

ACCELERATOR

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Putting your ideas in motion

NEWLY FUNDED RESEARCH SEEKS TRANSPORTATION SOLUTIONS



We're going digital!

In support of MnDOT's sustainability initiatives, this will be the last print edition of Accelerator. To receive the electronic version of this newsletter, subscribe at www.mndot.gov/research/accelerator.html.

Drivers seem to generally understand that flashing yellow arrow (FYA) lights indicate permitted (but not protected) left turns, but they can be confused by time-of-day changes in protective and permissive phasing. A newly funded research study will assess driver comprehension of different light configurations and develop improved guidance for FYA implementation. **PROPOSAL 583**

- **Can transverse rumble strips improve safety at rural intersections?**
- **Are Minnesota's pavement markings ready for automated vehicles?**
- **How do we best manage roadsides to serve as pollinator habitats?**
- **What methods can improve driver comprehension of flashing yellow arrows?**

The MnDOT Research Steering Committee and the Minnesota Local Road Research Board solicit research ideas each spring from transportation practitioners and later request proposals from universities. The research governing boards meet in December to hear these proposals and **select projects for funding**. Research

ideas for the upcoming funding cycle are currently being accepted.

Interested in serving on a **Technical Advisory Panel**? Panel members play an essential role in the success of a research project by guiding the work and reviewing deliverables. Reach out to research.dot@state.mn.us to get connected.

Learn more about the newly funded projects at mndot.gov/research/awards.html and click on a project title to sign up for project alerts.

Ideas for the 2020 funding cycle are due on **March 16**. Visit mndot-lrrrbideascale.com to submit an idea.

Twenty-three new Minnesota transportation research projects have been awarded funding. MnDOT's academic research solicitation was highly competitive this year, receiving 82 proposals for projects ranging from pedestrian crossing safety to snowplow driver fatigue.

Researchers hope to tackle cutting-edge transportation questions, such as:

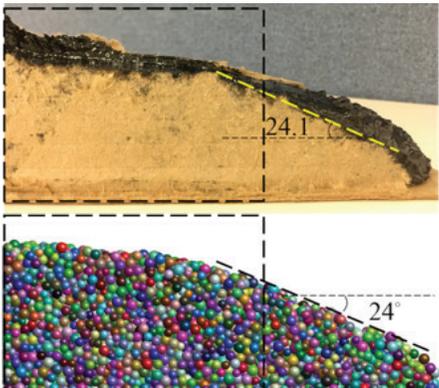
- **Have Minnesota's warmer winters increased the number of freeze-thaw cycles?**

Developing a High-Density Asphalt

MATERIALS & CONSTRUCTION – A dense asphalt pavement is a durable asphalt pavement. MnDOT’s asphalt designs aim for a density of 4% or 5% air voids to keep water out and asphalt strong under the weight of traffic. But in practice, air void content can range from 7% to 10%.

The Indiana Department of Transportation designs asphalt pavements with 5% air void content. Researchers in Minnesota sought to develop a similar high-density asphalt mixture using Minnesota materials. In this project, investigators evaluated 3% and 5% mixtures in various laboratory tests and digital modeling. Results from these studies allowed researchers to identify the physical qualities of fine aggregate that lead to easier compaction and long-term levels of density and stiffness. The next phase of this project will produce the new 5% mixture design.

TECHNICAL SUMMARY 2019-41



In one analysis, researchers compared the flow angle of asphalt poured (top) and modeled in the lab (bottom).

Reducing Asphalt Levels in Recycled Mixes During Hot Weather



MATERIALS & CONSTRUCTION – Summer heat at a paving site can push temperatures to 125 degrees Fahrenheit (°F). The safety and comfort of road crews are some of the challenges of summer projects; another is the asphalt itself. In high heat, the aged binder in recycled material can affect the workability of the mix. Under these conditions, crews often reduce the amount of added binder to maintain a workable product. But is that a good solution?

To evaluate this practice, investigators gathered mixes used in the field, prepared blends with standard and lowered amounts of binder, and tested performance at various temperatures. The results generally

confirm that less binder can be used at work sites during hot weather. At room temperature, the standard 2.5% to 3% new binder level remains best. But at 110°F, 1.75% mixes met performance tests, and at 125°F, 1.5% mixtures showed good performance. As working temperatures rise, compaction and density improve. While some other qualities deteriorate, the asphalt still meets performance standards.

The best news is that reducing binder levels to 1.5% can trim \$200,000 from expenses for 5 miles of a two-lane rural highway. A more workable asphalt, shorter labor windows and reduced material costs produce a clear win for local road agencies.

TECHNICAL SUMMARY 2019-43

Preferred Aggregate for Rural Pavement Base Courses

MATERIALS & CONSTRUCTION – The most widely used aggregate for rural pavement base courses in Minnesota is MnDOT Class 5 virgin aggregate. In an analysis of other aggregate base courses, MnDOT and the Local Road Research Board (LRRB) surveyed road agencies in states with similar climates to learn about their preferred base courses for low-volume asphalt and concrete pavements.

Survey responses from nine state transportation agencies showed that only Wyoming requires virgin aggregate or nat-

ural materials exclusively for low-volume pavement base courses; even MnDOT allows recycled base courses, if in practice it is not preferred.

MnDOT’s maximum aggregate size of 1.5 inches is typical, though the required minimum 10% crushed aggregate content is low. Other states specify crushed content levels as high as 100%. MnDOT and LRRB are using the report’s findings to identify aspects of their Class 5 preferences that warrant evaluation.

TRS 1905



Clear Roads Develops Snowplow Training Materials for Challenging Interchanges

MAINTENANCE OPERATIONS – Snowplow operators need to clear all sorts of interchanges and intersection configurations, including roundabouts and highway on-ramps. Through a project funded by the MnDOT-led Clear Roads multi-state pooled fund, researchers documented best practices in snow removal for various intersection geometries.

They created a practice manual, reference cards and a 66-minute video showcasing the most efficient pass sequences. These tools will not only help better train operators—resulting in more effective plowing—but will help Minnesota’s transportation agencies manage resources and justify the purchase of specialized equipment such as wing plows.

CLEAR ROADS PROJECT 14-03



The goal of the Federal Highway Administration’s e-Construction initiative is to move construction project management from a paper-based to electronic-based system. As a result, many state highway agencies now have a significant amount of nongraphical project data, which could be put to use for monitoring project performance and future planning.

Webinar — Next Phase in e-Construction: Use of Nongraphical Data

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A new webinar series produced by the Transportation Research Board addresses this next phase in e-construction. Presenters discuss the efficiencies gained through the use of nongraphical project data harvested throughout the typical project delivery process for smarter project delivery and management. Available at vimeo.com/showcase/6349877.

New Tool Allows MnDOT to Better Estimate Bridge Construction Time



BRIDGES & STRUCTURES – Because building a bridge is enormously complicated, engineers begin planning bridge construction projects years in advance. Staging, materials, traffic control and budgets must all be considered. Accurately estimating how long construction will take can reduce cost overruns and is essential for managing traffic control needs. Because estimations are incorporated into construction contracts, they must be as accurate as possible.

A new spreadsheet-based tool allows engineers to project time frames based on bridge design elements, work scheduling and other inputs. The tool draws on bridge construction data stored in a database of comparable projects completed in the past 10 years. The database will continue to expand with details from more bridge projects, making future project estimates even more accurate.

TECHNICAL SUMMARY 2020-01

Guidance for Potentially Acid-Generating Materials in Northern Minnesota

ENVIRONMENTAL – Across Minnesota and especially in northern regions of the state, the bedrock and surface rocks left over from glaciers contain minerals that are potentially acid-generating (PAG). When exposed to air and water, this sulfur-rich rock and soil can produce acidic drainage that can contaminate surface and groundwater, and harm vegetation and aquatic life.

PAG becomes particularly problematic for highway construction projects that expose and use local bedrock and soil. Acid

generated from these materials can degrade pavements, corrode metal and make slopes unstable.

A new, comprehensive manual helps MnDOT decision-makers identify and mitigate the effects of PAG materials at future highway construction sites. This resource incorporates insights from past Minnesota highway projects, the Minnesota Department of Natural Resources and other state transportation agencies.

TECHNICAL SUMMARY 2019-40



Membranes and limestone are used to prevent acidic drainage from PAG fill materials on this embankment in northern Minnesota.

Vulnerability Maps Help Road Agencies Anticipate Where Slopes Could Fail

POLICY & PLANNING –

Heavy rainfalls have become more frequent in Minnesota, and annual precipitation levels are climbing. Slopes near highways suffer when rainfall combines with flooding, frost action and geological factors to destabilize slopes and cause failures.

In two phases of research, investigators developed maps of roadways in 44 of Minnesota's 87 counties that chart slopes within a half-mile of roadways in 10-meter-by-10-meter units. Areas are color-coded for their vulnerability to failure based on slope shapes, proximity to risk factors like streams and past failures.

Available as PDFs and 20-by-30-inch posters, these maps point time-strapped state and county engineers toward slope segments that may require monitoring, future inspection or immediate attention. Research is in motion to finish mapping the entire state.

TECHNICAL SUMMARY 2019-12/28



New maps identify slopes susceptible to risk from rainfall and other factors, like this ditch washout on U.S. Highway 169 near Belle Plaine.

Integrated Approach Improves Pedestrian Crosswalk Safety

TRAFFIC & SAFETY – Traffic-related pedestrian deaths have been increasing in Minnesota. In 2016, there were 60 pedestrian fatalities, the highest number since 1991. The trend continued in 2019. In response, researchers investigated the Stop for Me campaign, which is sponsored by the St. Paul Police Department and community partners, to determine if this multifaceted, integrative program changed drivers' yielding behavior at crosswalks.

Researchers monitored the effects of the program's educational outreach strategies of flyers and online materials, high-visibility enforcement (warnings and tickets), and low-cost engineering treatments, such as one or more intersection signs placed across the 16 study sites.

Results showed significant improvement in drivers' yielding behavior over the course of the program. At the start of the project, the yielding rate was a very low 31.5%. The rate rose to 78% during a multiple street sign installation effort. This multifaceted, focused program, which successfully altered driver behavior and made crosswalk yielding the norm, could be easily transferred to other cities and communities.

For more about this campaign, visit smart-trips.org/stop-for-me.

TECHNICAL SUMMARY 2019-29



This image from the Stop for Me educational campaign shows the common hazard of a vehicle stopping too close to the crosswalk, restricting the crossing pedestrian's view of other traffic.

Transportation Research Synthesis

A *Transportation Research Synthesis (TRS)* summarizes transportation research activity and practices among state departments of transportation. To view these reports or request a TRS from the MnDOT Office of Research & Innovation, visit mndot.gov/research/TRS.html.

Best Public Engagement Practices for Reducing Roadwork Impact

POLICY & PLANNING — MnDOT's Office of Public Engagement and Constituent Services funded a study to determine how road agencies in Minnesota and other states manage construction projects to mitigate the impact of roadwork on local businesses.

Research and a survey of practice showed that every surveyed state and local agency recognizes the need to engage local business owners and the community in activities that communicate and reduce project impacts.

The most effective practices include virtual meetings and animated project models, Facebook and Twitter, and project communication panels formed locally by area businesses and citizens. These local groups work with transportation agencies, contractors and the public to issue weekly and sometimes daily updates about big projects and areas where traffic impacts will be felt.

TRS 1901

Reusing Wastewater at Minnesota's Truck Stations and Rest Areas



Investigators tested samples from truck station holding tanks.

ENVIRONMENTAL – Despite Minnesota's thousands of lakes and abundant surface water, 75% of the state's water comes from aquifers and is used at increasingly unsustainable rates. Researchers investigated the potential for wastewater reuse at MnDOT's 137 truck stations and over 50

rest areas, which could save money and conserve water statewide.

Investigators examined station wastewater samples across the state to identify possible contaminants and determined that these could be easily mitigated. They also identified state regulatory modifications that could promote easier wastewater reuse.

The project looked at various wastewater reuse systems and identified two that MnDOT would be able to easily implement and manage: a recirculating sand filter and a membrane bioreactor.

A long-term cost evaluation showed the membrane bioreactor to be the most economical for the agency; one of these has already been installed at Granite Falls and another station, with more sites being considered.

TECHNICAL SUMMARY 2019-22

Iron-Enhanced Ditch Check Filter Removes Stormwater Phosphorus



A filter like this placed in a ditch check (the gravel mound) will improve a swale's effectiveness in handling pollutants from highway runoff.

ENVIRONMENTAL – Linear swales, or shallow ditches, can effectively filter pollutants from highway runoff. Research has shown that more contaminants can be removed when ditch checks are installed along the swale. A ditch check is a low, permeable mound placed in the swale to slow water flow and remove more pollutants. Research was needed to monitor the performance of an existing Washington County ditch check designed with an iron-enhanced filter intended to remove phosphorus.

Through extensive monitoring and laboratory tests of collected samples, researchers showed that the iron-enhanced filter successfully removed phosphorus during the majority of the 40 rain events over the nonwinter months, reducing the phosphorus mass loads between 22% and 54%. Copper and zinc were not retained. They also recommended modifying the filter's orientation to increase its effectiveness and simplify routine maintenance.

TECHNICAL SUMMARY 2019-27

Entomologists Help MnDOT Count Endangered Bees, Improve Roadside Habitat



The endangered rusty-patched bumble bee can still be found in the Twin Cities, and MnDOT may be able to manage its roadsides to improve the pollinator's chances of survival.

ENVIRONMENTAL – Just 20 years ago, the endangered, rusty-patched bumble bee was common in the eastern U.S. and upper Midwest. No longer present in over 90% of its known range, the species can still be found in the Twin Cities.

MnDOT's wildlife management group funded research to count rusty-patched bumble bees in MnDOT roadside greenways and recommend practices that would improve the species' chance of survival.

Entomologists from the University of Minnesota studied bee populations at 94 roadside locations, developing a novel surveying method that offers a 95% probability of finding rusty-patched bumble bees in areas where they are present. Researchers also identified vegetation and other local factors that improve the bee's habitat so that MnDOT staff manages roadsides to optimize the survival of the endangered pollinator.

TECHNICAL SUMMARY 2019-25



OFFICE OF RESEARCH & INNOVATION

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Calendar

- 2/3 National Cooperative Highway Research Program (NCHRP) ballots on new problem statements due
- 3/1 NCHRP IDEA proposals, AASHTO Technology Implementation Group and Transit Cooperative Research Program synthesis topics due
- 3/3-4 Minnesota Transportation Conference, St. Paul
- 3/16** Ideas due for MnDOT/LRRB research RFP
- 5/1 NCHRP panel member nominations due

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