



TECHNICAL SUMMARY

Technical Liaison:

Rich Sanders, Polk County
Sanders.Rich@co.polk.mn.us

Project Coordinator:

Farideh Amiri, MnDOT
Farideh.Amiri@state.mn.us

Principal Investigator:

W. James Wilde, Minnesota State
University, Mankato

LRRB PROJECT COST:
\$35,000



Carried via trailer, a falling weight deflectometer measures pavement response to loads.



RESEARCH SERVICES & LIBRARY

OFFICE OF TRANSPORTATION
SYSTEM MANAGEMENT

Putting Research into Practice: Improving the Evaluation of Pavement Structural Capacity

What Was the Need?

One method that engineers use to predict the durability of a pavement is to evaluate how it will flex under the weight of traffic. Such deflections can be measured using a falling weight deflectometer, which uses an instrumented circular plate to both transmit a large load to a pavement and measure its response. FWD data can then be analyzed to determine whether a pavement—given its thickness and expected traffic—is strong enough to last for its expected service life when subjected to traffic from vehicles up to a certain axle load, which is the weight applied to a pavement at its point of contact with the wheels.

MnDOT's Office of State Aid conducted FWD testing for about one-third of the County State Aid Highway system. It shares this data with counties via its FWD Viewer Tool, a spreadsheet that includes four methods for analyzing FWD data to determine a pavement's maximum allowable axle load. MnDOT provides each county with a unique version of this tool that includes only data for the county's roadways.

One of the methods of FWD analysis included in the tool, called TONN, was recently updated to TONN2010 to account for stresses on pavement subgrade layers and use mechanistic-empirical design to predict the resulting damage. Consequently, TONN2010 predicts load rating more realistically than its predecessor. An implementation project was needed to incorporate the TONN2010 method into the FWD Viewer Tool and to develop a training program for tool users.

What Was Our Goal?

The objective of this project was to update MnDOT's FWD Viewer Tool with the TONN2010 method for analyzing FWD data, improving the ability of county engineers and MnDOT pavement engineers to evaluate the allowable axle loads on roadways for which they are responsible.

What Did We Implement?

This project updates MnDOT's [FWD Viewer Tool](#) with a new method for analyzing FWD data, TONN2010, developed in [Project 2011-02](#).

How Did We Do It?

Researchers worked with the primary investigator who developed TONN2010, Lev Khazanovich. With the assistance of the MnDOT State Aid Office, they then acquired the data necessary for TONN2010 calculations from MnDOT and local agencies, including:

- Average annual daily traffic from MnDOT's Traffic Data Analysis Group.
- Subgrade soil type, pavement and base layer thickness, and soil type from county engineers.
- The average daily temperature for the day prior to FWD testing from the Minnesota Climatology Working Group.

This project updated MnDOT's FWD Viewer Tool with an improved method for analyzing falling weight deflectometer data, allowing engineers to make more accurate estimates of the structural capacities of pavements.

“The updated FWD Viewer Tool provides users with a better comparison of various FWD analysis methods, giving engineers a better sense of which method is better-suited to a particular circumstance.”

—**Rich Sanders,**
Highway Engineer,
Polk County

“By improving engineers’ ability to evaluate the allowable axle loads on pavements, the updated FWD Viewer Tool will help agencies make the most cost-effective use of their resources.”

—**W. James Wilde,**
Professor, Minnesota
State University, Mankato,
Department of
Mechanical & Civil
Engineering

Produced by CTC & Associates for:

Minnesota Department
of Transportation
Research Services & Library
MS 330, First Floor
395 John Ireland Blvd.
St. Paul, MN 55155-1899
651-366-3780
www.mndot.gov/research



Photo by Raymond Wald

MnDOT uses FWD data to determine the strength and stiffness of pavement layers and to help set vehicle axle limits on some roads.

- Number of lanes and locale from the MnDOT State Aid website in the County State Aid Highway Segment Reports section.

Because the TONN2010 computation routine can be time-intensive, researchers conducted a TONN2010 analysis of all 370,000 statewide FWD tests in the FWD Viewer Tool database. Then they preloaded each county’s version of the tool with preprocessed data for their county, reducing computation time when using the tool.

Researchers then compared the TONN2010 analysis method to other analysis methods that have been used to analyze pavements and determine their appropriate allowable axle loads, including the AASHTO, TONN, INV-183 and Soil Factor methods.

Finally, researchers developed training materials for the updated FWD Viewer Tool, to reflect its inclusion of both TONN2010 and a module (developed as part of a separate effort, [Project 2014RIC14](#)) for predicting the load ratings of pavements after the addition of a structural overlay.

What Was the Impact?

The comparison of FWD data analysis methods showed that TONN was sometimes the least conservative method, calculating higher allowable axle loads for more roadways, and that the INV-183 was often the most conservative, with the TONN2010 method lying in between. For example, where TONN2010 calculates that 10 percent of FWD test locations show an allowable axle load of 10 tons or less, INV-183 predicts this load rating for 30 percent of locations, and TONN for 7 percent. The final report includes graphs of distribution curves comparing these methods using data from 250,000 FWD tests conducted between 2009 and 2010.

Training materials developed by researchers include a PowerPoint presentation, installation instructions, case studies and a troubleshooting guide. The program contains sections on the tool’s operation as well as basic technical background for the TONN2010 method and how it is used in the FWD Viewer Tool.

What’s Next?

As part of a separate effort, Project 2014RIC14, researchers delivered the training developed in this project to engineers throughout the state. With the improved FWD Viewer Tool, engineers can more accurately estimate the structural capacities of pavements.

This Technical Summary pertains to the LRRB-produced Report 2014RIC16, “Implementation of TONN2010,” published February 2014. The full report can be accessed at <http://www.lrrb.org/PDF/2014RIC16.pdf>. The research being implemented via this project can be found mainly in the LRRB-produced Report 2011-02, “Allowable Axle Loads on Pavements,” published December 2010. This report can be found at <http://www.lrrb.org/PDF/201102.pdf>.