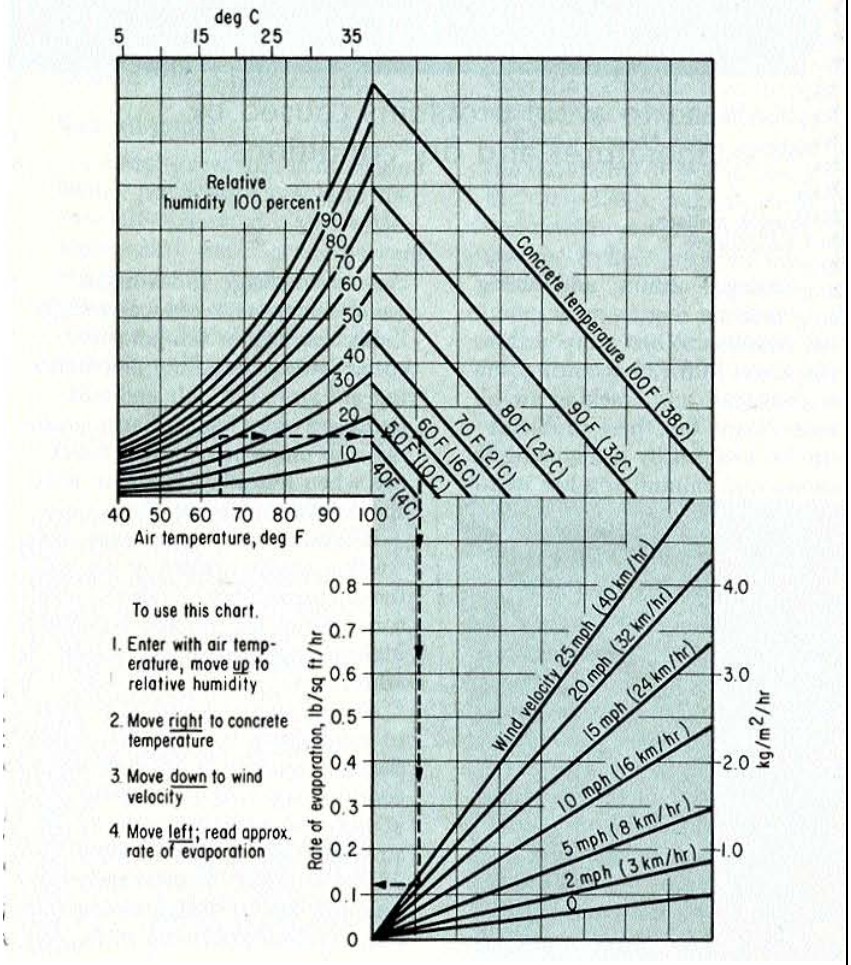

Figure 2. **Use this chart to estimate evaporation rate from concrete surfaces. Plastic shrinkage cracking is possible if the rate exceeds 0.1 pound per square foot per hour. When the rate exceeds 0.2 pound per square foot per hour, take steps to slow surface evaporation. Steps may include cooling the concrete, using a fog spray, or using windbreaks. (Chart is found in ACI 305-89, Hot Weather Concreting.)**

For a 1-hour delivery time, concrete in a white drum will be about 2.5°F cooler than concrete in a red drum.

- ❑ When possible, schedule deliveries to avoid the hottest part of the day. In arid climates, concrete poured after midnight is exposed to lower temperatures and less wind. Also, final set occurs near sunrise when early drying and cracking are less likely because relative humidity is highest.

- ❑ Don't add water at the jobsite other than that required initially to adjust to the specified slump.

PLACING AND FINISHING

Hot weather concreting requires having enough workers and equipment on the job to handle the unexpected. Anticipating problems is a part of the planning process.

- ❑ Have all forms, equipment, and workers ready to handle concrete, especially the first delivery of the day.

- ❑ Use a thermometer to monitor concrete temperature when the mix is delivered and call for plant adjustments if needed.

- ❑ Have at least one standby vibrator on hand for every three in use. Vibration equipment failures are more frequent in hot weather.

- ❑ Keep all equipment that touches the concrete cool: chutes, conveyors, pump lines, tremies, reinforcement, and buggies. Protect from sunshine if possible or spray with water.

- ❑ If there isn't a vapor barrier under the slab, dampen the subgrade before placing concrete. If there is a vapor barrier, compact a 1- to 3-inch-thick layer of damp sand over it before placing concrete

- ❑ Dampen side forms for slabs or walls with cool water before placing concrete.

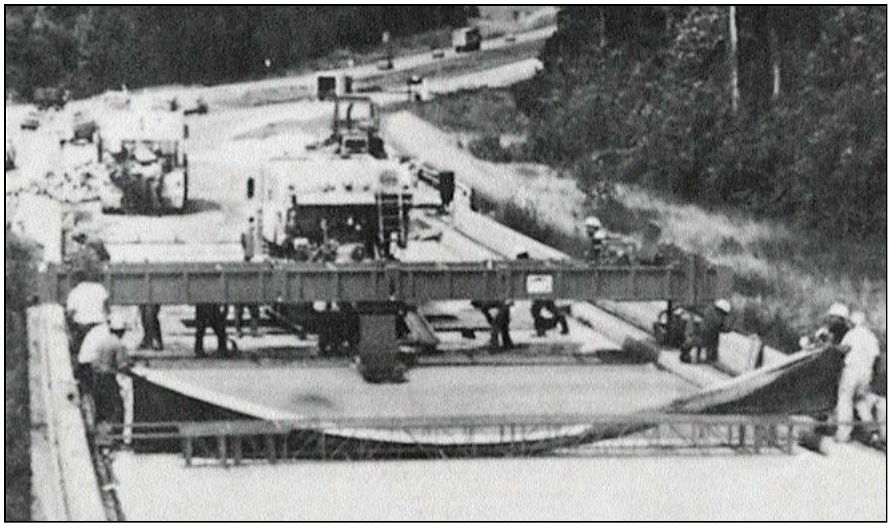

Figure 3. **Continuous wet curing is recommended during hot weather. The curing cover used here is burlap with a polyethylene coating.**

- ❑ Work fast but don't finish concrete while there's still bleedwater on the surface.

- ❑ When there's danger of plastic shrinkage cracking (see Figure 2), control evaporation from the concrete surface. Use fog sprays or spray on a monomolecular film. Under severe drying conditions, cover all exposed surfaces after they're placed and screeded, then uncover only that part of the surface being worked.

CURING AND PROTECTION

Curing is an especially critical operation during hot weather. Poor curing can cause low strength, cracking, and discoloration.

- ❑ Start curing as soon as finishing is completed.

- ❑ Cure continuously, preferably with water. Continuous curing is especially important during the first day after concrete is placed.

- ❑ Protect all surfaces from drying, even for a short time, since intermittent drying can cause pattern cracking. Use wet burlap or cotton mats, a continuous spray mist, or white-pigmented curing compound.

- ❑ Cure for the specified period but not less than 3 days. Seven-day curing is better.

- ❑ During curing, spray the outside surfaces of forms to keep them cool.

- ❑ When forms are stripped before the specified curing time has elapsed, provide a wet cover for the newly exposed surfaces.

TESTING AND INSPECTION

During hot weather, contractors and producers are sometimes penalized for others' mistakes. If test cylinders are treated improperly, low tests may result, with the concrete supplier or contractor often taking the blame. Careful testing can eliminate some of the disputes and job delays that result after low strength test results are reported.

- ❑ Make slump, air tests, and test cylinders immediately after obtaining the concrete sample.

- ❑ Don't leave test cylinders unprotected in the hot sun. High initial curing temperatures alone can reduce 28-day strength by as

much as 10%. Keep cylinders at 60°F to 80°F for the first 16 to 24 hours after casting. Do this by storing them in a shady location, a field curing box, an air-conditioned construction trailer, or wrapped in wet burlap. Evaporation from the wet burlap helps to keep cylinders cool.

- ❑ Prevent test cylinders from drying by casting them in plastic molds with a plastic lid or by covering them with plastic sheets.

- ❑ Make air content tests more frequently than on jobs at normal temperatures. Notify the batch plant when air content approaches the lower specification limit.

- ❑ Record at frequent intervals air temperature, concrete temperature, general weather conditions, wind speed, and relative humidity. Also record slump loss, water added on arrival, and corresponding mixing time.

References

1. "Hot Weather Concreting (ACI 305R-89)," American Concrete Institute, P.O. Box 19150, Detroit, Michigan 48219.

2. "What, Why, & How—Hot Weather Concreting," Concrete in Practice Note 12, National Ready Mixed Concrete Association, 900 Spring Street, Silver Spring, Maryland 20910.

3. "Hot Weather Concreting," Design and Control of Concrete Mixtures, Portland Cement Association, 5420 Old Orchard Road, Skokie, Illinois 60077.

4. Michael Lee, "Economical Cooling of Hot Weather Concrete," Concrete Construction, September 1989, page 791.

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