



PUTTING RESEARCH TO WORK

# BRIEF

## HIPERPAV Concrete Pavement Design Software Tailored to Fit Wisconsin

**H**IPERPAV (an acronym for High PERFORMANCE concrete PAVING) is a computer program that allows pavement designers to evaluate the effects of design, materials, environment and construction factors on the early-age behavior of concrete pavements. Since its development nearly 10 years ago, HIPERPAV has been widely recognized as a useful tool for simulating the first 72 hours after concrete placement. The simulation includes the critical curing period after construction when strength and stresses develop. Simulating a pavement's behavior during this time is useful in identifying potential risks in hot and cold weather, identifying base restraint problems, determining saw cutting windows, and predicting strength for opening to traffic.

### What's the Problem?

HIPERPAV was developed under FHWA sponsorship to include "typical" material types and properties representative of the nation as a whole. Because HIPERPAV's terminology and inputs are not localized for individual states, the software may be challenging to learn and use in some areas. Such is the case in Wisconsin.

HIPERPAV was introduced in Wisconsin several years ago, but the software has been used infrequently in the state. Wisconsin DOT has used HIPERPAV primarily in forensic evaluation, to help identify the most likely causes of concrete pavement failures. This application provides valuable information, but does not tap HIPERPAV's full potential in the design, planning and construction phases. If adopted by WisDOT and its contractors, HIPERPAV could help facilitate a systematic approach to maximizing pavement quality, optimizing construction procedures, controlling costs, increasing productivity, and enhancing long-term pavement performance.

### Research Objectives

To encourage broader acceptance and use of HIPERPAV by WisDOT staff and contractors, researchers sought to customize the software to better represent the state's design and construction practices, and to include Wisconsin conditions, terminology, and guidelines for proper input selection.

### Methodology

Researchers met with the WHRP project oversight committee and stakeholders in the state's paving industry to determine desirable features for HIPERPAV-Wisconsin. The group identified the inputs and software functionality requiring customization. Researchers then performed an information search of typical Wisconsin design standards and construction procedures; consulted documents including WisDOT standard concrete pavement specifications; and identified typical input values and terminology for concrete pavements in Wisconsin.

Researchers developed a list of typical default input values and input ranges for Wisconsin and incorporated them into the HIPERPAV model. Whenever values for an input were not available, or if an input was not used in the state, the default values in the national version of the software were included.

### Results

Researchers created HIPERPAV-Wisconsin, a fully customized version of the national HIPERPAV software. The software's functionality was enhanced in several areas, including:

**Compressive Strength Analysis.** The option to use compressive strength data to predict the design strength of concrete in the field was added. The national HIPERPAV model uses tensile strength, a measurement used less commonly in Wisconsin.

**Evaporation Rate Analysis.** Users can enter user-defined values for evaporation rate thresholds.

#### Investigator



*"Based on the success we've had in Wisconsin, I think we'll see more states wanting to customize HIPERPAV."*

—J. Mauricio Ruiz

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## Project Manager



*“HIPERPAV-Wisconsin can help designers and contractors recognize significant risk for transverse cracking ahead of time and adjust their plans as needed.”*

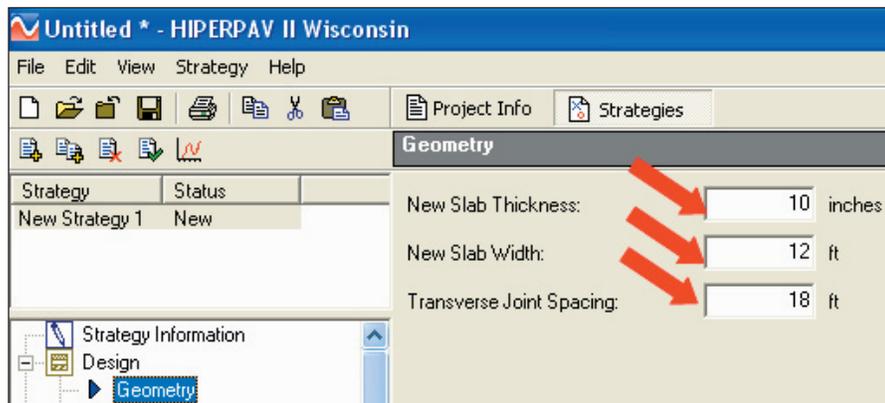
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Values for slab thickness, slab width and joint spacing typical for Wisconsin were included as defaults in the HIPERPAV-Wisconsin software (Fig. 7, page 7 of the final report).

**Design.** Researchers adjusted the materials terminology in the slab support analysis area to include the base types most commonly used in Wisconsin.

**Materials and Mix Design.** Researchers developed a library of state-approved cements, including information on manufacturer and plant location and chemical composition.

As part of the implementation program, researchers developed sample case studies for proactive and postmortem concrete paving scenarios for use during a training workshop. Users can practice using the software to solve the problems described in these scenarios, which include step-by-step instructions for selecting inputs and interpreting results.

## Implementation

As an initial implementation activity, researchers conducted a full-day, hands-on workshop in November 2005 on the use of HIPERPAV-Wisconsin, which was attended by 23 people from WisDOT and the concrete paving industry.

In coming months, WisDOT staff will meet with the WHRP Rigid Pavement Technical Oversight Committee to chart a course for implementing HIPERPAV-Wisconsin and for incorporating the software into department construction projects. Additional phases of implementation could include changes to WisDOT policies and specifications; more detailed testing and characterization of local materials; development of databases on materials and mix designs; local validation of the software's accuracy; and workshops and technology transfer activities.

## Benefits

HIPERPAV-Wisconsin will facilitate a more systematic assessment of the variables that can cause early-age pavement to crack. Pavement designers can use the software to evaluate the interaction between climatic conditions and commonly used concrete mixture proportions on a project-by-project basis to prevent transverse cracking, plastic shrinkage cracking and other distress. Contractors can use HIPERPAV prior to construction to evaluate the implications of using different concrete constituents under varying climatic conditions.

In addition, as experienced consultants, contractors and WisDOT staff retire, use of HIPERPAV-Wisconsin can help mitigate the loss of these professionals' knowledge and experience in pavement design and construction.

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*Nina McLawhorn, Research Administrator*