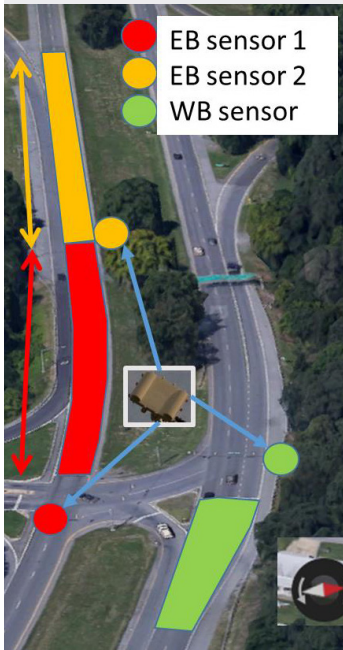


SAFETY

RESEARCH 2017

INNOVATIONS FROM STATE DOTs



The intelligent dilemma zone protection system can dynamically extend the all-red phase at an intersection when needed.

Dynamic Signal Adjustment Helps Drivers Avoid Dilemma Zone Collisions

MARYLAND

Drivers' actions in an intersection's dilemma zone—the area where the decision to stop at a yellow light or continue through it is not clear-cut—can lead to side-angle and rear-end crashes. In Maryland, researchers and practitioners have developed an intelligent dilemma zone protection system (DZPS) that is reducing these crashes by anticipating drivers' decisions and responding.

The DZPS has three components: wide-range speed and location sensors, software modules to predict driver response, and web-based monitoring to enable the system to dynamically extend the all-red phase (where every signal in all directions is red). This provides additional clearance time when a potential red-light-running vehicle is detected. Measured benefits of DZPS include a 30 to 40 percent reduction in dilemma zone length and fewer vehicles approaching the intersection at speeds greater than the posted speed limit. The all-red system extensions have helped prevent crashes between through traffic and vehicles entering the intersection from the cross street. [Research overview.](#)

The eight safety research projects

highlighted on these pages were selected by the Research Advisory Committee of the American Association of State Highway and Transportation Officials (AASHTO). They comprise two high-value projects from each of the four AASHTO regions, funded primarily through the State Planning and Research (SPR) Program.

As the nation's cornerstone state research program, SPR provides Federal Highway Administration funding to the states to address top concerns and identify solutions at the state level. States further address areas of common concern through the Transportation Pooled Fund Program.

This publication and its companion featuring high-value maintenance research complement *Research Makes the Difference 2017*, a compilation of award-winning transportation research across all fields. All of these publications may be found at research.transportation.org.

Updated Approach Improves Collision Risk Assessment in Bridge Design

FLORIDA

When a ship strikes a bridge, it can lead to expensive repairs, bridge closures, and even loss of life. Florida DOT is engaged in a multi-year effort to improve its procedures for impact-resistant bridge design. In the latest project, researchers developed a revised methodology for assessing the risk of a vessel striking a bridge. Using new analysis procedures, the researchers were able to develop risk estimates that agreed with historical observations. Then they used a partial, reduced-scale replica of a barge to conduct impact testing, validating a model for predicting the damage caused by an impact.

Researchers applied the new methodology to two in-service bridges in Florida and compared the results to those from the existing AASHTO method. The analysis showed that present-day computing power makes the new procedure for bridge design and analysis feasible. Through its ability to consider a large number of variables, the new procedure gives engineers the means to address complex real-world problems, and Florida expects this tool will lead to more accurate risk estimates and better bridge designs. [Final report.](#)



A barge strike caused the collapse of the Interstate 40 bridge in Webbers Falls, Oklahoma, in 2002.

Guardrail Research Enhances Safety While Reducing Maintenance Costs

NORTH CAROLINA

Research at North Carolina DOT has provided an in-depth understanding of the performance of W-beam and Thrie-beam guardrails under various conditions. Using modeling and simulations, guardrails that had previously been evaluated under impact conditions at AASHTO Manual for Assessing Safety Hardware test levels 2 and 3 (MASH TL-2 and TL-3) were evaluated at the TL-4 and TL-5 levels, which include impacts from heavier vehicles.



Source: North Carolina DOT

A single-faced Thrie-beam guardrail (left) joined with a W-beam guardrail.

Single-faced W-beam and Thrie-beam guardrails generally perform well under vehicular impacts at MASH TL-3 conditions. When used as highway median barriers, two runs of these guardrails are typically installed, one on each side of the median. While this is effective in preventing cross-median crashes, the two runs of guardrails create difficulties for maintenance operations such as mowing. Replacing this configuration with a single run of double-faced guardrail eliminates this problem, and the double-faced guardrail outperformed the single-faced rail in the TL-4 and TL-5 simulations.

North Carolina DOT is using the results of this research to make informed design and installation decisions about the placement and use of double-faced W-beam and Thrie-beam guardrails and to enhance safety by reducing cross-median crashes. The research results can also be used to evaluate the benefits of providing safety hardware at higher standards than those currently recommended by FHWA's Office of Safety. [Project web page.](#)

Targeted Mitigation Measures Help Prevent Deer-Vehicle Collisions

WYOMING

Up to 2 million wildlife-vehicle collisions occur in the United States every year, threatening the safety of road users and wildlife alike. Wyoming, home to deer, moose, and elk, records over 2,000 such incidents annually on average, with some roadway sections experiencing more than 100 collisions per mile each year. Wyoming DOT estimates that deer-vehicle collisions cause up to \$29 million in injury and vehicle damage costs each year.

Researchers analyzed carcass and collision records to identify 27 roadway sections that experience more than six deer-vehicle collisions per mile per year. They analyzed existing and potential warning sign locations and compared spatial and temporal patterns at collision sites with known migration characteristics, assessing how migration times and seasonal use of roadways by drivers converge.



Source: Wyoming DOT

Wyoming DOT is tailoring its deer-vehicle crash mitigation efforts to crash site data identified by researchers.

By identifying the roadway sections with the highest deer-vehicle collision rates, Wyoming DOT was able to target mitigation measures appropriately, evaluating warning sign placement and effectively prioritizing locations for installing crossing structures. This targeted approach improves the cost-effectiveness of the department's mitigation efforts. [Final report.](#)

Modified Right-Turn Designs Offer Big Safety Benefit

ILLINOIS

Right-turn lanes on state routes must be designed to accommodate semi-tractor trailer trucks, leading to long approaches that gradually flatten to be almost parallel to the roadways they enter. This may encourage the dominant crash type for such intersections: a right-turning vehicle striking the right-turning vehicle ahead that has stopped or slowed as its driver scans upstream traffic.

Illinois DOT created modified right-turn-lane designs in Peoria over an eight-year period ending in 2014. The modified facilities have a more perpendicular approach angle for a sharper right turn. Researchers studied driver behavior at modified and control sites to assess crash reductions and cost-benefit ratios.

They found that drivers at modified sites used less exaggerated head turns, executed fewer roll-and-go stops, and stopped at the designated stop bar more frequently than drivers at more conventional turns.

These behaviors contributed to a 59 percent reduction in approach crashes at the modified sites. Conventional designs with low right-turn angles and high head-turn angles had significantly higher crash rates. When the costs of modifying the intersections were annualized over 15 years, the safety benefits exceeded the costs by a factor of 14 to 1. **Final report.**



Illinois DOT restriped this right-turn lane to create a safer turn.

Eco-Driving Training Promotes Employee Driver Safety and Fuel Efficiency

MASSACHUSETTS

When Massachusetts DOT wanted to evaluate training and operations techniques that would improve employee driver safety, improve fleet fuel efficiency, and reduce greenhouse gas emissions, the agency tested a combination of classroom training and in-vehicle feedback devices designed to improve driver behavior. A literature search revealed that idling, speeding, and aggressive acceleration are major contributors to fuel inefficiency, greenhouse gas emissions, and unsafe driving.

Massachusetts DOT equipped 133 department-owned vehicles with real-time feedback devices, and designated drivers were given a 1½-hour eco-driving training session. Researchers found that the real-time feedback significantly reduced speeding and aggressive acceleration.

Even after the feedback was discontinued, this effect was sustained among pickup truck drivers, though the effect was not sustained among drivers of SUVs or sedans. The eco-driving training also reduced drivers' idling rate for the first month after training.

The research team concluded that the combination of training and real-time feedback can significantly improve fuel economy, reduce emissions, and improve safety. **Final report.**



Training and real-time feedback in the vehicle helped Massachusetts DOT employees drive more safely while reducing emissions and improving fuel economy.

Quantifying Benefits of Posting Speed Limits Below Recommended Levels

MONTANA

Montana DOT usually posts speed limits at the levels recommended by engineering guidelines. Speed limits are occasionally set at levels lower than recommended, typically based on factors such as school zones, resident requests, political pressure, or perceived safety benefit.

Montana DOT researchers examined the impact on safety and operations of posting speed limits lower than engineering recommendations. The research team studied literature, then surveyed state transportation agencies before analyzing speed and safety data collected from a variety of roadways.

Researchers evaluated sites with speed limits that were lower than the recommendation by 5, 10, 15, and 25 mph, as well as sites posted at the recommended limits. The literature revealed that little published information exists on the practice of setting posted speed limits lower than engineering recommended values. However, 22 of 28 survey respondents indicated that their agencies engage in this practice. This research showed that as the gap between the recommendation and actual speed limit grows, driver compliance weakens. Light enforcement has little effect, though heavy enforcement increases compliance.

Researchers also found that crash frequency and fatalities and injuries fell at the 5 mph gap, but results were more mixed at other gap levels, with little observed benefit. This research will help decision makers better respond to future requests for lower speed limits.

[Project web page.](#)



Source: Montana DOT

Montana DOT occasionally posts speed limits lower than engineering recommendations.

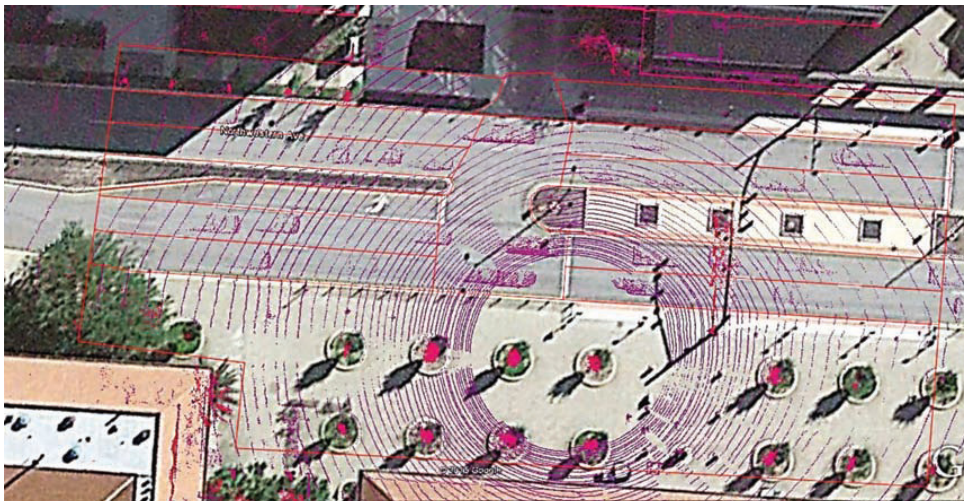
New Lidar Scanning Tool Shows Promise in Traffic Safety Applications

INDIANA

Collecting accurate traffic data is an important component of improving intersection safety. However, the most commonly used tool, video analysis with human observers, demands significant time and labor.

Researchers for Indiana DOT are taking a different approach. They have evaluated a new lidar-based portable traffic scanner for studying near-crashes at intersections. Researchers installed the lidar system in their instrumented van and used it to gather traffic data at several intersections in West Lafayette, Indiana, to test its feasibility for safety studies.

Researchers found the lidar traffic scanner to be more effective than video analysis for studying near-crashes. Even in light rain, fog, and nighttime conditions, the lidar scanner detected and tracked heavy motor vehicles, light motor vehicles, bicycles, and pedestrians—including estimating their speeds and pathways—without human effort. Lidar data map easily onto video and other formats and considerably expand the amount of information available for the study of intersection traffic safety. [Final report.](#)



Source: Indiana DOT

Lidar data mapped onto a satellite image of a pedestrian crossing.

AMERICAN ASSOCIATION OF
STATE HIGHWAY AND
TRANSPORTATION OFFICIALS

AASHTO
THE VOICE OF TRANSPORTATION



Access the electronic edition of this document with project links, as well as more high-value state DOT research projects, at AASHTO's research website, research.transportation.org.