2014-19TS
Published July 2014

RESEARCH SERVICES & LIBRARY

OFFICE OF TRANSPORTATION SYSTEM MANAGEMENT

TECHNICAL SUMMARY

Technical Liason:
Brian Kary, MnDOT
Brian.Kary@state.mn.us

Project Coordinator:
Dan Warzala, MnDOT
Dan.Warzala@state.mn.us

Principal Investigator:
John Hourdos, University of Minnesota

PROJECT COST:
$140,000

Data was primarily collected via cameras at the I-94 commons Third Avenue Field Laboratory station, which overlooks an area with a particularly high crash rate.

Safety Impacts of Variable Speed Limit Advisories on the I-94 Commons High Crash Area

This project evaluated variable speed limit advisories implemented as part of the Active Traffic Management system for the I-94 commons high crash area. The variable speed limit advisories had minimal impact on safety, suggesting the need to improve VSL algorithms and reconsider their potential to affect driver behavior.

What Was the Need?

The I-94 commons area in downtown Minneapolis presents a unique safety challenge. The 1.4 miles westbound between 11th Avenue and the Lowry Hill Tunnel experience the highest crash rate in the state: 4.81 crashes per million vehicle miles, or roughly one crash every other day. The corridor has two significant bottlenecks with about five hours of congestion per day during the afternoon rush alone.

One experimental approach to improving safety and alleviating congestion—particularly in areas such as the I-94 commons that have no room for expansion—is the variable speed limit system, which displays advisory speed limits on changeable message signs in response to varying traffic conditions. As vehicles approach the commons, the system measures speeds at the bottlenecks and, if traffic is too slow, can transmit a command to display reduced advisory speeds to drivers up to 1.5 miles upstream from the slowdown. While VSLs in some states are enforceable, the I-94 system does not change the legal speed limit.

In theory, speed reductions prompted by these advisory signs should reduce the number of shockwaves, where a high-speed vehicle has to brake as it meets slower traffic ahead, causing a wave of reduced speed to travel upstream as other high-speed vehicles behind have to brake as well. However because the system is experimental, MnDOT needed to monitor its impact and quantify its benefits.

What Was Our Goal?

The goal of this project was to evaluate the impact of automated VSLs on safety in the I-94 commons area.

What Did We Do?

Researchers collected data for this project using the University of Minnesota I-94 Field Laboratory, which consists of a set of permanently deployed video cameras and machine vision sensors—cameras that can be positioned as needed to track the speeds of individual vehicles—at three locations.

Researchers studied video collected between 10 a.m. and 8 p.m. every weekday during three periods: "Long Before" activation of the VSL in 2008; "Before" activation from April through Sept. 27, 2012; and "After" activation from Sept. 28, 2012, through fall 2013. This data was supplemented by loop detector volume and speed data, VSL actuation details and crash records.

Researchers used three methods to evaluate the VSL system's safety impact on the I-94 high crash area:

- Directly identified crashes and near crashes in video footage.

continued

"I-94 in downtown Minneapolis has been one of the highest crash locations in the state for a long time. We wanted to improve these conditions by using variable speed limits, a new technology that very few places in the world have tested."

—John Hourdos,
Director, Minnesota Traffic Observatory, University of Minnesota

"We've deployed the Active Traffic Management system, which includes variable speed limits, on I-35W and I-94. Since it's a new, experimental system, we wanted to continue to monitor and quantify its benefits and look at opportunities for improvements."

—Brian Kary,
MnDOT Freeway Operations Engineer

Produced by CTC & Associates for:
Minnesota Department
of Transportation
Research Services & Library
MS 330, First Floor
395 John Ireland Blvd.
St. Paul, MN 55155-1899
651-366-3780
www.mndot.gov/research

The I-94 commons area has a major bottleneck where the I-35W northbound ramp merges with I-94 westbound (between Cedar Avenue and 11th Avenue). Vertical red lines indicate locations of gantries that display VSL advisories.

- Used machine vision sensor data and VSL actuation records to describe shockwave characteristics.
- Examined the first three shockwaves of each day using data from machine vision sensors and VSL actuation records.

They also extrapolated the trajectory of vehicles involved in crashes and near crashes to determine if they passed VSL gantries while advisory limits were displayed.

What Did We Learn?

This research suggested little change in driver behavior and vehicle speeds due to the VSL system:

- The total rate of crashes and near crashes per million vehicles traveled decreased slightly from the Before period to the After period, from 116 to 107. However, the Before period did not include any winter months; excluding these months from the After set caused the rate to increase to 132 incidents per million vehicles traveled.
- Loop machine vision sensor data did not show a change in shockwave activity or propagation speed in the Before and After data sets.
- Video analysis suggested some impact on shockwave generation patterns. After activation, the first shockwave was more likely to happen early in the day, and the second and third shockwaves were more likely to follow within five to 10 minutes.

About 39 percent of vehicles involved in crashes or near crashes received instruction from a VSL sign immediately upstream of the incident location.

What's Next?

The I-94 commons poses challenges for traffic flow and safety because of its high traffic levels and limited room for expansion. This research suggests that the current VSL system—designed to warn motorists of slowed or stopped traffic ahead—is inadequate for reducing collision rates in this complex corridor. A new project is starting this year to develop and deploy a queue warning system specifically for this high crash rate location.

The University of Minnesota is also studying the impact of lane control signals, another aspect of the Active Traffic Management system used to direct traffic to a clear lane after a collision has occurred. Another safety study will investigate the combined effect of the system and geometric improvements.

This research suggests that wider implementation of VSLs may not be justified until MnDOT more fully understands how to use it to produce positive impacts.

This Technical Summary pertains to Report 2014-19, "Investigation of the Impact of the I-94 ATM System on the Safety of the I-94 Commons High Crash Area," published May 2014. The full report can be accessed at http://www.lrrb.org/PDF/201419.pdf.