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OFFICE OF TRANSPORTATION SYSTEM MANAGEMENT

TECHNICAL SUMMARY

Technical Liaison:
Tom Peters, MnDOT
Tom.Peters@state.mn.us

Project Coordinator:
Dan Warzala, MnDOT
Dan.Warzala@state.mn.us

Principal Investigator:
Stephen Druschel
Minnesota State University, Mankato

PROJECT COST:
$116,444

Pole-mounted time-lapse cameras with detachable bases documented deicer and plow testing on side-by-side test tracks.

Field Effects on Deicing and Anti-Icing Performance

What Was the Need?

Advances in equipment and treatment options continue to move the practice of winter maintenance forward. While laboratory testing has informed the use of alternative chemicals and improved treatment methods, testing in the field under real-world weather conditions is needed to confirm or refute anecdotal evidence and observations made by researchers and the snowplow operators clearing winter roadways.

What Was Our Goal?

This project aimed to expand on the laboratory analysis of winter maintenance chemicals conducted in Phase I by taking data collection into the field. A key goal was to assess the influence of factors other than ice melt capacity—the focus of Phase I—that contribute to deicer and anti-icer effectiveness and persistence. These factors include temperature, traffic level and type, pavement type, plow speed and deicer stickiness.

Following up the laboratory testing in Phase I, this primarily field-based investigation examined four aspects of winter maintenance to make Minnesota roads safer with greater efficiency: traffic's effect on anti-icer persistence, deicer and plow effectiveness, and the influence of pavement on anti-icer persistence.

What Did We Do?

A four-part research plan examined the life cycle of winter maintenance, from plowing and the application of chemicals to the drainage of chemical residue after the roadway has been treated. In the field, researchers assessed:

- **Anti-icer persistence.** Using roadway drainage systems with ready access from below, researchers calculated chloride concentration and flow drainage at eight locations off North Star Bridge, an elevated section of U.S. Highway 169 in Mankato, Minnesota, in response to actual traffic.
- **Deicer effectiveness.** Two Minneapolis-area locations with large parking lots not typically used during the winter months provided the test environment. Researchers set up nine parallel treatment lanes of 900 to 1,000 feet in length that offered varied snow and weather conditions for testing. These side-by-side test tracks were expected to generate more comparable results than a more typical linear testing environment, which may not control for other factors that could impact results (different pavement types, for example). Maintenance staff from MnDOT's Metro District, using equipment from the Chaska truck station, assisted with testing.
- **Plow effectiveness.** Using these same side-by-side outdoor test tracks, researchers observed MnDOT plow trucks in action in actual snow conditions on nonstorm days. Field observations augmented by still and time-lapse photography evaluated the effectiveness of plowing techniques for different snow conditions, taking into consideration truck speed, site geography, snow structure and storm composition.

In the lab-based portion of this study, researchers used test sections of asphalt concrete and portland cement concrete pavements to examine the impact of roadway wetness as traffic removes the salt or other chemical application through splash, spray and runoff. Chloride content was measured to see how long a chemical stuck to the pavement in response to the application of artificial precipitation.

continued

"The side-by-side test tracks allowed us to conduct field tests in a controlled, outdoor environment under real-world winter conditions. This will help MnDOT reinforce or improve current winter maintenance practices."

—Tom Peters,
Research and Training Engineer, MnDOT Maintenance Operations

"We expanded on the lab findings from Phase I by using science and math to eliminate misconceptions and to support and strengthen the observations made by winter maintenance operators in the field."

—Stephen Druschel,
Associate Professor, Minnesota State University, Mankato, Department of Mechanical and Civil Engineering

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of Transportation
Research Services & Library
MS 330, First Floor
395 John Ireland Blvd.
St. Paul, MN 55155-1899
651-366-3780
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Plowing at 5 mph.

Plowing at 20 mph.

The side-by-side test tracks allowed researchers to test the effects of different plowing speeds within similar snow and weather conditions of a single site on a single day.

What Did We Learn?

Results from the four elements of the study follow:

- **Anti-icer persistence.** Consistent with other studies' conclusions, researchers found that most chloride left the bridge deck quickly, with the majority leaving through salt spray or "throw" from the snowplow, not through the drainage systems installed to carry the flow away from the bridge deck. This leaves the roadway susceptible to re-freezing, providing 45 to 60 minutes of protection and then requiring retreatment.
- **Deicer effectiveness.** Consistent with expectations developed in lab studies, warmer temperatures provided more melt from the deicer. Little melt was observed below 10 degrees Fahrenheit unless sunlight provided warming, and prewetting produced no significant difference in deicer performance. Dry pavements may be better candidates for pretreatment, with researchers noting that any wetness on the pavement ahead of a storm limited anti-icer effectiveness. Truck traffic after deicer application was found to significantly improve deicer performance, resulting in both a wider and quicker melt.
- **Plow effectiveness.** Even with different snow and temperature conditions, the evaluation of plow speed provided the same findings: Snow rises higher in the curvature of the plow at higher speeds, creating a broader spray off the plow ends, and higher speeds decrease scrape quality.
- **Salinity response in pavement.** Researchers found little difference in anti-icer persistence across pavement types. Salinity in pavement drainage typically started high and declined with flow, and most of the change in salinity values occurred within 0.30 inches of precipitation or less.

What's Next?

The results from this project provided scientific support for some of the anecdotal evidence reported by snowplow operators in the field and also prompted new questions. However, the severity and length of the 2013-2014 winter hampered testing. The research team has proposed a third phase of this project to continue their work in the field, which is expected to include further examination of the impact of truck traffic on deicer effectiveness, variations in plow setup, and expanded testing under varying weather conditions and snow structure.

This Technical Summary pertains to Report 2014-43, "Salt Brine Blending to Optimize Deicing and Anti-Icing Performance and Cost-Effectiveness, Phase II," published November 2014. The full report can be accessed at http://www.lrrb.org/PDF/201443.pdf.