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RESEARCH
SERVICES SECTION

TECHNICAL SUMMARY

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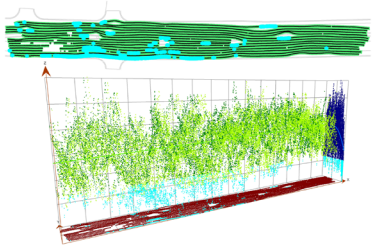
PROJECT COST:
$84,457



Users can visualize data in a number of ways, including a 3-D trend analysis showing compaction value data points along and across the plane of compaction.

Managing Intelligent Compaction Data

What Was the Need?

To provide a strong and uniform foundation for a pavement, underlying layers must be compacted by rollers. Since 2005, Mn/DOT has completed several demonstration, pilot and implementation projects designed to improve the use of intelligent compaction. IC involves using sensors to measure the vibrations of rollers, which can be correlated to soil stiffness during the compaction process, allowing operators to make real-time adjustments. Rollers are also equipped with Global Positioning System technology to map the measures and time of compaction to its location, and store this data for future use in forensic analysis, long-term pavement management and mechanistic-empirical pavement design.

IC-equipped rollers produce very large quantities of data. Further, the software provided by roller manufacturers to manage this data is proprietary and expensive, may change and does not always include the capabilities desired by Mn/DOT. Previous pilot projects encountered problems using proprietary software for quality control and quality assurance; Mn/DOT required software customized to its needs.

What Was Our Goal?

The goal of this project was to develop software and processes for storing, processing and visualizing the large quantities of data produced by IC-equipped rollers so that it could be used for quality control and assurance.

Researchers originally intended this software for quality assurance use in the field, but complexities led to a revision of this goal to create an office tool for data analysis. Researchers aimed to develop software to convert data from the formats provided by roller manufacturers to a universal format that could be imported into a graphical information systems database.

What Did We Do?

Investigators began by developing database structures for storing IC data, including values related to the vibration of roller drums, such as frequency, amplitude and speed, stiffness measurements, and the time and location of each measurement. The databases also included tables for storing other material properties, and the general characteristics of equipment, such as drum size.

Investigators then developed software to import IC data into this database structure to identify data that was not collected at the specified operating settings and to export the data into a GIS format as a GIS shapefile—a condensed data file that contains the information essential to interpreting geographic information and spatial data within a geodatabase, in this case, to create a color-coded visualization of the quality of compaction by creating a map of the compaction area.

Finally, the team created a manual covering use of the software and processes for importing, converting, validating, visualizing and conducting a geostatistical analysis of data.

What Did We Learn?

Researchers produced a software package for handling the vast amounts of data produced by IC. This package is currently capable of handling data produced by Caterpillar equipment, and with further modifications, it would be capable of handling data from other manufacturers' equipment. This would eliminate the need for Mn/DOT to pay proprietary software fees that can run as much as $40,000 per license.

continued

"This software gives us an excellent tool to review intelligent compaction data so that we can visualize uniformity and identify undercompacted areas, thereby improving the quality of compaction."

–Rebecca Embacher,
Mn/DOT Assistant Grading and Base Engineer

"Before this project, there was no standard output of IC data and no standard software to view it. We wanted a program developed in-house to use for any manufacturer's data, without having to pay exorbitant licensing fees."

–Lee Petersen,
CEO, CNA Consulting Engineers

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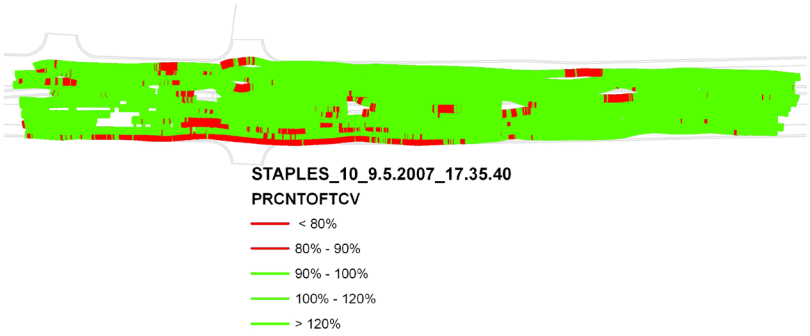

After loading data into GIS software, users can view and analyze compaction value data as it compares to target compaction values via color-coded maps of the compaction area. In this case, compaction areas meeting or exceeding the target value of 80 percent are coded green, and areas not meeting it are coded red.

The software gives researchers a way to visualize and analyze compaction results, allowing the evaluation of compaction process, the uniformity of compaction across a pavement foundation, and the identification of weak and strong areas. The software can be used to direct field personnel where to conduct quality assurance testing using in situ measurement devices.

This software will also help Mn/DOT refine its specifications for contractors, such as acceptable variations in stiffness and in grade and layer thicknesses. It is applicable to both bound and unbound materials.

The final report includes a handbook describing the software's target functionality, terminology, geodatabase structure and processes for filtering and importing data into geographic information system software.

What's Next?

Researchers presented their results at the 2010 Transportation Research Board conference and will use this software to analyze data from recent MnROAD projects.

This project is part of a larger, ongoing Mn/DOT effort to implement IC technology. Information about both completed and active projects can be accessed at http://www.dot.state.mn.us/materials/researchic.html.

This Technical Summary pertains to Report 2009-35, "Mn/DOT Intelligent Compaction Implementation Plan: Procedures to Use and Manage IC Data in Real Time," published December 2009. The full report can be accessed at http://www.lrrb.org/PDF/200935.pdf.