

# PAVED SHOULDERS ON PRIMARY HIGHWAYS IN IOWA: AN ANALYSIS OF SHOULDER SURFACING CRITERIA, COSTS, AND BENEFITS

## EXECUTIVE SUMMARY

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*Center for Transportation  
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IOWA STATE UNIVERSITY



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## **EXECUTIVE SUMMARY**

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## PAVED SHOULDERS ON PRIMARY HIGHWAYS IN IOWA EXECUTIVE SUMMARY

### Background

Almost 50 percent of rural fatal crashes in the United States occur on tangent alignments and level roads away from intersections. Single-vehicle run-off-the-road crashes are the highest crash type in rural areas nationally. Fatigue, drowsiness, and distracted driving are major contributing factors to single-vehicle run-off-the-road crashes. These types of rural accidents appear to be rising with an increase in inattentive driving and more long-distance commercial travel.

The scope and seriousness of this type of crash is very significant. The estimated annual cost of run-off-the-road crashes in the United States is \$80 billion. In addition to these costs, there are the hidden costs of emotional distress and family disruptions.

In Iowa, approximately 25 percent of all fatal crashes involve a single vehicle that runs off the road and fails to recover. Four of Iowa's 15 fatal accidents (5 of 15 fatalities) reported for the week ending July 13, 2001, had the following notes:

- “drop off pavement, overturned in ditch” (age 63)
- “drop off pavement, lost control, overturned” (age 43)
- “car drop off pavement, over corrected, head-on into semi” (ages 99 and 75)
- “drop onto shoulder, lost control, overturned” (age 70)

Even more recently, on the morning of September 16, 2001, a 1988 Chevrolet S-10 was traveling south on IA 330 southwest of Marshalltown when the driver steered onto the granular shoulder, and lost control when trying to recover. The vehicle spun into the northbound lane, where it was struck by a 1998 Buick Park Avenue and then by a 1990 Chevrolet van. Four fatalities occurred immediately as a result of the impacts, and another passenger died later. This crash is still under investigation.

The Iowa State Patrol fatal crash investigation officers report that deficient granular shoulders are a major contributing factor to many of Iowa's fatal crashes. A very significant number of past highway crash tort claims in Iowa were related to the maintenance of our granular shoulders.

The above information explains why a recent survey (conducted by the University of Northern Iowa Center for Social and Behavior Research) found that 66 percent of Iowans surveyed supported providing paved shoulders with rumble strips on Iowa highways.

The American Association of State Highway and Transportation Officials *AASHTO Strategic Safety Plan* identifies reducing run-off-the-road crashes as a high-priority emphasis area in the effort to achieve a significant reduction in highway crashes. The Iowa Safety Management System (Iowa SMS) Coordination Committee has also listed this as a priority emphasis area. Identifying high-crash horizontal curves and a review of the Iowa Department of Transportation (Iowa DOT) paved shoulder policy on rural multi-lane and Super 2 highways are two strategies in the Iowa SMS *Toolbox of Highway Safety Strategies*.

The Iowa DOT has recently revised its paved shoulder policy for National Highway System (NHS) roads to provide a two-foot paved shoulder on new two-lane construction and 3R projects. Iowa rural freeways and expressways provide for a two-foot paved right shoulder but no paved shoulder on the left side. However, if the average daily traffic (ADT) is greater than 10,000 vehicles per day (vpd), full-width paved shoulders are considered.

## **Study Scope**

Iowa's paved shoulder and rumble strip policy is considerably more conservative than neighboring states, particularly on rural four-lane and high-volume two-lane highways. A study committee was formed at the Iowa DOT to review the costs and benefits of providing wider paved shoulders and rumble strips along Iowa's non-interstate freeways, expressways, and Super 2 highway corridors.

The Center for Transportation Research and Education at Iowa State University was retained to review past related research, survey neighboring states on their paved shoulder policies, and develop crash data on Iowa freeways and expressways. The CTRE research was done in conjunction with the *Systematic Identification of High Crash Locations* project (TR-442) sponsored by the Iowa Highway Research Board and Iowa DOT.

The results of these collaborative efforts are documented in this report. The report discusses the maintenance and safety benefits and program impacts of enhancing Iowa's paved shoulder policy. Alternative paved shoulder policies and programming strategies are also discussed.

## **Research Findings**

### *National Studies*

There is considerable evidence, from numerous research studies, that high-volume two-lane and four-lane rural highways with paved shoulders are much safer than similar roadways without paved shoulders. For example, a Minnesota Department of Transportation study found that two-lane rural roadways with paved shoulders at least four feet wide reduced single vehicle and total crashes by up to 15 percent. An Australian study found that roads with paved shoulders had fatal crash rates 60–70 percent less than roads without paved shoulders.

Paved shoulders provide the opportunity to install shoulder rumble strips, which further enhance motorist safety. Research reports indicate that the installation of shoulder rumble strips can additionally reduce run-off-the-road crashes by 20–50 percent.

A survey of state departments of transportation identified studies that determined shoulder rumble strip installation projects had a benefit/cost ratio between 30:1 and 60:1. Rumble strips also proved more cost effective than other safety improvements such as guardrails, culvert end treatments, and slope flattening.

Previous research indicates that partially paved shoulders become cost effective on rural two-lane roadways if traffic volumes are in excess of 1,500–2,000 vpd. Full-width paved shoulders are generally not cost effective on roads carrying less than 3,000 vpd.

## Iowa Studies

The 1996–1999 crash data on Iowa’s rural freeways were reviewed as part of the 2001 *Speed Study Report* to the Iowa Legislature. The interstate system has paved shoulders, and many miles of the interstate have shoulder rumble strips as well. For the most part non-interstate freeways in Iowa do not have paved shoulders. Other than this difference, these highway classes have similar design standards. Table ES.1 reflects the difference in crash rates on these rural freeways with (interstate) and without (non-interstate) paved shoulders. Both the total crash rate and the fatal crash rate are 50 percent less on Iowa freeways that have full-width paved shoulders. Much of this difference can be attributed to full-width paved shoulders and rumble strips.

**Table ES.1. Crash Rates for Rural Non-interstate and Interstate Freeways in Iowa**

	<b>Number of Miles</b>	<b>Total Crash Rate*</b>	<b>Fatal Crash Rate*</b>
Rural non-interstate freeways	126	103	1.18
Rural interstate freeways	654	53	0.57

\*Per hundred million vehicle miles of travel.

The 1995 Iowa DOT Paved Shoulder Task Force determined that providing a three-foot-wide full-depth paved shoulder became cost effective on roadways with an ADT in excess of 2,100. This analysis included both safety and maintenance benefits.

### **Paved Shoulder Practices in Neighboring States**

Table ES.2 provides a summary of the paved shoulder practices for Iowa and neighboring states. Each of the states provide an 8 to 10 foot wide paved right shoulder on four-lane rural highways and, for the most part, a 6 to 8 foot wide paved shoulder on high-volume two-lane highways.

### **Alternative Paved Shoulder Policies**

The Iowa DOT paved shoulder policy is considerably more conservative than those of neighboring states (see Table ES.2 for comparisons). However, it is not fiscally prudent to implement further enhancements to our paved shoulder policy on our *entire* roadway system at this time.

If changes to the paved shoulder policy are implemented, the initial enhancements are recommended to focus on the high-volume roadways (freeway, expressway, and Super 2 highway corridors) where the safety and maintenance benefits would be maximized.

Three alternative paved shoulder policy enhancements were evaluated. The first alternative would provide for paved shoulders on freeway, expressway, and Super 2 corridors comparable to the practices of neighboring states. The second and third alternatives would enhance the paved shoulder practices on freeways, expressways, and Super 2 corridors to a level between our current standards and those of neighboring states. All proposed standards and cost estimates are based on a “full depth” eight-inch-thick asphalt cement concrete (ACC) paved shoulder. See Table ES.3 for details.

**Table ES.2. Paved Shoulder Practices in Iowa and Neighboring States**

State	Total Shoulder Width/Shoulder Width Paved		Miscellaneous
	Rural Multi-Lane Highways	Two-Lane Highways	
Iowa	Right 10 ft/2 ft Left 6 ft/0 ft Greater than 10,000 ADT consider full-width paved shoulder	NHS 10 ft/2 ft Non NHS: ADT > 2000 10 ft/2 ft ADT < 2000 8 ft/2 ft	2-ft paved shoulder on 3R projects Rumble strips on full-width paved shoulders and 2-ft portland cement concrete (PCC) shoulders
Illinois	Right 10–12 ft/8–12 ft Left 6 ft/4–6 ft	Principal arterial 10 ft/10 ft Minor arterial 10 ft/4 ft	3R improvements: 3-ft paved shoulder if ADT > 3,000 1–2 ft paved shoulder if ADT < 3,000 Rumble strips on freeways and expressways or high accident locations
Minnesota	Right 11.5 ft/10 ft Left 5.5–11.5 ft/4–10 ft	ADT > 2,000 9.5–11.5 ft/8–10 ft ADT < 2,000 4–8 ft/1.5 ft min	Min 4-ft paved shoulder if bike usage anticipated Rumble strips on paved shoulders greater than 4 ft
Wisconsin	Right 10 ft/8–10 ft Left 6–10 ft/3–10 ft	ADT > 1,250 6–10 ft/3 ft min	Min 5-ft paved shoulder if bike ADT > 25 bicycles per day Rumble strips on most paved shoulders
South Dakota	Right 8/8 ft Left 4/4 ft	ADT > 2,500 8/8 ft ADT < 2,500 28-ft pavement	Rumble strips on all paved shoulders
Nebraska	Right 10 ft/8 ft Left 6 ft/4 ft	Priority System 10 ft/8 ft ADT > 3000 8 ft/8 ft ADT < 3,000 28 ft pavement	Rumble strips on all paved shoulders located to facilitate bikes
Missouri	Right 10 ft/10 ft Left 4 ft/4 ft	ADT > 3,500 variable-width paved shoulder	Rumble strips provided on all paved shoulders

**Table ES.3. Alternative Paved Shoulder Width Standards**

	Total Shoulder Width/Shoulder Width Paved		
	Freeway/Expressway		Super 2
	Right	Left	
Alternative 1	10 ft/10 ft	6 ft/6 ft	10 ft/10 ft
Alternative 2	10 ft/6 ft	6 ft/6 ft	10 ft/6 ft
Alternative 3	10 ft/4 ft	6 ft/2 ft	10 ft/4 ft
Existing	10 ft/2 ft	6 ft/0 ft	10 ft/2 ft

*Cost Assessment*

Table ES.4 reflects the estimated per-mile construction costs for the alternative paved shoulder standards.

**Table ES.4. Estimated Construction Costs for Alternatives**

	Estimated Construction Cost (per mile)			
	Current	Alternative 1	Alternative 2	Alternative 3
New expressway, four lane	\$3,000,000	\$3,187,000	\$3,134,000	\$3,054,000
3R for expressways, four lane	\$400,000	\$650,000	\$580,000	\$470,000
Reconstructed Super 2	\$2,000,000	\$2,107,000	\$2,054,000	\$2,027,000

There are 91 miles of non-interstate freeways/expressways with paved shoulders. Excluding the interstate system, there are approximately 500 miles of freeways and expressways with granular shoulders in Iowa. The long-term budget impact, based on today's costs to replace these granular shoulders with paved shoulders, is estimated in Table ES.5.

**Table ES.5. Cost to Replace Granular Shoulders on Existing Freeway/Expressway System**

	Cost
Alternative 1	\$125,000,000
Alternative 2	\$90,000,000
Alternative 3	\$36,000,000

It is estimated that paved shoulders would reduce maintenance costs by about \$7,000 per mile over a 20-year period. However, an additional cost of between \$9,000 and \$37,000 per roadway mile would be required to resurface the paved shoulders in the future, depending on width.

**Recommendations**

1. Adopt a goal to have new paved shoulder standards fully implemented on existing and proposed freeway/expressways and Super 2 corridors within 20 years.
2. Phase in the new standards on freeway and expressway initial construction and 3R projects as funding becomes available in the current five-year program or beginning in FY 2006.
3. Consider applying new standards to all two-lane corridors with a design ADT in excess of 3,500 vpd.
4. Provide funding (two million dollars/year) to pave shoulders on existing freeways/expressways that have above-average crash rates and that are not programmed to be resurfaced within 10 years.
5. Provide funding to install shoulder rumble strips on selected existing freeways and expressways that do not currently have rumble strips.
6. The design and placement of rumble strips on expressways and Super 2 roadways should safely accommodate bicyclists.



7. For primary routes that warrant bicycle accommodations, including but not limited to sections designated as part of Iowa's Vision Corridors, a six-foot-wide paved shoulder should be considered.
8. A new paved shoulder standard similar to Alternative 2 would be the most cost effective improvement alternative. The study committee recommends that consideration be given to providing a six-foot paved shoulder, with milled in rumble strips, on both sides of all freeways, expressways, Super 2 corridors and two-lane roadways with ADTs greater than 3,500 vpd. The current 28 foot width pavement standard would apply to two lane roadways with traffic volumes less than 3,500 vpd.

## **Notes and Acknowledgments**

This research was performed at the Center for Transportation Research and Education (CTRE) in conjunction with the *Systematic Identification of High Crash Locations* project (TR-442) sponsored by the Iowa Highway Research Board and the Iowa Department of Transportation.

Much of this Executive Summary was authored by Tom Welch, State Traffic Safety Engineer, Iowa DOT Office of Traffic and Safety. As such, the recommendations presented in the Executive Summary are those of the Iowa DOT but are not necessarily identical to those presented in the body of the full report. This in no way indicates disagreement on conclusions.

For a copy of the full report, please contact the Iowa DOT Office of Traffic and Safety or CTRE. An electronic copy of the report is available under “Research” on CTRE’s web site, [www.ctre.iastate.edu](http://www.ctre.iastate.edu).