



TRANSPORTATION POOLED FUND  
PROGRAM

## TECHNICAL SUMMARY

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### TOTAL PROJECT COST:

\$455,000

### MnDOT CONTRIBUTIONS:

\$100,000

### PARTICIPATING STATES:

CA, MN, WA plus FHWA

# Pooling Our Research: Using Composite Pavements to Improve Road Performance

## Why a Pooled Fund Study?

To combine the durability of concrete pavements with the ride quality and serviceability of asphalt, engineers sometimes use thermally insulated concrete pavements (TICPs). These composite pavements are constructed by placing an asphalt layer over a newly constructed concrete pavement. This layer insulates the underlying concrete from variations in temperature and corresponding variations in expansion and contraction, which can cause stresses that lead to cracking and other forms of deterioration. The asphalt layer also serves as a wearing course that can be easily replaced. Because the stresses of the concrete layer in TICPs are lower than those of typical concrete pavements, the thickness of the concrete layer can be reduced, which can simplify construction.

Despite the benefits of TICPs, there is a lack of information about the best practices for their design and construction. Further, it is unclear under what circumstances using them would be more cost-effective than regular pavements.

## What is the Pooled Fund Study's Goal?

The objective of this MnDOT-led, multi-state study was to perform life-cycle cost analysis comparisons and develop design and construction guidelines for TICPs. Research was also needed into the applicability of the Mechanistic-Empirical Pavement Design Guide (MEPDG) as well as reflective cracking and asphalt rutting models developed in California to TICPs.

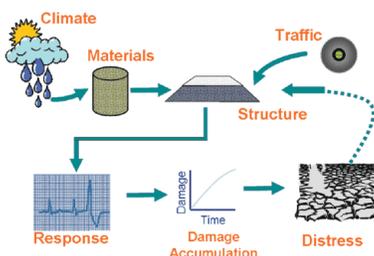
## What Did We Do?

Researchers began by conducting structural modeling, investigating the applicability of the MEPDG to TICP design. They reviewed the MEPDG climatic models for asphalt overlays of concrete pavements and the MEPDG's use of a single-load, duration-dependent dynamic modulus—a way of measuring pavement stiffness in response to typical traffic loads—to characterize the behavior of the asphalt layer. Next, they reviewed MEPDG, Caltrans and NCHRP models to develop new mechanistic-empirical (M-E) models for reflective cracking, rutting, faulting and transverse cracking in TICPs as well as a companion program to the MEPDG allowing use of these models.

Researchers then developed guidelines for the construction of asphalt overlays on concrete pavements, including continuously reinforced, jointed and roller compacted concrete pavements. To do so, they reviewed the state of the practice for the design and construction of these pavements; observed their construction at Minnesota's MnROAD pavement research facility and the University of California Pavement Research Center; reviewed quality control and assurance procedures; and interviewed pavement experts to gather their input about important construction concerns.

Finally, researchers developed procedures to compare the life-cycle costs of TICPs with jointed plain concrete pavements (JPCPs), accounting for agency and user costs as well as environmental and sustainability aspects.

*TPF-5(149): Design and Construction Guidelines for Thermally Insulated Concrete Pavements. These pavements resist deterioration, improve ride quality, and simplify construction and maintenance. This pooled fund study provides MnDOT with the information it needs to design and construct these pavements and determine when they should be used.*



The MEPDG's manual and accompanying software provide engineers with models for predicting how pavements will deteriorate over time depending on their structure and materials along with the expected climate and traffic.



## RESEARCH SERVICES

OFFICE OF POLICY ANALYSIS,  
RESEARCH & INNOVATION

*“This project involved exceptional cooperation between the FHWA and several states and universities to bring a concept developed several years ago to fruition, adding to MnDOT’s toolbox for projects that require a long-term pavement fix.”*

—Tim Clyne,  
Senior Research Engineer,  
MnDOT Office of  
Materials and Road  
Research

*“One important result of this project is improvements to models in the Mechanistic-Empirical Pavement Design Guide, the most popular mechanistic-empirical tool for engineers.”*

—Lev Khazanovich,  
Associate Professor,  
University of Minnesota  
Department of Civil  
Engineering

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The final report for this project includes detailed advice about the construction of composite pavements, including roller placement for proper compaction of asphalt overlays at longitudinal joints.

### What Did We Learn?

Structural modeling results uncovered significant issues with the MEPDG’s climate model and use of climate data, which led to faulty predictions in transverse cracking in asphalt overlays. Researchers made recommendations for correcting these issues, and some corrections have been incorporated into AASHTO’s next generation M-E procedure, DARWin-ME. Researchers also found that the using a single-load, duration-dependent dynamic modulus to characterize the behavior of the asphalt layer was insufficient for composite pavements subjected to a combination of traffic loads and temperature curling. Consequently, they developed an alternative procedure for computing these stresses.

Researchers found that the software for NCHRP 1-41 reflective cracking models had some issues and so developed their own model. They also developed companion software to the MEPDG that incorporates these models, allows users to choose between models without requiring a large number of input parameters and allows designers to incorporate the results of different material characterization procedures.

The final report reviews important aspects of the construction of jointed and roller-compacted concrete pavements as well as the construction of asphalt overlays. Guidelines include a review of mix design criteria (such as mitigating reflective cracking, minimizing rutting and mitigating low-temperature cracking) and selection.

Results of the life-cycle cost analysis show that with one exception, JPCPs were generally more cost-effective than various TICP designs. As the cost of asphalt increases, other materials in the TICP (most notably the concrete used for the structural layer) must decrease to make TICPs cost-competitive with JPCPs.

### What’s Next?

MnDOT will incorporate the models developed in this project into the MEPDG. Investigators recommend further research to refine the models, including the method used for computing the asphalt layer dynamic modulus and the assumption that the temperature of the asphalt layer is equal to that of the bottom surface of the concrete layer.

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*This Technical Summary pertains to Report 2013-02, “Design and Construction Guidelines for Thermally Insulated Concrete Pavements,” published January 2013 and funded through pooled fund study TPF-5(149), Design and Construction Guidelines for Thermally Insulated Concrete Pavements. The full report can be found at <http://www.lrrb.org/PDF/201302.pdf>, with pooled fund study information at <http://www.pooledfund.org/Details/Study/376>.*

*For more than 25 years, FHWA’s Transportation Pooled Fund Program has been providing state DOTs and other organizations the opportunity to collaborate in solving transportation-related problems. The TPF Program is focused on leveraging limited funds, avoiding duplication of effort, undertaking large-scale projects and achieving broader dissemination of results on issues of regional and national interest.*