Salting roadways during the winter can cause significant corrosion to bridges. In 2013, while preparing the Highway 169 Nine Mile Creek Bridge for repairs, inspectors encountered two concrete beams with severe deterioration beyond the scope of routine repair.

To repair the girders, MnDOT tried a novel method developed in Michigan: placing steel reinforcement cages around the damaged beam ends and encasing the ends in concrete through a process called “shotcrete.”

The repair was more extensive than that studied in Michigan so MnDOT monitored the repaired beams monthly, and, when the Nine Mile Creek Bridge was replaced in 2017, sent the girders to the University of Minnesota for load testing. Researchers found the strength of the repaired beams actually exceeded the strength of the undamaged beams.

“This innovative method works remarkably well,” said University of Minnesota professor Carol Shield.

The findings will help MnDOT and other transportation agencies avoid lengthy traffic closures and more costly repairs. The other option involves removing the bridge deck to replace the damaged beam and recasting the deck and barrier.

In April, MnDOT bridge engineer Paul Pilarski presented project results at a national bridge preservation conference. MnDOT has used the new technique to repair seven additional beams, including at the Interstate 94 bridge in downtown Minneapolis.

**New Repair Technique:**

- Reduces costs by an estimated $290,000
- Eliminates several weeks of lane closures

**In the News**

Watch a KSTP-TV news story about the project, including video of load testing, at bit.ly/MnDOTbridgerepair.
New Specs for Tightening Anchor Bolts Improve Sign Safety

BRIDGES & STRUCTURES – Installers and inspectors in Minnesota follow national guidelines for tightening anchor bolts on signs, light poles and traffic signals. Still, field crews find loose nuts on roughly 20 percent of these bolts at any given time. At this rate of loosening, crews would have to inspect the entire system annually.

This issue is not unique to Minnesota. Many state DOTs experience similar problems with loose anchor bolts on sign structures. In fact, one state estimates 60 percent of its bolts are loose.

To determine why these bolts were loosening on MnDOT structures, researchers surveyed maintenance staff and observed installation and retightening practices in Iowa and Minnesota. In the lab, they compared tightening specifications and techniques for various types and sizes of bolts. In the field, they used strain gages and cameras on sign structures to see how structural and environmental strains affect bolt tightness.

Investigators found that national standards don’t necessarily work well in the field. They created improved specifications for installing and retightening anchor nuts, with procedures tailored to bolt sizes and baseplate materials, and a step-by-step checklist that guides crews in properly lubricating and tightening anchor nuts.

“We presented results at the annual national meeting for maintenance supervisors, and everyone was very excited about the results,” said Jihshya Lin, MnDOT bridge and fabrication methods engineer. “They will be very useful—not just to MnDOT, but to other states.”

Bridge Office Expands Drone Use

BRIDGES & STRUCTURES – Since 2015, MnDOT has used unmanned aircraft systems (UAS) to inspect more than 60 Minnesota bridges, developing procedures and perfecting techniques for inspecting structures in award-winning research projects. Phase III of an ongoing research effort evaluated a drone that flies within a protective rolling cage to take readings and videos in confined spaces.

Researchers developed a system for using this new drone with other UAS, cameras and inspection tools to create reports detailed with models, maps and photographs. The new system saves thousands of dollars a day inspecting large and difficult structures, keeps inspectors out of harm’s way and all but eliminates lane closures. A project in progress is formalizing a drone inspection program in MnDOT’s Metro District.

Prioritizing Pavement Markings on Low-Volume Roads

MAINTENANCE – Maintaining the yellow centerlines and white edge lines on Minnesota’s roads can strain the limited budgets of local agencies. A new decision-making tool can help decide which pavement markings are worth installing and maintaining. The new prioritization approach incorporates both past research and local state of the practice. It grew out of a literature search into the effectiveness of typical 4-inch and enhanced 6-inch markings, a survey of Minnesota counties and a review of the existing County Road Safety Plan. The spreadsheet tool and related materials are available at lrrb.org.

Hard Rock Data Aids Iron Range Bridge Design

MATERIALS & CONSTRUCTION – Bridge designers needed data on hard rock that was too strong for MnDOT’s standard testing approach. Researchers used a high-capacity load frame to test rock samples from a site in northern Minnesota and to examine the stiffness characteristics of concrete-filled steel piles used throughout the state. The stiffness and strength information improves MnDOT’s rock database and was used in building a 204-foot-tall bridge—Minnesota’s highest—on U.S. Highway 53 between Virginia and Eveleth.
Uniform Assessment Methods Improve Planning for Both Highways and Bridges

MnDOT’s Flash Flood Planning Program Recognized

When road crews respond to natural emergencies, they require nimble fleets and thorough preparation. A recent report on resiliency and redundancy in transportation systems funded by a group of transportation agencies from Puerto Rico and 14 states, including Minnesota, emphasizes short-term event preparation and long-term climate change planning. MnDOT’s flash flood assessment program, piloted in 2014 as part of its climate change mitigation and adaptation program, prepares for floods by carefully calculating asset vulnerability to optimize responses. The program was one of 14 highlighted in the study. Read more about the flash flood project and other programs on MnDOT’s climate change website, mndot.gov/climate.

Implementation of Strategic Research Plan is Underway

To help guide future research investments, MnDOT senior leadership recently completed a five-year comprehensive strategic plan that looks at streamlining the research governance structure at MnDOT and developing a clearinghouse of information about the agency’s research portfolio that provides better decision-making data.

MnDOT Research Services recently completed a visioning session with agency stakeholders as the first step in implementing the recommendations of the strategic plan, which include:

- Establishing agencywide research strategic priorities
- Tracking all research expenditures, including those outside Research Services
- Tracking research investment levels to measure return on investment
- Reporting on the outcomes of research projects beyond their life cycle
- Identifying the value and impact of research at a topic and program level

Although much of the transportation research performed by MnDOT is administered and tracked by MnDOT Research Services, several MnDOT specialty offices also invest in their own research to support or guide their work.

Research Services is developing a system that can track this additional research, as well as the outcomes of all the research, into an annual report. Moving forward, this report will aim to answer MnDOT senior leadership’s questions about the level and value of research investments and help guide future decisions on where to invest research dollars.

WEBINARS ON DEMAND

MnDOT Traffic Topics
ITS and the Connected Corridor (Recorded July 17) mndot.gov/trafficeng/topics
NRRA/MnROAD Research Pays Off
UAV and Close Range Photogrammetry (CRP) Studies for Transportation Infrastructure Surveys and Condition Assessment (Recorded Sept. 18) mndot.gov/mnroad/researchpaysoff
TRB
Continuous Access Priced Managed Lanes—What Have We Learned So Far? (Recorded Sept. 20) trb.org/main/blurbs/178002.aspx
FHWA
GIS in Transportation: Drone Use in Bridge Inspections at Minnesota DOT (Recorded Oct. 2) bit.ly/FHWA-drone-webinar

MATERIALS & CONSTRUCTION – Pavement engineers often explain the maintenance and construction needs of Minnesota’s 14,000-mile highway system in terms of remaining service life (RSL), an estimate of years of service after which a road will require replacement or rehabilitation. MnDOT’s Bridge Office uses different ways to describe the needs of its 20,000 bridges, which makes judging and funding the needs of both systems challenging.

Uniform Assessment Methods Improve Planning for Both Highways and Bridges

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<table>
<thead>
<tr>
<th>Calendar</th>
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<tbody>
<tr>
<td>11/14</td>
<td>LRRB RIC Committee meeting, MnROAD facility</td>
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<tr>
<td>12/4-5</td>
<td>MnDOT TRIG winter meeting, Arden Hills (FY2020 research selection)</td>
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<tr>
<td>12/12-13</td>
<td>LRRB winter meeting, Minneapolis (FY2020 research selection)</td>
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<tr>
<td>01/13-17</td>
<td>2019 Transportation Research Board Annual Meeting, Washington, D.C.</td>
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