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.

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

The Minnesota Local Road Research Board (LRBB) 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 LRBB 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
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

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

Technology Exchange

The Minnesota Local Transportation Assistance Program (LTAP) is a nationwide effort designed to foster and improve information exchange among local practitioners and state and national transportation agencies. The 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.

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

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December 2017

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.

The Gustafson of WS&B & 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 Raymond the Myron Calkins Young Leader of the Year Award. Raymond has been involved in public works for more than 10 years, working in both the private and public sectors.

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

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."

Thank you, Jim
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 lime on a second test section reduced dust production by 34 percent.

Since then, the shingle-aggregate 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 distraction incurred 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.

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.

In addition, the Minnesota Pollution Control Agency (MPCA) granted approval this year. "This approval opens the door for the Minnesota Department of Transportation to pursue RAS use in gravel roads," said David Saftner, a consultant to the LRRB.

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, reggrading and compacting 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.” LTA

- Slope Stabilization Guide for Minnesota Local Government Engineers (MN/RC 2017-17G, June 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. LTA

- Field Usage of Alternative Deicers for Snow and Ice Control (LRRB/MnDOT, TRS 1706, Sept. 2017)
- Traffic Impacts of Bicycle Facilities (LRRB/MnDOT, 2017-23, June 2017) LTA

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)
- 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 approval opens the door for the Minnesota Department of Transportation to pursue RAS use in gravel roads,” said David Saftner, a consultant to the LRRB.
First-person vision goggles: The next evolution in bridge inspection?

Joe Campbell, the FHWA Minnesota Division assistant bridge engineer, has started a series of meet- ings 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 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 feeling 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 wearing the FPV goggles would see. 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 view through the goggles

Minnesota LTAP’s Mindy Carlson models the goggles.

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

The drone, goggles, and a tablet

The photo above gives the general impression of the drone location and the view an inspector wearing the FPV goggles would see.

Minnesota LTAP’s Mindy Carlson models the goggles.

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The view through the goggles

Minnesota LTAP’s Mindy Carlson models the goggles.
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 1. 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 inspector. “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.

Winning Use of Drones for Bridge Inspection

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)

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

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 workzone 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 teardown 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.)
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 can also 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 336 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 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 1,300 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)

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

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. “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 (LRBB/MnDOT 2014-06TS, March 2014)
• Final report: Research Using Waste Shingles for Stabilization or Dust Control for Gravel Roads and Shoulders (LRBB/MnDOT 2014-06, Jan. 2014)
• Ben Wetzell, Dem-Con Companies, benwetzell@dem-con.com, 952-224-7111
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:**
  - 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 sustainable, and in some cases, cost-effective pavements.**
  - **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 specific 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 or 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)
- 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 drivers to return to normal following a storm.

**Other great resources are:**
- LRRB’s site: lrrb.org
- MnDOT Library’s catalog: dot.state.mn.us/library
- LTAP
- 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

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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)

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=p1rbZ66FpM)—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

Minneapolis LTAP offers leadership course

Minnesota LTAP will present a new course—Transitions 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

MARK YOUR CALENDAR:
Minnesota Roadway Maintenance Training and Demo Day
MAY 17, BEMIDJI

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 credits) LTAP

ATTSA Northland Chapter “How To”
(0.5 RS credits) LTAP
March 20–21, Fargo

Training and Demo Day
March 27, Mankato

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.

Trucking for Winter Maintenance Supervisors and Operators
(1 RS credit) LTAP
May 17, Bemidji

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 mnltap.umn.edu/roadsscholar.

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