Texas A&M Transportation Institute

Texas Department of Transportation

PROJECT SUMMARY REPORT

0-7136: Texas Guidelines for Optimizing Roadway Cross-Section

Background

Highways and streets in Texas contain a wide variety of cross-sections, combining through lanes, turning lanes, medians, shoulders, and other features. Providing an appropriate cross-section is important for both operational and safety performance. It is useful to periodically evaluate whether a given cross-section is the most appropriate based on expected conditions. No statewide guidance exists for selecting the optimal cross-section, and discussion of potential cross-section alternatives would also benefit practitioners.

What the Researchers Did

The project team compiled and reviewed existing road cross-section guidance (for urban, suburban, and rural environments), along with research findings, to identify content that would be appropriate for inclusion in Texas-based guidelines for cross-section optimization. A subsequent task focused on considering the data needs for assessing a proposed cross-section treatment, using the results from previous efforts to determine if existing guidance and data are sufficient to develop cross-section optimization guidelines. The project concluded by providing recommendations for further evaluation and adoption.

What They Found

The information compiled in this project provided support for the following guidelines for selecting the optimum cross-section for rural highways:

- Super 2 highways always provide superior safety performance compared to two-lane undivided (2U) highways, but they may not be cost-effective at low volumes.
- Between 3,000 and 15,000 vehicles per day (vpd), passing lanes and turning lanes (e.g., Super 2 or Super 2 with a two-way left-turn lane [TWLTL]) can improve 2U safety and operational performance.
- Between 15,000 and 20,000 vpd, widening to a four-lane cross-section (with a TWLTL [4T] or a median buffer [4M]) is more effective.
- Above 20,000 vpd, highways should be widened to four lanes with a full-width TWLTL (4T) or median (4D). 4D always provides superior safety performance than 4T but is not always a cost-effective alternative due to significantly higher costs of construction. Therefore, a benefit-cost analysis is recommended before selecting a specific cross-section.
- Four-lane undivided (4U) cross-sections have poor safety performance and mediocre operational performance compared to other alternatives and should be avoided. Existing four-lane undivided roadways should be evaluated for conversion based on the volume ranges described above.
- The effects of traffic volume, shoulder width, truck percentage, and driveway activity on safety and operational performance should be considered when selecting the cross-section of any rural highway.
- Appropriate transitions and lane addition and reduction tapers as described in the *Roadway Design Manual* must be used when changing cross-sections.

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- Where passing lanes are provided in the vicinity of intersections, the beginning and ending of passing lanes and turning lanes should be appropriately separated based on guidance from TxDOT Project 0-7044.
- Turning lanes for intersections should be considered for locations that meet the warrants described in National Cooperative Highway Research Program Report 780, the American Association of State Highway and Transportation Officials *Green Book*, and Potts et al.

The research team also compiled recommendations for guidelines on selecting urban cross-sections. Some principles are similar for both rural and urban, while others differ because the typical speeds found in the urban environment are lower than those in the rural environment. The following guidelines are recommended for selecting cross-sections for urban roadways:

- For roads with higher speeds (e.g., 50 mph and higher), the recommendations for rural cross-sections can be applied to urban and suburban cross-sections, supplemented by guidance in the *Highway Capacity Manual* on uninterrupted flow.
- For roads with lower speeds (e.g., 45 mph and lower), the practitioner should consult the guidance in the *Highway Capacity Manual* on capacity and level of service for interrupted flow conditions. Practitioners should use the *Highway Capacity Manual* methodology to determine the number of through lanes for given conditions on a specific facility or segment.

What This Means

To provide the best opportunity for implementing these guidelines, the research team developed recommendations for updates to the guidance in the *Roadway Design Manual* and the *Access Management Manual*. The key piece of guidance included in those recommendations is the preferred cross-section for various combinations of rural highways, presented in Table 1, to be included in the *Roadway Design Manual*.

Table 1. Potential Guidelines for Selecting Rural Cross-Sections.

Annual Average Daily Traffic	Driveway Activity Index[a] per Mile	Truck Percentage	Preferred Cross-Section
≤3000	Any	Any	Two-Lane Undivided/Two Lanes with TWLTL
3000–15,000	≤30	Any	Super 2
	>30	≤15%	Super 2 with TWLTL
		15–25%	Super 2 with TWLTL
		>25%	Four Lanes with TWLTL
15,000–20,000	≤30	≤5%	Four Lanes with 4-ft Median Buffer[b]
		15–25%	Four Lanes with 4-ft Median Buffer[b]
		>25%	Four Lanes with TWLTL
	>30	≤15%	Four Lanes with 4-ft Median Buffer[b]
		15–25%	Four Lanes with TWLTL
		>25%	Four Lanes with TWLTL
>20,000	Any	Any	Four Lanes with TWLTL/Four-Lane Divided

[a] The driveway activity index is the number of residential driveways. The index is equal to three times the number of industrial driveways, or 12 times the number of commercial driveways (measured per mile).

[b] 6-ft minimum shoulder width. Greater widths are desirable.

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