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Improving Concrete Pavement Curing

tech transfer summary

RESEARCH PROJECT
Investigation into Improved Pavement Curing Materials and Techniques

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KEY WORDS
concrete layer uniformity—concrete pavement properties—curing materials and techniques—degree of hydration—electrical conductivity—maturity—microstructure development—moisture content—permeability—sorptivity—temperature

Objectives

- Evaluate the effect of different curing materials and techniques on concrete pavement properties.
- Better understand the relationships between various concrete test measurements and concrete properties affected by curing.

Problem Statement

Curing of concrete is important for concrete pavement durability. Adequate curing can help

- ensure the uniformity of the concrete layers
- control moisture and temperature conditions, both of which promote cement hydration and concrete microstructure development
- prevent or minimize random cracking in concrete pavements during the first few days after construction

A variety of curing materials and techniques are available for use in concrete pavement construction. Spraying of a liquid, membrane-forming curing compound is a commonly used curing method. Curing compounds are generally economical, easy to apply, and maintenance free.

However, little is known about how different curing materials and techniques affect the properties of concrete layers. Reliable standard testing procedures are needed to evaluate the effectiveness of different curing methods.

Research Methodology

Different curing materials and application techniques were selected and evaluated in the lab and field.

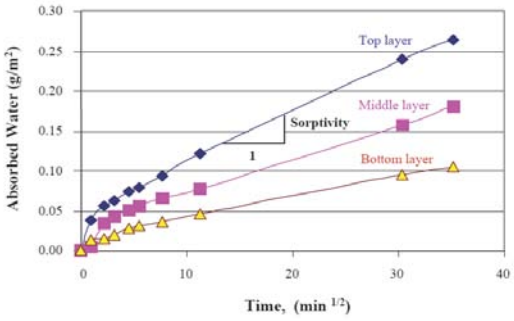
In the lab investigation, three curing compounds were applied to mortar specimens at three different times after casting using single- and double-layer applications. Electrical conductivity, moisture content, sorptivity, and degree of hydration tests were performed at different depths of the specimens. Flexural and compressive strengths were also tested.

In the field investigation, three curing compounds were applied to recently placed concrete using two different application rates. Electrical conductivity, temperature-maturity, and rapid chloride permeability tests were performed at several locations.

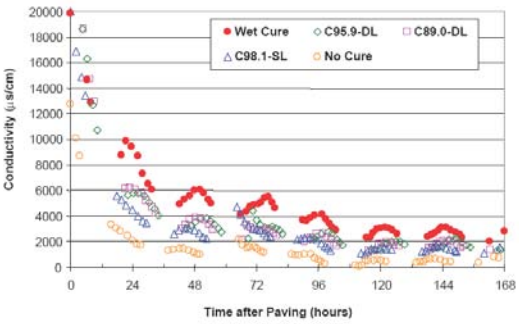
Statistical analysis was used to examine the relationships between these concrete properties as affected by curing.

Key Findings

- Concrete property values vary considerably with depth. Regardless of curing method, properties of the near-surface layer of concrete (such as moisture content, sorptivity, degree of hydration, and permeability) differ from those of the internal concrete.
- Adequate curing can provide concrete pavement with more uniform properties throughout its depth. Application of a curing compound significantly increases moisture content and degree of cement hydration and decreases sorptivity of the near-surface layer, which reduces the differences in concrete properties between the near-surface layer and internal concrete.
- For given concrete materials and mix proportions, the optimal curing compound application time depends primarily upon weather conditions.
- If a sufficient amount of a high-efficiency-index curing compound is uniformly applied, double-layer application is not necessary.
- Of the test methods applied in the lab study, the sorptivity test proved to be the most sensitive for evaluating the subtle changes in near-surface-layer concrete properties related to microstructure caused by different curing methods. Sorptivity measurements of the near-surface layer of concrete demonstrate a close relationship with moisture content and degree of hydration. Because of the close relationship, the sorptivity of concrete in the field might be estimated from moisture content and degree of cement hydration measurements, but further research is needed for application of the sorptivity test method for field concrete specimens.
- In the field, the electrical conductivity tests demonstrated the differences among concrete pavements treated with different curing methods.
- Rapid chloride permeability tests demonstrated the property differences between layers of concrete. However, permeability, strength, and maturity tests did not provide adequate evaluation of the subtle changes in the near-surface layer of concrete provided by different curing methods.



Typical concrete sorptivity test results



Average electrical conductivity of top layer of concrete treated with different curing methods in the field

Implementation Benefits

Adequate curing helps ensure that concrete achieves and maintains its designed properties by ensuring the uniformity of the concrete layers. Curing can help control moisture and temperature conditions, both of which promote cement hydration and concrete microstructure development. Curing can also help prevent or minimize random cracking in concrete pavements during the first few days after construction.

Implementation Readiness

This research has provided useful insight into the relationships between curing methods and concrete properties and has established a baseline for further development of testing procedures for evaluating curing materials and techniques.