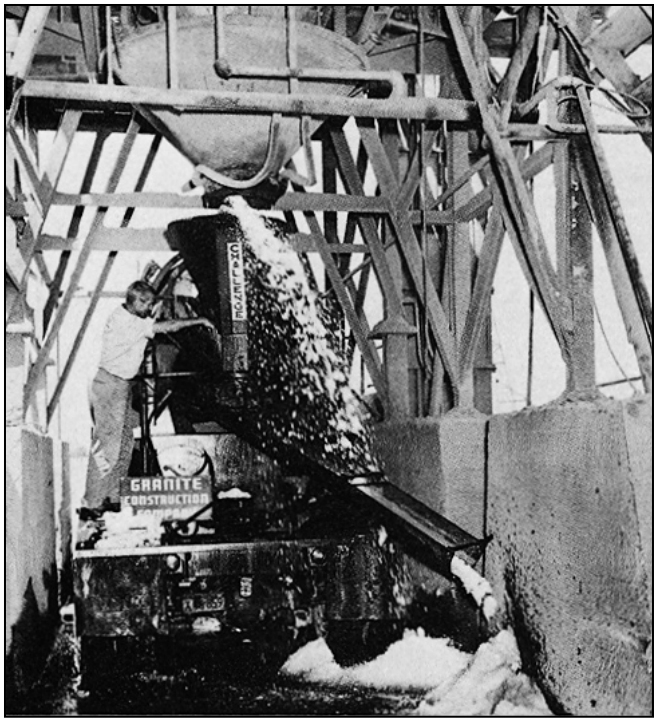
What to do with concrete in hot weather

A checklist of time-tested ideas



Flaked ice being charged directly into mixer drum on a hot day. Use of ice may not be the most economical method of controlling batch temperature, but it can provide a substantial temperature reduction. Careful weighing is required to maintain correct water-cement ratio.

High air temperature during concreting, sometimes aggravated by the effects of wind or low relative humidity or both, can impair the quality of both fresh and hardened concrete. Rising temperatures and falling relative humidities increase the bad effects. Troubles usually arise when the workers are unaccustomed to the weather and type of construction. Their improvised responses to the unexpected seldom succeed, and the damage that the hot weather causes can never be completely alleviated. The immediate effects on fresh concrete can be:

- more water demand for the same slump or workability
- greater slump loss
- faster setting
- more likelihood of plastic cracking
- more difficulty in controlling the air content

Later on, the hardened concrete may have:

- lower strength
- more drying shrinkage and tendency to crack
- less durability in freeze-thaw exposures
- less uniform surface appearance

All of these adverse effects can be virtually overcome by careful selection of materials and procedures for hot weather work. The key to success is advance planning. Be ready before the thermometer begins to rise.

Good guidance can be found in "Hot Weather Concreting, ACI 305R," available from the American Concrete Institute, Box 19150, Detroit, Michigan 48219. Circumstances vary widely, but the ACI report suggests that for a given local operation the dividing line between hot weather concreting and normal methods is somewhere between 75 and 100° F.

PLANNING

A successful, well-run hot weather job is the result of thorough and careful planning. Some items on the following list may be controlled by the designer or specifier, and some may be the responsibility of the contractor. However, the builder should be alert to all of the possibilities since the specifier may not always anticipate just when and under what weather conditions the work may be done.

- ❑ 1. Design (or redesign) the mix specifically for hot weather conditions. Consider replacing some of the cement with fly ash or other pozzolan, to improve workability and ultimate strength. Water-reducing, retarding admixtures can help decrease the tendency to crack.
- ❑ 2. Use the largest size and amount of coarse aggregate compatible with the job. This also helps minimize the tendency to crack.
- ❑ 3. Specify the maximum acceptable delivery temperature of the concrete so that the supplier can plan to cool his materials as needed.
- ❑ 4. Plan the locations of construction joints ahead of time with hot weather contingencies in mind.
- ❑ 5. Locate contraction (control) joints at slightly smaller intervals than when concreting at lower temperatures.
- ❑ 6. Use sunshades or windbreaks.

❑ 7. Delay construction of indoor slabs on grade until after the walls are up and the roof is on.

❑ 8. Supply enough equipment in good repair, and provide enough workers, to make the. job run smoothly even when the unexpected happens.

❑ 9. Be ready to notify the concrete supplier promptly if any changes in schedule become needed as the job progresses.

CONCRETE PRODUCTION

The concrete producer's responsibility is to mix the concrete a reasonably short time before use and deliver it at the temperature specified. The following methods can be used to slow the rates of setting and hardening and minimize the tendencies toward cracking.

Worker carefully sprinkles formwork and reinforcement to lower temperatures just ahead of the concrete placement.

❑ 1. Shade stockpiles. Sprinkle aggregates ahead of time for evaporative cooling, or cool them by other means.

❑ 2. Use ice as part of the mix water, or cool the water with liquid nitrogen.

❑ 3. Paint the mixer and storage bins or silos white to absorb as little heat as possible from the sun.

❑ 4. Reduce the time between mixing and placing as much as possible. If a complete jobsite plant is impractical, review the ACI 305 procedure for delaying final mixing until the ready mix truck reaches the site. This requires carefully charging cement as the last ingredient into a non-rotating drum.

❑ 5. Avoid excessive mixing, but turn the drum at least 70 to 100 revolutions at the mixing speed designated by the manufacturer.

DELIVERY AND DISCHARGE

Delays in delivery can undo the best mixing practices. The concrete producer should set up and maintain a good delay-free schedule for delivering the concrete to the proper location on the site. Batch and mix the materials at the site, possibly using a jobsite plant, if the project is large enough.

Do not add water to ready mixed concrete at the job site unless it is part of the amount required initially for the specified maximum water-cement ratio and the specified slump. On some jobs contractors may find that they themselves can exercise best control.

PLACING AND FINISHING

For successful placing and finishing it is necessary to provide a suitably modified environment in which workers and equipment can function well and concrete can be suitably protected from rapid warming or drying. Here are some ideas that have proved helpful on many jobs.

❑ 1. Schedule placement for the cool time of the day such as early morning or late afternoon. On some jobs concreting at night may be advantageous.

❑ 2. See that the path for the mixer truck on the site is clear of obstacles and safe to drive over.

❑ 3. Have all forms, equipment and workers ready to receive and handle concrete, especially the first delivery.

❑ 4. If sunshades or windbreaks or both are to be used, have them in place.

❑ 5. Have at least one standby vibrator on hand for every three vibrators to be used, since vibration equipment failures are more frequent in hot weather.

❑ 6. Keep all equipment that touches the concrete cool: chutes, conveyors, pump lines, tremies, reinforcement and buggies. Protect from sunshine if possible. If they can't be kept cool, spray-cool them as necessary with water.

❑ 7. If there is no vapor barrier under the slab, dampen the subgrade before placing concrete.

❑ 8. Dampen side forms for slabs or walls with cool water.

❑ 9. Use a thermometer to monitor the temperature at which concrete is being delivered, and call for adjustments at the plant if necessary.

❑ 10. Perform all operations rapidly, but don't finish slabs prematurely, while bleed water is on surface.

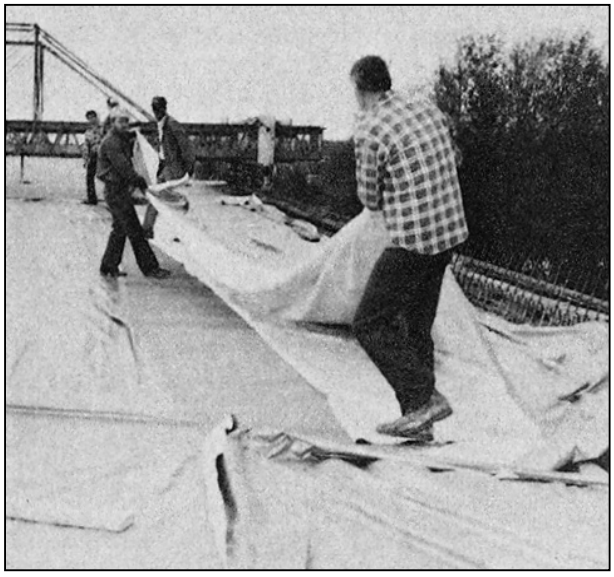
❑ 11. If necessary, protect slab concrete at all stages against undue evaporation. Cover with sheet material, and uncover only that part of the surface that is being worked; or apply a fog spray or mist above the surface; or spray on a monomolecular film to retard evaporation.

CURING AND PROTECTION

Although concrete gains strength faster in hot weather, the rate finally slows down and the ultimate strength can actually be lower than that of concrete placed and cured at lower temperatures. The following procedures can minimize these and other bad effects.

❑ 1. Continuous curing, preferably with water, is particularly important during the first day after concrete is placed.

❑ 2. Protect all surfaces from drying, even intermittently, since this can produce pattern cracking. Wet burlap or cotton mats, continuous spray mist, and white curing compound are among the acceptable materials.



Prefabricated curing blanket of synthetic backing with a white reflective surface helps keep concrete cool while retaining water so essential to proper curing. Blankets of this type may be of particular interest in areas where curing water supplies are restricted.

❑ 3. Cure for specified period, but not less than 3 days. Seven days is better.

❑ 4. During this period spray exteriors of forms to keep them cool.

❑ 5. As soon as possible to do so without damage, loosen forms of walls and structural elements, and run water down inside (not suitable for architectural surfaces).

❑ 6. When forms are removed, take care to provide a wet cover to newly exposed surfaces.

❑ 7. After stripping forms in such structures as tunnels and pipelines, close the structures to prevent drafts and drying of the surfaces.

TESTING AND INSPECTION

On jobs requiring testing and inspection, standard procedures should be supplemented with those of ACI 305R, which include the following:

❑ 1. Consider making more frequent tests for slump and air content than on jobs at normal temperatures.

❑ 2. Make slump and air tests, and prepare test cylinders without delay.

❑ 3. Test cylinders stored on the job and used to help determine when it is safe to strip forms, remove shores, and put the structure into service must be cured as nearly as possible under the same conditions as the structure.

❑ 4. For the first 24 hours store acceptance test cylinders that are to be transferred to the laboratory at 60 to 80 degrees F and protect them against loss of moisture. Transfer cylinders to laboratory promptly at age 24 hours.

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