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OFFICE OF TRANSPORTATION SYSTEM MANAGEMENT

TECHNICAL SUMMARY

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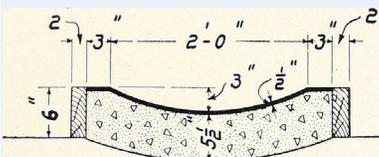
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Principal Investigator:

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PROJECT COST:

\$89,989



Use of mechanistic-empirical design will allow for thinner pavements that save on costs without compromising performance.

MNPave Rigid Brings Mechanistic-Empirical Design to State and Local Roads

What Was the Need?

In 2002, AASHTO published the Mechanistic-Empirical Pavement Design Guide. This guide and accompanying software updated AASHTO's 1993 Guide for Design of Pavement Structures, in which pavement design methods relied on limited data from AASHTO road tests conducted in the 1950s. The MEPDG improved on the previous method by relating the mechanical causes of pavement distress, such as cracking, to extensive empirical data on pavement performance. By inputting various design parameters concerning a pavement's structure and materials as well as information about expected traffic and climate conditions, engineers can use mechanistic-empirical design to estimate the damage a pavement will sustain over time.

The software developed in this project will make mechanistic-empirical design for concrete pavements more accessible to state and local engineers, allowing them to design pavements that save on costs while maintaining performance.

Because of the complexity of MEPDG, which can involve a time-consuming process of specifying a very large number of inputs, state departments of transportation have been focused on making the methodology more accessible to state and local engineers. To do so, they have developed state-specific software that assists engineers with inputs by incorporating state-specific environmental conditions and design methods. In Minnesota, state and local engineers use MnPAVE Flexible for the mechanistic-empirical design of asphalt pavements. However, until recently they did not have a similar tool for concrete pavements and relied on a program called RigidPave that uses AASHTO's outdated 1993 design procedures.

What Was Our Goal?

The goal of this project was to create a mechanistic-empirical software tool for designing concrete pavements in Minnesota by adapting AASHTO's MEPDG to Minnesota conditions.

What Did We Do?

Researchers began by determining which version of MEPDG software to use as the foundation for the design software. A number of versions of MEPDG software have been produced over the years, each with its own advantages and limitations. Researchers compared the performance of these versions for a series of identical concrete pavement construction projects. Because of problems with and lack of documentation for the latest version, DARWin-ME, they chose to work with MEPDG 1.1, released in 2009.

Then researchers established a simplified set of design inputs—such as design life, climate, traffic and concrete thickness—relevant to Minnesota engineers. To do so, they conducted three rounds of sensitivity analyses in which they performed 20,000 MEPDG project runs (generating performance estimates from design inputs) using data from Minnesota concrete pavement projects. These runs, which also used Minnesota climate and traffic data, allowed researchers to establish which design parameters were both important to Minnesota pavement engineers and influential on the software's performance models.

Finally, using selected inputs, data from Minnesota concrete pavement projects and MEPDG version 1.1, researchers generated a database of 11,000 concrete pavement

“MnPAVE Rigid is a new approach to designing concrete pavements and one that gives state and local engineers a user-friendly way to use mechanistic-empirical design.”

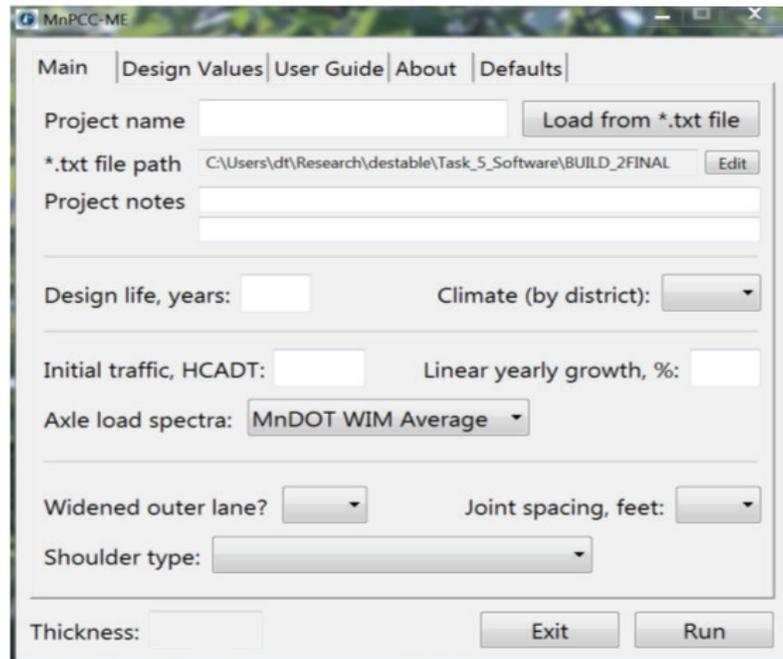
—**Luke Johanneck**,
Research Project Engineer,
MnDOT Office of Materials
and Road Research

“This was a strongly collaborative project, with engineers at MnDOT helping us customize the MnPAVE Rigid software to their needs.”

—**Lev Khazanovich**,
Associate Professor,
University of Minnesota
Department of Civil,
Environmental, and
Geo-Engineering

Produced by CTC & Associates for:

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MnPAVE Rigid allows users to modify a manageable number of inputs, while defaults for advanced parameters are preset using a database of thousands of MnDOT pavement projects.

projects whose characteristics and performance would be used to represent Minnesota pavements for the final design software. Incorporating this database into the final software product saves engineers the very time-consuming processes of finding the right values for inputs and waiting for the software to run calculations.

What Did We Learn?

The final software, MnPAVE Rigid, is a standalone Microsoft Windows executable program that can be dragged to any desktop. The software is portable and requires no installation. Because it includes a database of Minnesota concrete pavement projects, the software requires that users modify only critical input parameters and produces instantaneous results. It also incorporates previous MEPDG calibrations for Minnesota pavements, local climate and weigh-in-motion traffic data, and the advanced analysis features of its counterpart for asphalt pavements, MnPAVE Flexible.

MnPAVE Rigid can also be easily modified if necessary by MnDOT research engineers to provide new default values for advanced inputs or to modify the database using other MEPDG methods. Researchers also created a user's guide to accompany the software.

What's Next?

An update of MnDOT's Pavement Design Manual (due in November 2014) will make MnPAVE Rigid its primary design program for new concrete pavements as well as for unbonded overlays and some whitetopping, replacing RigidPave. The software will give Minnesota state and local engineers an easier way to incorporate state-of-the-practice mechanistic-empirical principles into the design of rigid pavements. Doing so is expected to produce thinner pavements, saving on costs and emissions while maintaining performance. MnDOT is also considering further refining this software to make its inputs more consistent with those of MnPAVE Flexible so that during the contracting process, Minnesota can more easily compare the cost-effectiveness of using an asphalt or concrete pavement for a particular project.

This Technical Summary pertains to Report 2014-27, "Simplified Design Table for Minnesota Concrete Pavements," published July 2014. The full report can be accessed at <http://www.lrrb.org/PDF/201427.pdf>.