TEXAS TRANSPORTATION INSTITUTE
THE TEXAS A&M UNIVERSITY SYSTEM

PROJECT SUMMARY REPORT

Project Summary Report 4064-S
Project 0-4064: Design Criteria for Improved
Two-Lane Section (Super 2)

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Super 2 Highways: Two-Lane Rural Highways with Passing Lanes

Figure 1. Passing lane section on two-lane highway

Many of Texas' highways are two-lane roadways and will remain so for the foreseeable future. As traffic volumes increase, motorist satisfaction and traffic performance on those roadways will decrease. The traditional answer to these problems, provision of a four-lane roadway, appears to be out of reach for many of these facilities due to fiscal constraints. An alternate solution is the provision of periodic, short-term passing lanes, otherwise known as a "Super 2"design, shown in Figure 1. These lanes allow motorists increased opportunities to safely and easily pass slower vehicles, improving traffic flow at a much lower cost than a traditional expansion to four lanes.

This report summarizes the development and nature of the Texas Transportation Institute's (TTI) recommendations for the design of Super 2 highways as developed in TxDOT Project 0-4064: "Design Criteria for Improved Two-Lane Section (Super 2)."

What We Did . . .

Researchers focused on three critical elements of the design of Super 2 highways: passing lane length and spacing, lane and shoulder width requirements, and signing and marking strategies. Researchers reviewed the literature and conducted site visits and field studies in Kansas, Minnesota, and Texas. In addition, a computer-based survey was conducted in five TxDOT districts to examine driver understanding and acceptance of signs, markings, and highway design characteristics of passing lanes.

Passing Lane Length and Spacing

The selection of an appropriate passing lane length and the spacing between passing lane segments are critical to the effect of the passing lane on traffic operations. If the passing lane is too short, platoons are not effectively dispersed. If the lane is too long, efficiency is lost.

The research team selected an advanced microscopic simulation program, TWOPAS, to simulate the passing lane sections. TWOPAS has recently been upgraded by the Federal Highway Administration and has the ability to model two-lane, two-way rural highways with passing lanes. A hypothetical two-lane highway was simulated under a variety of traffic mixes and volumes. Passing lane designs that were tested had passing lane spacings between 1 and 8 miles and passing lane lengths between 0.25 and 2 miles. Tested traffic volumes ranged between 400 and 1,000 vph, while the percent trucks varied from 0 to 40 percent.

The primary measures of effectiveness used were percent time delay and the derived level of service. Based on time delay, optimal length and spacing requirements were established for various traffic volumes. Varying the percent trucks in the traffic stream showed that percent time delay on two-lane highways with passing lanes is

relatively insensitive to the percentage of trucks.

Lane and Shoulder Width Requirements

Safety on highways is usually enhanced by the provision of wider lanes and shoulders that provide greater recovery room for errant drivers. Similarly, the provision of passing lanes also enhances safety through the accommodation of passing maneuvers that reduce platoon sizes and reduce the number of unsafe passes. Although conflicts do not always arise, providing a passing lane sometimes necessitates the temporary reduction of the shoulder and, occasionally, the lane width.

Researchers reviewed state design guidelines, national design guidelines, widths on existing passing lane sections, the current literature, and available international design guidelines regarding lane and shoulder widths in passing lane sections. The lane widths typically recommended were either 12 ft or widths that matched adjacent roadway sections, while shoulder width recommendations ranged from "minimum" values of 4 to 6 ft to "desirable" values that matched adjacent roadway sections.

Researchers also used a computer-based survey. Respondents were asked whether they would feel comfortable stopping to change a tire on various width shoulders (presented pictorially). Of the 134 drivers surveyed, 70 percent reported they would be comfortable stopping on 10-ft shoulders, 49 percent reported they would be comfortable stopping on 6-ft shoulders, and 20 percent reported feeling comfortable stopping on 4-ft shoulders.

Signing and Marking

Following a review of the literature, researchers used the computer-based survey to test driver understanding of passing lane signs and markings. By understanding what drivers perceive to be the purpose and meaning of signs and markings, designers can more effectively convey the intended use of the roadway.

Using both open-ended and multiple choice questions, researchers gained input regarding:

- Regulatory signs intended to tell the driver to stay in the right lane unless passing,
- Informational signs providing the distance to the next passing lane,
- Pavement markings allowing or prohibiting passing, and
- Entrance pavement markings encouraging staying in the right lane.

The Researchers Recommend . . .

Based on the findings from the studies conducted, researchers developed recommendations for the design of passing lanes. The length, spacing, shoulder width, and lane width recommendations are provided as suggested modifications to TxDOT's *Roadway Design Manual*, while the signs and markings are provided as the basis for a potential standard detail drawing.

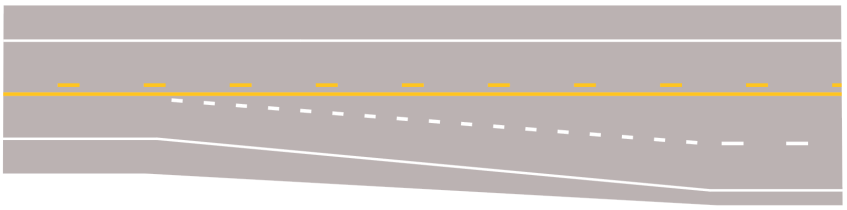

Figure 2. Lane addition marking

Researchers next conducted a field study involving the entrance pavement markings from the survey. The entrance markings consisted of a white skip-stripe pattern at the start of the passing lane, extending across the added lane. The striping pattern is similar to that used at the addition of turning lanes, providing a strong cue to drivers to stay in the right, or outer, lane. The markings, shown in Figure 2, were installed at three locations in Texas. Driver lane selection behavior was monitored through the use of classifiers and video taping in the before and after studies.

Length and Spacing

Recommended passing lane length and spacing values are shown in the following table. The values were determined based on the premise of minimizing cost and percent time delay. These values are generally longer than those recommended in the literature, reflecting current higher speed limits for rural roads than the speed limits in effect during previous research.

Passing lanes should be located to best fit existing terrain and field conditions. Uphill grades are preferred sites over downhill grades. Passing lanes on significant uphill grades should extend beyond the crest of

Recommended values of length and spacing for level terrain

Two-Way ADT (vpd)		Recommended Passing Lane Length (mi)	Recommended Distance Between Passing Lanes (mi)
Level Terrain	Rolling Terrain		
≤1950	≤1650	0.8-1.1	9.0-11.0
2800	2350	0.8-1.1	4.0-5.0
3150	2650	1.2-1.5	3.8-4.5
3550	3000	1.5-2.0	3.5-4.0

the hill. Passing lane sections should be placed to avoid major intersections. If present, minor intersections that do not require deceleration lanes should be located near the midpoint of passing lane sections, avoiding transition areas.

Traffic signals on highways in incorporated areas tend to build platoons. These platoons of through traffic leaving the last traffic signal in an incorporated area should be broken up before entering subsequent rural two-lane highway sections, if practical. The last signal should desirably feed into a continuation of the urban four-lane cross-section (if present in the city) or, alternatively, into a passing lane section. A one-half-mile multi-lane section located immediately outbound of the last traffic signal is preferred; however, an outbound passing lane starting near the outskirts of the developed area is an alternative in more restrictive conditions.

Signs and Markings

Based on available research and the studies performed by the research team, the following recommendations are made:

- Advance signing should be provided regarding the upcoming passing lane so that drivers are aware of its presence. The preferred sign (and associated sign placement) is that the passing lane is upcoming in two miles. This sign will permit drivers to delay passing maneuvers until they can be made more comfortably, although passing may still be permitted prior to the passing lane section.
- A sign should be provided near the end of each passing lane section stating that in "X" distance another passing lane will be provided. This advance signing will inform the driver of the repetitive nature of the passing lane design, allowing the driver to understand the purpose and nature of the roadway's characteristics.
- A dashed white line in the transition area extending from near the highway centerline to the beginning of the white dashed line separating the passing lane from the right lane should be provided. Drivers were more likely to comply with state laws regarding driving in the right lane unless passing when this marking was used. Testing of Texas drivers also indicated better compliance in lane selection when driving in platoons, without unnecessarily delaying the initiation of passing maneuvers.
- Standard taper rates as defined in the *Texas MUTCD* should be used to add and drop lanes for the passing lane section.

A recommended detail drawing has also been developed for use by TxDOT to denote recommended sign and marking layouts for passing lanes.

Lane and Shoulder Width

Current lane width recommendations for passing sections range from 10- to 12-ft, a desirable width of 12-ft, or a minimum width to match that of the existing lanes on the two-lane roadway.

Recommendations for shoulder lane width are not as straightforward. Several items should be considered in determining the shoulder width for a passing lane section. Studies have indicated that the addition or widening of a shoulder greatly improves safety—shoulder widening can reduce related accidents by up to 49 percent with the addition of an 8-ft shoulder. Therefore, it follows that the presence of a shoulder in a passing lane section increases the overall safety of the passing lane. The presence of a shoulder also increases the driver's comfort level. Additionally, driver expectancy may be violated when traveling from a two-lane section with a wide shoulder to a three-lane section with no shoulder or with a very narrow shoulder. However, as noted in the literature, passing lane sections are short, and few vehicles are likely to stop in these sections. If vehicles do have to stop for an emergency, extra width for going around the vehicle is provided by the width of the additional lane.

Other user groups should also be considered in the provision of shoulders in passing lane sections. Pedestrians and bicyclists may also use the roadways with passing lane sections; if so, they may travel on the shoulder. Rumble strip installation also affects these users; if a rumble strip is placed in the center of the shoulder, usable space for pedestrians and bicyclists is limited.

Based upon existing recommendations from other states and other countries, upon the considerations previously noted, and upon the survey results, researchers recommend the values shown in the following table for lane and shoulder widths in passing lane sections.

Recommendations for lane and shoulder width

Lane Width	
12 ft or Values in Table 3-8 of TxDOT's *Roadway Design Manual*	
Shoulder Width	
Minimum (allowable only where traffic volumes are below 2000 ADT):	6 ft if rumble strips are used 4 ft if rumble strips are not used
Desirable	Values in Table 3-8 of TxDOT's *Roadway Design Manual*

For More Details . . .

This reasearch is documented in Report 4064-1, *Design Guidelines for Passing Lanes on Two-Lane Roadways (Super 2)*

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TxDOT Implementation Status February 2002

This research established design criteria for three critical elements in the design of Super 2 Highways: passing lane length and spacing, shoulder width requirements, signing and pavement marking strategies. The research will be incorporated into TxDOT's *Roadway Design Manual* to be implemented statewide.

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