



TECHNICAL SUMMARY

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TOTAL PROJECT COST:

\$270,351

LRRB COST:

\$50,000



The standard work zone signage layout is not always effective at capturing driver attention.



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New Work Zone Signage and Devices May Improve Flagger Safety

What Was the Need?

Work zone safety is a serious concern nationwide. In Minnesota alone, there were 1,700 work zone-related crashes in 2012. Distracted driving in work zones is a particular safety concern, with potentially catastrophic effects when drivers do not obey the flagger or approach the flagger while traveling too quickly. As a result, MnDOT and the Local Road Research Board (LRRB) have a strong interest in improving methods to attract the attention of drivers as they approach work zones.

Researchers at the University of Minnesota [previously developed](#) a warning horn that can be positioned ahead of a flagger to alert drivers as they approach. That development only included engineering of the horn, however. Research was still needed to evaluate how drivers would react to it.

What Was Our Goal?

This project's objective was to test how several layouts of attention-attracting devices, including speed trailers, portable rumble strips and barrel horns, affected driver behavior when drivers approach work zone flaggers.

What Did We Do?

Investigators first tested three work zone configurations in the driving simulator at the University of Minnesota's Center for Design in Health. The first configuration was the control, while the second and third were two versions of the experimental configuration:

- MnDOT's standard configuration with four warning signs in a series: Road Work Ahead, One Lane Road Ahead, Be Prepared to Stop and "flagger-ahead" figure signs.
- A layout with a One Lane Road Ahead sign, a combined flagger-ahead figure and 45 mph speed limit sign, a combined 45 mph speed limit sign and dynamic speed trailer that displays the driver's speed, and a Be Prepared to Stop sign 50 feet ahead of portable rumble strips.
- A layout identical to the second configuration but with the addition of flashing LED lights around the perimeter of the One Lane Road Ahead sign and a warning horn that sounds when drivers exceed 45 mph approaching the dynamic speed display.

The simulator experiment included 160 drivers, equally split between men and women, from four age groups. The drivers were randomly assigned to different sequences of the three configurations. Investigators monitored and analyzed driver speed as drivers approached the simulated work zone to evaluate each layout's effectiveness and select a layout for field testing.

Field tests conducted by the Minnesota Traffic Observatory gathered data about driver behavior in response to two layouts: the minimum standard setup following guidelines in the Minnesota Manual on Uniform Traffic Control Devices, and a setup with a One Lane Road Ahead sign, a flagger-ahead figure sign, a dynamic speed display and warning horn that sounded when drivers exceeded 45 mph, a Be Prepared to Stop sign and

A driving simulator and field tests found that a dynamic speed display and barrel horn that sounds when drivers are traveling too fast while approaching a work zone flagger, in conjunction with reconfigured signage, were successful at reducing driver speeds, which may improve work zone safety.

“A frequent comment from maintenance staff throughout the state is that distracted driving and drivers not obeying flaggers are endangering worker safety.”

—Robert Vasek,
Maintenance Operations
Engineer, MnDOT Office
of Maintenance

“Cars today are well-insulated and have excellent sound systems. These features can draw drivers’ attention away from the road and cause them to not focus sufficiently on road signs.”

—Kathleen Harder,
Director, Center for
Design in Health,
University of Minnesota

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In field tests, the dynamic speed display trailer and warning horn reduced driver speed, particularly among the fastest and potentially most dangerous drivers.

portable rumble strips. The tests took place on Minnesota State Highway 70 in Pine City in October 2014 and on County State Aid Highway 8 in Spring Valley in October 2015.

What Did We Learn?

Analysis of driver speeds in the simulator experiment suggested that the experimental sign layout effectively encouraged drivers to reduce speeds earlier as they approached a flagger. Additionally, the warning horn resulted in reduced speeds for drivers who were driving fast enough to activate it. LED lights, however, did not contribute to a reduction in speed. Several drivers left their lane to avoid rumble strips, suggesting the devices successfully captured driver attention.

The first field test (using the standard setup) did not collect enough data to be statistically valid due to short work zone working periods and low traffic volume. However, the data that were collected matched observations from the second field test (using the experimental setup), which found that the combination speed trailer and horn reduced average driver speeds approaching the work zone by about 5 mph relative to the standard layout. Perhaps more importantly, the distribution of speeds was narrower with the experimental layout, which had almost none of the high-speed outliers that the standard layout had. This suggests that the devices were effective at attracting the attention of the fastest and potentially most dangerous drivers as they approached the work zone.

Investigators did not identify any impact from the rumble strips on driver speeds. However, since drivers only encountered the rumble strips after slowing down in response to the speed trailer and horn barrel, the field test cannot be considered a valid assessment of rumble strip impact.

What’s Next?

It is unclear whether the devices tested in this project will be implemented. LRRB plans to discuss options with the state work zone safety working group, a group of stakeholders that includes maintenance personnel, law enforcement personnel and safety device manufacturers.

The warning horn is still an experimental device that has not yet been commercialized, so any future implementation would be dependent upon its becoming available on the market.

MnDOT and LRRB will continue evaluating work zone safety options, including alternative layouts and automated flagger devices.

This Technical Summary pertains to the LRRB-produced Report 2017-07, “Flagger Operations: Investigating Their Effectiveness in Capturing Driver Attention,” published February 2017. The full report can be accessed at mndot.gov/research/reports/2017/201707.pdf.