Project Summary

Texas Department of Transportation

0-5577: Operational Effects of Shoulder and Centerline Rumble Strips on Two-Lane Undivided Highways

Background

Shoulder rumble strips (SRS) placed near or on the edgeline of two-lane roadways provide warning to drivers as soon as they leave the travel lane and thus provide the largest amount of recovery area for the driver to correct the errant vehicle's trajectory. A small offset (the distance from the outside edge of the edgeline to the inside edge of the rumble strip) may promote better lane keeping by reducing inadvertent encroachments onto the shoulder, but the small offset may also shift the lateral placement of vehicles in the travel lane toward the centerline (especially where travel lane widths are narrower than 12 ft). This could increase the potential for head-on and opposing-direction sideswipe crashes. SRS could be installed farther from the edgeline (i.e., a larger offset) to reduce any potential negative effect on vehicle lateral placement; however, at some maximum distance, it is likely that SRS will no longer warn a driver in time for them to correct their errant vehicle trajectory before leaving the paved roadway surface.

Centerline rumble strips (CRS) provide warning to errant drivers who may be veering into oncoming traffic. However, there is concern that the lateral placement of vehicles in the travel lane may shift excessively toward the shoulder where CRS are used (especially where lane widths are less than 12 ft) and increase the potential for run-off-road crashes.

The goal of this project was to investigate the impact of SRS and CRS on the lateral placement of vehicles in the travel lane of two-lane, undivided roadways. The project also investigated how much recovery time (and the related distance traveled) that distracted drivers require to correct errant vehicle trajectories once alerted by SRS.

What the Researchers Did

Researchers designed and conducted field studies on two-lane, undivided roadways to evaluate the impacts of depressed SRS (including edgeline rumble stripes [ERS]) and CRS on the lateral placement of vehicles in the travel lane. They assumed that vehicle paths located near the center of the travel lane would minimize the likelihood of crashes and thus improve safety. Researchers also designed and conducted a closed-course study to observe how distracted drivers exited the travel lane, reacted to SRS, and corrected their errant vehicle trajectory.

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What They Found

At CRS-only sites and sites with both CRS and ERS on narrow (1- to 3-ft) shoulders, drivers tend to position the center of their vehicle closer to the center of the travel lane than if the rumble strips were not there, potentially resulting in a higher level of safety. In contrast, at sites on roadways with shoulder widths greater than or equal to 9 ft, neither CRS nor the combination of CRS and ERS appears to practically affect the lateral position of vehicles in the travel lane.

Unfortunately, the effect of providing only SRS located within 7 to 9 inches of the edgeline was less consistent. It does appear that in some cases SRS located near the edgeline may cause drivers to center their vehicle to the left of the center of the lane (i.e., closer to the centerline). Researchers did find that SRS located further from the edgeline (35 inches) did not practically affect the lateral position of vehicles in the travel lane. Furthermore, the previous results imply that the detrimental effect of SRS close to the edgeline on vehicle lane placement can be mitigated by including CRS.

As expected, distracted drivers typically exited the travel lane at very shallow angles (less than 2 degrees) and reacted very quickly when alerted by SRS (on average less than 0.5 second). During this reaction time, most drivers (83 percent) travelled laterally less than 1 ft before starting to correct their errant vehicle trajectory back in the opposite direction toward the travel lane. Compared to drivers that did not hit the SRS, drivers who contacted the SRS did not change their lateral velocity as much, indicating a less severe change in direction and potential safety benefit. Subsequent computations by the researchers indicate that lateral offsets that position the center of 16-inch wide SRS in the middle of shoulders at least 4-ft wide should provide enough remaining shoulder width for 85th percentile distracted drivers to correct their errant vehicle trajectory before leaving the paved roadway surface.

What This Means

Researchers' recommendations for the use of depressed SRS and CRS on two-lane, undivided roadways are as follows:

- CRS may be used for lane widths as narrow as 10 ft.
- The combination of ERS and CRS may be used for lane widths as narrow as 11 ft.
- CRS may be installed in conjunction with SRS that are placed on the edgeline (i.e., ERS) or within 9 inches of the edgeline. In addition, the use of CRS should be considered when SRS are located more than 9 inches but less than 35 inches from the edgeline. Researchers do not believe that CRS are needed when SRS are placed 35 inches or more from the edgeline.
- The maximum allowable lateral offset for depressed SRS should be increased to allow for SRS to be placed in the middle of shoulders 4 ft or greater in width.

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