Updates from the States: Iowa (January 2015)

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Concrete pavement research for the state of Iowa is accomplished through research programs run by the Iowa Department of Transportation (Iowa DOT) Research and Technology Bureau, and guided by the Iowa Highway Research Board (IHRB). Pavement research is conducted in-house at the DOT and through various partnerships.

The DOT often partners the University of Iowa, Iowa State University, and the University of Northern Iowa in order to accomplish research goals. The Institute for Transportation (InTrans) and the National Concrete Pavement Technology Center (CP Tech Center) at Iowa State University are actively involved with Iowa DOT through DOT-University partnerships on a number of concrete pavement research efforts. Iowa DOT is also actively involved in many Transportation Pooled Fund (TPF) projects associated with concrete pavements. TPF projects include state partnerships that bring together a group of people interested in accomplishing research on the same topic as well as several other state DOTs, academic research centers (such as the CP Tech Center), industry agencies, and the federal government.

Recently Completed Research

Optimizing Pavement Base, Subbase, and Subgrade Layers for Cost and Performance of Local Roads

This report describes test results and comparative analysis from 16 different PCC pavement sites on local city and county roads in Iowa. At each site, the surface conditions of the pavement and foundation layer strength, stiffness, and hydraulic conductivity properties were documented. The field test results were used to calculate the in situ parameters used in pavement design methodology (AASHTO 1993). Overall, the results of this study demonstrate how in situ and lab testing can be used to assess the support conditions and design values for pavement foundation layers and how the measurements compare to the assumed design values.

The Pavement Condition Index (PCI) prediction model developed from multi-variate analysis in this study demonstrated a link between pavement foundation conditions and PCI. The model analysis shows that by measuring properties of the pavement foundation, the engineer will be able to predict long term performance with higher reliability than by considering age alone. This prediction can be used as motivation to control the engineering properties of the pavement foundation for new or re-constructed PCC pavements to achieve some desired level of performance (i.e., PCI) with time.

This project was completed by D. White and P. Vennapusa at the CP Tech Center at Iowa State University. Click here to read the full report.

This project is contributing to research objectives identified in CP Road Map Track 10: Concrete Pavement Foundations and Drainage.

Evaluating Roadway Subsurface Drainage Practices

The bearing capacity and service life of a pavement is affected adversely by the presence of undrained water

in the pavement layers. In cold winter states like Iowa, this problem is magnified further by the risk of frost damage when water is present. Therefore, well-performing subsurface drainage systems form an important aspect of pavement design for the Iowa DOT. However, controversial findings have been reported in literature regarding the benefits of subsurface drainage.

The goal of this research was to conduct an extensive performance review of primary interstate pavement subdrains in Iowa, determine the cause of the problem in drains that are not functioning properly, and investigate the effect of poor subdrain performance due to improper design, construction, and maintenance on pavement surface distresses, if any.

An extensive literature review was performed in addition to a field investigation on 64 pavement sites during the fall season of 2012. Statistical analysis was conducted on the compiled data from field investigations to further investigate the effect of drainage on pavement performance.

It was determined that most subsurface drainage system blockage in Iowa is due to sediment, soil, and tufa (calcium carbonate deposits). Few pavement surface distresses were observed near blocked subsurface drainage outlet spots. More shoulder distresses (shoulder drop or cracking) were observed near blocked drainage outlet spots compared to open ones. Both field observations and limited performance analysis indicate that drainage outlet conditions do not have a significant effect on pavement performance. The use of recycled portland cement concrete (RPCC) subbase in PCC pavements results in tufa formation, a primary cause of drainage outlet blockage in JPCP.

The report found that a primary cause of tufa formation is related to the use of RPCC subbase; however, locations which utilized blended RPCC and virgin aggregate experienced fewer blockages. The report also found that rodent guards on the ends of subdrain outlets tend to collect debris and cause blockages. Since there was very little evidence of rodent activity, the report recommends elimination of these guards.

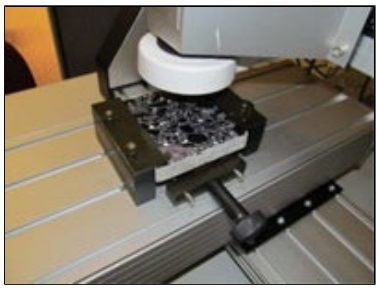
This report was completed by H. Ceylan et al. at the CP Tech Center at Iowa State University. Click here to read the full report.

This project is contributing to research objectives identified in CP Road Map Track 10: Concrete Pavement Foundations and Drainage.

Evaluation of the RapidAir 457 Air Void Analyzer

An adequate air void system provides freeze-thaw durability to concrete pavements; this is imperative in a wet freeze environment such as Iowa. Air content is tested in the plastic state with a pressure meter during construction to ensure conformance with construction specifications. Actual, in place, air content of some concrete pavements in Iowa have been found to have low air content. This may be due to a variety of factors such as excessive vibration or inadequate mixing.

Determining hardened air void parameters is a time consuming process involving potential for human error. The RapidAir 457 air void analyzer is an automated device used to determine hardened air void parameters. The device is used in Europe and has been shown to quickly produce accurate and repeatable hardened concrete air results.



This research investigated how well the RapidAir 457 results correlate to plastic air content and the image analysis air technique. The repeatability and operator variation were investigated, as well as the impact of aggregate porosity and selection of threshold value on hardened air results.

Based on the testing, it was found that the RapidAir457 air void analyzer is an excellent tool for obtaining hardened air void parameters in concrete. The results are accurate, repeatable, and far less time consuming than other methods.

This report was completed by Todd Hanson at the Iowa Department of Transportation. Click here to read the full report.

This project is contributing to research objectives identified in CP Road Map Track 1: Materials and Mixes for Concrete Pavement.

Ongoing Research

The Iowa DOT is sponsoring numerous research projects that are currently underway. Some of these include the following:

Alkali Content in Fly Ash Measuring & Testing Strategies for Evaluating Compliance: The primary objective of this project is to develop an improved procedure for rapidly determining the available alkali content of fly ash. This will help Iowa DOT Engineers avoid using high-alkali fly ash in projects that could be susceptible to ASR.

Development of a Wireless MEMS Multifunction Sensor System and Field Demonstration of Embedded Sensors for Monitoring Concrete Pavements: Wireless multi-sensor networks have the potential to monitor structural health, supporting efficient operation and maintenance of civil infrastructure through simultaneous measurement of multiple properties. The objective of this research is to develop a wireless MEMS multifunction sensor capable of real-time monitoring of strain, moisture content and temperature in pavement. Temperature data could alert construction staff to freezing or elevated temperatures. Measurement of strain could be used to estimate remaining fatigue life.

Impact of Curling and Warping on Concrete Pavement: The project will survey selected pavement panels under wet, dry, warm, and cold conditions, assessing load transfer between selected panels and their neighbors. This information will then be correlated with the pavement mixture, construction details, climate, and pavement performance to determine the amount of curling and warping considered acceptable.

Assessment of PCC Concrete Setting Time and Joint Sawing: This project seeks to establish a standard timeframe for contractors to begin sawing joints in slabs on grade, an issue which can lead to problems with raveling or cracking. The project will assess the suitability of three different approaches to evaluating when the concrete is at the prime sawing temperature and consistency – p-wave, i-button/maturity meter, and calorimeter. The project will also develop a protocol for implementing whichever method is the most cost effective.

Impacts of Internally Cured Concrete Paving on Contraction Joint Spacing: Internal curing is a relatively new technique being used to promote hydration of portland cement concretes. The application where this technology has not been investigated to any depth is in the area of pavements. It is believed that inclusion of about 20% to 30% lightweight fine aggregate will not only improve strength development and potential durability, but more importantly will significantly reduce shrinking and warping, thus reducing cracking risk, particularly in thinner pavements or those with relatively large panel sizes.

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.

Newsletter staff

- Steve Klocke, Snyder and Associates, Program Manager
- Dale Harrington, Snyder and Associates, Program Manager
- Sabrina Shields-Cook, Editor

The National Concrete Pavement Technology Center at Iowa State University provides operations support services to the CP Road Map program.

CP Tech Center
2711 S. Loop Drive, Suite 4700
Ames, IA 50010
Phone: 515-294-5798
Fax: 515-294-0467
Email: Program Management ~ Communications ~ Webmaster