Drift-free roads design tool now online

An online tool is now available to help transportation agencies design drift-free roads. The Minnesota Drift-Free Roads Design Module allows user to create two types of mitigation strategies: a proper road design and a snow fence design. A suitably designed roadway will deposit snow in ditches rather than on the roadway, and blowing snow that does reach the road will move across without drifting. Snow fences capture blowing snow upwind of a problem area and store that snow over the winter season.

With the tool, users are able to enter a site-specific blowing snow problem and examine solutions. For designing a snow fence, users will need roadway compass orientation and fetch distance. For road design, users need the following parameters: distance from edge of pavement to toe of backslope, depth of the ditches, height of the cut above the road surface, and compass orientation of the roadway.

Free chainsaw safety training available at your site

Minnesota OSHA Workplace Safety Consultation offers chainsaw safety training to help private- and public-sector employers meet the requirement that employees using a chainsaw be properly trained. Free on-site training is available, upon request, for groups of all sizes.

Employees using a chainsaw to remove trees, limbs, or brush or for storm cleanup are regulated by either the OSHA Logging Operations standard or the ANSI Z133.1-2000 Arboricultural Operations standard, regardless of the end use of the wood. Public works departments may be mostly cutting down storm-damaged wood, the most dangerous kind.

Details are online at doli.state.mn.us/WSC/chainsawsafety.asp. For additional information or to request training, contact trainer Ed LaFavor, ed.lafavor@state.mn.us or 218-362-5915. LTAP

Road salt: report looks at alternatives to keep our roads safe and waters healthy

Rock salt is the most common deicer used for winter maintenance in Minnesota. It’s affordable and effective, but causes damage to lakes, rivers, and groundwater. With concern growing about the high chloride levels in Minnesota’s waters, the Minnesota Local Road Research Board funded a review of approaches that might lead to lower salt use.

Reducing salt use continued on page 6

The tool was created by partnering staff at the Minnesota Department of Transportation and the Minnesota State Climatology Office, with technical support from the University of Minnesota.

Drift-free roads continued on page 7
Low-cost system collects data needed for reducing roadway-departure crashes

Roadway-departure crashes are a major safety issue on both the national and state levels. Rapid advancements in vehicle technology—including systems that warn drivers when they’re leaving their lane or even take control of the vehicle—are opening up possibilities to tackle this challenge. These systems require the creation of highly accurate maps of roadways and their boundaries so that they can reliably determine the precise location of the vehicle on the road.

To help acquire this road geometry information, U of M researchers have developed and evaluated a low-cost mobile data-collection platform. Mounted on a vehicle, the system consists of a GPS receiver capable of receiving real-time corrections, a LiDAR (light detection and ranging) scanner, and a computer—all costing roughly $6,000.

“Using this hardware, the system was able to detect and position curbs and guardrails with an accuracy of better than 4 inches,” says Brian Davis, a research fellow in the Department of Mechanical Engineering. “It could also determine road centerlines to within 2.5 inches relying only on the GPS-provided data.”

Also as part of their work, the researchers created an algorithm to process the data after collection to reduce the need for costly manual extraction of road features. Davis co-authored the final report with principal investigator Max Donath, director of the U’s Roadway Safety Institute.

The new system can serve multiple purposes and could especially benefit rural counties, which typically do not have access to high-end data-collection systems. “For example, more accurate measures of road curvature acquired inexpensively and automatically could be used to match speed limits with curves and provide curve-speed warnings using smartphones,” Davis says. “Low-cost pavement quality to inform maintenance decisions is another way to use these data.”

In Minnesota, more than half of all fatal car crashes are caused by vehicles departing from their lanes. Many of these involve running off state and county rural roads.

The sensor platform can be installed on various types of vehicles.

Minnesota award winners honored at APWA Congress 2015

Congratulations to our very own Jim Grothaus, director of Minnesota LTAP, for receiving the Donald C. Stone Award from the American Public Works Association (APWA). Established in honor of Donald C. Stone, the founder of APWA, the award aims to recognize outstanding and meritorious achievement of individuals assisting in the areas of continuing and graduate professional education for public works professionals.

“We are fortunate to work in a state where transportation education is a valued resource and to have the support of a great APWA chapter that is passionate about education,” Grothaus says.

The Minnesota Chapter of APWA received four other awards during the 2015 APWA Congress in Arizona:

- City of Waconia: Excellence in Snow & Ice Award (received at the 2015 Snow and Ice Congress)
- Minnesota Chapter: Presidential Award for Chapter Excellence
- MN 2005: Exceptional Performance in Journalism Award
- Target Field Station: Project of the Year

Kudos to all the award winners!LTAP

APWA president Brian Usher (left) presents an award to Jim Grothaus.

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Aging equipment: life-cycle analysis tool helps decide replacement time

Picking the right time to replace equipment can have a big impact on agency budgets. A project sponsored by the Minnesota LRRB developed an analytical tool to allow agencies to determine the optimal time—from a cost perspective—for equipment replacement. The methodology developed is available in an Excel spreadsheet.

Three agencies were selected for use as case studies: Minneapolis, Eagan, and Dodge County. Researchers conducted interviews with these agencies’ fleet managers and procurement personnel. They also evaluated equipment data provided by the agencies for a cross section of their equipment.

Using this information, researchers developed a life-cycle cost-analysis algorithm. The analysis requires several parameters, including initial cost, annual usage, annual tire cost, and useful life. Users can perform the analysis based on 2010 to 2014 fuel prices or on fuel prices they define. Local agencies could adapt the Excel tool to their needs, although it is difficult to find a widely agreed-upon methodology, according to the report.

Learn more:
• When is It Most Cost-Effective to Replace Aging Equipment? technical summary (MnDOT/LRRB, 2015-16TS)
• Major Equipment Life-cycle Cost Analysis final report (MnDOT/LRRB, 2015-16) LTAP

One conclusion of note: Engine efficiency should be a high priority in the replacement/repair decision.

Matrix riprap protects bridge abutments, reduces costs

Riprap cover—rock or other material—is often used to protect the side slopes of spill-through abutments from river scour. Obtaining large enough stone in some regions of the state, however, can dramatically increase project construction costs. The results of a new LRRB-funded study show that using smaller pieces of partially grouted riprap can reduce the costs associated with bringing in large pieces of riprap.

Abutments are the vertical substructures at bridge ends; spill-through (open) abutments, which only partially retain the embankment soil, need protection from river erosion and scour. They are used frequently in Minnesota’s waterway bridges.

Partially grouted riprap, or matrix riprap, is defined as placing conventional riprap material and then “welding” contact points with a specialized grout mixture. The grout covers and penetrates the riprap and bonds neighboring stones together, forming a “matrix” armor layer that serves to protect the structure.

Lab testing showed that the strength of partially grouted riprap was more than three times greater than conventional riprap, says Jeff Marr, principal investigator and associate director of engineering and facilities at the U of M’s St. Anthony Falls Laboratory (SAFL).

“Using matrix riprap in place of larger stone on bridge abutments could provide valuable savings for transportation organizations while delivering results that are as good as, or better than, other abutment-protection measures,” he says. LTAP

Learn more:
• Preventing Bridge Scour with Matrix Riprap technical summary (MnDOT 2015-15TS)
• Matrix (Partially Grouted) Riprap Lab Flume Study final report (MnDOT 2015-15)

Steel culvert pipe maps show service life statewide

This LRRB-sponsored project developed a series of steel pipe service-life maps for the state of Minnesota. A field campaign during the summer of 2014 collected soil resistivity and soil pH data state-wide (along with other observations). This information was used to calculate the service-life estimates for different types of steel pipe. Roughly 50 to 90 sample sites were selected per district, with samples taken from the embankments of state-trunk and county highways.

Calculations of service life were completed for 1B-, 16-, 14-, 12-, 10-, and B-gage galvanized and aluminized steel pipe. The maps demonstrate that aluminized pipe overall provides a greater potential for higher service life than galvanized pipe.

To provide a quick reference for the end user in selecting pipe material, regional areas of similar character were grouped together into six zones using the generated service-life maps. LTAP

Learn more:
• Minnesota Steel Culvert Pipe Service-Life Map final report (MnDOT 2015-31)
Preventive maintenance—in the lab and on the road

At this year's Pavement Conference in February, two presenters looked at different sides of preventive pavement maintenance. Mike Anderson, director of research and laboratory services for the Asphalt Institute, discussed his research on how asphalt aging can affect the timing of maintenance. Then Mark Watson, who oversees pavement preventive maintenance for MnDOT's Metro Division, outlined his pavement maintenance planning process.

**Asphalt aging and the timing of preventive maintenance**

Anderson began by reviewing studies done to characterize and quantify the aging of asphalt pavements. He referred to a 1977 study that correlated cracking with a loss in ductility, a 1981 test that looked at changes in binder viscosity over time, and a 1995 study that looked at how stiffness increases with aging and with increased pavement depth. Next he described a 2005 study conducted at Texas A&M by Dr. Charles Glover et al. Those researchers used a dynamic shear rheometer (DSR) to quantify the change in an asphalt binder's stiffness as the binder is transformed from an elastic solid to a viscous fluid via temperature change. "They looked at a range of temperatures where we expect asphalt binders to crack—and they found a good correlation between cracking and a change in ductility," Anderson said.

Then Anderson discussed a study that he supervised, which was conducted on the low-volume road at MnROAD. For that study, an asphalt pavement was constructed in 2008. Then, in each succeeding year for five years, an additional 100-foot segment of the pavement was chip-sealed. One control segment was left unsealed throughout the study. The goal was to see how changes in binder ductility, rheological properties, and cracking occurred over time.

However, the results of the MnROAD study were not what Anderson had expected. "We thought we would see something like [Figure 1]," he said. "If you plot the aging parameter vs. time for the unsealed section," Anderson explained, "you would expect the aging to increase and at some point reach the onset of cracking (the dotted red line in Figure 1). And if you did the same thing for the segment that was sealed immediately, it should progress to cracking much slower. But what we saw at the tops of the segments (see Figure 2) was no significant difference—though we did see aging with time at lower depths.

"And why did that happen? We're not really sure. But it had only been five years from the time it was constructed to when we did the coring. So maybe we just didn't get enough aging on the roadway," Anderson said.

He showed that this hypothesis was corroborated by a similar—but longer-term—study done on Minnesota Highway 56. In the TH56 study, a section of pavement was built in 1999; then successive segments were chip-sealed in 2000, 2001, 2002, and 2003. "Then we took cores in 2012," Anderson said. "We were hoping to see greater differences because it had been a longer time." Figure 3 shows the results of the TH56 study.

"Based on these results," Anderson said, "it appeared that you got the most benefit from sealing within the first couple of years. For the segments that were chip-sealed three or four years after construction, we had values that were pretty similar to the control. Though we didn't get quite what we were expecting on the MnROAD study, we did see data from the TH56 study suggesting that earlier sealing is better." 

**Selecting preventive maintenance projects**

Mark Watson, who oversees pavement maintenance project development for MnDOT's Metro Division, described his process for choosing preventive maintenance projects and deciding what treatments to use on them. Table 1 (page 5) lists preventive maintenance treatments used in the Metro Division along with Watson's comments.

Next, Watson explained how Metro's preventive maintenance funds are allocated. He said there are funds specifically set aside for preventive maintenance as well as some money earmarked for bridge maintenance. Watson explained that triage is done to decide which of the Metro Division's 1,763 miles will get which treatments. The raw data for these decisions is provided by MnDOT's instrumented vans that annually record conditions on all state-owned highways. That data goes into a decision tree, part of which is shown in Figure 4.

Watson explained that the full decision tree has 20 treatment options, ranging from full reconstruction to doing nothing. Plugging data into the decision tree generates a list of potential projects. "It doesn't capture all the maintenance activities we're doing. It also doesn't capture all project components—ramps, shoulders, frontage roads, other assets. Also, sometimes the [suggested] segments might not be the most economical once you figure mobilization and traffic control. Since the computer can't see those things, we take it to the next step—the project level."

**Eyes-ball the potential projects**

Watson's next step is to observe the listed projects. "It's one thing to have a number on a computer screen," he said. "It's another to go out and see it in the field. So we do a Metro drive-around and look at the overall conditions of the projects—cracking, ravelling, potholes, rutting, age, time since the last treatment. We also look at scheduled next treatments for five to ten years out. And one of the most important things we do is talk with the maintenance supervisors. They know where the bad spots are, how much patching has been done, what's going on with the spring-thaw, and specific problem areas." 

Preventive maintenance continued on next page

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**Figure 1:** Expected outcome of MnROAD study

**Figure 2:** Approximate results of MnROAD study

**Figure 3:** Approximate results of TH56 study

**Figure 4:** Part of MnDOT's preventive maintenance decision tree

---

**Equation:**

\[ MCE = \frac{E_s - E_c}{C_s - C_c} \]

Where:

- \( MCE \) = marginal cost effectiveness
- \( E_s \) = Effectiveness of selected project
- \( E_c \) = Effectiveness of comparison project
- \( C_s \) = Cost of selected project
- \( C_c \) = Cost of comparison project
Permeable pavements could improve safety, benefit environment

In the quest for sustainable pavement options that will improve road safety and are friendly to the environment, permeable pavements may be an answer, according to findings of a new study.

Researchers led by Professors John Gulliver and Lev Khazanovich of the U of M’s Department of Civil, Environmental, and Geo-Engineering completed a comprehensive review of permeable pavement research and construction in northern climates. The project was funded by MnDOT and the LRRB.

What are permeable pavements?

Permeable pavements are designed to absorb water and allow it to drain directly into the underlying layers of a pavement structure. They generally consist of a surface layer of a permeable material—such as asphalt, concrete, or pavers—and then one or more layers of aggregate with void spaces that can store stormwater runoff until it infiltrates into existing soil or is carried downstream by drain tile, Gulliver explains.

Infiltration is considered a “green” utilization of road runoff, and the permeable pavement will filter any water that runs off through the drain tile. Other safety and environmental benefits include a big reduction in water spray during storms, greater skid resistance, a smoother ride, and noise reduction.

There are two important aspects to permeable pavement design—structural performance and hydrologic performance, i.e., providing enough storage volume to temporarily store stormwater runoff.

Permeable pavement installations of different types are more common in Europe, but in the United States, use has primarily been for parking lots, recreational areas, and low-volume roadways. One of the concerns has been cold-weather performance, such as the potential for frost heave and damage from winter maintenance operations.

The final report includes findings from nine case studies of permeable pavements in Minnesota and other northern climate locations.

Case study: St. Michael

In a project in St. Michael, MnDOT researchers studied and compared the durability, maintenance requirements, hydrologic benefits, and environmental considerations of two porous asphalt sections and one densely graded asphalt section.

Temperature sensors within the pervious concrete cells revealed that the pervious concrete had more uniform temperature gradients throughout the pavement structure as compared to conventional concrete. This may be beneficial because large temperature gradients can cause warping and stresses, Gulliver says. Also, the data suggest that the pervious concrete cells experienced fewer freeze-thaw cycles than conventional concrete.

Finally, moisture was found to freeze at greater depths in the pervious concrete cells. The permeable pavements performed well in ride-quality, permeability, strain response, safety, and quietness,” Gulliver says. “As an added environmental benefit, they also performed better in water quality of runoff and infiltration. This could offer a solution to environmental problems involving stormwater runoff into lakes and streams, which often occurs with conventional non-permeable pavement structures.”

Additionally, that study indicated that snow and ice melt faster on the permeable pavements due to the void space, which allows heat from the ground to rise and keep the pavement warmer overall. The permeable pavement was also quiet and provided better skid resistance—an important safety measure for drivers—than a dense-graded impermeable surface, he says.

Case study: Robbinsdale

A reviewed case by Wenck and Associates conducted cold-weather comparisons on porous-asphalt paired intersections in Robbinsdale to determine how unsalted permeable asphalt compares to salted impermeable at residential intersections. The study found that unsalted permeable asphalt had a similar performance to salted impermeable asphalt in terms of melting time and bare pavements. “This may be an important source reduction mechanism for the salt concerns of cities in Minnesota,” Gulliver says.

Case study: Shoreview

The researchers also reviewed a case study of permeable pavements in Shoreview. In 2009, the city replaced a conventional asphalt road nearly a mile long and 25 feet wide in the Woodbridge neighborhood with pervious concrete, which was chosen as the best option to effectively manage stormwater runoff from the site to nearby Lake Owasso.

To collect samples of the infiltrated water, crews installed three wells over 40 feet below the ground surface near the pervious concrete system. Mark Maloney, Shoreview’s city engineer, says permeable pavements continued on page 7

Table 1: Preventive maintenance treatments used in the Metro Division

<table>
<thead>
<tr>
<th>Surface Treatments</th>
<th>Mark Watson's comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thin (2&quot;) asphalt overlay</td>
<td>“This is a gap-graded mixture that provides an open surface, which reduces splash and spray. It’s a thin surface so you can either include or not include the shoulders. And because it’s thin and has the open structure, a heavy tack coat is wicked up into the mix and creates a solid bond to the underlying pavement.”</td>
</tr>
<tr>
<td>Ultra-thin (5/8&quot;) bonded wear course (trade name: NovaCHIP)</td>
<td>“We use micro-surfacing in heavy traffic areas because it cures quickly.”</td>
</tr>
<tr>
<td>Micro-surfacing (3/8&quot;) to 1/2”</td>
<td>“This is a pretty aggressive chip seal that gives us high friction values. We usually don’t use it in a town or city where the road is used by cyclists or pedestrians.”</td>
</tr>
<tr>
<td>Chip seal (3/8&quot;)</td>
<td>“Fog seal produces low friction values. Even though the friction level would come back in a few months as the thin film wears off, a few months is too long to wait, so we put the sand on top.”</td>
</tr>
</tbody>
</table>

Localized Treatments

| Crack sealing (jout-and-seal)—smaller cracks | --- |
| Crack sealing (clean-and-seal)—larger cracks | --- |
| Mastic—even larger cracks | --- |

MnROAD Phase Two benefits exceed $10 million/year

A MnDOT report summarizes the outcome of the many different research projects at MnROAD completed during Phase Two, which began in 2007. The Phase Two initiative achieved a benefit-to-cost ratio of more than 3-to-1—not including the savings from the other 16 state agencies involved with the studies. Benefits of MnROAD Phase-II Research final report (MnDOT 2015-19) is available at Irb.org. LTAP

Preventive maintenance from previous page

Finally, Watson commented on several additional issues that are factored into the final decisions:

- Stringing: “We try not to put chip seals on roads that recently got marked. We also consider adding bike lanes.” He also said that, since Metro switched to recessed markings, 80-90% of those markings are surviving snowplowing.
- ADA compliance: “The Department of Justice now says we need to put in ramps for microsurfacing projects.”
- Traffic: “We want to coordinate with local projects; if a road is being used as a detour route, we don’t want to make things worse,” Watson concluded by pointing out that this process is the result of MnDOT’s 14+ years of experience with pavement management.

—Richard Kronick, LTAP freelancer LTAP
The Clear Roads program publishes new materials for winter maintenance

The Clear Roads pooled-fund research program has published the following new materials. All are available at clearroads.org.

Clear Roads is a national research consortium focused on rigorous testing of winter maintenance materials, equipment, and methods for use by highway maintenance crews. The Minnesota Department of Transportation is the lead agency.

Comparison of Material Distribution Systems

Spreader systems range from relatively inexpensive—such as in-house modifications to a dump truck’s tailgate—to sophisticated vehicles that are designed specifically for spreading deicing materials. Spreaders may be outfitted with prewetting systems or salt slurry generators and additions like ground-speed controllers or zero-velocity units. With such a wide range of approaches, it can be difficult for an agency to identify which options will deliver the best performance cost-effectively.

To help agencies compare and select spreader systems, researchers created a catalog of 85 systems and components, along with a report that captures practitioners’ experiences with spreader performance.

Environmental Factors Causing Fatigue

During winter events, equipment operators work long, stressful hours, and fatigue can be a major problem resulting in higher crash rates, lower productivity, and increased health issues. This project identified sources of fatigue in snowplow operators and developed realistic recommendations for reducing or eliminating fatigue. General recommendations include:

- Encourage the use of breaks and naps to reduce fatigue.
- Encourage drivers to report fatigue.
- Increase vehicle maintenance and use equipment such as segmental snowplow blades or rubber blades that reduce noise and vibration.
- Consider scheduling shifts so they do not start or end during the circadian low between 2 a.m. and 6 a.m.
- Offer shift options.
- Increase personal interactions between managers and drivers, and involve snowplow drivers in the decision-making process.

Developing a Totally Automated Spreading System

Automating the material application rate setting may improve the effectiveness of the material spreader by reducing the potential for human error. This is of particular importance as winter maintenance agencies face the prospect of a shrinking, less-experienced workforce as operators age and retire. In this project, researchers wrote three guides:

- An introduction to spreader automation technology
- A hierarchy of automation elements that snowfighters can use to assess their current equipment
- An overview of available systems comparing the features of different products

Reducing salt use from page 1

The 50-page synthesis looks at three areas:

- Non-chloride deicers
- Permeable road surfaces; pavement texture, color, and material options that would provide better melting or traction
- Winter speed limits or other winter driving changes

Non-chloride deicers

The synthesis gives short descriptions of various types of non-chloride deicers. Accompanying tables present characteristicssuch as environmental harm, ice melt capability, waste color, cost, melting temperature range, and corrosiveness to steel—for both non-chloride and chloride deicers.

“There is no ‘perfect solution’ as far as product selection,” says Connie Fortin of Fortin Consulting, one of the report’s authors. “No chemicals currently marketed and used in winter maintenance are harmless for lakes, rivers, and wetlands. The most strategic use of deicers is to use a selection of products that will meet your needs and reduce the total volume of deicer, abrasive, or additives needed.”

Permeable road surfaces; pavement texture, color, and material options

The synthesis then turns to a review of pavement options that reduce the need for deicers.

One option is use of permeable road surfaces. Permeable pavements allow water to pass through and infiltrate into the soil. As a stormwater best management practice, permeable pavements have been used to reduce runoff and the water quality degradation that can be associated with it. (See related article on page 5.)

Other options touched on in this section include:

- Reducing road widths. Narrower roads mean less area for salting.
- Reducing snow drifts. Easy modifications can be made to roadway design or the design of adjacent areas to significantly reduce the amount of salt used. (See page 1 for an article about a blowing snow control website.)
- Color. Using darker asphalt could attract sunlight and speed the melting process. Pavement roughness or grooving. Rougher surfaces slow ice formation and reduce adhesion.
- Pavement overlays. Overlays may reduce ice adhesion by increasing surface roughness and/or through better retention of applied anti-icing chemicals.

“The possibility of using other pavement options to decrease the reliance on road salt is promising,” says coauthor Nancy Mulhern. “The use of chlorides cannot be reduced beyond a certain point unless changes are also made to the roadways or other transportation alternatives are pursued. Some of the methods to reduce the use of chloride have straightforward implementation pathways and are not excessively expensive. In fact, many of these pavement options are less costly overall than the current use of deicers for winter maintenance.”

Winter speed limits or other winter driving changes

The final section looks at five ways for the public to be involved in reducing chloride use: increased public awareness, winter driver education, tire technology, winter speed limits, and reduced road use during a storm event.

“Minnesota needs more public awareness around safe winter driving and the impacts of road salt on our transportation infrastructure and environment,” says coauthor Lauren Tieden. “And the driving instruction provided to new drivers does not address winter driving techniques in much detail.”

Variable speed limit signage could encourage drivers to slow down, in turn reducing crashes or allowing roads with a lower level of service to be safely used. Good tires—whether winter, studded, or all-season—that do not have worn treads provide traction to let drivers use snowy and icy roads without requiring bare pavement conditions.

The final approach discussed is getting and keeping vehicles off on the road during storms and clean-up. Drivers are much less likely to stay put if a trip is work-related. “State and local officials could start the conversation with large employers and other organizations to discuss options such as public transportation options or telecommuting,” Fortin suggests.

Chloride Free Snow and Ice Control Material (TRS 1411) is available at Irbr.org. LTAP

MARK YOUR CALENDAR:

15th Annual Road Salt Symposium
Feb. 4, Chaska
More fun with words!

“Writing can be important for you’re job.”

Did you catch the error in that sentence?

It should be:

“Writing can be important for your job.”

• “You’re” is contraction of “you are.”

• “Your” indicates possession. (Hint: if you can replace “your” with “his,” it’s the right pick.)

Do you see any errors in this one?

“Look over there. They’re cleaning their trucks.”

This one is correct as is.

• “There” indicates a place, position, or point. It’s also used with “to be” verbs (be, am, was, were), for example, “There is a party tonight.”

• “They’re” is a contraction of “they are.”

• “Their” is possessive. (Hint: if you can swap in “my,” it’s the right pick.)

Free web-based seminars on highway/bridge construction

More than 90 web-based training courses are available through the Transportation Curriculum Coordination Council (TC3). Courses fall under several categories, such as pavements and materials, geotechnical, construction and maintenance, highway safety, and site and personal safety.

TC3, a state-based initiative of the American Association of State Highway and Transportation Organizations (AASHTO), develops and maintains a national curriculum for various transportation disciplines. AASHTO partners with the Federal Highway Administration and the National Highway Institute (NHI) to deliver the training.

Users must log in at the NHI website to register for the free courses. Creating an account allows you to view your training history.

Read more about TC3 at tccc.gov. LTAP

Permeable pavements from page 3

the use of permeable pavements allowed the city to eliminate the need to build and maintain conventional stormwater infrastructure, such as inlets, pipes, and ponds in the Woodbridge neighborhood.

“One benefit was that the city was able to accomplish its goal of reconsidering public infrastructure to modern, sustainable standards without negatively impacting the character of residential neighborhoods,” he says.

After four complete winters, the pervious concrete road in the Woodbridge neighborhood has no unusual operational issues and the system is performing as intended, according to the research report.

Maloney says that the city of Shoreview will continue to consider and use permeable pavements as possible solutions to public infrastructure problems. “Shoreview’s permeable pavement installations were innovative solutions to real-world problems, such as how to rebuild public roadways in an age of increasing concern for water management,” he says. LTAP

—Lexi Gusso, LTAP intern

Low-Cost Rural Surface Alternatives: Demonstration Project (Rural Department of Transportation, FHWA Project TR-664)

This report describes stabilization methods for preventing or mitigating freeze-thaw damage to granular surfaced roads and identifies potentially effective and economical methods given soil and climate conditions.

Porous Asphalt Pavements with Stone Reservoirs (Federal Highway Administration, April 2013)

This tech brief provides an overview of the benefits, limitations, and applications of porous asphalt pavements with stone reservoirs, including considerations for design, construction, and maintenance.

Asphalt Mixture Performance Characterization Using Small-Scale Cylindrical Specimens (Virginia Department of Transportation, VCTR 13-428)

This report investigates the use of small-scale cylindrical specimens as an alternative to conducting dynamic modulus testing of asphalt mixtures.

Blended Aggregates for Concrete Mixture Optimization (Federal Highway Administration, FHWA-IF-15-019)

This tech brief explains how the measurement of aggregates in concrete mixtures for paving applications can have an impact on workability and mixture performance.

Evaluation of Aggregate Subgrade Materials Used as Pavement Subbase/Granular Subbase (University of Wisconsin Center for Transportation, FHWA-67-13-013)

This report evaluates the field performances of its new aggregate subgrade specifications by using an image analysis technique to characterize the size, shape, texture, and angularity properties of selected aggregate subgrade materials.

Developing a Transportation Safety Plan: Information Tools for Tribal Governments (Federal Highway Administration, Summer 2013)

This report provides instruction modules to aid in development of transportation safety plans for tribal transportation planners.

Statewide Cycloplan: Bicycle Planning Tool & Participatory GIS (FHWA-ATL-15-29)

This report explains development of a cyclo-path that enables bicycle routing for the state of Minnesota, features a user-friendly interface, and provides useful features for transportation planners.

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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, ctstlib@umn.edu.

Drift-free roads from page 1

College of Food, Agricultural and Natural Resource Sciences.

The design tool is one of the components of the Blowing Snow Control Tools website. The site also includes:

• Cost-Benefit Web tool: This tool allows transportation agencies to estimate the return on investment of implementing blowing snow control practices such as living snow fences or standing corn on private lands.

• Webinars demonstrating how to use both tools.

• Videos, including Fences that Save: Cost-Effective Snow Control Tools. This video describes the standing corn row program. It was produced by MnDOT Video Services.

For more information, see snowcontroltools.umn.edu. LTAP
1. In a clear zone, this must be crashworthy.
2. Rock or other material used on an embankment slope to prevent erosion.
3. These secure loads...and get moved along the sideline.
4. _____ pavements absorb water and allow it to drain to the underlying layers.
5. What some gravel roads…and athletes’ abs...look like.
6. Vertical substructure at bridge ends.
7. Part of a truck…and what you might do before the big game.
8. Reinforced ____ is used to make rigid pipe for culverts.
9. This winter maintenance product damages our waters.
10. Drift-free roads deposit snow in the ______ rather than the underlying layers.
11. Standing ____ rows can be used as living snow fence.
12. This can lower your productivity and increase crash rates.
13. MnDOT uses a decision ___ to prioritize maintenance.
14. This LTAP training will be in Little Falls on May 19.

**Find the hidden answer...and win an online course registration!**

It’s time for Minnesota’s beautiful fall colors: orange, maroon, gold...and purple. When you finish our fall puzzle, the letters in the shaded boxes, moving from top to bottom, will spell out someone who wore maroon & gold with great success. Puzzle answers are taken from articles in this issue and from our online courses. E-mail the answers to us at mnltap@umn.edu by November 15, 2015. We’ll hold a drawing to pick up to five lucky winners of a free registration for one of our online courses. The winners and the answers will be posted in January. **LTAP**

**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.

**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: mnltap@umn.edu/training. To be added to our print or electronic mailing lists, e-mail mnltap@umn.edu or call 612-625-1813.

**CTAP workshops**
Career 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 elective 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.

**MAAPT 62nd Annual Asphalt Conference**

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**First Annual 2016 National Road Research Alliance Conference (formerly TERRA)**

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**Extending Pavement Life through Pavement Preservation Techniques, Strategies, and Performance Measures**

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**Winter Maintenance Training and Demo Day**

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