University of Minnesota

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Advanced hybrid buses have better fuel economy, fewer emissions

One of Metro Transit's new advanced "super hybrid" buses—built in Minnesota and billed as the cleanest, most efficient diesel-electric hybrid buses in the United States—garnered national attention at the American Public Transportation Association's Bus and Paratransit Conference May 5–8 in Indianapolis.

Unique because of its all-electric accessory systems, the bus was featured at the event so that transit professionals from across the country could experience this new hybrid technology firsthand, says Chuck Wurzinger, assistant director of bus maintenance at Metro Transit. The bus is one of two

***Hybrid** continued on page 4*

Quality-of-life study helps MnDOT evaluate performance measures

As part of a study on transportation and quality of life, the Minnesota Department of Transportation (MnDOT) has partnered with researchers from the University of Minnesota's Tourism Center to compare current MnDOT performance measures with quality-of-life factors that matter most to Minnesotans.

The evaluation was designed to help MnDOT ensure alignment between the factors that best predict transportation satisfaction among Minnesota citizens and the indicators MnDOT uses to track and measure its performance. The study team was led by Ingrid Schneider, Tourism Center

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MnDOT honored for intersection safety efforts: U of M to evaluate proposed technology

Intersection crashes continue to represent a significant share of transportation fatalities and serious injuries throughout the country. To improve safety, many agencies have turned to intersection conflict warning systems (ICWS). These systems, which give motorists real-time warnings about cross traffic, save lives at intersections that might not otherwise warrant more traditional traffic-control devices or geometric improvements.

The Minnesota Department of Transportation (MnDOT) was recently honored for its efforts in designing, testing, and helping deploy ICWS throughout Minnesota while leading a national effort to do more of the same throughout rural America. The White House named Sue Groth, MnDOT's state traffic engineer and co-chair of the state's Toward Zero Deaths program, as one of 12 people who are transportation "Champions of Change." Groth was selected for work conducted by MnDOT and its partners to improve intersection safety.

"These champions represent the very best in American leadership, innovation, and progress," said USDOT Secretary Ray LaHood at a May 8 ceremony.

A variety of ICWS have been developed and tested in many states over the past several years. Fourteen installations of varying designs are currently in place in Minnesota, including three sites with technology developed by the Intelligent Transportation Systems (ITS) Institute, a part of CTS, under funding from MnDOT and the USDOT. This technology—Cooperative Intersection Collision Avoidance System–Stop Sign Assist (CICAS–SSA)—warns drivers stopped on a secondary rural road when gaps in cross traffic on the highway are too small to cross safely or allow a turn.

No specific guidance has been available, however, for the many different types of intersections regarding placement, size, messaging, and so on—which means a fairly broad range of approaches are in use. MnDOT is a member of a Federal Highway Administration pooled-fund program that established an approach for more consistent deployment and further evaluation of ICWS. In addition to 15 states and other transportation agencies, several national standards groups and industry associations were engaged in this effort.

Moving forward, MnDOT is now launching a three-year Rural Intersection Conflict Warning System (RICWS) project that will deploy one type of system at a minimum of 20 and up to 50 additional intersections, says Jon Jackels, ITS program engineer with MnDOT.

The first of the new installations, in Carver County, will be

***Intersection** continued on page 5*

Intersection crashes account for

48%

OF INJURY-RELATED INCIDENTS AND GENERATE

$101 BILLION

OF SOCIETAL COSTS EACH YEAR.

(Source: National Highway Traffic Safety Administration)

Courtesy MnDOT

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Rebuilding stronger, less expensive roads with recycled asphalt

While the eco-friendly mantra "reduce and reuse" has been around for decades, its role in asphalt pavement rehabilitation has been discovered much more recently. In years past, when an asphalt road began to deteriorate, the answer was either to apply a hot-mix asphalt overlay to the road's surface or perform a complete reconstruction of the pavement.

"The problem is that other options should be considered," says University of Minnesota civil engineering professor Joseph Labuz. "Fully reconstructing a road is expensive and time consuming, and though the overlay method is fast and less expensive, it doesn't always provide a lasting solution because previous distresses and cracks eventually make their way up to the new layer of pavement."

As an alternative to these two methods, in-place asphalt recycling continues to gain popularity. Full-depth reclamation (FDR) is a pavement recycling technique in which the existing pavement and some of the existing base layer are broken up and blended to form an improved base for a new asphalt surface. Sometimes an additive is mixed in with the recycled pavement layer to further increase its stability, which is known as stabilized full-depth reclamation (SFDR).

As FDR and SFDR gain popularity, highway engineers need ways to effectively evaluate their properties and correctly apply pavement design guidelines. Few documented field studies have measured material performance, however, so assigning the proper design values to FDR and SFDR pavements is done conservatively.

To provide engineers with more guidance, the Minnesota Department of Transportation (MnDOT) sponsored a U of M study to estimate the proper design values and assess the effects of seasonal temperature changes on these pavements.

"MnDOT uses granular equivalency (GE) to describe stiffness of asphalt and base materials," says Shongtao Dai, research operations engineer with MnDOT's Office of Materials and Road Research. When this project was initiated in 2009, there was no well-defined method to determine GE, he explains, and MnDOT recommended a GE of 1.0 (equivalent to a "class 5" aggregate).

Over three years, the U of M research team led by Labuz evaluated tests performed by MnDOT to determine the stiffness of seven sections of FDR and SFDR county roads in Minnesota. During the spring thaw of each year, tests were conducted daily during the first week of thawing to document seasonal weakening of the pavement's base layer. After the spring thaw period, tests were conducted monthly at each location to capture the pavement strength changes throughout the season.

The study results demonstrate the benefits of SFDR pavements in particular: SFDR pavements were determined to have a higher "stiffness rating" than had previously been assigned by MnDOT, and GE was estimated at about 1.5—meaning less expensive aggregates could be

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There's no need to haul in aggregate or haul out old material for disposal using

FULL-DEPTH RECLAMATION.

And recycling normally

COSTS UP TO 50% LESS

than when old pavement is removed and replaced.

READ CATALYST ONLINE

for links to research reports and other resources.

Hybrid from page 1

advanced hybrids built for Metro Transit in 2012. They currently operate on local routes with frequent stops in downtown Minneapolis and its surrounding communities.

The decision to purchase the new hybrids was greatly influenced by the results of a University of Minnesota study aimed at improving fuel economy in diesel-electric hybrid buses, Wurzinger says. The "Superbus" study, led by mechanical engineering (ME) professor David Kittelson, included an energy audit of major accessory systems on a standard hybrid bus. The study was funded by Metro Transit, CTS, and the U of M's Institute for Renewable Energy and the Environment (IREE).

Study findings indicated that up to half of the fuel consumed by hybrid buses is used to power accessory systems. According to the research team, powering these systems electrically could significantly improve fuel efficiency.

The new advanced hybrids do just that, using all-electric systems to power the heating, air conditioning, engine fans, power steering, and air compressor. These components improve fuel economy, reduce emissions, and allow the buses to be operated in electric-only mode for short periods.

One of the buses also has start/stop capabilities, which allow the engine to shut down at bus stops and traffic lights. "This reduces engine idle time while maintaining all other bus functions, including passenger comfort and safety features," Wurzinger says.

Although the buses have been in service for only a short time, they are already showing promising increases in fuel economy, Wurzinger says. "We have also operated them consistently on electric power inside the bus garage, which helps keep the air clean in the building. This reduces the amount of ventilation required in cold weather, which means less energy is used to heat the building."

Along with a standard hybrid bus and a conventional diesel transit bus, one of the advanced hybrids will be monitored and evaluated in a new study conducted by U of M researchers in collaboration with Metro Transit. The multidisciplinary research team includes Kittelson, ME associate professor Will Northrop, ME research associate Winthrop Watts, and applied economics associate professor Steven Taff.

As part of the study, funded by IREE, the team will collect real-world, on-the-road data from the three buses in all seasons on a variety of route types. The researchers then plan to compare the efficiency and emissions of the buses and make recommendations to Metro Transit about which configuration is the best for a given application. Data collected from the study will also allow Metro Transit to work with bus manufacturers to optimize bus performance.

"We believe the results will be useful in writing bus technical specifications and also in determining if a certain type of bus is best suited to a certain type of bus route," Wurzinger says.

Ultimately, this information could be used to determine which buses to assign to which routes as well as which type of bus to purchase given fleet replacement or expansion requirements.

The project is scheduled for completion in 2015.

Metro Transit has more than

130

HYBRID BUSES IN SERVICE—

about

15% OF ITS TOTAL FLEET.

The advanced hybrid buses:

- Emit 30% less CO_2 and produce fewer nitrogen oxide, nitrogen dioxide, and particulate matter emissions than a standard hybrid.
- Use a regenerative braking system, which captures and stores energy otherwise lost as heat.
- Have better fuel economy than standard hybrids, which are already up to 35% more efficient than conventional buses on comparable routes.

New fuel cell prototype could power rural ITS applications

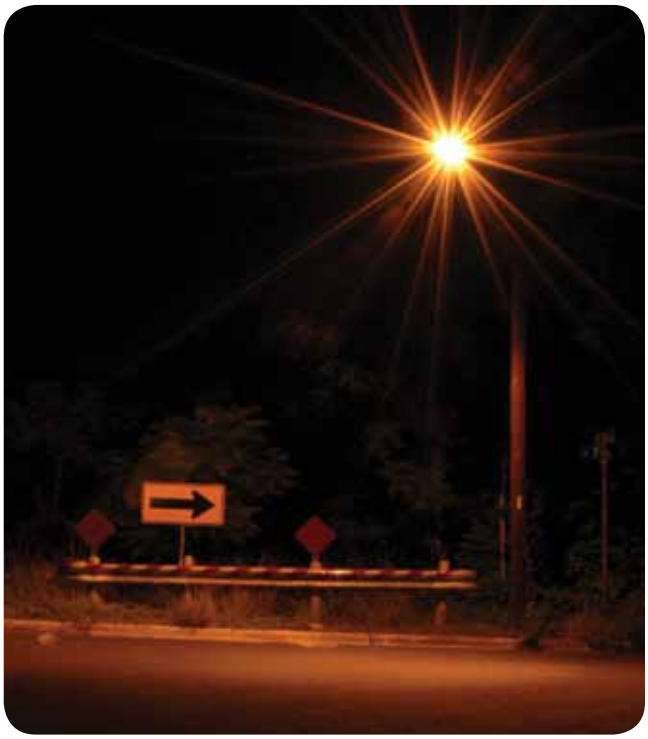
Intelligent transportation systems (ITS) technologies can be used to enhance transportation safety and mobility, but the sensors and communications equipment needed for ITS applications typically require access to electricity. In rural areas, limited access to the power grid can make it challenging to implement ITS devices.

Current solutions for providing power to off-grid locations include battery packs or diesel generators, both of which require constant maintenance to recharge, refuel, or replace. Other alternatives include solar panels and wind turbines, but cost and performance concerns have limited their use.

"One of the issues with these green power alternatives, such as solar panels, is dependability… especially in the long, cold, and dark Minnesota winters," says Victor Lund, a traffic engineer with St. Louis County Public Works. Until this technology matures, there is a need for other options that can provide confidence in generating power, Lund says.

To provide a more effective and dependable power alternative, researchers from the University of Minnesota Duluth (UMD) have developed a portable prototype system that uses hydrogen-based fuel cells to generate electricity. The UMD research team was led by chemical engineering associate professor Steven Sternberg, and the project was sponsored by the ITS Institute.

The hydrogen-based fuel cell provides a clean, compact, high-efficiency energy source for an accompanying battery pack, which could be used to operate various ITS devices. The prototype is completely independent of the power grid, works well in cold weather, and requires maintenance only once each week for recharging. The cost of the system is about $7,500, with an additional operating cost of $2,000 per year for fuel materials.



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In addition to powering ITS devices, the fuel cells could provide power for rural intersection roadway lighting.

Potential applications include powering variable message signs, dedicated short-range communication technologies, and warning blinkers on traffic signs. According to Lund, the system's applications extend beyond powering ITS devices. For instance, the fuel cells could be used for rural intersection roadway lighting or as a back-up source for traffic signals in case of a power outage.

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evaluated by the ITS Institute. Led by research fellow Arvind Menon, researchers will use technology developed previously under the CICAS-SSA program to monitor the proposed RICWS and demonstrate its accuracy and reliability. They will then estimate the cost to reach the desired level of accuracy (99.95 percent of vehicles). RICWS costs vary significantly depending on factors such as the type of system, type of road, and location, Jackels says. Using the research findings, MnDOT will then proceed with the other 19 locations.

Jackels credits almost a decade of work with University researchers for helping build the foundation for the ICWS project. "That learning was really helpful to getting us where we are," he says.

Many local partners are involved, Jackels notes, including Aitkin, Blue Earth, Carver, Kanabec, Kandiyohi, Lyon, Nicollet, Olmsted, Rice, St. Louis, and Wright Counties, as well as Edwards Township and the City of Glencoe.

Jackels anticipates more research may come out of this project. "Did RICWS make a difference? Did it change behavior at non-instrumented intersections? What impact did it have on the entire system?" The goal, he says, is to have complete standards for highway intersection design—and ultimately, safer roads.

"This is a winner because it's going to save lives across the nation," Jackels says.

AN AVERAGE OF

21% OF FATALITIES

TAKE PLACE IN U.S. INTERSECTIONS.

(Source: Federal Highway Administration)

Minnesota LTAP Demo Day finds audience eager for hands-on training

Chains, blades, and fire have been among the most common and useful tools for centuries, especially for building and maintaining roads. But even with today's improvements, use of such tools can be ineffective or, at worst, turn deadly in a heartbeat without adequate training.

One place for local transportation agency personnel to get this important training is the Minnesota Roadway Maintenance Training and Demo Day. It's an annual offering from the Minnesota Local Technical Assistance Program (LTAP), a program within CTS.

This year's event, held in Rochester on May 1, included classroom sessions and outdoor demonstrations. Topics included chainsaw safety, gravel road maintenance using a motor grader, prescribed burning on prairies, asphalt pavement maintenance, and cargo securement of heavy loads, equipment, and machinery.

About 150 attendees divided into groups to watch the demonstrations, mesmerized as a chainsaw abruptly halted after starting to rip into a pair of protective chaps and as a firefighter set a patch of straw aflame to simulate a controlled burn of prairie grass—an age-old technique to manage roadsides and other non-native areas.

"Fire is probably one of our best tools," said Tom Eckdahl, a manager with the Olmsted County Parks Department, demonstrating a prescribed burn. "We can utilize fire as a tool to cover more acres with less costs and actually have a better application. We're not out there applying herbicide."

John Okeson, a retired Becker County maintenance supervisor, co-led the gravel road maintenance demo. "We find over the years that a lot of operators are running that piece of machinery [a motor grader] with no formal training. They really don't have an idea what they should be doing," he said. "There's a lot of good training available out there. Go get it and you'll be well rewarded for it."

Prescribed burning was one of the topics at the Demo Day.

MnDOT, the Minnesota Local Road Research Board, and the Federal Highway Administration, along with Minnesota LTAP, sponsored the training in partnership with the Minnesota Chapter of the American Public Works Association and the Minnesota Street Superintendents Association.

Next year Minnesota LTAP plans to bring the training to the central or northern part of the state.

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considered. In addition, while both pavement types exhibited the seasonal effects typical for asphalt pavements—lower stiffness in the spring than in the summer and fall—most of the SFDR pavements showed improved seasonal stiffness.

"The research has provided guidance and confidence to MnDOT on determining GE values for SFDR materials," Dai says.

Brian Noetzelman, county engineer of Pope County and a member of the project advisory panel, adds that if the GE for SFDR rose from 1.0 to 1.5, it would give 50 percent more carrying capacity to the existing base GE at a minimal cost. "Current 9-ton designs could now be 10-ton designs with the same design structure. What a tremendous savings for counties!"

NEW RESEARCH REPORTS

Recently published reports on transportation-related research at the University of Minnesota explore the following topics:

DYNAMIC HORIZONTAL CURVE WARNING SIGNS
(CTS 12-12)

WARNING DEVICES FOR WORK ZONES
(MnDOT 2012-26)

FREEWAY TRAFFIC SPEED ESTIMATION
(CTS 13-21)

Research reports are available at **cts.umn.edu/Publications/ResearchReports**.

***Quality** from page 1*

director, and Karla Rains, director of customer relations at MnDOT.

To conduct the evaluation, the research team first analyzed data collected using surveys and focus groups in a previous phase of the quality-of-life study. The data included information on the categories that contribute to quality of life in Minnesota, the role of transportation, and the specific factors or services within transportation that affect citizens' quality of life.

From these data, the team identified a list of key transportation elements that drive customer satisfaction. Results indicate that the most significant predictors can be grouped into three categories: maintenance/safety, mobility, and transparency. Within those categories, 11 specific items—such as snow and ice removal, road smoothness, commute time, and satisfaction with long-term planning—account for 56 percent of the differences in citizens' transportation satisfaction.

The team then compared the factors most important to Minnesota citizens with MnDOT's current performance measures. Overall findings indicate that these existing measures, which track performance in nine major areas, broadly capture much of what is important for Minnesotans' transportation-related quality of life.

"This was an important key finding for us—we're already measuring and reporting on many of the things that matter most to our customers," Rains says. "It was encouraging and comforting to see that."

In addition to affirming MnDOT's existing measures, the evaluation identified a few gaps, specifically in the areas of safety, the environment, and transparency.

Top 11 predictors of transportation satisfaction:

- Pedestrian safety
- Visual appeal of the roadsides
- Safety on the road (excluding risks related to other drivers)
- Clearing roads of ice and snow
- Clearly visible highway signs
- Smooth road surfaces
- Commute time
- Travel time within/around the community
- Perception of MnDOT as financially responsible
- Perception that MnDOT does what's best for Minnesota
- Satisfaction with long-term planning

For example, MnDOT typically reports transportation safety in terms of total traffic fatalities and serious injuries from vehicle crashes. However, the quality-of-life study revealed citizen interest in a broader view of traveler safety. As a result, MnDOT plans to include bicycle, pedestrian, and railroad-grade crossing fatality data in future performance measures. "This is already data that we track, but now we plan to add more reporting of fatalities by mode than we have included before," Rains says.

Based on other study-identified topics of importance, MnDOT plans to add new performance measures focused on air pollution and conduct more reporting of information related to public trust.

"We continue to use this data as guidance in our planning, and it continues to be useful," Rains says. "We want to make sure we're listening and measuring ourselves against the things that are most important to our customers."

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MnDOT uses
CITIZEN INPUT
on transportation and quality of life to
EVALUATE ITS PERFORMANCE MEASURES.
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save lives in
INTERSECTIONS.
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Using
RECYCLED ASPHALT
in road construction
CONSERVES RESOURCES AND REDUCES COSTS.
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Advanced 'super hybrid' buses have better fuel economy, fewer emissions.
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