RESEARCH
PROJECT CAPSULE
22-1C
February 2022
TECHNOLOGY TRANSFER PROGRAM

Influence of Internal Curing on Concrete's Permeability in Simulated Field Conditions

JUST THE FACTS:

Start Date:
January 17, 2022

Duration:
24 months

End Date:
January 16, 2024

Funding:
SPR: TT-Fed/TT-Reg – 6

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Sponsored jointly by the Louisiana Department of Transportation and Development and Louisiana State University

POINTS OF INTEREST:

Problem Addressed / Objective of Research / Methodology Used / Implementation Potential

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PROBLEM

State highway agencies (SHAs) have begun to implement more internally cured concrete (ICC) mixtures in the design and construction of pavements and structures. Implementation of performance-based specifications has prompted research to understand the impact of internal curing on concrete's transport properties (e.g., permeability). Indirect assessment of permeability is possible by testing for surface resistivity (AASHTO T358).

Figure 1. Comparison between concrete slabs poured with and without internal curing in field conditions

LTRC recently conducted a ruggedness study examining the impact of pre-wetted lightweight aggregates on resistivity, and the results showed that lightweight aggregates did not have a detrimental impact on resistivity for 28- and 56-day tests. However, the AASHTO T358 curing conditions require that concrete remains fully saturated at all times prior to testing. This curing condition can significantly obscure the real impact of internal curing and make it difficult to assess actual benefits. Figure 1 illustrates how internal curing can improve the cement hydration by keeping the slab saturated after setting.

This research proposes to simulate more realistic conditions by limiting the 100% relative humidity (RH) curing conditions to only the first 7 days. Afterwards, for each subsequent surface resistivity test (e.g., 14-, 21-, 28-, 56-day), the samples will remain in laboratory conditions (30-50% RH) until being saturated again for 48 hours prior to testing.

An additional test method, bulk diffusion (ASTM C1556) is proposed to validate the results from the resistivity tests. Lastly, the use of internal RH sensors are proposed to monitor the concrete's degree of hydration over time.

OBJECTIVE

The objective of this study is two-fold. The first objective is to assess the influence of internal curing on concrete's transport properties using appropriate curing conditions. The second objective is to validate the surface resistivity results with bulk diffusion testing.

METHODOLOGY

To accomplish the objectives of this study, the research team will first perform an extensive literature review to determine the current state-of-practice and any research endeavors regarding internal curing and the assessment of concrete's transport properties.

Samples from a total of 12 concrete mixtures will be prepared, with the proposed experimental factorial shown in Table 1. Materials selected for these mixtures will be representative of those commonly used in Louisiana. To evaluate the influence of internal curing, two sample sets will be used: one set will be cured in a 100% RH moist room continuously prior to testing at various ages (7, 14, 21, 28, 56 days), while the other set will be cured for only the first 7 days in a 100% RH moist room, tested at 7 days, then maintained in laboratory conditions (30-50% RH) until return to 100% RH moist room 48 hours prior to subsequent testing at 14, 21, 28, and 56 days. Internal RH will be monitored after the initial 7 days of curing using an approach based on ASTM F2170, a procedure for taking internal RH measurements from concrete floor slabs.

Table 1. Proposed experimental factorial

Factor	Levels	Description
w/cm	2	0.35, 0.45
Total Cementitious Content	1	575 lbs/yd^3
LWA Dosage	2	0, 250 lbs/yd^3
Cementitious Combinations and Mixture ID	3	-100% Type I cement (100TI) -70% Type I cement and 30% Class C fly ash (70TI-30C) -50% Type I cement and 50% slag (50TI-50S)
Super Plasticizer Dosage	1	-13 oz/cwt @ 0.35 w/cm -5 oz/cwt @ 0.45 w/cm
Curing Conditions	2	-7-day 100% RH followed by 21 Days of Lab Environment (C7) -28-day 100% RH (C28)

Statistical analyses will be performed to evaluate the influence of internal curing on concrete's strength and transport properties. The data will be analyzed for correlations between the bulk diffusion and surface resistivity results. Results and findings from this study will be included in a final report.

IMPLEMENTATION POTENTIAL

The results on this study will provide a better outlook on the potential benefits of ICC. The results will provide DOTD with further guidance on expanding the use of ICC in structural concrete for increased durability.