Roadway Widths for Low-Traffic Volume Roads

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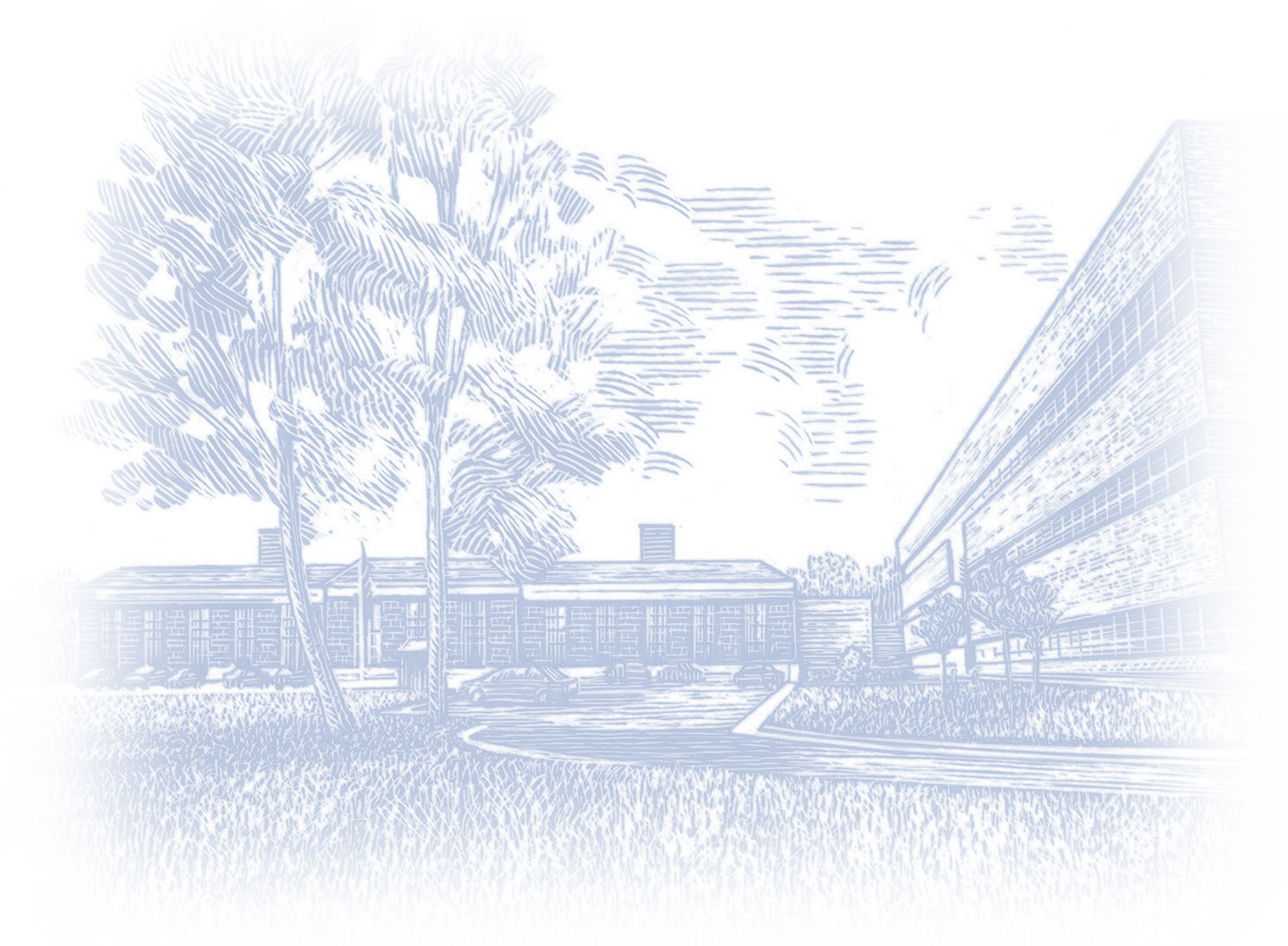

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Foreword

The United States has over 4.8 million km (3 million mi) of two-lane highways, and about 90 percent of these roads carry traffic volumes less than 2,000 vehicles per day. Many of these roads were designed and built to standards that have since been upgraded. For example, over one-fourth of the mileage has lane widths of 2.7 m (9 ft) or less and two-thirds have shoulder widths of 1.2 m (4 ft) or less. Because funding is not available to reconstruct all two-lane highways to meet current design standards of the American Association of State Highway and Transportation Officials (AASHTO), State and local highway agencies must decide which roads to reconstruct. Current design standards do not provide the guidance necessary to make safety, operations, and cost trade-offs. This investigation was undertaken to develop revised roadway width guidelines based on accident analyses, cost estimates, and operational considerations.

Data Bases Used

Existing data bases were reviewed to select those that would enable the development of accident relationships with important roadway variables, so expected accident benefits could be computed for various roadway width alternatives. The primary data source selected was a data base of approximately 3,862 km (2,400 mi) of two-lane road from seven States {with average daily traffic (ADT's) of 2,000 or below} from a previous FHWA study (Safety Effects of Cross-Section Design for Two-Lane Roads, October 1987). This data base was supplemented with data from approximately 2,736 km (1,700 mi) of paved and unpaved two-lane roadway (mostly local and collector roads) from two HSIS States (Utah and Michigan) and North Carolina. These State files contained a substantial sample of unpaved and low-volume sections on the roadway inventory with easily mergeable data files and good-quality data for many of the needed accident, roadway, and traffic variables. Field data were collected on these supplemental sections, including information on roadside safety, intersections, and driveways. The resulting primary data base thus contained approximately 6,598 km (4,100 mi) of low-volume, two-lane rural roads. Two of the independent data bases used for validation also came from HSIS States:Illinois and Minnesota.

Analysis Methods

A detailed statistical analysis was conducted on the primary data base, and accident rates were determined for various lane and shoulder widths. To validate and investigate these relationships further, three independent data bases totalling more than 86,902 km (54,000 mi) of low-volume, two-lane roads from two additional HSIS States -- Illinois and Minnesota -- as well as North Carolina, were obtained and analyzed. A methodology was developed to estimate construction costs for roadway widening projects on existing roadways and also for comparing roadway width alternatives for new roadconstruction.

Results

The data analyses focused on addressing seven safety issues:

Issue 1: What are the characteristics of accidents on low-volume roads? Low-volume roads (i.e., those with ADT's of 2,000 or less) have a slightly higher percentage of injury accidents (37.8 percent) than the full sample (i.e., including higher-volume roads) of rural roads (36.6 percent). Low-volume roads also had a higher percentage of nighttime, no-lighting accidents (39.0 vs. 31.1 percent) and a slightly higher percentage of snow and ice accidents (13.1 vs. 10.6 percent) compared to rural roads in the full sample. In terms of accident types, low-volume roads have a larger percentage of run-off-road crashes (55.8 vs. 30.6 percent), but a lower percentage of rear-end (6.0 vs. 19.8 percent) and angle and turning collisions (11.9 vs. 23.5 percent) than the full sample of rural roads. The percentages of crashes by type are shown in Table 1 for the low-volume roads and cross-section data bases.

Issue 2: Which accident types are related to roadway width? Accident types significantly associated with varying lane and shoulder widths are single-vehicle (i.e., fixed-object and rollover) and opposite direction (i.e., head-on and opposite-direction sideswipe) accidents. These accident types were combined together and termed "related" accident types for most of the analyses.

Issue 3: Which traffic and roadway variables have a significant effect on accidents? Accidents on low-volume roads are affected primarily by roadway width, roadside hazards, roadway terrain, and the number of driveways per mile. Interestingly, shoulder type (paved vs. unpaved) did not have a significant effect on accidents. State differences were also found to have some effect on accident rates, perhaps due to differences in accident reporting, driver characteristics, weather, and/or roadway maintenance practices between States.

Issue 4: What are the accident effects of lane and shoulder width on paved roads? Based on the primary data base, the presence of a shoulder is associated with a significant accident reduction for lane widths of 3.0 m (10 ft) or wider (Figure 1). For 3.0-m (10-ft) lanes, a shoulder of 1.5 m (5 ft) or greater was found to be needed to affect accident rate significantly. For 3.4- and 3.7-m (11- and 12-ft) lane widths, shoulders of 0.9 m (3 ft) or greater are associated with significant accident reductions. With m (13-ft) lanes, the accident rate for shoulders 1.5 m (5 ft) or wider was one-half that for narrower shoulders. For lanes of 2.4 and 2.7 m (8 and 9 ft), due to real-world limitations in sample sizes (e.g., few roadways have wide shoulders with narrow lanes), the effect of shoulder width could not be quantified.

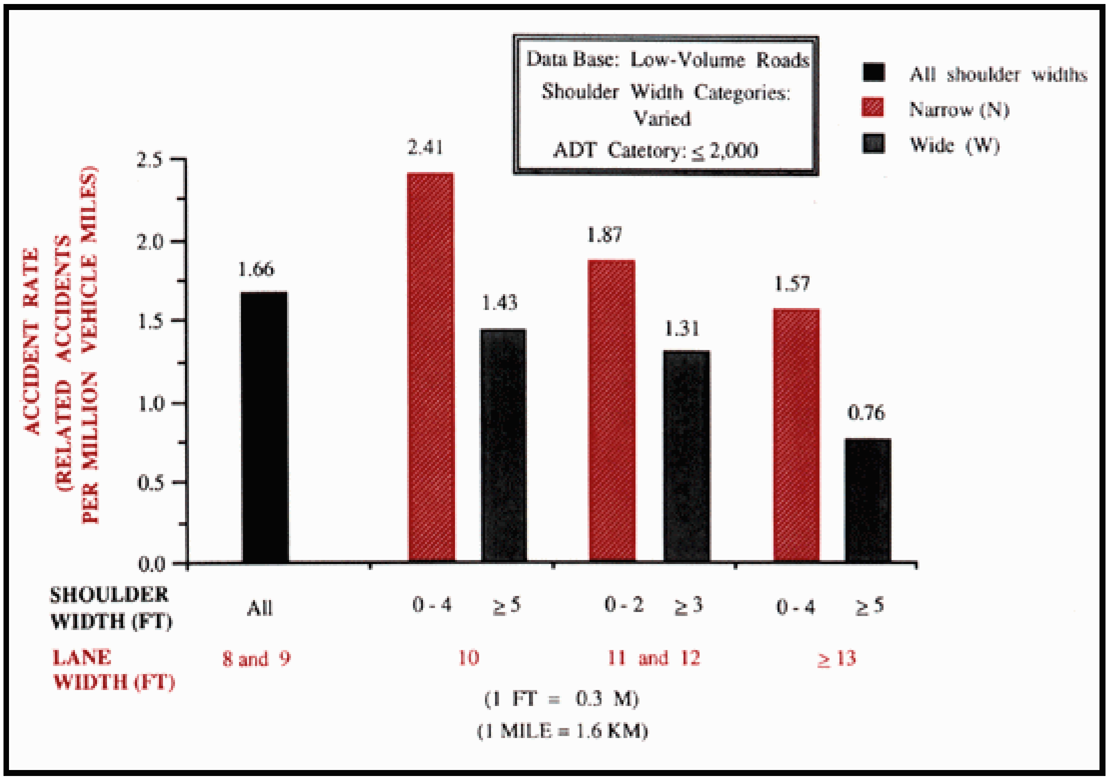

Figure 1. Rates of related accidents by lane width from the Low-VolumeRoads data base.

With respect to lane width on paved roads, two of the three validation data bases (Illinois and Minnesota) support the finding that overall, 2.7-m (9-ft) lane widths have lower accident rates than 3.0-m (10-ft) lanes with narrow shoulders. This effect was believed by the authors to be at least partly due to reduced vehicle speeds on these 2.7-m (9-ft) lanes, compared to 3.0-m (10-ft) lanes. Furthermore, the lack of shoulders on roads with 3.0-m (10-ft) lane widths provides inadequate room to recover for higher-speed vehicles that swerve beyond the edgeline. The primary data base and the same two validation data bases all show that 3.4-, 3.7-, and 4.0-m (11-, 12-, and 13-ft) lane widths have substantially lower accident rates than 3.0-m (10-ft) lane widths, particularly where narrow shoulders exist.

Issue 5: How are accident frequencies and severities affected by having a paved road surface vs. an unpaved (e.g., gravel or earth) road surface? For the primary data base, accident rates do not differ significantly between paved and unpaved surfaces for roads with ADT's less than 250 vehicles per day. Accident rates on unpaved roads are significantly higher than paved roads for ADT's above 250. For each of three lane-width categories {less than 2.7, 3.0-3.4, and 3.7 m (9, 10-11, and 12 ft) or greater}, unpaved roads had higher rates of related accidents than paved roads. However, results using Minnesota data showed no significant effect of pavement type on accident rate. Based on these analyses, the effects of paved vs. unpaved surface are somewhat unclear.

Using the unpaved road sections from the primary data base, related accident rates were considerably lower on roadways with a total width of less than 5.5 m (18 ft) compared to wider roadways. One possible explanation for this is again the lower vehicle speeds that often occur on narrow unpaved roads, which may result in lower accident rates. The accident rates on unpaved Minnesota roads fluctuated considerably for total widths up to 9.1 m (30 ft), then generally decreased as widths exceeded 9.1 m (30 ft) (Figure 2).

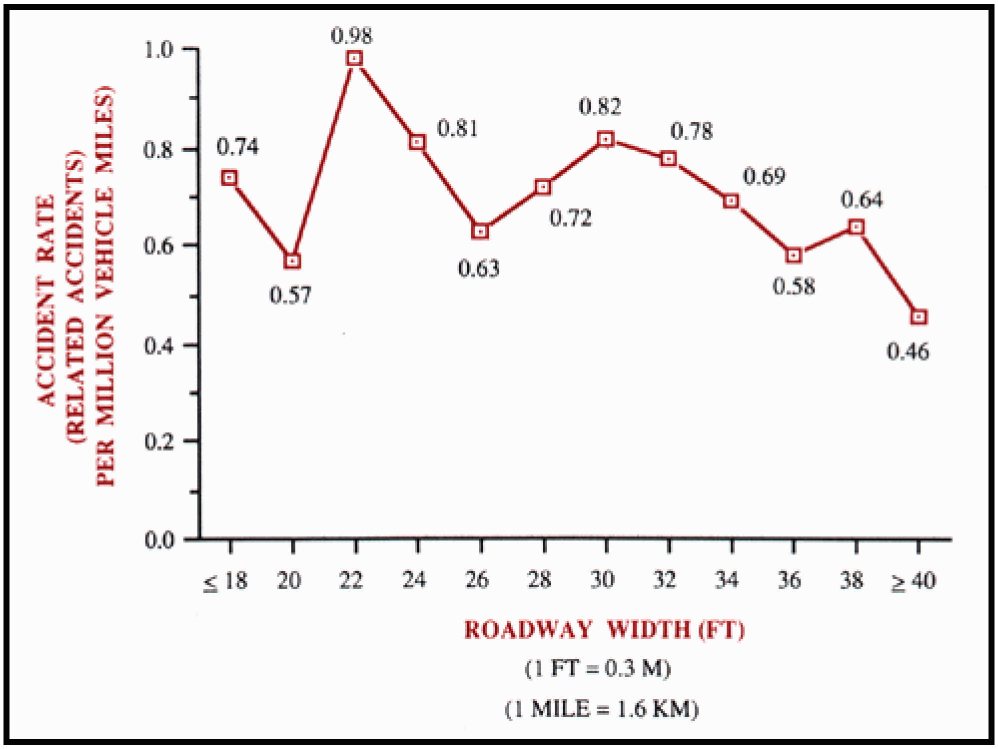

Figure 2. Relationship between accident rate and total width for unpaved roads in Minnesota.

Issue 6: What are the effects of large trucks? The percentage of truck traffic was not significantly associated with related accident rate. This finding may result partly from the lack of detailed information on truck sizes.

Issue 7: What are the expected accident benefits of wider lanes and shoulders on paved low-volume roads? A linear model was developed to estimate expected accident effects of variable roadway widths (see figure 1). After controlling for other traffic and roadway variables, lane widths of 3.4 m (11 ft) or greater had significantly lower accident rates compared to 3.0-m (10-ft) lane widths. For 3.0-m (10-ft) lanes, accident rates were 0.98/million vehicle miles (MVM) (0.61/million vehicle km) lower when shoulders exceeded 1.2 m (4 ft) than for shoulders of 0.9 m (3 ft) or less. For 3.4- and 3.7-m (11- and 12-ft) lanes, shoulder widths of 0.9 m (3 ft) or greater reduced the accident rate by 0.56 MVM (0.35/million vehicle km) as compared with narrower shoulders. The 3.4- and 3.7-m (11- and 12-ft) lane accident rates were identical after controlling for shoulder width.

Table 1. Summary of accident types and characteristics for low-volume road sites				
	Low-Volume Roads (Primary Data Base)		All Rural Roads (Cross-Section Data Base)	
Accident Type	**Numbers of Accidents**	**Percent of Total Accidents**	**Numbers of Accidents**	**Percent of Total Accidents**
Total	14,888	100.0	62,676	100.0
Property Damage Only	8,973	60.0	38,857	62.0
Injury	5,632	37.8	22,944	36.6
Fatal	283	1.9	875	1.4
Daylight	8,050	54.1	37,402	59.7
Dawn/Dusk	820	5.5	2,888	4.6
Dark with Lights	160	1.1	2,770	4.4
Dark without Lights	5,809	39.0	19,496	31.1
Light Unknown	49	0.3	120	0.2
Dry	10,306	69.2	41,957	66.9
Wet	2,442	16.4	13,487	21.5
Snow/Ice	1,952	13.1	6,657	10.6
Unknown Pavement	188	1.3	575	0.9
Run-off-Road/Fixed Object	4,017	27.0	12,091	19.3
Run-off-Road/Rollover	1,999	13.4	4,245	6.8
Run-off-Road/Other	2,287	15.4	2,840	4.5
Head-on	475	3.2	2,113	3.4
Opposite Direction Sideswipe	642	4.3	2,997	4.8
Same Direction Sideswipe	330	2.2	2,288	3.7
Rear-end	893	6.0	12,420	19.8
Parking/Backing	64	1.8	1,155	1.8
Ped/Bike/Moped	117	0.8	655	1.0
Angle & Turning	1,773	11.9	14,730	23.5
Train	20	0.1	47	0.1

Animal	1,404	9.4	5,212	8.3
Other or Unknown	667	4.5	1,883	3.0

Study Implications

The availability of HSIS data contributed to a fuller range of traffic and roadway conditions for the primary data base and also allowed a number of research findings to be validated. As a result of the data analyses, revised AASHTO roadway width criteria were developed and recommended to replace the guidelines in the current AASHTO "Green Book." The revised width criteria will be presented to AASHTO in the coming months to consider for adoption. The adoption of these revised design guidelines would be likely to reduce the costs of reconstructing two-lane rural highways, and would result in more cost-effective use of limited highway funding.

For More Information

This study was conducted by Charles V. Zegeer, Timothy R. Neuman, Richard Stewart, and Forrest Council, through a grant from the National Cooperative Highway Research Program (NCHRP). The final report, Roadway Widths for Low-Traffic-Volume Roads, was completed in June 1993 and is available through the Transportation Research Board at (202) 334-2934. For more information about the study, contact Charles Zegeer, University of North Carolina Highway Safety Research Center, at (919) 962-2202.

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