Timely and Uniform Application of Curing Materials

Objectives

- Observe and record how uniformly the curing materials are applied
- Document how curing compound application times and coverage relate to the development of distress
- Develop a measurable methodology to establish optimal times and assess uniform application

Benefits

- Establish a methodology that can be used for quality control, capable of measuring and monitoring the effectiveness of MFCC in the field
- Extend the service life of concrete

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Background

Concrete curing using Membrane Forming Curing Compound (MFCC) is widely used bystate transportation departments, due to less maintenance and low cost compared with water curing or covering with plastic sheeting. However, there is no existing method for quantifying or systematically evaluating the quality or effectiveness of curing in the field.

Many specifications rely on the curing application rate, which is the quantity of curing compound that can be applied on a specific surface area of concrete pavement. For some other states, the acceptance of the curing compound application depends on the inspector experience and quality standards such as uniform coverage compared to white paper sheet. Therefore, this study is exploring ways to provide a methodology that can be used as quality control, capable of measuring or monitoring the effectiveness of MFCC applications in the field.

Methodology

Laboratory testing provided anticipated baseline concrete performance for a variety of potential environmental conditions. Four field sites were assessed during the 2023 and 2024 construction season. The laboratory portion evaluated moisture loss and surface hydration for a wide range of simulated environmental conditions, quality of MFCC application, and timing. A new technique of embedded resistance was developed to assess the differences between the cure-affected zone and the bulk or interior of the concrete.

Field test construction on WIS 15

The field portion of the research involved simple observations of construction timing and measures of how much MFCC was applied along with chilled mirror humidity profiles, shrinkage, ground penetrating radar (GPR), and joint activation and movement assessment. The Evaluation Index (EI) parameter was utilized and showed that the optimum application rate can be determined from the

"Results from this study showed that sufficient application rate is more important than uniformity for most environmental conditions. Application rate and timing can be controlled in the field and were highly correlated to shrinkage, joint activation, and slab movement."

– Tirupan Mandal, WisDOT

anticipated weather conditions and that real-time monitoring using a weather station, relative humidity, and embedded resistance can confirm the applied MFCC is producing the desired concrete conditions. Finally, GPR can be used to confirm complete coverage.

Results

Results from laboratory tests showed that for most environmental conditions, having sufficient MFCC but non-uniformly applied is more beneficial than insufficient and uniform coverage. However, at the highest evaporative conditions both coverage rate and consistency are important. Results also show that when MFCC is applied too early, when significant bleed water is present, the long-term evaporation rate is much higher due to dilution of the MFCC. Also, the concrete tested at 0.5 inches below the surface was agnostic to environmental conditions, supporting definition of the cure-affected zone as between 0.5 inches and the surface.

The field results show that application of MFCC is highly variable, and the rate and timing can be controlled in the field and were highly correlated to shrinkage, joint activation, and slab movement. For the observed construction projects, the rate of paving varied between three feet per minute up to eight feet per minute. The curing cart speeds varied from 50 feet per minute to 100 feet per minute with most operational speeds around 75 feet per minute. For three of the sites, tining and curing operations occurred at the same time with the US 53 being the lone site where these operations were performed separately. Since the speed of the curing cart is so much greater than the paving operation, the curing cart operates for short bursts of activity. On average the curing cart operator allowed a gap of 100-200 feet to develop between the texture cart and the curing cart before applying the MFCC, with the texture cart approximately 50 feet behind the paver.

Recommendations for Implementation

Based on the results, the research team made several recommendations:

- Since time and rate of application of MFCC influence concrete properties, take the first 300 feet of the day to calibrate the speed of the application rate and adjust the bar height to ensure proper overlap. This improves uniformity and integration of the curing application as well as saw-cutting operations and joint activation.
- Conduct further research on chilled mirror-based technology to monitor internal humidity and rates of evaporation. Other sensor technologies such as time domain reflectometry also have potential for this application.
- Consider the use of GPR and GPS technologies for the paving operation to establish a fixed time window for texturing and curing operations.

Interested in finding out more?
Final report is available at:
WisDOT Research website

This brief summarizes Project 0092-22-03
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