



TECHNICAL SUMMARY

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IMPLEMENTATION PROJECT COST:

\$105,000



An LWD repeatedly drops a mass on a loading plate in contact with the ground to estimate its stiffness.



RESEARCH
SERVICES SECTION

Putting Research into Practice: Using the DCP and LWD for Construction Quality Assurance

What Was the Need?

For a highway to perform well over the long term, its soil and aggregate layers need to provide a stiff, stable foundation. Mn/DOT standards require inspections during construction to ensure that pavement foundation materials have been compacted enough to ensure this condition.

The sand cone test, which measures the density at a single point in a subgrade or base lift, has been used for many years to confirm an inspector's visual inspection. This test can take more than an hour and includes a laboratory component, which pulls the inspector away from observing construction at the site. New methods to replace this test have been developed that are quicker, can be performed entirely on-site and allow more flexibility by contractors so that construction doesn't have to stop for testing. These new methods are safer for inspectors because less time is spent kneeling near traffic at construction sites.

These new methods use devices that accurately measure in-place soil parameters such as stiffness and strength. These properties provide a more representative picture of a pavement's ability to handle traffic loads than laboratory density measurements, and they allow direct verification of the soil values used during pavement design. Since 1997, Mn/DOT has had a standard for using dynamic cone penetrometers; DCPs test soil strength by driving a metal cone into the ground with repeated drops of a weight. Now, Mn/DOT is also implementing light weight deflectometers, which determine stiffness by measuring the deflection of the ground induced by a dropped weight. Standard, robust LWD and DCP specifications are needed to enable effective transfer of these technologies around the state.

What Was Our Goal?

The objective of this implementation effort was to develop Mn/DOT-approved specifications for using the DCP and LWD in construction quality assurance: to determine the correct placement of the subgrade, granular fill, subbase and base materials.

What Did We Implement?

This project leveraged previous research sponsored by Mn/DOT and LRRB. One primary resource was Report 2006-20, "[Validation of DCP and LWD Moisture Specifications for Granular Materials.](#)" which validated the use of DCP and LWD technology. By using these devices on laboratory-prepared pavement specimens, investigators found that the Mn/DOT DCP specification accurately assessed compaction quality and provided some suggestions for improvement.

To develop the specifications, project team members also drew upon two studies that addressed the effect of soil moisture on stiffness and strength: Report 2006-26, "[Moisture Effects on PVD and DCP Measurements.](#)" and Report 2007-11, "[Pavement Design Using Unsaturated Soil Technology.](#)"

How Did We Do It?

Investigators synthesized information from these reports to develop draft specifications and then composed a field test plan to validate the specifications. An Olmsted County project was selected in which DCP and LWD measurements as well as traditional density testing were used to determine compaction quality.

continued

“These new tools dramatically reduce inspection time for determining the compaction of soils and subgrade applications.”

—Lawrence Berkland,
Assistant County
Engineer, Steele County
(Former Technical
Liaison)

“We’re happy to be implementing a construction inspection system based on material properties—strength and stiffness—critical to pavement construction and performance.”

—John Siekmeier,
Mn/DOT Senior Research
Engineer

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A DCP estimates soil strength by measuring how far a driven metal cone penetrates the ground.

Investigators analyzed the resultant data to validate the draft specifications and test protocols, determining how many DCP and LWD drops should be performed, and how to incorporate factors such as the ground’s moisture content and material type into the analytical process.

What Was the Impact?

This project produced draft specifications that will encourage the adoption of these technologies, which is expected to result in lower life cycle costs for pavements, increased compaction uniformity and higher productivity due to automation. In addition, use of these tests allows increased inspector presence at the construction site and improved inspector safety, and encourages more complete documentation and reporting.

These specifications covered the use of DCP and LWD for granular materials and fine-grained soils as well as target values for the tests to encourage the construction of higher-quality roads.

What’s Next?

The draft specifications produced by this project will be further refined and incorporated into Mn/DOT’s *Standard Specifications, Grading and Base Manual* and the department’s *Geotechnical and Pavement Manual* as well as the inspector and technician certification classes already required for DCP and LWD use. As the benefits of these technologies become increasingly apparent, more and more counties and cities are expected to acquire these tools. LRRB and Mn/DOT have purchased several LWDs that are available for loan to counties and cities.

This project relates to a larger, ongoing Mn/DOT effort to implement intelligent compaction technology to ensure that Minnesota’s roads are constructed with the highest quality at the lowest cost possible. An assessment of these efforts was recently issued as [“Putting Research into Practice: Intelligent Compaction Implementation—Research Assessment”](#) (2008-22).

This Technical Summary pertains to the LRRB-funded report “Using the Dynamic Cone Penetrometer and Light Weight Deflectometer for Construction Quality Assurance,” published February 2009. The full report can be accessed at <http://www.lrrb.org/PDF/200912.pdf>.

The research being implemented via this project can primarily be found in LRRB-produced Reports 2006-20, “Validation of DCP and LWD Moisture Specifications for Granular Materials,” published July 2006; 2006-26, “Moisture Effects on PVD and DCP Measurements,” published June 2006; and 2007-11, “Pavement Design Using Unsaturated Soil Technology,” published May 2007. These reports can be accessed at <http://www.lrrb.org/PDF/200620.pdf>, <http://www.lrrb.org/PDF/200626.pdf> and <http://www.lrrb.org/PDF/200711.pdf>, respectively.