HOT-WEATHER CONCRETING

TIPS FROM THE PORTLAND CEMENT ASSOCIATION

Concreting in hot weather often causes many quality-control problems. Adding water to the concrete at the job site can adversely affect properties and serviceability of the hardened concrete. Only by taking precautions can concrete work proceed smoothly.

• Concrete should be placed at a temperature limit probably between 75° F and 100° F. The limit should be established based on trial-batch tests at the limiting temperature rather than at ideal temperatures.

• Aggregates and water have more influence on temperature than other components. To approximate temperature of concrete, calculate from the temperatures of ingredients:

$$T = \frac{0.22\,(T_a W_a + T_c W_c) + T_w W_w + T_{wa} W_{wa} - 112 W_i^*}{0.22\,(W_a + W_c) + W_w + W_{wa} + W_i^*}$$

—T = temperature of the freshly mixed concrete.

—T_a, T_c, T_w, and T_{wa} = temperature of aggregates, cement, added mixing water, and free water on aggregates, respectively.

—W_a, W_c, W_w, and W_{wa} = weight of aggregates, cement, added mixing water, and free water on aggregates, respectively.

* *When ice is added in the mixing water, the heat of fusion of the ice must be considered, so the equation is modified where W_i is the weight in pounds of ice.*

• Of materials in concrete, water is easiest to cool. Misting water from a cool source should be used. It should be stored in tanks that are not exposed to direct sunlight. Tanks and pipelines carrying the mixing water should be buried, insulated, shaded, or painted white. Water can be cooled by refrigeration, liquid nitrogen or ice.

• Aggregates are 70 to 85 percent of the total weight of concrete. To lower the temperature of concrete 10° F requires only a 15° F reduction in aggregate temperature. Stockpiles should be shaded from the sun and kept moist by sprinkling. Sprinkling of coarse aggregates should be adjusted to avoid producing excessive variations in the free moisture content. Refrigeration is another method of cooling materials. Aggregates can be immersed in cold-water tanks, or cooled air can be circulated through storage bins. Vacuum cooling can cool aggregate to as low as 34° F.

• Cement temperature has a minor affect. Generally, a 10° F change will change concrete temperature by 1° F.

• Before concrete is placed, mixers, chutes, belts, hoppers, pump lines and other handling equipment should be shaded, painted white or covered with wet burlap.

• Forms, reinforcing steel and subgrade should be fogged or sprinkled with cool water just before concrete is placed. For slabs on ground, moistening the subgrade the evening before concreting is good practice. There should be no puddles on forms or sub grade at placement time.

• In extreme heat, improved results can be obtained by restricting placement to early morning, evening or at night.

• Prolonged mixing, even at agitating speed, should be avoided. The Standard Specification for Ready Mixed Concrete (ASTM C94) requires that discharge of concrete be completed within 1½ hours or before the drum has revolved 300 times, whichever occurs first. During hot weather the time can be reduced to one hour to 45 minutes.

• Floating should be done promptly after the water sheen disappears from the surface or when the concrete can support the weight of a finisher. When the rate of evaporation exceeds 0.2 lb/ft² per hour, precautionary measures are almost mandatory. Cracking is possible if the rate of evaporation exceeds 0.1 lb/ft² per hour.

• The following precautions (listed in order) can minimize the possibility of plastic shrinkage cracking:

—Moisten the subgrade and forms.

—Moisten dry and absorptive aggregates.

—Erect windbreaks to reduce wind over the surface.

—Erect sunshades to reduce surface temperatures.

—Cool aggregates and mixing water.

—Protect concrete with temporary coverings (e.g. polyethylene sheeting) during any appreciable delay between placing and finishing. Evaporation retarders (usually polymers) can be sprayed immediately after screeding to retard evaporation before final finishing and curing.

—Protect the concrete immediately after final finishing to minimize evaporation. This is most important to avoid cracking. Using fog spray to raise the relative humidity of ambient air is effective in preventing evaporation. Fogging should be continued until a suitable curing material such as a compound, wet burlap or curing paper can be applied.

• Retaining forms in place cannot be considered a satisfactory substitute for curing in hot weather; they should be loosened as soon as practical without damage to the concrete. Water should then be applied at the top exposed concrete surfaces—for example, with a soil-soaker hose—and allowed to run inside the forms. On hardened concrete and on flat concrete surfaces, in particular, curing water should not be excessively cooler than the concrete.

• The need for moist curing is greatest during the first few hours after finishing. In hot weather, continuous moist curing for the entire curing period is preferred. However, if moist curing can not be continued beyond 24 hours, the concrete surface should be protected from drying with curing paper, heat-reflecting plastic sheets, or membrane-forming curing compounds while the surfaces are still damp. Moist-cured surfaces should dry slowly after curing to reduce the possibility of surface crazing and cracking.

• White-pigmented curing compound can be used on horizontal surfaces. Applying curing compound in hot weather should be preceded by 24 hours of moist curing. If this is not practical, the compound should be applied immediately after final finishing. Concrete surfaces should be moist

• For unusual cases in hot weather and where careful inspection is maintained, a retarding admixture may be beneficial in delaying the setting time, despite the somewhat increased rate of slump loss generally resulting. Retarding admixtures should conform to the requirements of ASTM C 494 Type B.

• Heat generated during cement hydration raises the temperature of the concrete. ACI 211.1 states that as a general rule a 10° F to 15° F temperature rise per 100 lb of cement can be expected from the heat of hydration.