



MINNESOTA LTAP

TECHNOLOGY EXCHANGE

mnltap.umn.edu

Minnesota Local Technical Assistance Program

December 2017 Vol. 25, No. 4

INSIDE:

HONORS
APWA-MN national awards..... 2

LRRB SPOTLIGHT
Shingle mix for gravel roads..... 3
Slope stabilization 3
Alternative deicers 3

TECHNOLOGY
Goggles, drones, and bridges 4
MnDOT drone research..... 5
Automated flagger 5

PAVEMENTS
Pavement preservation..... 6
Recycled concrete aggregate..... 7

INFORMATION SERVICES
The Shelf & search tools..... 7
Snow removal metrics..... 7

WORKSHOPS AND TRAINING
Calendar 8
Snowplow training modules 8
Line to Leadership 8
Curb quiz..... 8

Drones offer advantages for bridge inspection



The use of drones—also known as unmanned aircraft systems (UAS)—has been shown to improve the quality of bridge inspections, reduce costs, and increase safety. The Minnesota Department of Transportation (MnDOT) and the Federal Highway Administration (FHWA) are both exploring the wider use of drones for bridge inspection.

Drones continued on page 5

ADA transition plans for local agencies: training and online guide available

The Minnesota Local Road Research Board (LRRB) is sponsoring a series of training courses on the federal Americans with Disabilities Act (1990). The training, which will be offered through Minnesota LTAP over the next year, will help local agencies



learn about the ADA, develop transition plans, and plan design and construction.

The ADA is a wide-ranging civil rights law intended to prohibit discrimination and improve the accessibility of facilities and public infrastructure. It specifically requires public entities with more than 50 employees that have responsibility over streets and walkways to create a transition plan that identifies the steps needed to bring the infrastructure under their authority into compliance. Many agencies still do not have transition plans, however, resulting in the potential for civil and civic lawsuits and possibly being ineligible for or losing federal funding.

In 2012, the LRRB published the *ADA Transition Plan for Public Rights of Way*, which contains model

ADA continued on page 2

Farewell, Jim Grothaus!



Jim Grothaus, long-time Minnesota LTAP director, has accepted a new position as technical resource promotion engineer with Hancock Concrete.

Jim joined the Center for Transportation Studies (CTS) in 2001 as manager of technical assistance and training. Most recently he served as CTS assistant

director of coordinated research and technology transfer. This included leadership of Minnesota LTAP, the Airport Technical Assistance Program, and many other projects and initiatives.

Jim received national recognition for his leadership in transportation education. He served as president of the National Local Technical Assistance Program Association from June 2012–June 2014 and held all leadership positions for the association. In 2015 he received the Donald C. Stone Award from the American Public Works Association for his work in the areas of continuing and graduate professional education for public works professionals.

"It is with a heavy heart that we say farewell to Jim," says Laurie McGinnis, director of CTS and member of the Minnesota LTAP Steering Committee. "He was instrumental in growing our training and technical assistance programs, and he excelled at making the connections and relationships that are so important to our work. He will be greatly missed for his leadership and commitment, and for his warmth and friendship. We wish him all the best as he moves forward in his new position."

"It has been a pleasure working with Jim the past three years since becoming the LTAP Steering Committee chair," says Mitch Rasmussen, division director at MnDOT State Aid. "Jim's assistance in getting me up to speed on the committee's purpose, mission, and goals made the job of chairing the

Farewell continued on page 2



TECHNOLOGY EXCHANGE
Minnesota Local Technical Assistance Program
Center for Transportation Studies
University of Minnesota
200 Transportation and Safety Building
511 Washington Avenue S.E.
Minneapolis, MN 55455-0375

HONORS

APWA–Minnesota wins national honors

The American Public Works Association (APWA) Minnesota chapter received eight awards at the 2017 APWA Public Works Conference in Orlando in August. Highlights from the chapter website are below.

Lee Gustafson of WSB & Associates received the Top Ten Public Leaders of the Year Award. Gustafson formerly served as director of engineering for the City of Minnetonka and was a member of the Minnesota LTAP Steering Committee.

Mark Ray received the Myron Calkins Young Leader of the Year Award. Ray has been involved in public works for more than 10 years, working in both the private and public sectors.

Tim Kelly, district administrator of the Coon Creek Watershed District, received the award for Professional Manager of the Year – Water Resources.

Two communities received Public Works Project of the Year Awards. The City of Mankato received the Project of the Year, Environmental <\$5M, for its Water Treatment Backwash Reclamation Project.

Hennepin County received the Project of the Year, Historical Restoration \$25–\$75M, for its Franklin Avenue Bridge Project. After considering the structural system and user impacts, Hennepin County elected to use an accelerated bridge construction (ABC) approach that utilizes prefabricated bridge elements. By using this precast construction method, the bridge closure time was reduced from two years to four months. (ABC is an innovation encouraged by the FHWA's Every Day Counts program.)

The Minnesota chapter received two national awards: the Exceptional Performance Award – Journalism (chapter) and the Donald C. Stone Award for Excellence in Education.

The Minnesota chapter also received the Presidential Award for Excellence (PACE) for the 6th year in a row. The PACE award recognizes chapters for contributions made to positively impact their membership, profession, and community.

Congratulations to all of the recipients! **LTAP**

Farewell from page 1

committee possible. I truly appreciate his style, professionalism, and friendship and will miss working with him through LTAP. I wish him the best of luck in his new endeavor."

"It is with mixed emotions that I say goodbye to Jim," says Mindy Carlson, LTAP program manager. "I'm sad to see him leave CTS but also very excited for what the future holds for him as he travels down this new (concrete?) road. Jim and I have been working together on LTAP for nearly 15 years. Through Jim, I have had the pleasure of getting to know so many of our LTAP students and stakeholders. One of Jim's best qualities is his ability to make people feel comfortable—he's an expert at bringing people together and having a conversation. He's that person who is 'everyone's friend'—he's a person you can confide in, he adds humor to most situations, and he is fair. I have truly enjoyed working with him. Thank you, Jim, you will be missed, and you will always be a part of the CTS and National LTAP families." **LTAP**



APWA president Ron Calkins (left) presents the PACE award to Minnesota chapter members.



ADA from page 1

transition plans, process guidelines for providing accessibility within public rights-of-way, and current ADA laws to help organizations fulfill this requirement. Please visit LRRB.org to view the guidebook.

The LRRB training will consist of three separate courses, each offered nine times throughout the state:

- Understanding Requirements and Developing a Transition Plan
- Design
- Construction

The training will also be posted on the web for later viewing.

The first course in the series—Understanding Requirements and Developing a Transition Plan—is designed to guide local agencies in their efforts to complete the self-evaluations and transition plans required under the ADA. The full-day course will provide context for the full implementation of Title II of the ADA but primarily focus on the responsibility of local agencies to build and maintain accessible

pedestrian infrastructure (sidewalks, curb ramps, signals, etc.). Classes are scheduled for December in each MnDOT district.

With additional content covering ADA design and construction, the course will provide attendees with information on the nuts and bolts of accessibility to help improve agency efficiency and influence project planning. The training will also cover the minimum requirements under the law along with recommendations for best practices from MnDOT.

Please see the Minnesota LTAP website for registration. **LTAP**

More resources:

- ADA Training: Understanding Requirements and Developing a Transition Plan (course offered throughout the state): mnltp.umn.edu/training/topic/ada/understanding.
- ADA Transition Plan for Public Rights of Way (LRRB/RIC, 2012RIC01)



Technology Exchange

The **Minnesota Local Technical Assistance Program** is part of the Federal Highway Administration's Local Technical Assistance Program (LTAP). LTAP is a nationwide effort designed to foster and improve information exchange among local practitioners and state and national transportation agencies. Minnesota LTAP is administered by the Center for Transportation Studies at the University of Minnesota, and cosponsored by the Minnesota Local Road Research Board and the Minnesota Department of Transportation.

The University of Minnesota is committed to the policy that all persons shall have equal access to its programs, facilities, and employment without regard to race, color, creed, religion, national origin, sex, age, marital status, disability, public assistance status, veteran status, or sexual orientation. This publication is available in alternative formats upon request.

Any product mentioned within should not be considered a product endorsement. Authors' opinions/findings do not necessarily reflect the views of Minnesota LTAP.

Contact us

Technology Exchange is published quarterly. For free subscriptions, mailing list changes, or extra copies, contact us at the address or phone number below.

Technology Exchange welcomes contributions and suggestions from its readers. Submit ideas and other comments to Pamela Snopl, managing editor.

Minnesota LTAP

Center for Transportation Studies
University of Minnesota
200 Transportation and Safety Building
511 Washington Avenue S.E.
Minneapolis, MN 55455
Phone: 612-626-1077
Fax: 612-625-6381
E-mail: mnltp@umn.edu
Web: mnltp.umn.edu

© 2017 Minnesota Local Technical Assistance Program (LTAP), University of Minnesota

Minnesota LTAP Resource Staff

Program Manager: Mindy Carlson, 612-625-1813, carlson@umn.edu
CTAP Instructor: Kathy Schaefer, 651-366-3575, kathleen.schaefer@state.mn.us
Workshop Registration & Facilitation: Teresa Washington, 612-624-3745, washi002@umn.edu
Managing Editor: Pamela Snopl, 612-624-0841, snopl001@umn.edu
Editors: Christine Anderson, 612-624-1572, ande4255@umn.edu; Michael McCarthy, 612-624-3645, mpmccarthy@umn.edu
Design: Angie Kronebusch, 612-624-0546, akronebu@umn.edu
Student Intern: Jamie Hulkonen

Photo Credits

Shutterstock, MnDOT, LRRB, FHWA, Dem-Con Companies, APWA-MN

Minnesota LTAP Steering Committee

Chair: Mitch Rasmussen, State Aid for Local Transportation Division, MnDOT
Joe Campbell, Federal Highway Administration
Will Elwell, Scott County; Minnesota Street Superintendents Association
Kent Exner, City of Hutchinson; City Engineers Association of Minnesota
Mike Flaagan, Pennington County; Minnesota LRRB Research Implementation Committee
Greg Isakson, Goodhue County; Minnesota County Highway Engineers Association
Steve Lillehaug, City of Brooklyn Center; City Engineers Association of Minnesota
Laurie McGinnis, Center for Transportation Studies
Gary Pedersen, Minnesota Association of Townships
Tom Peters, Office of Maintenance, MnDOT
Chris Petree, City of Lakeville; American Public Works Association – Minnesota Chapter
Lyndon Robjent, Carver County; Minnesota LRRB
Rich Sanders, Polk County; Minnesota County Engineers Association
Linda Taylor, Research Services Section, MnDOT

Printed on 50% recycled fibers, including minimum 30% postconsumer waste.



Use of shingle-aggregate mix for gravel roads is growing in state

In 2014 MnDOT completed a research project that investigated whether recycled asphalt shingles (RAS) could be incorporated into the surface of a gravel road without negatively affecting performance, and whether doing so would mitigate washboarding and dust. The results of the study were promising: In one test section, the blend of shingles and gravel significantly reduced the amount of washboarding, while a blend of shingles and limestone on a second test section reduced dust production by 34 percent.

Since then, the shingle-asphalt mix has been used in several areas of the state, and pilots are now under way in Scott and Carver Counties.

Smoother, less dusty roads

The 2014 study, funded by the LRRB, was triggered by two trends: too much shingle waste, too little gravel. According to the Minnesota Pollution Control Agency (MPCA), Minnesota generates more than 200,000 tons of waste roofing shingles annually, a majority of which heads to landfills. At the same time, the best gravel sources in the state have been used, and the grading and quality of surfacing gravel have worsened over time. Areas that use limestone gravel also face significant dust control issues that RAS may help to alleviate.

The specific prompt for the 2014 project was a gravel road in Jackson County that suffered severe washboarding. Washboarding is thought to be caused by the displacement of aggregate fines by passing vehicles, especially when accelerating or stopping. Use of a chemical stabilization product and mixing clay into the gravel were unsuccessful at addressing the problem. The county had the idea that blending ground shingles, which contain high-quality fine aggregate, might alleviate the problem.

Researchers first conducted laboratory testing to determine the physical characteristics of RAS and how it interacts with gravel, and then built two test sections. In Jackson County, the road was constructed with a 1-1/2-inch layer of 40 percent (by volume) shingles, ground to pass through a 1/2-inch sieve, and 60 percent class 5 natural gravel. Researchers monitored this road, a down grade that had experienced significant washboarding, for the performance of the surface.

The second test section, in Goodhue County, was constructed with an even mix of tear-off scrap shingles (TOSS) and Class 6 limestone by volume. Researchers evaluated this section primarily for the effect of RAS on the road's dust production.

Lab testing found that binding strength peaked at a mix of 40 percent shingles by volume. According to Jackson County personnel, the blend of shingles and gravel significantly reduced the amount of washboarding the road experienced. The section that used the shingle blend needed to be reshaped or bladed less often than control sections on the same roadway. County personnel also reported that the TOSS section recovered from the spring thaw faster than control sections, and it appeared to produce less dust.

In Goodhue County, researchers observed the dust generated and compared the dust quantities collected with the Colorado Dust Collector. Observations indicated a reduction in dust from the TOSS section compared to control sections. This finding was confirmed by the Colorado Dust Collector test, which found that the TOSS section produced 34 percent less dust than the control section after 298 days.



MPCA approval

Dem-Con Companies, a Shakopee-based waste and recycling firm, provided the RAS for the Jackson and Goodhue projects. The company, which has a history in processing shingles, submitted a Case Specific Beneficial Use Determination to the MPCA for the use of asphalt shingles in gravel roads. The MPCA granted approval this year. "This

Shingles continued on page 6

New guide offers cost-effective methods for slope stabilization

In a recent project, University of Minnesota Duluth (UMD) researchers determined effective methods for stabilizing slopes along Minnesota's locally maintained roads and created a guide recommending slope stabilization methods for common site types. Previously, there was no guide for public works engineers to stabilize slopes of the scale typically seen along locally maintained roadways. The Minnesota LRRB funded the project.

"We have recommended simple, effective methods for stabilizing at-risk sites and repairing common, recurring slope failures," says David Saftner, an associate professor in UMD's Department of Civil

Engineering. "While no single method is appropriate for all situations, several methods have proven effective, and our guidebook succinctly summarizes those methods for local government engineers."

The *Slope Stabilization Guide* begins with an overview of the common causes of slope failure and methods of stabilizing slopes. Next, eight different slope failure scenarios are presented. Descriptions of these scenarios include a summary of site conditions at each slope failure and recommended solutions to repair the failure such as removing and replacing soil, regrading and recompacting soils, managing groundwater and drainage, and using surface covers to prevent erosion. Following these descriptions are recommended resources that provide more information about each of the stabilization methods.

Ultimately, this study and guide address the need for a consistent, logical approach to slope stabilization founded in research and experience. "Our guide was developed using resources not typically available to all county engineering and maintenance departments such as soils lab testing, advanced modeling, and geotechnical analysis," Saftner says. "By implementing these recommendations, local government engineers can improve the stability of roadway embankments, minimize slope failure and associated damage, and decrease preventive maintenance costs." **LTAP**

- *Slope Stabilization Guide for Minnesota Local Government Engineers* (MN/RC 2017-17G, June 2017)
- Technical summary: *Field Guide Helps Local Engineers Stabilize Damaged Slopes* (MN/RC 2017-17TS, Sept. 2017)
- Final report: *Slope Stabilization and Repair Solutions for Local Government Engineers* (MN/RC 2017-17, June 2017)

New synthesis: alternative deicers

A new Transportation Research Synthesis (TRS) summarizes non-chloride-based deicers available on the market, including acetate, formate, glycol, and succinate-based deicing products.

A table provides a high-level summary of the non-chloride deicers under consideration. Based on this table, there are no clear standout deicers that are a best-case alternative to chloride-based deicers, but acetates appear to be the most moderate option because of functional temperature range, moderate cost, and impacts, the researchers say. However, the succinate-based products deserve consideration based on their potentially equal or similar performance to acetates and formates, they say. **LTAP**

- *Field Usage of Alternative Deicers for Snow and Ice Control* (LRRB/MnDOT, TRS 1706, Sept. 2017).





More from the LRRB and MnDOT:

- *Stakeholder Attitudes, Knowledge and Engagement in Local Road Systems Planning and Decision Making* (LRRB/MnDOT, 2017-39, Oct. 2017)
- *Prevention of Stripping Under Chip Seals* (LRRB/MnDOT, 2017-35, Oct. 2017)
- *Oversize/Overweight Vehicle Unified Permitting Process Phase I* (LRRB/MnDOT, 2017-26, Aug. 2017)
- *Traffic Impacts of Bicycle Facilities* (LRRB/MnDOT, 2017-23, June 2017) **LTAP**

Slope Stabilization Guide

for Minnesota Local Government Engineers






LRRB
LOCAL ROAD RESEARCH BOARD


Authors: David Saftner, Carlos Carranza-Torres and Mitchell Nelson

Report Number: MN/RC 2017-17G

Date Published: June 2017



mn
DEPARTMENT OF TRANSPORTATION



TECHNOLOGY

First-person vision goggles: The next evolution in bridge inspection?

Joe Campbell, the FHWA Minnesota Division assistant bridge engineer, has started a series of meetings around the state to further the discussion on drone use for bridge inspections. The presentations and demonstrations are focused on three parts:

- Discussion of the Federal Aviation Administration (FAA) Part 107 Rule of June 2016 for commercial drone/unmanned aircraft systems (UAS) use and its details that make it much easier for local public agencies to use drones in work activities.
- Drone systems consisting of accessories and peripherals that cost less than \$2,500, which can be useful tools to aid routine bridge inspections.
- First-person vision (FPV) goggles, the next evolution in bridge inspections, providing live images during inspection, control of drone camera movement, and photo/video functions.

FAA rule

Just over a year ago, the FAA issued a new Part 107 Rule. The rule modifies the requirement for commercial/government use of drones, simplifying the process for obtaining a "license" to operate a drone and making it easier for government agencies to use drones for official purposes. There are certain requirements to operate a drone under Part 107 that must be followed, Campbell says, but these rules should not affect the ability of a local public agency to inspect a bridge with a drone.

Drone systems

A number of recreational drones have come out over the past few years that cost under \$2,500. These drones are equipped with cameras that can shoot 4K high-resolution video and have 12+ megapixel cameras. "Some drones even include collision avoidance, which makes them very adaptable for bridge inspectors," Campbell says.

Just as in the case of cell phones and televisions, as the technologies advance and manufacturer competition grows, the costs of drones have dropped substantially over the past few years. As time passes, this trend is anticipated to continue. Newer drones will continue to evolve with technology while price points will remain competitive, he says.

Vision goggles

The exciting new development for drone technology has been the invention of FPV goggles. "This is the key point of the demonstrations," Campbell says.

The FPV goggles give an inspector the ability to get real-time, high-definition (HD) images using wireless technology. "This literally changes the way a bridge inspector can view the bridge and its



St. Louis County bridge inspection team leader Christopher Grahek wearing FPV goggles

components during routine bridge inspections," he says.

The FPV goggles give the perspective of being as close as 3 feet away (with a 2x or more zoom) from a bridge bearing that may be 30 feet above the ground or even over water—all while the inspector is standing in a safe area. The drone, paired with a set of FPV goggles, provides great visual acuity and gives a close-up view that was previously only available using snoopers, climbing gear, or other direct-access equipment. With the FPV goggle technology, the inspector can take these adaptive tools and have real-time HD visuals of the bridge components directly from the drone's camera.

This groundbreaking use of the FPV goggles and drones allows the bridge inspector to view images from the drone in a setting that is equivalent to being at the camera's location. There are even drones and goggles that can be paired to allow the goggles to control the view of the camera.

Campbell says that wearing the FPV goggles has been described as "a virtual-reality-like experience in the real world." According to one goggle manufacturer, "the visual a person gets when wearing FPV goggles is the feel of looking at an 18-foot home theater screen at 9 feet away." Campbell adds: "It is like sitting in the sixth or seventh row at a movie theater." The photo above gives the general impression of the drone location and the view an inspector gets when using the goggles.

The set-up that Campbell is using allows the inspector wearing the FPV goggles to take photos, record video, switch between photo/video mode, and even operate the camera gimbal movement right, left, up, and down. This pairing of the drone and goggles makes it very easy and natural for inspectors to focus on good visual inspection and easy documentation of the visuals they choose to record. It also allows the drone pilot to focus on the drone flight and collision avoidance, making the team inspection very efficient. The combination of the drone and goggles can be incorporated into a routine inspection, allowing the inspector to identify cracks and deficiencies at a distance of 3 feet.

The FPV goggles have been marketed primarily at the recreational market. The clarity, simplicity, and image quality makes them the perfect tool to complement a drone being used during bridge inspections, Campbell says.

For more information

Contact Campbell at joe.w.campbell@dot.gov or 651-291-6121 with questions or inquiries about attending or setting up a demonstration event.

Campbell plans to share more about the use of drones for bridge inspections in a future issue of the *Exchange*. Also in 2018, look for more information from Campbell concerning another new technology: the use of sonar to examine bridge scour. **LTAP**



The drone, goggles, and a tablet



Minnesota LTAP's Mindy Carlson models the goggles.



The view through the goggles

Drones from page 1

The third phase of a MnDOT research project into the use of drones for bridge inspection is now under way. This phase focuses on how the devices work in confined spaces.

Why is MnDOT studying drones?

MnDOT and local bridge owners have 600 bridge inspectors who monitor more than 20,000 bridges in Minnesota. Each bridge must be inspected once every 24 months. Bridges in poor condition and those considered fracture-critical (where failure of a single component could cause collapse) must be inspected every 12 months.

Large bridges can take weeks to fully inspect and often require inspectors to dangle from ropes or stand in buckets on the end of “snoopers,” cranes that reach from the bridge deck to below-deck level to put inspectors within sight of under-deck elements. Snoopers are expensive and require traffic lane closures, presenting safety risks to the traveling public and inspectors.

Phase 1 completed in 2015

MnDOT completed a small research project in 2015 to study the effectiveness of UAS technology applied to bridge safety inspections. The project team inspected four bridges at various locations throughout Minnesota. Results indicated that drones significantly augment inspection findings while reducing safety risks and inconvenience to inspectors and the public. The project earned a 2016 Minnesota State Government Innovation Award as well as awards and recognition from such groups as the American Public Works Association.

Drones designed specifically for structure inspections were unavailable during Phase I. The UAS used in that phase also had key operational limitations, including the inability to proceed when concrete and steel bridge components blocked Global Positioning System (GPS) signals. When that happened, the drone simply returned to base automatically.

Phase 2 examined more challenging bridges

In the second phase, MnDOT tested the use of an upgraded drone to examine larger and more challenging bridges. The new drone, which was specially designed for structure inspections, featured more robust imaging and infrared data-gathering capabilities, and was more flexible to control. Its operational

capabilities also were not diminished by the loss of GPS signals.

Investigators selected a prototype senseFly albris UAS to inspect four bridges. One was the Blatnik Bridge over the St. Louis River between Duluth, Minnesota, and Superior, Wisconsin, a 7,980-foot-long steel through-arch bridge with steel deck trusses. Researchers also investigated UAS use for infrared deck surveys.

The senseFly albris UAS offered a clear operational upgrade over the Phase I unit. It can operate without GPS; the camera lens can turn up and down at 90-degree angles; and protective shrouds and ultrasonic sensors prevent the propellers from striking bridge elements.

The drone worked well in the high, confined spaces of the Blatnik Bridge. It identifies and measures clearances, rope access anchor points, and other pre-inspection conditions for planning large-scale or emergency inspections. Photogrammetry software can be used with the UAS to develop three-dimensional models of bridges and bridge sites. Using infrared thermal sensors, the UAS can detect delamination of concrete while flying adjacent to lanes of traffic.

For smaller, confined spaces on bridges and culverts, the senseFly albris may not be ideal, according to the study. Despite its protective shrouds, it is not as collision-tolerant as needed for very tight spaces.

Costs were significantly lower with UAS inspections. Conventional inspection of the bridge would have required four snoopers, an 80-foot lift, and eight days of inspection, at a cost of about \$59,000 (without the cost of mobilizing equipment and traveling). The UAS Blatnik Bridge inspection would contract as a five-day, \$20,000 project.

Phase 3 to inspect confined spaces

Phase 3 will allow MnDOT to use a new drone specific to confined-space inspections. “This new drone is meant to reach places the prior drones could not, which will supplement our efforts nicely,” says Jennifer Wells, MnDOT maintenance bridge engineer. “Also, Phase 3 will include more bridge inspections in order to get a more comprehensive feel for cost and time savings.”

Phase 3, which began in the summer of 2017, uses the senseFly albris and the Flyability Elios, a collision-tolerant drone more suited to confined spaces such as box girders or culverts. During this



phase, researchers will identify which situations are best suited for drone use, what parameters should govern drone use in bridge inspections, and how UAS can be integrated into standard inspection operations at a county and district level. The Phase 3 project is scheduled to be complete by July 2018.

Based on the third phase of the research, MnDOT’s goal is to implement a statewide UAS bridge inspection plan, which will identify overall cost-effectiveness, improvements in quality and safety, and future funding sources for both state and local bridges.

(Adapted from the Crossroads blog and MnDOT Technical Summary 2017-18TS.) **LTAP**

More resources:

- Technical summary: *MnDOT Improves on Award-Winning Use of Drones for Bridge Inspection* (MnDOT 2017-18TS, August 2017)
- Final report: *Unmanned Aircraft System Bridge Inspection Demonstration Project Phase II* (MnDOT 2017-18, June 2017)

Self-propelled auto-flagger keeps workers out of traffic



Working with a Minnesota manufacturer, MnDOT-funded researchers developed a moving automated flagger assistance device (AFAD) that signals traffic at work zones. The AFAD is operated remotely by a worker who can stand off the roadway out of harm’s way.

MnDOT has used an AFAD to direct traffic in stationary maintenance and construction projects for several years. That AFAD, however, did not suit moving operations (such as pavement crack sealing) because the device requires towing. In this latest

project, MnDOT wanted to develop a self-contained, self-propelled mobile AFAD for use on moving work-zone roadway projects.

The new device offers large electronic signage, lights, and a traffic bar on a movable platform. It can be operated with a wired or wireless controller, as well as with controls on a handlebar mounted on the vehicle. It moves forward and backward, can be towed with a standard hitch, and employs onboard batteries and a charger.

Setup and takedown require more effort than conventional flagging, but this effort is not considered cumbersome, according to the final report. The moving AFAD can be operated by one person standing 400 feet or more off the roadway, and the device is large enough to be easily seen and understood by road users.

MnDOT is currently using the device, though modifications to improve its performance are expected.

“Everybody who has used the mobile AFAD has liked it,” says Jeremy Gjovik, transportation operations supervisor with MnDOT District 3. “We love our stationary AFAD unit. These units have really big

stop-slow signs—they’re so visible.”

(Adapted from the Crossroads blog and MnDOT Technical Summary 2017-18TS.) **LTAP**

More resources:

- Technical summary: *Self-Propelled AFAD Keeps Flaggers Safely Off the Road* (MnDOT 2017-09TS, June 2017)
- Final report: *Development of a Moving Automatic Flagger Assistance Device (AFAD) for Moving Work Zone Operations* (MnDOT 2017-09, March 2017)

From 2003 to 2015,
149
 roadway workers were
KILLED
 nationwide while
 flagging or directing traffic.

PAVEMENTS

Math proves the savings in pavement preservation strategies

Pavement preservation strategies can save money in maintaining an agency's highway network. Today, instead of individual projects and pavements, the focus is on sustaining infrastructure through whole-life investments and quantifying risks. Pavement preservation plays a key role in managing pavement systems in these whole-life programs.

Agencies have gained experience with preservation treatments and can tabulate the costs and expected impacts from using them. Each agency also can predict the need for preservation treatments from the age, condition, usage, climate, and other factors unique to sections of the pavement network. The EDC-4 pavement preservation initiative helps agencies pull together the information for their networks and identify strategies that take whole-life costs into consideration.



For example, from 2007 to 2012, the Kentucky Transportation Cabinet embarked on a process of diamond grinding—a treatment that corrects surface imperfections in pavements—for all 536 state-maintained lane miles of concrete pavement. The program reduced the average International Roughness Index (IRI) value—a method used to measure ride quality or comfort—from 112.1 to 74.5 over the five-year program. The cost of the program was about \$100 million, but the comparable cost of non-preservation treatments to achieve the same IRI values would have been in excess of \$1 billion.

The North Carolina Department of Transportation (NCDOT) has a long-standing chip seal program and has invested heavily in measuring performance, improving specifications, and training the workforce. Of NCDOT's 60,000 miles of paved secondary roads, about 44 percent have been treated with a chip seal, a surface treatment that combines layers of asphalt binder and aggregate.

The average cost of a chip seal treatment is \$25,000 per lane mile, compared to \$100,000 per lane mile for a traditional 1.5-inch mill-and-overlay project. By ensuring proper construction techniques and materials are used on chip seal projects, NCDOT is able to treat significantly more lane miles of paved roadways in a year than it could with a traditional mill-and-pave program.

The Washington State Department of Transportation (WSDOT) has a strategic maintenance policy under which \$13 million applied to 3,500 lane miles between 2009 and 2015 resulted in \$15 million in annual savings by delaying major resurfacing



Every Day Counts is the FHWA's initiative to advance a culture of innovation in the transportation community in partnership with public and private stakeholders. Every two years, FHWA works with state departments of transportation, local governments, tribes, private industry, and other stakeholders to identify a new set of innovative technologies and practices that merit widespread deployment through EDC. EDC-4 (2017-2018) builds on the progress of earlier rounds.

projects. In 2014, WSDOT implemented a policy that requires at least one maintenance treatment before a capital rehabilitation or resurfacing project can be programmed.

WSDOT found that when a chip seal is applied at the right time, the cost is 20 percent of the cost of asphalt resurfacing and 30 to 40 percent of the life-cycle cost of asphalt resurfacing. Because of that, WSDOT applied 1,500 lane miles of chip seal conversion between 2010 and 2015. The agency plans to convert at least 1,500 lane miles more over the next 10 years.

WSDOT estimates that applying preservation strategies to its network will save the agency \$80 million a year through 2025. That comes from an estimated difference between \$324 million as an average annual network cost baseline and a \$244 million average annual network cost with preservation strategies applied. **LTAP**

(Condensed from FHWA Innovator, Sept./Oct. 2017)

Shingles from page 3

allows shingles mixed with gravel to be used as an approved by-product on roads," says Ben Wetzell, waste services manager with Dem-Con.

Processing and blending

Manufactured shingles are run through a horizontal grinder and then are ready for use in gravel roads. Tear-off shingles are first run through a sort line to pick out large debris, then processed with a horizontal grinder. The grinder has several components that ensure RAS meets specifications. "Two magnets remove any ferrous material such as nails," Wetzell says. "Screens of various sizes can be used to grind to specific sizes such as a half-inch minus."

Once material is ground, RAS is ready to be mixed with aggregate to create a blend for application on gravel roads. Based on MnDOT and Dem-Con pilot studies in 2013 and 2015, a 1:1 blend by volume of RAS and gravel is recommended, Wetzell says.

After simple blending with a front loader until



RAS is evenly mixed with aggregate, the product is ready to be loaded into trucks and hauled to gravel roads. Once the trucks have reached their destination, material is dumped and immediately graded into the gravel road. After this initial grading, regular grading and maintenance can occur, and the roads can be traveled on immediately, Wetzell says.

Recent field tests

Additional field tests were conducted this year by Dem-Con in cooperation with Louisville (Shakopee) and Belle Plaine Townships. In Belle Plaine, a stabilizer was applied to the gravel surface of a 0.3-mile section. The stabilizer was blended 1:1 by volume with gravel aggregate. The result: a 68 percent dust reduction compared to the control section.

In Louisville, a stabilizing blend was applied to the limestone surface of a 1-mile test section. The result was a 50 percent dust reduction relative to the control section. "We plan to use the mix in the future on all township gravel roads," says John Weckman, a Louisville Township supervisor. "The cost is basically in the same ballpark as gravel. Plus, we don't grade as often because it packs harder. We graded three times this summer, instead of every two to three weeks in past years."

Other recent projects were in Becker County (4,500+ tons used) and Otter Tail County (3,325 tons). "The main goal was to keep shingle waste out of the demolition landfill," says Sandy Gunderson of Becker County's Land Use Department Environmental Services Division. "We have another pile started for use in the future." Other advantages, she says, are less chemical use for dust control and lower costs for landfill users: \$5.50/cubic yard for demolition recycled material, \$7.50/cubic yard for clean shingles, and \$9.50/cubic yard for clean demolition waste. **LTAP**

More resources:

- Technical summary: *Gravel Roads Made Smoother, Less Dusty with Addition of Scrap Asphalt Shingles* (LRRB/MnDOT 2014-06TS, March 2014)
- Final report: *Research Using Waste Shingles for Stabilization or Dust Control for Gravel Roads and Shoulders* (LRRB/MnDOT 2014-06, Jan. 2014)
- Ben Wetzell, Dem-Con Companies, benwetzell@dem-con.com, 952-224-7111



THE SHELF

Minnesota LTAP partners with the MnDOT Library to operate a state-of-the-art service that can help you track down almost any resource from Minnesota or beyond. Questions? Contact Marilee Tuite, Minnesota LTAP librarian, 612-626-8753, ctslib@umn.edu.

Impact of Low Asphalt Binder for Coarse HMA Mixes (MnDOT, June 2017)

Evaluates low asphalt binder content mixes to determine the potential for poor cracking performance and high permeability.

High-Modulus Asphalt Concrete Mixtures for Use as Base Course (National Center for Asphalt Technology at Auburn University, June 2017)

Considers the engineering properties of asphalt mixtures produced using a European specification for high-modulus asphalt concrete mixtures and used as base course.

Pavement ME Design: A Summary of Local Calibration Efforts for Flexible Pavements (National Center for Asphalt Technology at Auburn University, Aug. 2017)

Reviews state highway agencies' general approaches toward local calibration of flexible pavement performance models.

Improving Safety in Pavement Field Testing (Florida DOT, Sept. 2017)

Examines the risk to pavement testing operators when they measure pavement data in the field, both at highway speeds and within temporary traffic control or work zones; investigates the methods and technologies that would improve the safety of pavement field testing.

Small City Work Zone Sign Package Program Implementation (Iowa Local Technical

Assistance Program, Iowa State University, July 2017)

Identifies how smaller cities can acquire and set up devices to improve the safety of their work zones for their public works staff and the traveling public.

Manual on Pedestrian and Bicycle Connections to Transit (Transportation Research & Education Center, Portland State University, FTA Report No. 0111, July 2017)

Includes information on evaluating, planning, and implementing improvements to pedestrian and bicycle access to transit. It also explains how to integrate bike sharing with transit and make both options more accessible.

Reducing Speeding-Related Crashes Involving Passenger Vehicles: Safety Study (National Transportation Safety Board, July 2017)

Examines causes of and trends in speeding-related passenger vehicle crashes and countermeasures to prevent these crashes.

Establishing Procedures and Guidelines for Pedestrian Treatments at Uncontrolled Locations (Illinois DOT, FHWA-ICT-17-016, Aug. 2017)

Identifies the best practices of approving pedestrian crossings and pedestrian-crossing treatments at uncontrolled locations and to develop procedures and guidelines.

Improving Traffic Safety through Better Snow Fences: Image-Based Methods to Measure Trapped Snow Volume and the Snow Relocation Coefficient (Midwest Transportation Center, USDOT, Aug. 2017)

Examines three critical aspects of snow fence design: estimation of the snowfall, snow drift fluxes, and mapping of the snow volumes accumulated at the snow fence.

Assessment of Salt Procurement and Distribution Process (Ohio DOT, Aug. 2017)

Identifies current practices pertaining to winter maintenance, particularly in the procurement of rock salt, throughout the state of Ohio.

Collection of Freeze-Thaw Performance Data on Vail Avenue (Institute for Transportation, Iowa State University, Aug. 2017)

Examines 17 stabilized demonstration sections over a two-mile stretch of Vail Avenue in Hamilton County, Iowa, to identify cost-effective technologies and geomaterials for improving the performance of and mitigating freeze-thaw damage on granular-surfaced roads.

Safe Main Street Highways Part I: Washington State Collision Data and Geocoding (Washington State DOT, Sept. 2017)

Focuses on collision data from main street highways, which are stretches of state routes

Search me

The Minnesota LTAP website features custom search engines to help you find information. You can search:

- LTAP & TTAP Centers
- State DOTs
- Transit agencies
- University transportation centers

Bookmark mnltpap.umn.edu/publications/library.

Other great resources are:

- LRRB's site: lrrb.org
- MnDOT Library's catalog: dot.state.mn.us/library. **LTAP**

that also act as main streets for the local populations.

Safe Main Street Highways Part II: Analyses of Collisions Involving Pedestrians and Bicyclists in Washington State (Washington State DOT, Sept. 2017)

Identifies hot spots of pedestrian and bicyclist collisions on main street highways. **LTAP**

Using recycled concrete aggregate in new concrete pavement mixes can save money

In a MnDOT-sponsored study, researchers evaluated the performance of selected sections of concrete pavement in Minnesota that had been constructed with recycled concrete aggregate (RCA). They also developed guidelines for successful use of recycled aggregate in new concrete pavements.

Results showed that using RCA in concrete pavements can save money and is a sustainable practice that produces durable concrete pavement.

- **Historical performance.** Most of the existing pavement studied had not reached the terminal ride quality index of 2.5—the level that generally indicates a major pavement rehabilitation must be performed. Analysis showed that rehabilitation is required, on average, at about 27 years of service for RCA pavements and at 32 years for standard concrete pavements.
- **Materials and constructability.** Mix design can be adjusted to achieve traditional strength levels that older RCA mixes did not reach. Elimination of fines and stricter adherence to gradation specifications for concrete aggregate can achieve workable and durable mixes that are less likely to suffer excess drying shrinkage.

Pavements designed in this way meet the standards of the FHWA's INVEST program for sustainability in highway construction.

- **Life-cycle cost analysis.** Long-life RCA pavements are more economical in cost-benefit terms than are thinner, shorter-life RCA pavements.
- **RCA guidelines.** Researchers developed specification recommendations and design guidelines for the use of RCA in new pavement construction. Trial mixes are critical, and absorption and compressive strength must be examined before use. Recycled fines are not recommended, but otherwise RCA can be used in the full range of aggregate sizes between minimum and maximum. Recycled concrete pavement may not produce enough aggregate for both pavement and base course, but acquiring extra RCA to make the base course 70 percent recycled and 30 percent virgin makes the new pavement economical and sustainable. **LTAP**

More resources:

- Technical summary: *Using Recycled Concrete Aggregate in New Concrete Pavement Mixes* (June 2017)
- Full report: *Evaluation of Recycled Aggregates Test Section Performance* (Feb. 2017).
- *Recycled Materials in Unbound Aggregate Base Layers in Minnesota* (LRRB/MnDOT TRS 1604, Sept. 2016)

Report offers snow removal performance metrics

Transportation agencies measure their snow removal success in some way or another, but measures are often inconsistent—one agency's clear-pavement standard may not match another's. It's also difficult to determine if existing measures are accurately assessing the success of winter maintenance programs.

Clear Roads investigators surveyed more than 50 local, state, and international transportation agencies to better understand snow removal performance metrics in use and under consideration. The survey showed that outcome-based metrics have eclipsed traditional input- or output-based measures that focus on resources used.

More than 70 percent of agencies reported using outcome-based level-of-service (LOS) goals for road conditions or usage, with performance usually measured in terms of time required to achieve established LOS criteria. Maintaining safe and passable roads throughout storms, providing bare pavement as quickly as possible, and achieving specific traffic volumes were the most widely used LOS goals. Metrics included "bare pavement time," a measure of how long it takes to reach an observable level of uncovered pavement, and "speed recovery time," a measure of how long it takes driving speeds to return to normal following a storm.

Download the final report—*Snow Removal Performance Metrics* (CR14-05, May 2017)—at clearroads.org. **LTAP**



- Maximum cross slope is 2 percent.
- Maximum longitudinal slope is 8.3 percent.
- Minimal dimensions for a landing are 4 feet by 4 feet.

Answers to curb slope quiz on page 8:

WORKSHOPS & TRAINING

Calendar

For details and an up-to-date list of events, please see mnltp.umn.edu.

Truck-Weight Education Training

(1 RS credit) **LTAP**
Locations throughout the state in 2018

Road Salt Symposium

(1 RS credit) **LTAP**
Feb. 8, Plymouth

Extending Pavement Life through Pavement Preservation, Techniques, Strategies and Preventative Maintenance

(1 RS credit) **LTAP**
Feb. 13, Lakeville
Feb. 15, Detroit Lakes
Feb. 27, Duluth

Minnesota's Transportation Conference

Feb. 27–March 1, Mankato

62nd Annual Asphalt Construction & Quality Workshop

March 14, Brooklyn Center

Annual CPAM Concrete Paving Workshop & Awards Banquet

March 15–16, Alexandria

ONLINE TRAINING: Anytime, anywhere!

Culvert Design and Maintenance
(1 RS credit) **LTAP**

Sign Maintenance and Management for Local Agencies
(1 RS credit) **LTAP**

Gravel Road Maintenance and Design
(1 RS credit) **LTAP**

Work-Zone Safety Tutorial
(0.5 RS credit) **LTAP**

ATSSA Northland Chapter "How To"

(0.5 RS credit) **LTAP**
March 20–21, Fargo

Roads Scholar credit

You can earn credits in Minnesota LTAP's Roads Scholar (RS) program by attending LTAP and CTAP workshops and other cosponsored events. To learn more or enroll in the program, visit mnltp.umn.edu/roadsscholar.

LTAP workshops

LTAP workshops, along with events cosponsored by Minnesota LTAP, are marked with an **LTAP** at left. Check the web for details and to register online: mnltp.umn.edu. To be added to our print or electronic mailing lists, e-mail mnltp@umn.edu or call 612-625-1813.

CTAP workshops

Circuit Training and Assistance Program (CTAP) workshops bring LTAP services to your neck of the woods. CTAP uses a fully equipped van to provide on-site technical assistance and training. Each CTAP workshop earns 0.5 RS credit. For more information or to schedule classes, call the CTAP instructor, Kathy Schaefer, at 651-366-3575, or e-mail Kathleen.Schaefer@state.mn.us.

Minnesota Roadway Maintenance Training and Demo Day

(1 RS credit) **LTAP**
May 17, Bemidji

Transitioning into Leadership: Essential Skills for New Operators

(1 RS credit) **LTAP**
April 25, Lakeville

MARK YOUR CALENDAR:

Minnesota Roadway Maintenance Training and Demo Day
MAY 17, BEMIDJI

New from Clear Roads: plow operator and supervisor training modules

While every winter-weather state provides training for its winter maintenance crews, each program has its own strengths and focus areas. This Clear Roads project developed a comprehensive snowplow operator and supervisor training program that provides flexibility for states to modify or update the content as needed. The 22-module program covers equipment, materials, techniques, and procedures.

Jim Grothaus, Minnesota LTAP's former director, served as the principal investigator and local project manager. He was joined on the research team by Ann Johnson, project coordinator and author, and Connie Fortin, technical writer and content developer.

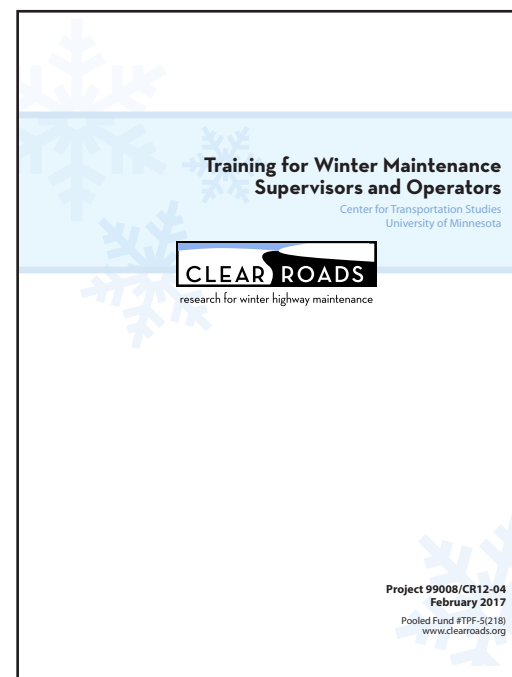
Through more than two years' work, the research team developed a comprehensive training program for entry-level and experienced snowplow operators and supervisors. Each module is designed to be presented by an instructor, and includes a PowerPoint

file with teaching notes and aids, and an instructor's guide with detailed directions, notes, resources, references, and suggested activities. A set of pre- and post-assessment tests is also included. The 22 modules contain 1,300 presentation slides and provide more than 42 hours of training materials.

For more information, or for access to the training materials for non-member agencies, please contact Clear Roads Administrator Greg Waidley at 608-490-0552 or greg.waidley@ctcandassociates.com. **LTAP**

More resources at Clearroads.org:

- Research brief: *Plow Operator and Supervisor Training* (Oct. 2017)
- Final report: *Training for Winter Maintenance Supervisors and Operators* (FR-CR 12-04, Feb. 2017)



Curb enthusiasm

Curb ramps allow people with mobility impairments to access sidewalks and pass through center islands in streets. Specific slope requirements are based on ADA standards. A short video from the City of Brooklyn Park—*ADA Ped Ramp Inventory* (2017, 1:23, youtube.com/watch?v=p1rbzZ66FpM)—demonstrates how to measure slopes. Take a look to answer the following questions. Answers are also on page 7.

Maximum cross slope is:

- 1 percent —2 percent —3 percent

Maximum longitudinal slope is:

- 6.8 percent —7 percent —8.3 percent

Minimal dimensions for a landing are:

- 3 feet by 4 feet —4 feet by 4 feet —5 feet by 5 feet

Minnesota LTAP offers leadership course

Minnesota LTAP will present a new course—Transitioning into Leadership: Essential Skills for New Supervisors—on April 25 at the City of Lakeville Water Treatment Facility.

This new course is designed for those thinking of transitioning from their current jobs to a supervisory or leadership position. It includes topics such as leadership vs. management, transitioning into leadership, managing different personalities, and leadership skills and tools.

Instructors are Chris Petree, public works director with the City of Lakeville, and Steve Albrecht, public works director with the City of Burnsville.

Minnesota LTAP is partnering with the American Public Works Association—Minnesota chapter to offer the course to local agency transportation personnel.

For more information, please see the Minnesota LTAP website. **LTAP**