2015-38TS
Published October 2015

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OFFICE OF TRANSPORTATION SYSTEM MANAGEMENT

TECHNICAL SUMMARY

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CONSTRUCTION PROJECT COST:
$113,300

RESEARCH COST:
$0

The Lightweight Inertial Surface Analyzer's lasers measure roughness, which indicates deterioration if it increases over time.

60-Year Concrete Design Performs Well in Early Tests

What Was the Need?

Concrete pavements designed to last for 60 years were first introduced in Minnesota about 15 years ago. Since then they have become a standard design for the busiest highways in the metro area. These 60-year pavements use high-quality materials and aggregates along with better construction techniques to extend pavement life over previous designs, which were typically intended to last 30 to 35 years. MnDOT hopes that 60-year pavements will reduce repair frequency and costs, and minimize the impact of repairs on traffic and travel times.

A test cell replicating the 60-year design features was built at the MnROAD research facility in 2008. Sensors were embedded in the pavement during construction to augment performance testing and strain monitoring.

Researchers conducted a series of tests on a MnROAD test cell of a 60-year concrete design. Stress levels within the pavement were significantly lower than in traditional 35-year designs at a similar point in their service life, which is strong evidence that the 60-year pavement will achieve its intended service life.

What Was Our Goal?

The goal of this project was to extrapolate the performance of 60-year concrete pavements based on data from a 7-year-old test cell at MnROAD.

What Did We Do?

Researchers used a variety of methods and tests to collect data about the pavement test cell, including the following:

- **Sensors** embedded in the pavement continually measure stresses within the pavement. Of particular interest to the pavement's durability are dynamic load response tests, conducted four times a year, in which the sensors measure stresses in the pavement while a five-axle tractor-trailer is driven on it.
- A **falling weight deflectometer** test collected dynamic load response data by dropping weights on the pavement and measuring strain responses.
- Fall and spring **distress surveys** evaluated cracking and spalling.
- A Lightweight Inertial Surface Analyzer measured the **International Roughness Index**, a measure of pavement smoothness and ride quality.
- Three ASTM tests measured **friction number**, an indicator of the pavement's skid resistance.
- An on-board sound intensity test measured **noise** from the tire-pavement interaction.
- The circular track meter test measured **surface texture**.
- Three **fault surveys** per year measured differences in elevation across pavement joints.

What Did We Learn?

After seven years, the test cell has shown no performance issues apart from those inherent in the original construction process. The small amounts of pavement distress observed were caused primarily by sensor installation rather than traffic or environmental factors. Stress levels within the pavement are significantly lower than those observed

continued

"The 60-year design includes a lot of small improvements over traditional concrete designs, including using the highest-quality aggregates, cement paste and dowel bars. Since these improvements add costs, we prioritize them for the busiest highways."

—Curt Turgeon,
Senior Administrative Engineer, MnDOT Office of Materials and Road Research

"By examining stresses in this pavement, we make tenable extrapolations of future performance based on the initial seven years of data. We project that this pavement should survive for quite a long time."

—Bernard Izevbekhai,
Acting Manager, Research Section, MnDOT Office of Materials and Road Research

Produced by CTC & Associates for:
Minnesota Department
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The FWD test consists of a loading plate, weight package, sensors and data acquisition equipment. Researchers drop the weight and measure deflection in each pavement layer to identify stresses likely to trigger eventual pavement failure.

in 35-year pavements at a similar point in their service life, which is strong evidence that the 60-year design will achieve its intended service life. Tests that are particularly indicative of the pavement's long-term performance include the following:

- The International Roughness Index has shown some small seasonal changes, but no significant change over time that might be caused by traffic loads. This is a strong indication that the pavement is not degrading.
- FWD tests showed no significant change in pavement deflection-under-load between tests conducted in 2009 and 2013. Additionally, the deflection in all cases was small—below 100 microns—which indicates that there is strong base and subgrade support for the pavement. Load transfer across joints was consistently excellent, with no significant change over time.
- Analysis of the FWD tests using the Evaluation of Layer Moduli and Overlay Design software calculated the elastic moduli of the individual concrete, base, subbase and subgrade layers. This analysis showed that deflections in all layers were small compared to what would normally trigger pavement deterioration.

Other tests also provided satisfactory results. Measured friction numbers were well above what is required for a safe pavement and did not decrease or increase significantly over time. Surface texture remained relatively constant under traffic, and the pavement generally experienced minimal depth of joint faulting. Noise levels were relatively high, but this is likely due to the transverse broom surface texture applied to the test cell.

What's Next?

One potential improvement to the 60-year pavement design that has been proposed is improved drainage of bases, which can help to reduce damage at concrete joints. Initial research has suggested that geocomposite joint drains may improve base layer drainage without making the base layer thicker; MnDOT has already implemented these into pavement designs.

The 60-year concrete design uses stainless steel-clad dowel bars to transfer loads across pavement joints. Since the design was introduced, several other high-performance dowel bars have been introduced. The performance and relative cost of these options may warrant further investigation.

Researchers will present the results of this study at the 2016 Transportation Research Board Annual Meeting.

This Technical Summary pertains to Report 2015-38, "Seven Year Performance Report on MnROAD High Performance Concrete Design Test Cell 53," published July 2015. The full report can be accessed at mndot.gov/research/TS/2015/201538.pdf.