CONCRETE IN PRACTICE

CIP 11

What, Why & How? Curing In-Place Concrete

WHAT is Curing?

Curing is the maintaining of a satisfactory moisture content and temperature in concrete. Curing begins after placement and finishing so that the concrete may develop the desired strength and hardness.

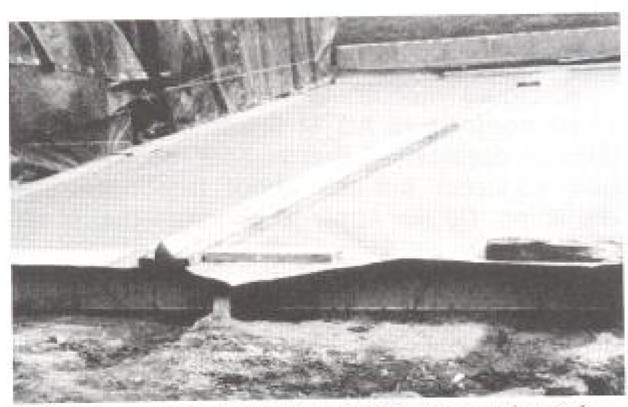
Without an adequate supply of moisture, the portland cement in the concrete cannot react to form a quality product. Drying may remove the water needed for this chemical reaction called "hydration" and the concrete will be weak. Temperature is an important factor in proper curing, since the rate of hydration is temperature dependent. For exposed concrete, relative humidity and wind conditions are also important; they contribute to the rate of moisture loss from the concrete.

WHY Cure?

Several important reasons are:

a. Predictable strength gain. Laboratory tests show that concrete in a dry environment can lose as much as 50 percent of its potential strength compared to similar concrete that is moist cured.[1] Concrete placed under high temperature conditions will gain early strength quickly but later strengths may be reduced.

Application of liquid membrane-forming compound with hand sprayer.



Slab-on-grade covered with waterproof paper for curing.

Concrete placed in cold weather will take longer to gain strength, delaying form removal and subsequent construction.

b. Improved durability, especially of non-air-entrained concrete slabs that may be subject to freezing conditions during construction. Well cured concrete has better surface hardness and therefore is more watertight.

c. Better serviceability and appearance. A concrete slab that has been allowed to dry out too early will have a soft surface with poor resistance to wear and abrasion. Proper curing reduces crazing, dusting, and scaling.[2]

HOW to Cure

Moisture Requirements for Curing—the concrete surface must be kept continuously wet or sealed to prevent evaporation for a period of at least several days after finishing. See the table for examples.

Systems to keep concrete wet include:

a. Burlap or cotton mats and rugs used with a soaker hose or sprinkler. Care must be taken not to let the coverings dry out and adsorb water from the concrete. The edges should be lapped and the materials weighted down so that they are not blown away.

b. Straw that is sprinkled with water regularly. Straw can easily blow away, and if it drys, can catch fire. The layer of straw should be 6 inches thick, and should be covered with a tarp.

c. Sprinkling on a continuous basis is suitable provided the air temperature is well above freezing. The concrete should not be allowed to dry out between soakings, since alternate wetting and drying may damage the concrete.

d. Ponding of water on a slab is an excellent method of curing. The water should not be more than 20° F cooler than the concrete and the dike around the pond must be secure against leaks.

e. Damp earth, sand, or sawdust will cure flatwork, especially floors. There should be no organic or iron staining contaminants in the materials used.

Sealing materials include:

a. Liquid membrane-forming compounds—must conform to ASTM Specifications[3] at the rate of application that is specified. Apply to the concrete surface about one hour after finishing. Do not apply to concrete that is still bleeding, or has a visible water sheen on the surface. While a clear liquid may be used, a white pigment will give reflective properties, and allow for inspection of coverage. A single coat may be adequate, but where possible a second coat, applied at right angles to the first, is desirable for even coverage. If the concrete will be painted, or covered with vinyl or ceramic tile, then a liquid compound that is non-reactive with the paint or adhesives must be used, or a compound that is easily brushed or washed off. On floors, the surface should be protected from the other trades with scuff-proof paper after the application of the curing compound.[4]

Example Minimum Curing Period to Achieve 50% of Specified Strength*

Type I Cement	Type II Cement	Type III Cement
Temperature—50°F		
6 days	9 days	3 days
Temperature—70°F		
4 days	6 days	3 days

*Values are approximate; specific values should be established for your mixtures and materials.[6]

b. Plastic sheets—either clear, white (reflective) or pigmented. Plastic should conform to ASTM Standards[5], be at least 4 mils thick, and preferably reinforced with glass fibers. The plastic should be laid in direct contact with the concrete surface as soon as possible without marring the surface. The edges of the sheets should overlap and be fastened with waterproof tape and then weighted down to prevent the wind from getting under the plastic. Plastic will make dark streaks wherever a wrinkle touches the concrete so plastic should not be used on concretes where appearance is important.

c. Waterproof paper—used like plastic sheeting, but does not mar the surface. Should also confrom to ASTM Standards.[5]

References

1. "Effect of Curing Condition on Compressive Strength of Concrete Test Specimens," NRMCA Publication No. 53.
2. "How to Eliminate Scaling," Concrete International, February, 1980. American Concrete Institute, Box 19150 Redford Station, Detroit, Michigan 48219.
3. ASTM C 309, "Specification for Liquid Membrane Forming Compounds for Curing Concrete," American Society for Testing Materials, 1916 Race Street, Philadelphia, Pa. 19103.
4. ACI 308, "Standard Practice for Curing Concrete," ACI Manual of Concrete Practice, Part 2, American Concrete Institute.
5. ASTM C 171, "Specification for Sheet Materials for Curing Concrete," American Society for Testing Materials.
6. ACI 306, "Cold Weather Concreting," ACI Manual of Concrete, Part 2, American Concrete Institute.

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