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November-December 2015

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ACCELERATOR

Putting your ideas in motion

Send in the Drones

Bridge inspectors utilized the Aeryon SkyRanger drone, shown here, on four bridges after receiving FAA approval.

UAVs Predicted to Improve Safety, Thoroughness of Bridge Inspections

Bridges & Structures — This past summer, MnDOT began testing the use of unmanned aerial vehicles, or drones, for bridge inspections.

Drones would allow inspectors to visually inspect hard-to-reach areas and collect more detailed information without blocking traffic or getting in harm's way. Bridge inspectors currently rely on rope systems and special inspection vehicles to access obscure areas.

"We're interested in using drones in areas where it may be dangerous for an inspector to go, such as culverts and confined spaces, or to get to places where inspectors cannot regularly gain access," said Jennifer Zink, MnDOT bridge inspection engineer, noting that drones would not replace human inspectors or physical inspections.

A test drone used to inspect four bridges suitably performed a variety of inspection functions that don't require hands-on physical inspection.

Researchers tested the drone's ability to gather high-quality still images and video footage. They also collected data from infrared cameras. In addition, the drone provided the ability to capture data needed to construct maps of bridge areas and 3D models of bridge elements. The images, which include infrared images to detect deck trouble spots, correlated with the findings of bridge inspection reports.

A follow-up study that began this month is employing advanced drone technology to inspect the Blatnik Bridge in Duluth. The drone is specifically designed to inspect structures, with a camera that can shoot upwards from beneath a bridge and the ability to operate without GPS, features identified as necessary in the first study.

Technical Summary 2015-40

Winter Maintenance Peer Exchange Kicks Off Season

Maintenance Operations & Security — Just a couple months shy of their busy season, 200 winter maintenance practitioners gathered at the 2015 National Winter Maintenance Peer Exchange the week of Sept. 21 in Bloomington, Minnesota.

States that belong to the Clear Roads and Aurora pooled fund programs held business meetings, receiving updates on research projects in winter maintenance and road weather information systems. The rest of the week, peer exchange participants discussed common research needs and shared their experiences with various winter maintenance techniques.

The highlight of the week for Steve Lund, MnDOT's state maintenance engineer, was hearing what innovative practices are working in other states — "everything from Michigan placing salt ahead of a snowplow's rear tires to avoid scatter, to Missouri's enhanced Tow Plow lighting scheme." A summary of these best practices, including MnDOT's snowplow dash cams, will be available soon.

The peer exchange is held every other year. New this year: winter maintenance vendors, who showcased products and participated in the discussions with their customers.

"We want vendors to hear our research needs because solutions come out of that community as well," Lund said.

See more about Clear Roads inside

A standing row of corn is shown in a screenshot of a KARE 11-TV broadcast on MnDOT's living snow fences program. For more information about the program, go to mndot.gov/environment/livingsnowfence.

Research-Based Approach Doubles Farmer Participation in Snow Control Program

Environmental — A tool that allows transportation agencies to determine the value of land for snow control measures has helped MnDOT increase the number of farmers protecting winter roadways with standing corn rows.

The Living Snow Fence Payment Calculator calculates which sites have the physical characteristics and crash history to warrant snow fence payments and the amount that would attract landowner participation.

Agencies can help keep roads clear of drifting snow by paying landowners to plant trees, shrubs or corn rows as windbreaks at problem locations. Research has shown these living snow fences can reduce snow- and ice-related crashes by up to 40 percent.

A new research implementation project has created a mobile-friendly Web version of the payment calculator tool; after several training sessions with MnDOT and county staff, standing corn row landowner contracts more than doubled, from 17 to 43. MnDOT is now using this tool along with promotional aids to further expand the program. Try it at **snowcontroltools.umn.edu.**

> "With this tool, we consider the farmer's economic vitality as well as the benefits related to crash reduction, travel time and carbon sequestration."
>
> —Dan Gullickson
> Living Snow Fence Program Coordinator

Technical Summary 2015-21

Guidebook Gives How-To for Permeable Pavements

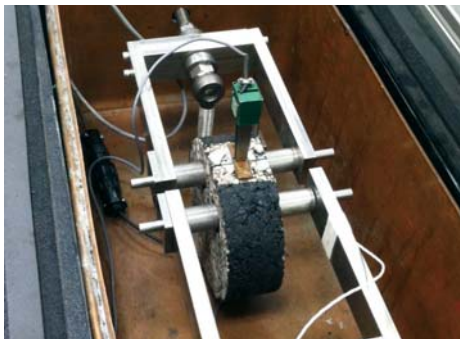
Materials & Construction — A new guide helps local agency engineers know where and how to best install permeable pavements, which absorb and filter stormwater runoff, to reduce the pollutants that flow into waterways and avoid a buildup of slush and snow on the road. Porous asphalt, pervious concrete and permeable interlocking concrete pavers are too porous to durably support highway traffic but have been used successfully in parking lots and low-volume roads. A review of literature and case studies, including experiences in Minnesota cities and the MnROAD pavement testing facility, reveals that most permeable pavement installations have performed well. The new guide collects best practices for maintaining these roads and parking lots as they need regular pressure washing or vacuuming to prevent clogging.

Technical Summary 2015-30

When to Stop Plowing? Traffic Recovery Data Now Available for Freeways

Maintenance Operations & Security — To determine when to stop plowing, MnDOT and local agencies need to know when roads are clear of snow and ice. This currently involves visual observations, which are imperfect, expensive and involve some lag time. Researchers designed a more cost-effective and accurate alternative, using existing traffic detectors on freeways, to tell when traffic flow patterns have returned to normal after a storm and successfully tested it on two Twin Cities routes. The software that accomplishes this data collection is being rolled out across the Twin Cities with the hope that it will be used daily to analyze winter maintenance operations and eventually expand statewide.

Technical Summary 2015-44



A disk-shaped asphalt sample held by clamps in a refrigerated box.

Lab Test Ensures Pavement Mixes Resist Cold-Weather Cracking

Materials & Construction — Testing asphalt pavement mixtures in the lab allows for adjustments to the mix to make the pavement in the field more resistant to low-temperature cracking. Previous research led to a laboratory test that could accurately measure fracture energy, and MnDOT has now tried out this disk-shaped compact tension test (above) on three construction projects using five asphalt mixes. Three of these mixes initially failed to meet minimum fracture energy requirements in the lab and were adjusted to improve the mix used in construction. MnDOT is conducting follow-up research and evaluating how to add this testing requirement for asphalt pavement construction projects.

Technical Summary 2015-20

Other Research

Cedar Avenue Bridge

Sound Waves Identify Cracking in Fracture-Critical Steel Bridges

Bridges & Structures — As bridges age, they are more likely to suffer from structural damage caused by traffic loading, weather fluctuations and winter deicing chemicals. MnDOT has been addressing this often unseen damage with an innovative acoustic emission bridge monitoring system. Installed in 2011 on the Cedar Avenue Bridge in Burnsville, the system detects sound waves generated by cracking in the steel components of the bridge.

Researchers optimized this system by calibrating it to distinguish sound waves associated with fractures from those caused by other routine factors. The project showed that the system holds promise for identifying critical fractures in steel bridges, including small cracks, and will help provide advance warning of structural distress before it becomes severe enough to cause collapse or require costly repairs.

Technical Summary 2015-36

The HumanFIRST portable driving simulator is equipped with three 32-inch HD displays, mirror displays and vehicle controls.

Vibrating Seat Technology Alerts Distracted Drivers

Traffic & Safety — A study using driving simulators demonstrated that tactile warnings to drivers effectively reduce the amount of time they spend drifting out of their travel lane. Since nearly half of all traffic fatalities involve run-off-road crashes, this technology could significantly affect driver safety. A lane departure warning system uses a GPS or highway sensors to track a vehicle's position. A portable simulator was equipped to provide vibrations in the left or right side of the seat pan. Sixty study participants drove through digital versions of real Minnesota routes, sometimes while performing a distracting task comparable to working a smartphone. Drivers reported trusting the system, but did not demonstrate any overreliance on it; their performance did not decrease from its original level after the system was turned off.

Technical Summary 2015-35

Winter Maintenance Support Tools From Clear Roads Program

Traffic & Safety — Minnesota helps develop winter maintenance guidance as the lead state of the 32-member **Clear Roads** cold weather research pooled fund, which met Sept. 21-22. Highlighted below are a few guidebooks recently produced or under development by this multi-state effort.

New - **Best Practices for the Prevention of Corrosion on DOT Equipment (13-04)**

This new user's manual assembles currently available knowledge on corrosion prevention to help agencies extend the life of winter maintenance equipment.

Updated - **Cost-Benefit Analysis Toolkit (11-02)**

To help winter highway maintenance managers justify the cost of new materials and equipment in the face of frequent budget cuts, Clear Roads created a web-based tool for estimating the cost-benefit ratio of key maintenance techniques. This toolkit was updated in 2013 to cover additional equipment and methods.

Coming Soon - **FHWA Roadway Salt Best Management Practices (14-10)**

Minnesota stepped up to help fund a best practices manual after the 2013-14 winter season severely depleted maintenance budgets and salt stocks around the nation, particularly in northeastern U.S. In addition to investigating the issues that led to salt shortages, this guidebook includes Midwestern examples from Minnesota and Iowa for best practices in salt usage, procurement and other logistics.

In Progress - **Snowplow Operator and Supervisor Training (12-04)**

Clear Roads is assembling the best and most extensive training materials from its members and partners into classroom courses that can be adapted and utilized by any state.

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Calendar

11/19 - 20	American Public Works Association – Minnesota Chapter Fall Conference, Brooklyn Center
11/23	LRRB Research Implementation Committee Meeting, Woodbury
12/2 - 3	TRIG Winter Meeting, Arden Hills
12/4	Freight & Logistics Symposium, Minneapolis
12/9 - 10	LRRB Winter Meeting, Minneapolis

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