

# Research Spotlight

## Project Information

**REPORT NAME:** Identifying Best Practices in Pavement Design, Materials, Construction, and Maintenance in Wet-Freeze Climates Similar to Michigan

**START DATE:** January 2017

**REPORT DATE:** February 2018

**RESEARCH REPORT NUMBER:**  
 SPR-1666

**TOTAL COST:** \$183,489

**COST SHARING:** 20% MDOT, 80% FHWA through the SPR, Part II, Program

## MDOT Project Manager Curtis Bleech, P.E.

Pavement Operations Engineer  
 Construction Field Services  
 Michigan Department  
 of Transportation  
 8885 Ricks Road  
 Lansing, MI 48197  
[bleechc@michigan.gov](mailto:bleechc@michigan.gov)  
 517-322-5769

## Study identifies best pavement practices in wet-freeze climates

In 2015, Michigan Public Act 175 established the [Roads Innovation Task Force](#). It directed MDOT to determine how the agency could improve the effective life span of state highways, with a goal of 50- to 75-year pavement longevity and reduced costs. MDOT also was directed to conduct a comprehensive examination of pavement best practices and innovations in domestic and foreign regions, specifically identifying new practices that MDOT might employ. This research project is the result of that effort. It revealed that MDOT is a leader in long-term pavement practices among national and international agencies in wet-freeze regions. Several practices were recommended for evaluation.

### Problem

To investigate pavement durability in the United States, the Federal Highway Administration (FHWA) divides the country into four regions. Michigan is in the wet-freeze region along with 17 other north central and eastern states that experience long winters with below-freezing temperatures for long periods. Abundant moisture leads to freeze-thaw events that can lead to pavement distresses such as cracking, frost heaving, material degradation and thaw weakening. Climate extremes and effects are crucial considerations in the design, construction and maintenance of pavements in wet-freeze regions.



This map shows the four climate regions of the United States as designated by the FHWA for investigating long-term pavement performance.

Investigators for this project had three objectives: document MDOT's current best pavement practices, document the best practices of other state and local agencies, and recommend practices that could be employed in Michigan while identifying possible barriers to incorporating them.

(continued)

*“This comprehensive study revealed that MDOT is a national and international leader in developing and implementing best practices for pavements in wet-freeze climates.”*

**Curtis Bleech, P.E.**  
Project Manager

## Research

Researchers had to ascertain the limiting factors of the wet-freeze climate to determine which regions most resembled Michigan. Then they had to investigate the best pavement design, material specifications, construction and maintenance practices of the agencies within those regions. Finally, they needed to synthesize the large quantity of data to identify best practices not currently used in Michigan that warranted evaluation.

First, researchers chose parameters based upon annual precipitation and number of freeze days to identify wet-freeze regions. These parameters influence pavement surface temperature, frost depth and number of freeze-thaw cycles that pavements undergo. Researchers selected 22 states, two Canadian provinces (Ontario and Quebec), and eight international cities in five countries (China, Japan, Norway, Russia, and the United Kingdom) with some regions of wet-freeze climate. For this study, a best practice was defined as a procedure that was shown by research and experience to produce optimal results and that was established as a standard suitable for widespread use.

Investigators examined four types of pavement: asphalt (flexible), concrete (rigid), composite and aggregate-surfaced, which was included for completeness though it isn't used in MDOT roadways. Four determining factors affect a pave-

ment's ability to withstand wet-freeze conditions: materials, design, construction, and preservation and maintenance procedures. Researchers examined these four factors mainly in two of the pavement types, asphalt and concrete, to identify best practices in the selected 32 wet-freeze climate regions. The result was a comprehensive literature review of best practices to meet the project's objectives. Finally, researchers performed extensive analyses of these large troves of data and developed a method to organize and present the research findings effectively.

## Results

Researchers summarized their findings in a comprehensive table and expanded upon the results throughout the report. The table serves as a quick guide to MDOT's and other agencies' best practices and includes the status of the technology (whether it is implementable), recommendations for implementation, and a reference to the section in the report where the practice is discussed. Researchers provided MDOT's current best pavement practices for completeness. Practices not in use at MDOT were examined for their effectiveness in other wet-freeze areas, for possible barriers to use in Michigan, and for reasons why the technology is promising for wet-freeze locations.

The research clearly showed that MDOT is a pioneer in developing and implementing best pavement practices in wet-freeze climates. The research team found few best practices not already in use by MDOT but recommended additional review of some practices as more research results become available. Of the 10 technologies listed, MDOT has examined or field-tested nine, including intelligent compaction, perpetual pavement and roller-compacted concrete. Only Chinese pavement practices remain to be considered. No current practices were recommended to be abandoned.

## Value

This project's results demonstrate that MDOT is a leader in the research, development and application of best practices for pavement construction, preservation and maintenance, both nationally and internationally.

MDOT benefits from the project's comprehensive findings that identify best pavement practices used in other states and countries with a climate like Michigan's. More communication and shared technical knowledge among wet-freeze climate agencies could lead to improvements in construction and maintenance, which could reduce costs and increase pavement durability and longevity.

## Research Administration

### Principal Investigator

**Zhanping You, Ph.D., P.E.**

Professor  
Department of Civil and  
Environmental Engineering  
Michigan Technological University  
1400 Townsend Drive  
Houghton, MI 49931  
[zyou@mtu.edu](mailto:zyou@mtu.edu)  
906-487-1059

### Contact Us

PHONE: 517-636-4555

E-MAIL: [mdot-research@michigan.gov](mailto:mdot-research@michigan.gov)

WEBSITE: [www.michigan.gov/  
mdotresearch](http://www.michigan.gov/mdotresearch)

**This final report is available  
online at**

[www.michigan.gov/documents/  
mdot/SPR-1666\\_Wet-  
freeze-20180330\\_620607\\_7.pdf](http://www.michigan.gov/documents/mdot/SPR-1666_Wet-freeze-20180330_620607_7.pdf)

Research Spotlight produced by  
CTC & Associates LLC, June 2018.