Texas A&M Transportation Institute

PROJECT SUMMARY

Texas Department of Transportation

0-6894: Guidelines for Design and Operation of U-Turns

Background

U-turn lanes are commonly provided at diamond interchanges to reduce delay for U-turning traffic and for the interchange as a whole; however, there are currently many unknowns related to their design, operation, and use. Project 0-6894 was tasked with identifying and investigating demand and capacity factors affecting U-turn lane use, determining the performance of U-turn lanes under various geometric and operational conditions, and determining the anticipated effectiveness of proposed solutions to U-turn operational issues. This project also provides a cross-sectional safety analysis of existing U-turn configurations.

What the Researchers Did

Researchers reviewed existing guidance and relevant literature to identify potential factors and solutions. They also asked engineers across the Texas Department of Transportation's (TxDOT's) 25 districts about their current practices and locations of potential study sites. Using those findings with input from the project advisory panel, researchers developed a set of 26 study sites (later trimmed to 25 sites) in 12 districts for simulation studies and field studies. Researchers collected traffic and site characteristics data that provided information to conduct VISSIM simulations of operations at these sites. The purpose of this was to establish baseline performance measures for each study site and to document these performance measures for U-turn lanes operating under various scenarios.

The baseline information provided a foundation for a qualitative safety evaluation for the study locations that were included in the operational analysis and a large, randomly sampled data set for a statistically reliable assessment of U-turn safety performance at Texas interchanges. Researchers then created more detailed simulation models for eight sites, using detailed traffic data such as gap acceptance, origin-destination splits, and queue waiting times. These detailed models were used in modeling 14 countermeasure treatments, which were evaluated to determine their effectiveness at improving U-turn operations.

Later, researchers partnered with TxDOT district staff to implement a selection of treatments and countermeasures and evaluate their effectiveness in real-world conditions at two sites with existing U-turn lanes. These treatments included the installation (or in selected cases, removal) of signs and/or markings to better communicate to drivers the expected operation at those sites. Another

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countermeasure treatment included traffic signal timing improvements. Researchers were not able to complete all field site evaluations during the project due to several reasons, one of which involved delays in contractors completing the installation of those countermeasures.

Researchers used results from the operational simulations, the safety data statistical analysis, and the field study operational evaluations to draw conclusions about the effectiveness of selected treatments and to develop recommended guidelines to be included in the TxDOT *Roadway Design Manual*.

Researchers also conducted statistical analysis of total crashes and injury crashes. Evaluation included diamond interchange sites with and without U-turn lanes.

What They Found

Researchers found that:

- U-turn lanes are beneficial when peak-hour volume at a diamond interchange is at least 2,000 vehicles per hour, or roughly 20,000 average daily traffic.
- Queues in the left approach lane can significantly affect U-turn traffic. This U-turn lane design should include an approach bay with a minimum length of 525 ft.
- Geometry and interactions with conflicting traffic affect U-turn lane capacity on the departure side. Departure capacity can be improved by:
  - Providing either a full added lane or a 100-ft or longer acceleration lane with a taper.
  - Removing driveways within 250 ft of a turn lane or using a means to minimize weaving to and from driveways.
  - Using pavement markings to guide conflicting interior left-turn traffic away from the merge area.
- U-turn lane design should provide sufficient turn radii to accommodate heavy vehicles.
- Improving traffic signal operation by adjusting splits and cycle lengths can also improve overall traffic operation.
- The cross-street annual average daily traffic, cross-street right-turn configuration, number of frontage road lanes, distance from the U-turn departure point to the nearest driveway, and U-turn minimum radius contribute to crashes at diamond interchanges. Analysis of sites with and without U-turn lanes indicates that there is no significant difference in crashes between sites with and without U-turn lanes.

What This Means

Project 0-6894 provides TxDOT with implementable guidelines for designing and operating U-turn lanes at diamond interchanges. These guidelines are formatted for inclusion in the *Roadway Design Manual* and other manuals dealing with access management, design, and operations of facilities. A key product of the safety analysis is a self-calculating spreadsheet tool that can be used to predict U-turn safety performance under various conditions.

For More Information

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