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ACI PRC-213.1-24
TechNote

Curing Efficiency of Internally Cured Concrete—TechNote

Keywords: curing compound; curing duration; degree of hydration; internal curing; lightweight aggregates; supplementary cementitious materials; wet burlap curing.

Introduction

Curing is important to develop strong and durable concrete (ACI PRC-308). Curing promotes the hydration of the cement and the reaction of the supplementary cementitious materials (SCMs) (ACI PRC-308; Taylor 2013). Curing historically consists of supplying water through wet fabrics (for example, burlap) or minimizing the water loss through the use of curing compounds (ACI PRC-308; Taylor 2013; Hajibabaee et al. 2018).

Internal curing (IC) provides a supplemental method that can be used to cure concrete. IC typically consists of partially replacing the fine aggregates with an equivalent volume of prewetted fine lightweight aggregates (FLWAs) or superabsorbent polymers (SAPs). The FLWAs or SAPs serve as the internal water reservoirs for curing (ACI PRC-(308-213); Kovler and Jensen 2007; Bentz and Weiss 2011; Weiss and Morian 2017).

IC improves bridge deck concrete by reducing early-age cracking, which enhances the durability and sustainability of concrete infrastructure (Bentz and Weiss 2011; Roberts et al. 2012; Barrett et al. 2015; Rupnow 2015; Carpenter 2019). While projects have been constructed using internally cured concrete, most of this work has used conventional curing (Rao and Darter 2013). A relatively limited amount of this work has focused on how IC impacts the construction processes (Roesler et al. 2014). Most notably, limited work has been performed to evaluate whether the duration of external curing can be reduced without loss of performance when IC is used. If IC can result in reduced external curing time, this may provide the state highway agencies (SHAs) with a tool to reduce the time of construction and the inconvenience to the traveling public and to improve safety for the construction workers in work zones (Huebschman et al. 2003; Guo et al. 2014).

This TechNote describes a process for determining equivalent curing durations for concrete made using conventional external curing and IC using prewetted FLWAs in ordinary portland cement (OPC) and SCM systems (Bouchelil et al. 2022). A steel trowel was used to screed and finish the sample surface. In this process, equivalent performance is defined by the depth of the curing-affected zone (CAZ). The CAZ is the thickness of concrete near the surface that can be impacted by external curing measures (that is, the skin of the concrete, approximately 0.2 to 1.2 in. [5 to 30 mm]) (ACI PRC-308; Cather 1992; Khanzadeh Moradllo et al. 2018). However, the impact of the surface finishing method on the CAZ was not examined. The criteria presented offer one approach that can be used to determine the duration of external curing that is equivalent to internal curing. This would allow any benefits of using internally cured concrete on construction time to be quantified.

Question(s)

Does internal curing impact the duration of external curing that is needed? If so, how much of a reduction in conventional external curing may be expected when internal curing is used?

Answer

The curing of concrete is aided with IC. As such, IC appears to be able to reduce the duration of external curing that is needed. The internally cured mixtures reduce the depth of the CAZ in some cases, especially in the samples with limited external curing durations (reduction of up to 0.6 in. [15 mm]). The application of IC in OPC and OPC-fly ash (FA) mixtures reduces the duration of external curing by approximately 50%. The silica fume (SF) mixture with low water-cement ratio (w/c) does not show this substantial decrease in curing time. For instance, whereas 14-day wet burlap may be specified on a bridge deck, 7 days of wet burlap with IC can provide the same level of performance. This may provide one option to address the construction schedule. The recommendation is limited to the mixtures reported in this TechNote.

Discussion

A variety of test methods have been used to assess curing efficiency by either measuring moisture/moisture loss or surface/near-surface physical properties. Jensen and Hansen (1995) proposed the use of a novel curing sensor that consisted of a capillary tube that is placed on the concrete surface. Relative humidity sensors have been implemented; however, large variability