In part one of this article (Summer Issue 2014), we discussed the critical role proper concrete curing practices play in the longevity and performance of exterior concrete. Now, as the Upper Midwest looks ahead once again to cooler temperatures, we’re focusing part two of our series on the importance of concrete curing—the challenges associated with new variables presented by the advent of winter, proper placement and finishing procedures, and considerations for late-fall curing.

Ironically, many industry practitioners think curing is only necessary for the attainment of design strength; however, it’s critical to both the short- and long-term performance of exterior concrete.

What is concrete curing?

According to Dr. Peter C. Taylor, associate director of the National Center for Concrete Pavement Technology and author of “Curing Concrete,” curing is generally defined as “actions taken to maintain moisture and temperature conditions in a freshly placed cementitious mixture to allow hydraulic cement hydration and pozzolanic reactions to occur so that the potential properties of the mixture may develop.” Most of the critical performance properties for early-age exterior concrete are actually related to the paste development within the upper 30 mm (1.2 inches) of the concrete member.

The real costs of proper curing can be relatively low when compared to the performance benefits it provides, namely the preservation of the mix’s design durability and longevity. Simply stated, you can pay now for proper curing, or you can pay in the near future for concrete replacement.

Cold-weather construction issues

1. It increases the rate of evaporation of water from the concrete’s surface, leading to plastic shrinkage cracking.
2. In rapidly decreasing temperatures, the pore water can freeze, causing internal damage.
3. Colder temperatures greatly slow the rate of hydration of the cement (hydration essentially stops at 29°F).
4. Thermal shock related to rapid evaporation and temperature change once temperature protection is removed.
The importance of water and temperature

Water plays an essential role in the production and placement of cast-in-place concrete. Water is needed to hydrate the cement (water of necessity) and to assist in the placement process (water of convenience). At AET, we also understand the “Rule of 20” with respect to the speed of chemical reactions associated with the hydration of cement. For every 20°F increase in temperature, these reactions will occur twice as fast; for every 20°F drop in temperature, they occur half as fast. If a concrete placement occurs in colder temperatures and is not protected and/or heated, the delayed progress of hydration will significantly impact the timing of finishing, curing methods, heat-loss protection and length of time the curing should be conducted.

A normal time delay needs to occur between placement and finishing phases to allow the water of convenience to rise to the top of the concrete and evaporate away (termed bleed water). Colder temperatures delay this process significantly; an unsuspecting finisher could either seal off or work the bleed water back into the concrete surface, negatively impacting its strength and durability.

Cast-in-place concrete has pores, and although bleeding occurs, the pores typically retain water, which is available for continued hydration. Nevertheless, if temperatures prevent complete hydration from occurring, the saturated pores may cause freezing deterioration of the concrete’s upper surface.

Common curing challenges

Horizontal surfaces, especially exterior slabs, often present the most challenge given the large surface-to-volume ratio and the usual demand for these features to be serviceable as quickly as possible. Furthermore, these members are often placed at the tail end of a project, which generally occurs in the fall when weather conditions—low relative humidity, cooler temperatures and blustery winds—are less than ideal. (See sidebar for additional notes on cold-weather construction issues.)

Curing methods

There are two methods for curing exterior concrete: one includes the use of water; the other includes the use of a chemical compound.

Generally speaking, water curing for seven days is the most effective curing method, especially if the project schedule and weather permit. The benefits of a water cure include the maximization of the hydration reaction; the availability of water is essential to the hydration process—and a properly performed hydration process is key to reducing the potential for plastic shrinkage cracking. (In part one, we addressed the use of materials such as polyethylene, burlap and “barlene” covers to maintain the availability of water at the concrete’s surface.)

If the shape of the member (e.g., as in a vertical structure), weather conditions, time of the year, aesthetics, and final use of the placement do not allow for water curing, so a chemical compound may be used.

Chemical curing compounds fall into one of two categories of liquid membrane-forming chemicals under ASTM Specifications C 309 or C 1315. The distinction between the materials complying with C 309 is that these chemicals primarily provide curing properties during the early hardening stages of concrete, whereas materials consistent with C1315 also incorporate longer-term sealing characteristics, as well as alkali resistance, resistance to degradation from ultraviolet light, and non-interference with adhesion properties.

Curing benefit studies

The American Concrete Institute’s (ACI) “308R-01: Guide to Curing Concrete (Reapproved 2008)” extols the benefits of properly water curing exterior concrete. Below is a figure from Murdock, Brock and...
The availability of the water within the proper temperature range drives the hydration process to fill in the capillaries and pores in the upper portion of the placement.

**Late-fall considerations**

ACI and other experts indicate that newly placed concrete requires 21 days to air-dry after water curing. If the advent of colder weather doesn’t allow for this critical step, decisions must be made regarding the use of a chemical compound.

Dr. Kim Basham of KB Engineering suggests there are two options:

1. Use a penetrating water-repellent product such as silane and siloxane. These materials are breathable, plus their hydrophobic properties restrict the ingress of water molecules and deicers, providing added protection for the advent of winter weather.
2. In accordance with ACI 308R-15, select a combination curing and sealer product meeting the C1315 specification, which ACI recognizes as breathable.

Furthermore, to avoid the use of deicers during the first winter season experienced by the exterior concrete, it is highly recommended to simply broadcast sand for better traction.

As always, the use of proper curing techniques is highly dependent upon construction planning and its ability to accommodate special performance needs of exterior concrete design. Too often, planning is ignored for reasons of costs, schedule and weather constraints. However, giving full consideration to proper curing techniques is key to a successful project—one that will withstand the test of time for years to come.

Look for Part Three in our spring 2015 issue.
AET UPDATES

New Employees July - October
Denise Anderson  Kathryn Kalman
Esrom Belete  Joshua Koenig
Liang Chow, EIT  Sasha Lee
Shawn Dedeker  Stephanie Massignan
Christopher Diers  Brady Mensing
Matthew Friedman  Ryan Menter, PE
Colton Froehlich  Ronda Sells
Bryan Hadley  Walter Slack, PE
Alexander Ignatenco  Matthias Welter
Benjamin Jessen  Marcus Williams
Megan Hoppe, PE, returned to AET as a Senior Geotechnical Engineer in October. Welcome back!

During this time we also hired 8 interns—welcome!

Promotions and Certifications
Bob Elliott – VP Environmental Technical Services
Jim Miller – Manager, Albertville Office
Robert Temme – VP West Region

AET in the News
Gail Cederberg, PhD, principal in AET’s Environmental Services Division, has committed to serving another term as co-chair of the Midway Chamber of Commerce’s Economic Development Committee.

The AET Community Care Challenge is happening now! Throughout the challenge (Nov. 17 - Dec. 12), AET will host a series of on-site events to raise money and collect food for local charities. Please consider donating to our cause at http://www.crowdrise.com/AETCommunityCareChallenge.

Employee Spotlight – Doug Trangsrud
Doug Transgrud rejoined AET this past summer as manager of the firm’s St. Paul Construction Services Department.

As such, Doug relies on a diverse mix of experience—ranging from commercial buildings to transportation infrastructure— to keep projects on track. Doug previously worked at AET from 2005 to 2006. He is in the process of relocating from Rochester. We are very pleased to welcome Doug and his family back to the Twin Cities.

See Us at These Upcoming Events
University of MN Concrete Conference
Dec. 4 – Brooklyn Center, MN
MAPA Annual Meeting
Dec. 10-12 – St. Louis Park, MN

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