THE ELIMINATION OR MITIGATION
OF HAZARDS ASSOCIATED WITH
PAVEMENT EDGE DROPoffs DURING
ROADWAY RESURFACING

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AAA
Foundation for Traffic Safety
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EXECUTIVE SUMMARY

One safety feature on U.S. highways is the roadway shoulder. Roadway safety standards require that shoulders meet specifications for width and stability.

Unfortunately, roadways are often resurfaced without restoring the adjacent shoulders to bring them up to the resurfaced roadway level. This condition can lead to vehicle tires dropping off the pavement edge, and, subsequently, to a collision.

A study by Ivey and Griffin ranked pavement edge shoulder dropoff among the top accident-related pavement disturbances. The National Research Council’s Transportation Research Board has determined “that pavement edge drop hazards are greater than previously believed” and that “pavement edge drops are a common source of tort claims against highway agencies.”

This study sought to determine the extent of the pavement edge dropoff problem and recommend changes in contract scope or performance that will eliminate or mitigate such occurrences. The study involved extensive interviews with city and county engineers, public works directors, transportation consultants, government legal departments, contractors, and public risk insurance managers. In addition, a questionnaire was sent to public risk managers and resurfacing contractors to determine the experience and opinions of contractors who had been involved in litigation involving pavement edge dropoffs.

Our findings are that dropoffs of four or more inches are unsafe if the roadway edge is at a 90-degree angle to the shoulder surface. Unsuspecting drivers whose tires slip off a resurfaced road and onto an unimproved shoulder are likely to lose control as they attempt to climb back onto the roadway, especially if the dropoff is four inches or greater in depth. The pavement edge creates a “scrubbing” condition that must be overcome through oversteering. Drivers lose control as they oversteer to climb back onto the road. At the same time, their rear wheel catches the edge of the shoulder and swings the car around. This action brings them into the next lane, where they may then strike oncoming cars head-on or in a side-sweep type of collision or lose control of their own vehicle.

Using a 45-degree-angle fillet of asphalt provides a surface that vehicles could use to climb back onto a roadway with no loss of control. Road contractors can attach a special edging device to their resurfacing equipment and by using less than one percent additional paving material, contractors can lay down a 45-degree-angle fillet that allows car tires to climb the edge safely, without oversteering.

Solutions to the pavement edge dropoff hazard are to:

1. Perform shoulder resurfacing at the same time as the roadway resurfacing, resulting in no shoulder dropoff, or

2. Require the contractor, in areas where resurfacing contracts must be bid separately, to provide a 45-degree-angle fillet along the edge of the roadway as part of the scope of work, and

3. Install signs warning the motoring public of the existence of a low shoulder condition (short-term solution only).
A Message from the Sponsor

This study was sponsored by a grant from the AAA Foundation for Traffic Safety. Founded in 1947, the AAA Foundation for Traffic Safety is a not-for-profit, publicly-supported charitable research and educational organization dedicated to saving lives and reducing injuries by preventing traffic accidents.

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INTRODUCTION

Highways provide the predominant mode of transportation in the United States and much of the world. The highway system in the United States consists of over 3,900,000 miles of public roads and streets, of which 3,100,000 miles are rural roads.¹

Highway traffic consists of a vast fleet of personal vehicles for transporting individuals and small groups, and commercial vehicles for transporting freight and larger groups of passengers. Vehicle ownership in the United States is the highest in the world. The national average is 0.56 passenger cars per capita.² Each year 52,000 deaths and over 4,000,000 injuries occur on roadways within the United States and Canada.³

Features such as increased sight distance, increased lane widths, widened clear zones along the roadway, and wider, higher-type shoulders have been added to highway facilities in the United States to improve safety for the travelling public. These improvements work extremely well to provide adequate time for the driver to perceive approaching roadway conditions and/or to recover from an errant movement. However, in order to be effective, proper maintenance of such improvements is imperative.

One safety feature, the roadway shoulder, has been recognized as desirable ever since engineers began paving our roadways. However, the width, uniformity, and stability of roadway shoulders has varied greatly from roadway to roadway and along different sections of the same roadway. Roadway safety standards have required that improvements be made in the integrity of the shoulder. This has been achieved by using construction materials that provide a more stable shoulder and by using a wider shoulder width, as shown in Figure 1. Also, shoulders are usually required along modern roadway pavement edges to provide a safer travel way for the motoring public. “A shoulder is the portion of the roadway contiguous with the traveled way for accommodation of stopped vehicles, for emergency use, and for lateral support of the sub-base, base, and surface courses. It varies in width from only 2 feet or so on minor rural roads, ...to about 12 feet on major roads.”⁴ Shoulders may be paved with concrete or asphalt, or stabilized with granular or other materials and/or sodded.

Unfortunately, roadways are often resurfaced without restoring the adjacent shoulders to bring them up to the resurfaced roadway level (see Figure 2). This condition can lead to vehicle tires dropping off of the pavement edge, and, subsequently, to an accident. In fact, a study by Ivey and Griffin ranked pavement edge-shoulder dropoff among the top accident-related pavement disturbances.⁵

The purposes of this report are to:

• identify the scope of work in resurfacing contracts which can lead to such dropoffs;
• identify the magnitude of contract work creating such dropoffs; and
• recommend changes in contract scope or performance to eliminate or mitigate such occurrences.

Conditions where the existing roadway cross sections have side slopes which drop directly from the travel lane into a side ditch were not addressed in this study. These types of roadway do not have an existing shoulder. Additionally, this study was confined to two-lane rural roadways within the United States, although some recommendations are also valid for multi-lane facilities.
Figure 1
Flush Pavement Edge/Shoulder Joint Detail, Before Resurfacing
Figure 2
Pavement Edge/Shoulder Joint Detail With Pavement Edge Dropoff, After Resurfacing
Pavement edge dropoffs have been a known hazard for nearly forty years. The 1954 and 1965 editions of the AASHO Policy on Geometric Design of Rural Highways (Blue Book), observed that: “Unstabilized shoulders frequently are hazardous because...the shoulder at the pavement edge may be several inches lower than the pavement,” and that “All types of shoulders should be constructed and maintained flush with the paved surface if they are to fulfill the function for which they are intended.” Recent editions (1984 and 1990) of the AASHTO A Policy on Geometric Design of Highways and Streets (Green Book) state that: “Regular maintenance is necessary to provide a flush shoulder. The dropoff can adversely affect driver control when driving onto the shoulder at any appreciable speed.”

In 1979, Humphreys, Mauldin, and Sullivan at the University of Tennessee identified abrupt changes in elevation at the edge of the through-traffic lanes as a significant hazard in highway work zones. However, at that time, there were various aspects of the dropoff conditions about which more information was needed, including the height of the dropoff, the time which the dropoff was to exist, and the level of traffic control which should be utilized for a specific condition. In their study, a high research priority was assigned to developing additional information regarding the vehicle dropoff and loss of control phenomenon.

An extensive amount of research has since been performed on the topic of pavement edge dropoffs. The Texas Transportation Institute at Texas A & M University has completed several studies on the effects of driver response and vehicle reaction with respect to height and dropoff slope of a pavement edge dropoff.

Dropoff related accidents typically begin when the right side tires of a vehicle drop from the roadway pavement surface to the shoulder. Then, upon the vehicle’s reentering the roadway, the driver oversteers, enters the oncoming lane of traffic, and is involved in a “head-on” or “side swipe” collision with another vehicle, or loses control and is involved in a single-vehicle accident (see Figure 7).

Both tire and vehicle size are substantial factors in the influence a particular pavement edge dropoff has on a vehicle’s ability to reenter the roadway. As the tire size (height) increases, pavement edge dropoff has less influence on the ability of the tire to mount the pavement edge. Likewise, a larger vehicle uses momentum and sheer weight to overcome the resistance force of the pavement edge.

Pavement edge dropoffs have different effects on the tire depending upon their “effective edge height.” Effective edge height is defined as “…the point at which the tire rubs on the edge to generate an edge mounting force system.” Results of this research show that rounded edges and sharp edges may have generally the same safety characteristics (see Figure 3). It should be noted that pavement edge slopes of 1:1 (45 degrees) or flatter have a different effect on the vehicle as illustrated in Figure 4, which represents an effort to summarize all research and testing available for interpretation, including testing from the California Department of Transportation, Systems Technology, and the Texas Transportation Institute.

Terms used to describe the relative degrees of safety in Figure 3 are defined as follows:

“SAFE” No matter how impaired the driver or defective the vehicle, the pavement edge will have nothing to do with a loss of control. (This includes the influence of alcohol and/or drugs and any other infirmity or lack of physical capability.) (Includes the subjective severity levels 1 through 3.)

“REASONABLY SAFE” A prudent driver of a reasonably maintained vehicle would experience no significant problem in traversing the pavement edge. (Includes the subjective severity levels 3 through 5.)

“MARGINALY SAFE” A very high percentage of drivers could traverse the pavement edge without significant difficulty. A very small group of drivers may experience some difficulty in performing the scrubbing maneuver and remaining within the adjacent traffic lane. (Includes the subjective severity levels 5 through 7.)

“QUESTIONABLE SAFETY” A high percentage of drivers would experience significant difficulty in performing the scrubbing maneuver and remaining within the adjacent traffic lane. Full loss of control could occur under some circumstances. (Includes the subjective severity levels 7 through 9.)
Figure 3
Relative Degrees of Safety for Various Edge Conditions

LONGITUDINAL EDGE ELEVATION CHANGE (Inches)

These numbers are subjective severity levels.

Figure 4
Pavement Edge Profiles, Effective Edge Heights, and Initial Steer Angles

<table>
<thead>
<tr>
<th>Condition</th>
<th>Pavement Edge Profile</th>
<th>Effective Edge Height, ( \Delta e ), Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><img src="image1" alt="Pavement Edge Profile" /></td>
<td>4.0</td>
</tr>
<tr>
<td>2</td>
<td><img src="image2" alt="Pavement Edge Profile" /></td>
<td>2.5</td>
</tr>
<tr>
<td>3</td>
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<td><img src="image6" alt="Pavement Edge Profile" /></td>
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<td><img src="image8" alt="Pavement Edge Profile" /></td>
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</tr>
<tr>
<td>9</td>
<td><img src="image9" alt="Pavement Edge Profile" /></td>
<td>0.20</td>
</tr>
</tbody>
</table>

*These values determined from the effective edge height and Figure 16.*

Adapted from Don L. Ivey and Dean L. Sickling, "The Influence of Pavement Edge and Shoulder Characteristics on Vehicle Handling and Stability", page 35.
“UNSAFE” Almost all drivers would experience great difficulty in returning from a pavement edge scrubbing condition. Loss of control could occur under some circumstances. (Includes the subjective severity levels 9 through 10).11

Other factors which influence the path of the vehicle when reentering the roadway are the vehicle’s speed and proximity of the tires to the edge of the roadway. Tires which have dropped off and are immediately adjacent to the pavement edge create a “scrubbing” condition. When a “scrubbing” condition exists, a greater steering angle is required to climb the dropoff than when tires have dropped off and are several inches away from the edge of the pavement. The approach angle of the tire relative to the pavement edge then greatly affects the driver’s capability to steer the vehicle onto the pavement and to remain in control without penetrating into the adjacent lane (see Figure 5). The inability of the driver to remain in the right lane is due to the dynamics of the forces acting on the vehicle at the time the scrubbing tire reenters the roadway. In a fraction of a second, the resisting force acting against the tire is conquered. Consequently, before the driver can react (in less than one wheel revolution), “The cornering force may have doubled due to increases in the available friction on the pavement and the right front wheel load due to cornering.” Then, “The vehicle yaws radically to the left, pivoting about the right rear tire, until that wheel can be dragged upon the paved surface.”12 This results in the redirection of the vehicle into the adjacent lane.

Adding a 45-degree fillet along the pavement edge dropoff enables a vehicle to more easily reenter the roadway without oversteering into the oncoming traffic lane (see Figures 6 and 7). When asked when a 45-degree fillet would be applicable, Dr. Don Ivey of the Texas Transportation Institute stated to one of the authors that “A 45-degree slope is better for all cars and trucks under all conditions.”

DATA COLLECTION METHODS

The authors initiated this study by attempting to ascertain whether or not resurfacing of rural roads without bringing the shoulder up to the roadway grade was a problem of national scope. Several methods were employed to determine the prevalence of contracts issued nationally that did not include shoulder work. These methods included the following:

1) Discussions and interviews were conducted at a “Round Table” meeting with county engineers, public works directors, transportation consultants, transportation training specialists, and a staff member of the National Asphalt Paving Association at the national 4-R Roads and Bridges Conference in Cincinnati, Ohio, in December 1991;

2) Questionnaires were mailed nationwide to resurfacing contractors to determine the experience and opinions of contractors who had been involved in litigation involving pavement edge dropoffs and to find company contacts to discuss the problems associated with contracts which exclude shoulder work;

3) Questionnaires were mailed nationwide to members of the Public Risk Insurance Managers Association in order to obtain the viewpoints of individuals in the business of protecting governmental agencies from liability in matters such as pavement edge dropoffs;

4) Personal meetings and telephone conversations were conducted with contacts provided in the contractors’ questionnaires returned across the nation. Discussions revolved around their experience with traffic accident litigation relative to contracts excluding shoulder work, and how the problems associated with this type of contract could be solved or mitigated;

5) Personal meetings were held with city and county engineers to discuss their experiences, viewpoints, and awareness of contracting roadway resurfacing with the exclusion of shoulder work;

6) Telephone conversations with governmental legal departments were conducted to discuss perceived liability and to determine if these departments had been involved in any lawsuits involving alleged pavement edge dropoff accidents; and

7) Reviews of previous pavement edge dropoff litigation cases were made to determine existing conditions at
Figure 5
Tire Against Barrier of Pavement Edge Dropoff
Figure 6
Tire Against Pavement Fillet Wedge
Figure 7
Influence of Different Pavement Edges on Vehicle Reentry Path

NOTES ABOUT TEST CONDITIONS:
1) LANE WIDTHS OF TWELVE (12) FEET WERE USED AND
2) INITIAL VELOCITY OF 50 MPH (73.33 F/S).

TRUCK ROADWAY REENTRY PATH WITH PAVEMENT EDGE HEIGHT OF 4 INCHES & 2-INCH RADIUS OF EDGE ROUNING.

TRUCK ROADWAY REENTRY PATH WITH PAVEMENT EDGE HEIGHT OF 4 INCHES & FILLET WEDGE.

Source: Don L. Lively and Dean L. Sicking, "The Influence of Pavement Edge and Shoulder Characteristics on Vehicle Handling and Stability," pages 37 & 38.
the accident scene, events leading up to the accidents, common factors that were considered in these cases, and the court rulings.

In order to uniformly compare the responses from the questionnaires which were sent to resurfacing contractors and to public risk insurance managers, the same basic questions and format were utilized.

Information requested on the contractors’ questionnaire included the following, with reasons for the requested information shown in parentheses:

1) State(s) in which company normally does business (to determine in what region(s) of the country the company operates and how large an area it serves);

2) Number of years in operation (to gauge the experience of the company and possible exposure to this type of resurfacing problem);

3) Average dollar amount of rural two-lane roadway resurfacing (to determine size of the company’s operation and possibly the profits versus losses involved in this type of litigation);

4) Approximate number of miles of rural two-lane roadway resurfacing (to gauge the approximate amount of roadway resurfacing performed annually);

5) Approximate percentage of contracts that do not require the contractor to build the shoulder back to grade (to determine the number of contracts being issued without shoulder work and the relative degree of exposure to the problem of pavement edge dropoffs);

6) Extent of warning of shoulder dropoff if shoulder work is not included in the contract (to determine if contractor puts forth an extra effort for safety);

7) Involvement in any legal actions where it was alleged that a traffic accident resulted from a pavement edge dropoff where shoulder restoration was not included in the contract (to obtain information about the problems and results with this type of contract);

8) Contractor’s opinion as to whether or not adding two and one-half inches of resurfacing to a rural two-lane roadway without bringing the shoulder up to grade results in a hazard to the motorist (to determine contractor’s thoughts about the pavement edge dropoff hazard); and

9) Willingness to discuss the issue and, if so, name and number of contact person (to obtain name and number of person to speak with about the problem and possible recommendations or thoughts about how to correct this type of problem).

Copies of the questionnaires for both contractors and public risk insurance managers are included in the Appendix.

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**DATA COLLECTION RESULTS**

First, discussions and interviews were conducted at the “Round Table” meeting at the national 4-R Roads and Bridges Conference in Cincinnati, Ohio, in December of 1991. Several of the engineers and public works officials present expressed concerns and told of their experiences regarding roadway pavement edge dropoffs. However, a few of the engineers in attendance were unaware of the problems associated with the pavement edge dropoff. The overall consensus was that pavement dropoffs, especially during construction, present significant problems that need to be addressed.

Next, a contractors’ questionnaire and corresponding form letter were developed to obtain the information required to determine the magnitude of the problem of pavement edge dropoff accidents. These questionnaires also aided in determining the proportion of the resurfacing contracts that do not include shoulder work as a part of the project’s scope of work. A mailing list of resurfacing contractors covering 14 states was then obtained, and the form letters and questionnaires were mailed.

Upon receipt of the mailing, many of the contractors contacted their corporate attorneys, who in turn contacted the research team to find out more about how the questionnaires were going to be used. After assuring the attorneys that all data would be sanitized, these attorneys still declined to participate. As a result, only a few of the contractors’ questionnaires were returned. This low questionnaire return by the contractors (only ten percent of 71 questionnaires mailed) made it necessary to personally contact some of the contractors who had responded. Some of these contacts were very helpful, while others displayed a reluctance to talk about the
problem of pavement edge dropoff. Others requested that the contact be made through their corporate attorneys. When these attorneys were contacted, they were also concerned about who was conducting the study, why the study was being conducted, and who would see the final report. Again, even after assurances of confidentiality, these attorneys still responded with short, vague answers. They expressed concern about governmental agencies reading a report in which the agencies were criticized, possibly causing agencies to ban the contractors from future projects.

Subsequent telephone conversations with the contractors that did respond made it clear that the problem of pavement edge dropoffs is very real. These contractors told of cases where the governmental agencies would be several months behind in raising the shoulder. These and other contractors stated that some governmental agencies would not approve or pay for placing signage along a roadway where pavement edge dropoffs exist. Contractors have also reported that most dropoff related accidents occur late at night in a section of the project that has been completed.

After the limited response by the contractors, other sources were sought and contacted. The Public Risk Insurance Managers Association was then contacted at the national level and asked to assist in this research by providing a randomly generated mailing list of public risk insurance managers across the nation. After obtaining approval from their board of directors, a list of 417 names and addresses of public risk insurance managers in 42 states across the nation was provided and used to distribute another questionnaire.

This questionnaire was developed for public risk insurance managers by modifying the contractors' questionnaire to apply to the governmental sector. By editing the contractors' questionnaire, a more analogous comparison could be made between the two groups.

Some of these questionnaires reached disciplines in the public sector other than agencies responsible for roadway resurfacing, such as public school systems and hospitals. Even so, questionnaires from agencies responsible for resurfacing roadways were returned from 32 states. These returns were completed by public risk insurance managers or the engineers responsible for resurfacing contracts. Of these returns, 18 of the 116, or 17%, were from agencies which had been involved in litigation involving an accident allegedly caused by a pavement edge dropoff. Information from these questionnaires varied from very little to detailed. Contained within the detailed responses were items such as contract copies, specifications, maps, and construction details.

Contract scopes of work and procedures for dealing with longitudinal pavement edge dropoffs varied from no information or guidance to very specific details.

At this point, the information obtained from both sets of questionnaires corresponded with the expectations and past experiences of the research team. These responses also paralleled the philosophies of contractors and governmental officials expressed during round table discussions, telephone conversations, and personal interviews. During these discussions, some of the contractors and governmental officials noted their awareness of lawsuits relating to pavement edge dropoffs, whether from personal experience or information from a neighboring area. Other county engineers and governmental agencies' representatives were unaware of the problems associated with pavement edge dropoffs. Those who were aware of the problems expressed great concern about how to combat them.

Some resurfacing contractors go beyond the contract requirements and pull the shoulder up to the edge of the resurfaced roadway with a motor grader, at their own cost, in order to minimize the hazard to the motoring public and to minimize their exposure to lawsuits. Some of the contractors involved in accidents allegedly caused from pavement edge dropoffs stated that they refuse to leave the project site until "Low Shoulder" signs or other precautions have been implemented to protect/warn the motoring public of the pavement edge dropoff hazard.

Meanwhile, other contractors do not go beyond the limits of the contract's scope of work, and they leave the pavement edge dropoff exposed.

Various governmental agencies require that contractors obtain approval for sign placement within a construction work zone. Some contractors have been denied the required approval to place "Low Shoulder" warning signs on their projects. Thus, the public is left unaware of the existing pavement edge dropoff hazard.

Furthermore, some contracts have plans included that show a one to two-foot shoulder through out the entire project, when in fact the roadway may not have any shoulder due to wear or erosion. In these cases contractors reported that they required the governmental agencies to change their typical sections in the contract to show zero feet to two feet. This is an effort to reduce the contractor's liability in the case an accident does occur because of an inadequate shoulder.
When questioned as to why resurfacing contracts are issued without shoulder work being included, one governmental official stated “...that during the winter motor grader operators are busy keeping snow removed from the roadway, and in order to keep these operators employed during the warmer months of the year, they are responsible for building up the shoulders to match the resurfaced roadway.” From remarks such as this one, it is easy to understand why so many contracts are let which do not include restoration of shoulders to grade.

REVIEW OF PRACTICES

Roadway maintenance responsibilities are categorized differently from state to state. Some states, such as North Carolina and Virginia, perform all of the roadway design, construction, and maintenance outside city limits; therefore, counties and local governments in these states are not involved in road work at all. However, other states, such as Arizona, Florida, Illinois, Maryland, and Oregon, have chosen to require that counties and local governmental agencies be responsible for design, construction, and maintenance of a portion of the roadway facilities. Consequently, some local governmental agencies may choose to manage road work as they deem necessary.

Focusing on roadway resurfacing, some governmental agencies choose to do the maintenance with their own work forces, while others choose to turn over the entire maintenance procedure to a private maintenance contractor. Still others choose to contract a portion of the roadway maintenance work.

If the latter course is taken, a contract may be written requiring the contractor to resurface the roadway only from edge of pavement to edge of pavement, excluding the restoration of roadway shoulders. The shoulder restoration is then to be accomplished by the responsible governmental agency. In many cases, a timely shoulder restoration is performed and a safe driving surface put in place.

However, in other cases, when the resurfacing is accomplished and the contractor has fulfilled his contractual requirements, he is compensated and then released from the project. Meanwhile, the shoulder has not been raised to the same elevation as the edge of pavement and will not be until the government crews can get to the project. Often, this may take several weeks or months, during which time the roadway has a pavement edge dropoff and is open for public use.

Reasons for the governmental crews not performing shoulder work are varied from region to region. However, common reasons include the following:

1) Work crews may be behind schedule on other projects;
2) Work crews may be understaffed for their work loads; and
3) Capital funds may be exhausted for the fiscal year.

During the time the roadway has a pavement edge dropoff, safety may be severely compromised, and depending upon the height of the dropoff, a vehicle hazard may be evident. One result of a pavement edge dropoff is that when a driver attempts to bring a tire back onto the roadway, the dropoff acts as a barrier against the tire, preventing it from easily reentering the roadway. This barrier is directly influenced both by the effective edge height of the pavement edge dropoff and whether or not the tire is scrubbing against the pavement edge. If the right front tire is scrubbing, the driver turns the tire sharply toward the roadway, and is applying more steering force to the tire than would be necessary if the tire was not scrubbing. When this condition occurs and the tire mounts the dropoff, the driver has usually oversteered, which then results in the driver losing control of the vehicle. As a consequence of this loss of control, any of the following may occur:

1) The vehicle may have a head-on collision with or side-swipe an oncoming vehicle in the opposing lane of travel;
2) The vehicle may strike the ditch or other physical obstacle on the opposite side of the roadway;
3) The vehicle may go into a skid on the roadway and perhaps overturn;
4) The driver may over-compensate to the right and strike the ditch or other physical obstacle on the right side of the roadway; and
5) The condition may be corrected and no accident occurs.\textsuperscript{13}

Situations which can lead to a pavement edge dropoff are not purely due to the installation of the new layers of
pavement added to the existing roadway surface. In many cases, the existing roadway shoulder may have been worn away by traffic prior to the installation of the new pavement. As these areas of wear vary along a roadway edge, so does the amount of dropoff.

Thus, existing dropoffs may vary from negligible up to several inches. Areas of greater dropoff usually occur where drivers have to make changes in direction of their vehicles, such as in curves.

When a typical two-and-one-half inch overlay of new asphalt is applied, a nominal dropoff can easily exceed four inches. In these situations, the driver may be encountering a difficult section of roadway which may result in the tires dropping from the roadway surface as many had prior to the resurfacing. Now the dropoff condition has reached a magnitude that can seriously alter the ability of the tire to reenter the roadway.

Since research and common sense show that a sloped edge is easier for a tire to climb, the use of an asphaltic fillet or angled edge would help alleviate the problems associated with pavement edge dropoffs. “The use of a beveled edge, with a bevel angle of 45 degrees, was found to greatly reduce the control problems attributable to edge drops.” Installation of this asphaltic fillet can be easily accomplished with today’s modern paving equipment.

By simply attaching a device known as a “moulding shoe” to the paving machine, the asphaltic fillet can be formed along the pavement edge as the overlays are placed on the roadway surface. The moulding shoe not only forms the shape of the asphalt fillet, but also reduces the amount of hand work required to finish the pavement edge.

Compaction of the asphalt fillet can then be accomplished by the use of an edge compacting device attached to the compaction rollers. Such a device “...consists of a hydraulically powered wheel which rolls alongside the compactor’s drum while simultaneously pinching the edge of the mat towards the drum and providing lateral resistance.”

Different types of moulding shoes are in use today in the paving industry. Many are fabricated by individual contractors to fit their own paving screeds and may be adjusted to provide various angles or side slopes at the edge of a paving pass.

In general, the lay-down costs associated with using the moulding shoe are insignificant. Also, additional material quantities and costs are minimal for the added fillet wedge. For example, when resurfacing a typical twenty-four foot wide, two-lane rural roadway with two twelve-foot lanes, the following layers of asphalt are used: a one-and-one-half inch leveling course and one inch surface course, for a total of a two-and-one-half inch overlay. The corresponding asphalt volume required per mile of overlay is 978 cubic yards. The volume of asphalt required to place a 45-degree-fillet along each side of the same roadway is eight-and-one-half cubic yards. This fillet wedge volume equates to less than one percent of the roadway asphalt overlay requirement.

Many rural roadways, in the experience of the authors, have dropoffs of one to two inches or more before resurfacing is undertaken. In such cases overlays with 45-degree-angle fillets will require somewhat more asphaltic concrete, but not an excessive amount. For example, where the dropoff could be as much as four-and-one-half inches (two-and-one-half inches of new asphalt and two inches of existing dropoff), the asphalt volume required to place a fillet along both sides of a one-mile length of roadway would be 27.5 cubic yards, or 2.8% of the roadway asphalt overlay requirement.

According to discussions with resurfacing contractors, the effort might be considered as incidental and would not increase the unit cost of asphalt placement. Thus, the increased cost, usually paid for in dollars per ton of asphalt, would only be one to two percent of the typical resurfacing contract.

Benefits of using an asphaltic fillet are profitable for both the long-term life of the roadway and the short-term repaving project. These benefits include:

1) Increased safety during construction, due to the ease of bringing a tire back onto the roadway surface after it has dropped to a shoulder that has not been raised to the new roadway surface elevation;

2) Increased future safety for drivers trying to reenter the roadway once the shoulder material is again worn away over time by tires on the roadway shoulder and by erosion; and

3) Added protection from roadway drainage for the roadway base and sub-base materials.
RECOMMENDATIONS

The National Research Council’s Transportation Research Board has determined: “that pavement edge drop hazards are greater than previously believed” and that “In addition, pavement edge drops are a common source of tort claims against highway agencies.” Therefore, it is strongly recommended that the most effective way of solving the problems associated with pavement edge dropoffs is to simply eliminate the issuance of contracts where shoulder work is excluded or not included in the resurfacing contract. Governmental agencies must be educated and made aware of the risk and liability associated with these types of contracts.

If, for whatever reason, the governmental agency still believes there is a need to issue “no shoulder work” contracts, as a minimum one of the following recommendations should be implemented into resurfacing contracts in order to provide safer roadways and to help minimize the exposure to liability:

1) Require that shoulder materials be pulled up to the new surface as a non-pay item;

2) Require that appropriate signing remain installed along the roadway to inform the motoring public of the existence of a low shoulder condition;

3) Require that a 45-degree-angle asphalt fillet be installed as a part of the roadway resurfacing, along the edge of the roadway;

4) Both recommendations 2 and 3; or better still

5) Both recommendations 1 and 3.

It is believed that implementation of this policy could best be accomplished through public risk insurance management enforcement. In this manner, governmental agencies would be required to look after their own best interests as well as that of the public without adding large costs. Implementation at the contractors’ level is not feasible because the contractors cannot easily change the scope of the contracts under which they are to be working.

CONCLUSIONS

Pavement edge dropoffs, as a result of roadway resurfacing, can and do cause traffic accidents and ensuing lawsuits.

Many government officials are unaware of the severity of the problems related to pavement edge dropoffs. This is because they have not been personally involved in lawsuits related to this condition or have not been educated as to the ramifications surrounding pavement edge dropoffs.

On the other hand, many contractors are aware of these problems, but are unable to implement a standard solution, due to the lack of power over the contracting agencies or the cost of implementing such a solution (which would consume a portion of their small operating profit in a very competitive business).

The authors strongly believe that the best way to eliminate resurfacing dropoffs as described herein is to simply eliminate contracts which limit the scope of work. In this way, contractors will be able to schedule shoulder work as a part of the contract, and lengthy delays due to a slow governmental agency response will be eliminated.

A simple and cost effective mitigation of this problem would be to require the installation of a 45-degree-angle asphalt fillet along each side of the roadway as a resurfacing standard. This contract standard would tie the existing shoulder into the resurfaced roadway and allow a vehicle to reenter the roadway in a reasonably safe manner. This type of resurfacing standard would still allow a governmental agency to use its own forces to completely restore the shoulder. Moreover, the asphalt fillet would not only help to solve an interim problem, but would provide a safer long-term roadway edge along with a stronger roadway/shoulder interface. The cost of such an asphalt fillet is minimal in comparison to the total amount of the resurfacing contract, and the fillet would save countless dollars in lawsuits, human lives, and property damage.
REFERENCES


Appendix
CONTRACTORS' ROADWAY RESURFACING & SHOULDER IMPROVEMENT QUESTIONNAIRE

In what state(s) does your company normally do business? ______________________________

Number of years in operation? ______________________________

Approximate annual average dollar amount of rural two-lane roadway resurfacing? __________

Approximate number of miles of rural two lane roadway resurfaced annually? ______________

Approximate percent of rural two-lane resurfacing that does not require the contractor to rebuild
the shoulder back to grade? (Please circle one) 0  20  40  60  80  100 Percent

Would you be willing to share, in confidentiality, a copy of a typical resurfacing contract which does
not include shoulder work? If so, please send it with the questionnaire. (Feel free to remove
any items that may identify the source.)

If shoulder work is not included in a contract, does your company do anything to eliminate or warn of
the shoulder drop-off? (YES NO) If yes, please describe. __________________________________________

Has your company been involved in any legal actions where it was alleged that a traffic accident
resulted from a pavement edge drop-off, where shoulder restoration was not included in the
contract? (YES NO)

If yes, how many over the past five years? ______________________________

Do you believe that adding 2.5 inches of resurfacing on a rural two-lane roadway without bringing
the shoulder up even with the resurfacing results in a hazard to the motorist? (YES NO)

Why or why not? __________________________________________________________________________

Please indicate whether or not you would be willing to briefly discuss this issue (YES NO).
If yes, please give name of person to contact, and telephone number. ________________________________

Name of your company (optional). ____________________________________________________________
PUBLIC RISK MANAGER’S ROADWAY RESURFACING & SHOULDER IMPROVEMENT QUESTIONNAIRE

In what state is your government located? ____________________________________________

Type of government (State or County)? ____________________________________________

Approximate annual number of miles of rural two-lane roadway resurfacing let in contract?

Approximate percent of rural two-lane resurfacing where the scope of work does not require the contractor to rebuild the shoulder back to grade? (Please circle one) 0 20 40 60 80 100 Percent

Would you be willing to share, in confidentiality, a copy of a typical resurfacing contract which does not include shoulder work? If so, please send it with the questionnaire. (Feel free to remove any items that may identify the source.) ____________________________________________

If shoulder work is not included in a contract, does your agency do anything to eliminate or warn of the shoulder drop-off after the contractor has passed final inspection and until the shoulder has been raised to the roadway level? (YES NO) If yes, please describe. ____________________________________________

Has your agency been involved in any legal actions where it was alleged that a traffic accident resulted from a pavement edge drop-off where shoulder restoration was not included in a resurfacing contract? (YES NO)

If yes, how many over the past five years? ____________________________________________

Do you believe that adding 2.5 inches of resurfacing on a rural two-lane roadway without bringing the shoulder up even with the resurfacing results in a hazard to the motorist? (YES NO)

Why or why not? ____________________________________________

Please indicate whether or not you would be willing to briefly discuss this issue (YES NO).

If yes, please give name of person to contact and telephone number. ____________________________________________

Name of your governmental agency (optional). ____________________________________________