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RESEARCH SERVICES & LIBRARY

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Research Improves Ramp Metering, Reduces Delays

Thanks to a 2012 study that improved MnDOT's computerized Intelligent Road Information System by adding a Traffic Information and Condition Analysis System, ramp meters are now more in sync with real conditions. The meters come on for shorter times and only activate when needed, resulting in less delay on metro highways; in a case study of Highway 100, the delay on the mainline dropped by nearly half.

On one stretch of highway, motorists experienced 48 percent fewer delayed vehicle hours — defined as the vehicle hours of traffic flow with speeds less than 45 mph — in October and November 2012 compared with the same period in 2011, even as total volume on that section of road increased by 2.7 percent. In spring 2013, the amount of delayed vehicle hours had been reduced by 17 percent. **Technical Summary 2012-04**

For more information about the upgrade, see our Crossroads blog: **mntransportationresearch.org**.

New Riprap Recipes Reduce the Cost of Protecting Our Bridges from Scour

Scour is one of the main causes of bridge failure: Fast-moving water can strip away the soil that supports bridge foundations.

To prevent this condition, we can shore up the area with supporting rocks, called riprap, but these rocks must be large and angular to interlock and form a strong barrier. These types of rocks are difficult to come by in many parts of Minnesota, and transporting them can dramatically increase bridge construction costs.

A new strategy is now being used at five current sites and three more being added this summer as part of research coordinated by MnDOT and funded by the Local Road Research Board. Matrix riprap, also known as partially grouted riprap, permits the use of more widely available smaller and less angular rocks. They are bonded together with enough grout to enhance erosion protection, but also leave space to allow drainage and "self-healing" after floods. The approach also helps prevent vandals from removing rocks. While matrix riprap has been effective for bridge piers, engineers weren't sure how well it would do at abutments (i.e., at the ends of the bridge).

After site visits and a literature review, researchers performed several laboratory tests on riprap: They tried to pull apart specimens with and without grout using steel cables attached to a half-ton electric hoist; they also flowed water at various velocities through steep chutes toward a scale-model bridge abutment shielded with various kinds of miniature-scale riprap.

Using grout made the specimens much harder to pull apart and added significant strength to shield against moving water, while decreasing porosity by about 10 percent. Surprisingly, researchers found that using more angular rocks didn't help, even though angularity has been part of MnDOT's current riprap specifications.

"Not only is matrix riprap significantly stronger than regular riprap, it helps prevent vandalism as well."

—Nicole Bartelt
Assistant Waterway Engineer
MnDOT Office of Bridges and Structures

Further research is still needed to establish when matrix riprap can be expected to fail and to evaluate environmental effects when grouting occurs underwater. Additional investigation should be completed to better understand the application and performance of the matrix riprap, however, this study can be used to support the use of matrix riprap in place of larger rocks or other bridge countermeasures. **Technical Summary 2015-15**

"Beyond its utility for driver warning systems, high-accuracy map data will be useful for MnDOT and Minnesota local agencies for a variety of other reasons, including inventory tracking, pavement monitoring and pavement marking maintenance."

—Rick West, County Engineer, Otter Tail County

Transportation Research Syntheses

Transportation Research Syntheses are short-term research projects that summarize research activity and practices among state departments of transportation. To view any of these documents or request a TRS from MnDOT Research Services & Library to answer your questions about a transportation topic, visit mndot.gov/research/transportation-research-syntheses.html.

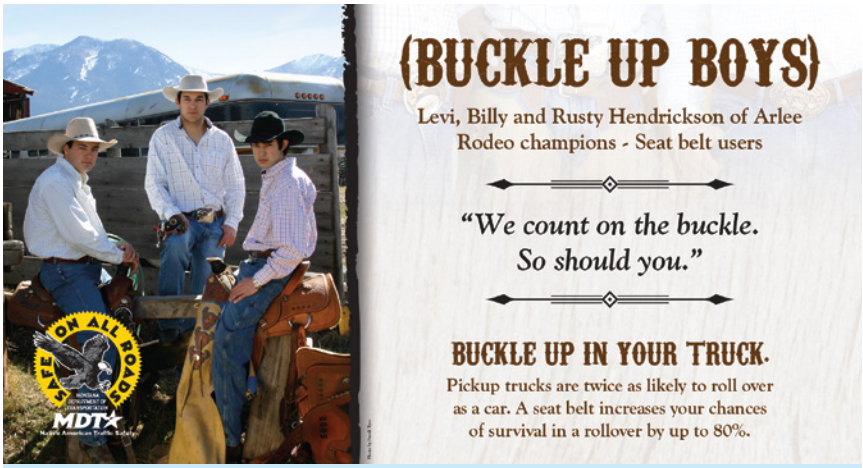
How Do States Report Intrusions into Work Zones?

Traffic & Safety — MnDOT already has good data and reporting practices about crashes, especially those that happen in work zones, and is now looking to standardize practices regarding work zone "near misses." A survey of state DOTs revealed that collecting data about these work zone intrusions does not appear to be a common practice. The few states that do collect intrusion data ask workers to use electronic or paper forms, although implementing smart work zone technologies such as pan-tilt-zoom cameras is being considered in Oregon. Staff members from other states said they are not particularly confident that their data collection systems capture information about all work zone intrusions that occur. **Transportation Research Synthesis 1506**

Mapping Roadways Will Support Lane Departure Warning Systems

Traffic & Safety — More than half of Minnesota's fatal car crashes are caused by vehicles drifting out of their lanes. MnDOT uses engineering tactics such as rumble strips to try to counter this drift, but more techniques are needed. Minnesota has been looking into lane-departure warning systems, where vehicles use global navigation satellite systems to alert drivers when they are drifting. These systems require highly accurate maps of roadways and their boundaries, and an LRRB-sponsored research project took on the task of developing a low-cost, vehicle-mounted system to create such maps for our many local roads.

While a previous phase of the project (**Technical Summary 2014-22**) deployed a laser-based system to detect curbs and guardrails, this phase tested a mounted video camera (shown at left) for automated detection and mapping of fog lines (the white lines that mark the outer boundaries of roadways). The result was highly accurate and cost-effective, allowing for wide-scale deployment. **Technical Summary 2015-11**



Advertisements using spokespersons who have a positive image among a target audience is a potential strategy for increasing drivers' concern for safety.

Focusing Safety Efforts Through 'Safety Culture'

Traffic & Safety — To craft and target educational campaigns about highway safety, we need to better understand how people make decisions and where they most need help. The idea of a "safety culture" has been successfully applied to improve safety in industries such as commercial airlines and public health. It involves measuring and influencing norms about acceptable behaviors. For example, if drivers think everyone speeds, driving after drinking is common and most people don't wear seat belts, then they are less likely to behave safely themselves. However, a publicity campaign to correct these misconceptions may help change people's behavior.

Researchers conducted a mail survey of 10,000 random households (with an acceptable 36 percent response rate) to determine attitudes about safety and risky driving behaviors. Then they analyzed the results to connect people's stated beliefs to their behaviors. Researchers found that yes, many respondents misperceived norms in Minnesota, and recommended some responses to be considered by a new MnDOT traffic safety culture implementation team. For example, workplaces should be encouraged to establish rules about safe driving, and MnDOT should create positive messages that use stories about real people rather than relying on statistics to argue for safer behavior. **Technical Summary 2015-13**

Researchers have developed a tool that analyzes readings to determine when WIM sensors require recalibration.

Protecting Our Roads Through Improved Weigh-in-Motion Systems

Policy & Planning — Weigh-in-motion systems are used to measure freight traffic on highways and enforce vehicle weight restrictions, which prevent overloaded trucks from prematurely wearing out our roads. Three studies looked into ways to improve WIM processes:

- WIM sensors are calibrated only twice per year, and researchers developed a tool to analyze WIM readings to determine when a sensor has drifted out of calibration and needs attention. **Technical Summary 2015-18**
- WIM currently classifies vehicles by axle spacing and vehicle weight, whereas automatic traffic recorder sites consider only axle spacing. Investigators analyzed WIM and ATR data to develop a proposed single classification scheme, which should improve data by reducing vehicle misclassification at WIM sites and ensuring vehicles are classified the same way at all sites. **Technical Summary 2015-17**
- As part of the previous study, researchers also evaluated the use of license plate reader cameras for vehicle classification; however, the reader did not capture an adequate number of truck license plates in a high-speed WIM environment. **Technical Summary 2015-17**

How Much is Too Much Carbonate in Concrete?

Materials & Construction — When building roads, MnDOT specifies high-quality aggregates to use in its concrete, but the Minnesota sources for these aggregates are being depleted rapidly. Widening the range of acceptable materials would reduce costs. The most common type of aggregate used is Class C, which is natural or partly crushed gravel; current specifications limit the maximum amount of carbonate aggregate to 30 percent by weight. Too much of the more porous carbonate rock has been thought to be less durable through freeze-thaw cycles.

However, new research performing laboratory evaluations on 15 aggregate sources (Classes C and B) suggested that the 30 percent limit should be re-evaluated, and that some more available aggregates with higher carbonate content could still perform well if they meet other criteria. More data on critical pore index ranges is being collected and analyzed to determine whether limits could be changed. **Technical Summary 2015-14**

Designing Culverts to Ensure That Fish Can Swim Through

Environmental — Culverts allow streams to flow under roadways, but box culverts (below) can become barriers to fish and other aquatic organisms if water flow patterns are significantly different through the culvert than in the rest of the stream. Sediment on the bottom of the culvert can help by slowing water flow, but these sediments may not fill in naturally. By performing laboratory simulations using a scale model of a stream channel, researchers monitored sediment transport through a culvert under various conditions and suggested changes to construction practices, including filling a culvert with sediment during installation and placing large rocks in some culverts to keep sediment in place. Based on the experiments, several design recommendations were suggested for embedded culverts where maintaining a natural streambed is a design goal. Information gathered will help provide general guidance for a potential fish passage design manual for the state of Minnesota. **Technical Summary 2015-08**

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Calendar

8/1	TRB annual meeting abstracts due
9/1	NCHRP problem statements and IDEA proposals due
	ACRP Synthesis of Practice topics due
9/14	Research Implementation Committee meeting, Golden Valley
9/15	Rail Safety IDEA proposals due
9/16	Proposals due from universities
9/17	LRRB meeting, Olmsted County

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