Updates from the States: South Dakota (June 2015)

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The South Dakota Department of Transportation conducts research to improve transportation technology. Specific goals include evaluation of new materials and methods, development of design and analysis techniques, and study of underlying causes of transportation problems. The research effort addresses topics considered most important to the Department's mission of providing a transportation system for the state of South Dakota. Some of the responsibilities include developing annual research programs, administering contract research, conducting in-house research, and advising other SDDOT offices. The majority of SDDOT research is done through contracts with universities and other research partners.

A list of South Dakota’s current and past research projects may be found by clicking here.

Recently Completed Research

Jointed Plain Concrete Pavement Design and Construction Review
This project (SD-2008-06) involved a broad review of South Dakota’s Jointed Plain Concrete (JPC) practices to identify possible changes to current practices that would have beneficial results. The work included a review of joint designs (spacing & sealant), use of dowel bars (size, number, and distribution), the amount and type of curing compound, and work on concrete mixture optimization.

The project included field evaluation of newly constructed JPC pavement sections, construction of JPC test sections, and laboratory analysis of concrete mixtures. A new laboratory technique that involves measuring the “specific work” of fresh concrete was developed to compare the workability of different mixes.

The research resulted in the following conclusions:

- Pea rock exhibits poor freeze-thaw durability and should not be used in concrete mixtures.
- Increasing the top aggregate size from 1.0” to 1.5” enhanced the workability of the mixture.
- Increasing the curing compound to 1.5 times the normal application rate resulted in better pavement smoothness over time.
- Unsealed transverse joints exhibited significantly higher moisture ingress than joints sealed with silicone.
- High initial load transfer efficiency was achieved at joints with reduced dowel bar arrangements.
- Two concrete mixtures were developed that provide optimum performance with lower cost (i.e., less cement).

Mitigation of Corrosion in Continuously Reinforced Concrete Pavement
Between 1995 and 2009 the SDDOT replaced over 250 miles of two-lane interstate with continuously reinforced concrete pavement (CRCP). After being in service for less than 15 years, several of these pavement sections show signs of distress including Y-cracking, network cracking, and cluster cracking. The purpose of this study was to assess the extent and severity of corrosion in the CRCP, identify the factors that contributed to the corrosion, and investigate mitigation strategies to preserve pavement life.

The objectives were to determine the extent and severity of corrosion in SDDOT CRC pavements, identify contributing factors of the corrosion, and investigate cost effective maintenance or mitigation strategies to extend the life of the pavements.

The field work included general observations, crack mapping, core sampling, dust sampling, half-cell potential measurements, and concrete cover sampling at various sites. The laboratory work performed on samples collected from these sites included scanning electron microscope (SEM) analysis of reinforcement and potentiometric chloride testing of vertical dust samples.

General observations identified areas of severe spalling; however, severe corrosion was not observed. Vertical and lateral chloride profiles showed chloride concentrations above the threshold (1.244 lbs./yd3) in the top inch of pavement and within the first half inch of a crack, but concentrations were below the threshold at the level of reinforcing. SEM analysis generally showed limited-to-no signs of corrosion. A strong correlation between crack density and elevated half-cell potential measurements was identified. The results of this study show that observed pavement distresses are likely not the effect of corroded reinforcement and that reinforcement at cracked locations is the main area that is susceptible to corrosion caused by deicing salts.

The field testing of the mitigation products did not show any conclusive evidence that they reduce the corrosion of CRCP. Portions of the laboratory testing did show a reduction in corrosion in comparison to the control specimens, but for other types of specimens, no significant difference between the control specimens and specimens tested with sealers and migrating corrosion inhibitors were found.

Climate and Groundwater Data to Support MEPDG
The Mechanistic Empirical Pavement Design Guide (MEPDG) places a strong emphasis on the influence of climate conditions and groundwater on the prediction of pavement performance. This report compares pavement performance predictions using three different climate data sources.

The results of the study show that the groundwater table depth does not have a significant impact on pavement performance predictions with the current MEPDG software. However, determination of the stiffness and strength of highway base/subbase layer materials under different moisture content conditions is recommended.

Tolerances for Placement of Tie Bars in PCC Pavement
Ideally, tie bars are placed perpendicular to the joint, at the mid-depth of the slab with equal embedment lengths on both sides of the joint. However, post construction investigations of tie bar installations using ground penetrating radar in South Dakota pavements have revealed that many bars are misaligned or missing. A misaligned tie bar could inhibit the bar’s ability to provide load transfer across the joint and to prevent excessive joint opening. For this reason, several state DOTs have established specifications for tie bar placement tolerances, though there is little research available to determine whether those tolerances are appropriate. The goal of this project was to perform structural analysis to study the impact of tie bar placement and determine if SDDOT tie bar placement specifications are adequate.

The results indicate that vertical translation, vertical skew, and horizontal translation in excess of the tolerance allowed by the SDDOT did not cause significant adverse effects on the joint performance. However, horizontal skew in excess of 20 inches (approximately 33 degrees) resulted in reduced tie bar force and increased joint opening.

Research In Progress

Fiber Reinforced Concrete for Structure Components

Technological advancements in fiber reinforced concrete (FRC) offer possible solutions to many problems. Fibers have been used in concrete to control plastic shrinkage cracking and drying shrinkage cracking. Some type of fibers (micro fibers) are designed to produce greater impact, abrasion, and shatter resistance in concrete. There is some evidence that fibers increase the flexural strength and ductility of concrete, thereby enhancing moment resisting of structural steel reinforcement. The improved material properties of FRC tend to enhance the flexural and shear behavior of structures, making it an attractive material for numerous highway infrastructure component applications.

This project is intended to investigate recent product development, evaluate fiber products currently on the market, and generate guidance for application of FRC and specifications for use of fibers in concrete.

Additional Information

One point of interest is that the SDDOT has been utilizing Ground Penetrating Radar (GPR) to inspect tie bar location in the hardened concrete after PCC paving. SDDOT Materials Lab personnel perform a project's initial GPR inspection on tie bars within the first few days of production. If a project has few deficient tie bars, a single follow-up inspection will be performed later in the project. Between the two inspections, approximately 25%–40% of the tie bars are checked. If significant issues are found during the initial inspection, the project will be checked in its entirety or until issues are resolved.

To perform this inspection, the SDDOT utilizes two antenna mounted on an ATV (one on each side of the longitudinal joint). The data is recorded and viewed on-site. When an area needs a closer look, the more versatile push cart GPR or hand-held GPR units are used. Issues that need immediate attention are communicated to the project engineer. The recorded information is later analyzed in the office, put into report form, and delivered to the project engineer.

Common tie bar placement deficiencies found include: missing bars, bars too close to transverse joints, bars that are too shallow or too deep, and bars that have shifted horizontally.

For additional information on SDDOT's tie bar placement requirements and inspection process please contact Darin Hodges.

About the CP Road Map E-News

The ***CP Road Map E-News*** is the newsletter of the Long-Term Plan for Concrete Pavement Research and Technology (CP Road Map), a national research plan developed and jointly implemented by the concrete pavement stakeholder community. To find out more about the CP Road Map, or to get involved, contact Steve Klocke, 515-964-2020.

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