Texas A&M Transportation Institute

PROJECT SUMMARY

Texas Department of Transportation

0-7035: Examine Trade-Offs between Center Separation and Shoulder Width Allotment for a Given Roadway Width

Background

Studies have consistently shown that four-lane undivided roadways have poor safety performance compared to four-lane divided and two-lane cross sections. Four-lane undivided rural highways experience relatively high crash frequencies—especially as traffic volumes increase—resulting in conflicts with high-speed opposite-direction vehicles. However, there is not always sufficient space within the available right of way to accommodate a traditional four-lane divided cross section. Some states, including Texas, have started providing a narrow centerline buffer area that is separated by longitudinal pavement markings. This additional buffer area shifts the lateral placement of vehicles and introduces a greater physical separation between approaching vehicles. However, the provision of a centerline buffer comes at a cost of reduced lane or shoulder widths. Other cross sections such as Super 2 with and without a two-way left-turn lane (TWLTL) and four-lane with a TWLTL are also possible alternatives to four-lane undivided roadways.

A framework is needed to assist road design engineers in making decisions on cross sections for new and resurfaced rural roadway segments to optimize operational and safety performance. This framework should incorporate variables such as traffic volume, heavy vehicle mix, cross-sectional width, and access point density.

What the Researchers Did

In this research project, researchers evaluated the safety and operational benefits of converting a four-lane undivided highway into other cross-section alternatives without changing the total roadway width. First, researchers selected a sample of rural highway segments with various cross sections, including four-lane undivided, four-lane with a 4-ft median buffer, four-lane with a TWLTL, Super 2, and Super 2 with a TWLTL cross sections. Researchers analyzed five years of crash data to determine the relationship between crash frequency, exposure, access point density, horizontal curvature, cross-sectional widths, and operating speed variables. Researchers conducted the analysis for several collision types to develop guidelines for selecting one cross section over the other. The guidelines account for traffic exposure, cross-sectional width, and access point density, which are the three key variables for selecting a cross-section type.

Second, researchers collected operating speed data in the field using side-fire radar units. They also collected video footage of driveway activity for a few sites. Researchers produced estimates of daily driveway volumes based on the partial day counts. The driveways were categorized based on the land use, and the volumes were then used to convert the commercial and industrial driveways into equivalent residential driveways in terms of vehicular volumes. Researchers used various

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statistical methods to evaluate the operational difference between different cross sections. They also developed regression models to quantify the effects of different lane and shoulder widths on operating speeds.

Finally, researchers developed VISSIM simulation models to evaluate the operational impacts of different cross sections considered in the project. The geometry consisted of a 21-mile model of a hypothetical facility designed to represent a generic Texas rural highway. Each facility was analyzed with varying pavement widths, truck percentages, volume levels, and driveway densities to develop guidelines for prioritizing different cross sections. Based on safety and operational effects, researchers developed a framework that allows the analyst to select a cross section, which depends on traffic volume, heavy vehicle mix, cross-sectional width, and access point density.

What They Found

Horizontal curve presence, driveway density, shoulder width, and operating speed have been identified as key influential variables on the safety of rural highways. There is no one best cross section for all circumstances although it is clear that the four-lane undivided cross section generally has the worst safety performance of all the cross sections considered. The Super 2 cross section has the best safety performance in all circumstances at volumes up to 15,000 vehicles per day. Shoulder width and driveway density have varying effects on different cross sections. The effect of shoulder width on the safety performance of four-lane roadways with a 4-ft median buffer is substantial, with shoulders of less than 6 feet significantly increasing crashes. These cross sections are highly effective in reducing lane departure crashes. These cross sections produce excellent safety performance at volumes above 15,000 vehicles per day as long as they haves at least 6-ft shoulders and driveway density is low. Four-lane highways with TWLTL sections provide better safety performance when the driveway density is higher.

With respect to operations, all cross sections experience significant delay if the total pavement width is less than 60 ft. A four-lane highway with a TWLTL is the only cross section to have much lower average delay for any heavy vehicle proportion and driveway density when the traffic volume is greater than 25,000 vehicles per day. Therefore, it is necessary to account for both safety and operational effects when selecting a cross section.

What This Means

In Texas, four-lane undivided rural highways constitute more than 1,700 miles of the highway network that are maintained by the Texas Department of Transportation (TxDOT). Due to these highways' poor safety performance, some districts have already started converting them to different cross-section types.

Researchers developed a framework that assists practitioners in making decisions on cross sections for new and resurfaced roadway segments. The research team recommends using the framework to convert the existing four-lane undivided sections that experience significant safety issues. Additionally, researchers recommend potential revisions to the current standard in the TxDOT *Design Manual* for the selection of a cross section. The crash modification factors for the centerline buffer developed in this research study are recommended to be included in the TxDOT Work Codes for use in developing projects in the Highway Safety Improvement Program.

For More Information

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