Curing Concrete Slabs

Companies and people who place concrete are often focused on organizing and planning, forming, placing, and finishing. Curing doesn't get the same consideration—especially on residential applications. But curing plays an important role in terms of the ultimate strength, durability, abrasion resistance, volume stability, permeability to water, and resistance to freezing, thawing, and de-icing concrete (Ref. 1). Good curing delays shrinkage and in the case of wet curing can delay shrinkage until after curing is complete.

Water-cement ratio

Generally speaking, concrete produced with a low water-cement ratio is stronger, more durable concrete. But mixes with water-cement ratios lower than 0.40, especially high performance concrete (HPC) mixes, don't have enough water to properly hydrate the cement. Mixes with water-cement ratios of 0.40 and above have enough water to promote good curing if the water can be retained in the slab during the curing cycle.

Curing when there is sufficient water in the concrete

The most popular and least expensive method of curing is to spray membrane-forming curing compounds on the surface and edges of freshly finished concrete shortly after the final finishing operation is complete. This method doesn't prevent moisture from leaving the slab, but it does retard moisture loss. The goal is to maintain 80% relative humidity in the concrete for a minimum 7-day period after placement. But you must be sure that the curing compounds used will be compatible with sealers or coatings that follow. During the late fall months, when temperatures drop below 40° F, many specifiers require that no curing methods be used for exterior slabs on grade because water is naturally retained and the concern is to eliminate as much water as possible before winter.

Other curing methods include wrapping a slab (including the edges) with polyethylene film, ponding it with water, placing dirt or sand on the slab and keeping it moist, and using wet coverings like burlap and burlap-polyethylene sheeting.

Curing when the water-cement ratio is below 0.40

Mixes below a 0.40 water-cement ratio don't have enough water in the concrete for curing. When the water-cement ratio is 0.36 or less, few capillaries are formed and the concrete is so dense that water can't penetrate from the outside. Any reduction in water in this concrete could result in autogenous shrinkage—a condition that occurs when cement paste loses volume due to insufficient water for hydration (Ref. 2). HPC mixes are especially vulnerable to this.

The best curing method for these mixes is wet curing, starting with maintaining high air humidity levels

Above: When concrete mixes with water-cement ratios of less than 0.40 are being used, it's important to ensure that no mix water evaporates. Here, the contractor is fogging the air with a pressure washer while concrete is being placed. Below: Cotton mats are increasingly being used for wet curing. On the Wacker Street project in Chicago, cotton mat placement followed about 100 feet behind concrete placement.

PHOTOS: JOE NASVIK

Ways to cure concrete

- Use evaporation retarders during finishing operations
- Apply film-forming chemical curing compounds immediately after initial set
- Apply sealers rated as a curing material, which can be placed upon initial set. (Useful for colored concrete applications.)
- Cover slabs with waterproof paper such as kraft paper
- Cover slabs with polyethylene film
- Use insulating blankets (during cold-weather concreting)
- Wet cure with:
  Continuous sprinkling or fogging
  Burlap coverings
  Cotton mats (becoming more popular)
  Ponding and immersing concrete in water
  Coverings of earth, sand, or sawdust that are kept wet

just after placement by fogging the air. Moisture-retaining coverings must be placed as soon as they won't damage the surface of the concrete. They are immediately saturated to wet the surface. It's important that the covering remain wet for the duration of the curing period, with no periods of drying out. This procedure is intended to keep any moisture from leaving the slab, starting from the moment it's placed.

According to Steve Kosmatka, materials engineer for the Portland Cement Association, Skokie, Ill., the advantages of wet curing concrete are:

- Increased strength gain
- Increased abrasion resistance on the surface
- Less permeable concrete with increased resistance to chloride penetration and freeze/thaw damage
- Increased resistance to early cracking—slabs gain strength before drying out and have more resistance to shrinkage forces

If wet curing is specified for a floor, water must be prevented from moving through control joints to the subbase and increasing curling problems. Periodically moistening burlap and covering it with polyethylene is perhaps the best way to do this.

It should also be noted that water, or the materials used for curing, can discolor finished surfaces.

— Joe Nasvik

References:
1. Beatrix Kerkhoff, William C. Panarese, and Steven R. Kosmatka, *Design and Control of Concrete Mixtures, 14th edition*, Portland Cement Association, 2002, p. 219.
2. Design and Control of Concrete Mixtures, p. 258.