Making Good Concrete Even Better

Answers to common questions about curing.

Poorly cured concrete starts its life with a defect that could be fatal. Water-filled voids, instead of filling with hydrated cement, remain empty after the mix water evaporates. Surface concrete especially is weak and porous, and more likely to be damaged by wear, rebar corrosion, aggressive chemicals, and freezing and thawing. Avoiding this handicap requires the designer to specify adequate curing and the contractor to use curing methods that work.

What is curing?

Curing maintains the moisture content and temperature needed for cement to hydrate. There is more than enough water in most concrete to hydrate all the cement. But as concrete dries, hydration stops. Curing prevents early moisture loss.

Curing also controls concrete temperature when necessary. Temperature affects the speed of hydration. The warmer the concrete the faster cement hydrates and the faster the concrete gains strength. At air temperatures between 50° F and 80° F, there's no need to control concrete temperature. Fortunately, much concrete is placed within this range; the contractor doesn't have to spend money on temperature control. Outside this range, though, precautions may be required.

How do extreme curing temperatures affect compressive strength?

Concrete temperatures below 50° F make it hard to achieve early strength. Hydration is slow, so early strength is low. Below 40° F early strength development is greatly retarded and at 32° F little strength develops.

Cement hydrates faster at temperatures above 80° F. Although concrete gains strength rapidly, its ultimate strength isn't as high as that of concrete cured at lower temperatures.

What methods and materials are used for curing?

Methods for maintaining the needed moisture content for curing fall into two categories:

Applying water continuously

Preventing excessive moisture loss

The first category includes ponding water on slabs, sprinkling or fog-spraying water, using soaker hoses, and applying saturated cover materials. Cover materials may include burlap, straw, earth, or sand.

Curing compounds are commonly used to prevent excess moisture loss. Other options include reinforced waterproof paper and polyethylene sheets.

Are curing compounds as good as curing paper or polyethylene sheets?

Membrane-forming curing compounds let some water evaporate through the membrane. In this respect they aren't as effective as curing paper or polyethylene sheets which retain all the moisture *if they remain intact and in place.* But sheets of curing paper or plastic may be damaged on a construction site or dislodged by wind or workers.

For many concrete jobs, curing compounds are the most economical curing method. Don't use them, though, on surfaces that are to receive a bonded overlay. If the concrete surface is to be coated, check with the coating and curing compound manufacturers to see if the two are compatible.

What precautions are needed to ensure good curing when a curing compound is used?

Use enough curing compound and apply it uniformly. The typical coverage is 200 square feet per gallon. It's best to use two applications at right angles to each other. Spraying is the fastest method, but brushes or rollers work for small areas.

Pigmented compounds or ones with fugitive dyes make it easier to see if the material has been applied uniformly. Uniform application eliminates bare spots and pinholes in the curing membrane.

20 N. Coburn Ave. ♦ Orlando, FL 32805-2198 ♦ (407) 841-2940 ♦ Fax (407) 839-1890 ♦ (800) 432-4746

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How does cold weather affect the choice of curing methods?

Avoid water curing during freezing weather. Water running out of heated enclosures freezes, causing an icing hazard. Water-cured concrete also is likely to be nearly saturated when protection is removed. This makes it vulnerable to damage caused by freezing. In cold weather you want to seal in mix water with a curing compound, plastic sheets, or waterproof paper. Then as hydration proceeds, internal water-filled voids will be partially emptied. When compressive strength reaches 500 psi, water in the voids will be reduced enough to prevent damage caused by freezing.

What special curing precautions are needed during hot weather?

Rapid drying of flatwork in hot weather causes surface cracking. Workers have to apply water, curing compounds, or coverings quickly after finishing to prevent plastic shrinkage cracking.

Immediate, continuous curing during hot weather also helps to prevent craze cracking. Early drying or intermittent wetting and drying is a chief cause of this kind of pattern cracking.

Water curing is preferred in hot weather. Effective methods include wet burlap covered with polyethylene or continuous water spray. For large areas of flatwork, curing compounds are more practical. White-pigmented compounds help keep concrete temperatures down because they reflect sunlight and reduce heat absorption by the slab.

Is leaving forms in place an adequate curing method for vertical surfaces?

Under most conditions, leaving forms in place is an acceptable curing method. Keeping the forms wet helps cool them to further reduce moisture loss. Contractors should weigh the cost of leaving forms in place for up to 7 days against stripping forms as soon as possible and curing by other methods.

Absorptive wooden forms left in place are not a satisfactory means for curing water containment structures during hot, dry weather. Loosen the forms as soon as possible so curing water can be run down inside them.

What curing methods are recommended for colored concrete?

Cure colored concrete with material recommended by the manufacturer of the dry shake color or coloring admixture. Color-matched curing sealers are widely used for flatwork.

Rule out any methods that may stain the concrete; moist earth, straw, and wet burlap. Running water or fog sprays are poor choices because they may stain the concrete or cause efflorescence. Plastic sheets and waterproof paper can cause a blotchy appearance because of uneven moisture distribution at the top surface. Even curing compounds commonly used for normal-colored concrete are likely to be unsightly until they wear off.

Is it always necessary to have some sore of moisture retention system?

ACI 308-81, Curing Concrete, says natural curing from rain, mist, high humidity, low temperature, or moist backfill is sometimes sufficient. Its effect must be at least the equivalent of keeping the concrete above 50° F and moist for the first 14 days with Type II cement, 7 days with Type I cement, or 3 days with Type III cement. Check project specifications to be sure they done specifically prohibit natural curing.

How do I cure stucco and rough surfaces?

To cure stucco, try using a hand sprayer and apply tow or three coats of water per day for 2 days. The required moistening frequency depends on the weather and the number of applied mortar coats. For rough-textured surfaces, apply the curing compound thicker than normal, at a coverage rate of about 100 square feet per gallon.

Is there a field test that tells whether or not concrete has been properly cured?

No field test lets you know if curing was done right. Strength tests of field cured cylinders can indicate curing affects, but cylinders differ from structural concrete members. They aren't compacted in the same way, and they have a different area-to-volume ratio that affects how fast they dry. So the same drying conditions may affect cylinders differently than they affect the structure.

Also, poor curing has its most pronounced effect on a thin layer of surface concrete. The lower quality of this layer might affect strength only marginally, but reduce durability considerably.

Color differences give a clue to curing effectiveness. Well-cured concrete is typically darker in color than poorly cured concrete. Color differences also are caused by differences in cements and admixtures, though, so color comparison is a crude method at best.

The best way to guarantee proper curing is by thorough inspection; making sure curing is started promptly, done correctly, and continued long enough. The effort is time-consuming but in this case an ounce of cure is worth a pound of prevention.