Research Report
KTC-09-09/SPR330-07-3I

KENTUCKY TRANSPORTATION CENTER

EVALUATION OF THE USE OF SNOWPLOWABLE RAISED PAVEMENT MARKERS

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EVALUATION OF THE USE OF SNOWPLOWABLE RAISED PAVEMENT MARKERS

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16. Abstract

The objective of this study was to evaluate the effectiveness and durability of snowplowable raised pavement markers (RPM) installed on the RPM system in Kentucky. The durability evaluation dealt with the marker housing.

The data show that continued use of the currently approved snowplowable RPM can be justified if the castings are properly installed on new pavements with a commitment that the pavement will be maintained. An evaluation of centerline rumble strips installations showed that they should be considered on rural, two-lane roads with 12-foot lane widths (having new pavements) and paved shoulders.

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EXECUTIVE SUMMARY

The objective of this study was to evaluate the effectiveness and durability of snowplowable raised pavement markers (RPM) installed on the RPM system in Kentucky. The durability evaluation dealt with the marker housing.

An analysis of crash data on rural, two-lane roads found the crash rate was lower on the RPM system on rural, two lane roads compared to similar roads not on the system. Also, the percentages of nighttime and wet, nighttime crashes were slightly lower on RPM system roads.

A comparison of crashes before and after installation of centerline rumble strips found that total crashes decreased as well as crashes involving a head on or "opposite direction sideswipe" collision. Also, crashes during darkness (including wet pavement) decreased. The number of snow and ice related crashes and motorcycle crashes did not increase, and those types of crashes occurring after the installations were not related to the centerline rumble strips.

A survey of the durability of marker castings found that, on asphalt pavements, about 4.5 percent of the castings were missing. There was a range in the percent missing with about 11 percent missing on roads with a pavement over 12 years old and about 30 percent missing on asphalt pavements rated as in poor condition.

Durability problems with castings were primarily the result of the pavement condition. No significant problems were found with the installation process. The data show that it should be expected that some marker castings will be removed as a part of snowplow operation but the losses can be kept to a minimum if the installation process is carefully monitored and the markers and pavement are routinely inspected to ensure they remain secure.

The data show that continued use of snowplowable raised pavement markers can be justified if the markers are properly installed (on new pavements only) with a commitment that the pavement will be maintained. When the lenses are replaced (on an approximate three-year cycle), the castings should be inspected with any loose markers removed.

Using the installation cost along with the cost of lense replacement on a three-year cycle results in a total cost of about $30 per marker over a 15 year pavement life. Using the marker spacing results in a cost of about $4,000 per mile for the life of the pavement to install and maintain the markers. This is a very small cost compared to the paving cost.

Centerline rumble stripEs should be considered on rural, two-lane roads with 12-foot lane widths and paved shoulders. The rumble strips should only be placed on new pavements.

An evaluation of alternative snowplowable marker designs and wet reflective tape should be conducted to determine if they could provide adequate reflectivity with improved durability compared to the currently used snowplowable marker.

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1.0 BACKGROUND

The Manual on Uniform Traffic Control Devices (MUTCD) (1) defines a raised pavement marker (RPM) as a device with a height of at least 0.4 inch mounted on or in a road surface that is intended to be used as a positioning guide or to supplement or substitute for pavement markings. Guidance is given on the lateral positioning and longitudinal spacing of RPM when supplementing and substituting for other markings.

In Kentucky, the first major evaluation of a RPM as a traffic control device was conducted in 1975 (2). The report stated that RPM were found to be a very effective method of delineation, particularly under wet, nighttime conditions. This evaluation resulted in extensive use of RPM as a supplement to painted lane lines. These markers were installed on the surface using epoxy. An additional evaluation of RPM at high-hazard locations (sharp curves and narrow bridges) supported a recommendation of additional use on rural, two lane and four lane roads (3).

A 1981 study summarized the nationwide experience pertaining to various lane delineation methods (4). The large majority of states had experience using RPM with many using a snowplowable marker. The Stimsonite marker was the most common type of snowplowable marker used at that time.

An evaluation of the statewide installations of RPM in Kentucky between 1975 and 1979 was conducted in 1981 (5). In this period about one million RPM were installed on about 3,000 miles of road at a cost of approximately $2 million. The average cost per marker was $1.78. All of these markers were surface mounted and significant damage occurred from snowplowing during some of the more severe winters. Rubber-tipped snowplow blades were used but metal blades were necessary when heavy snowfall and very cold temperatures occurred. An analysis of crashes found a 20-percent reduction in wet-night crashes and a 10-percent reduction in dry-night crashes. This corresponded to a four-percent reduction in all crashes for the interstate system.

Due to extensive snowplow damage to surface-mounted RPM, an evaluation of snowplowable RPM was conducted in 1982 (6). The evaluation of several potential types of RPM resulted in the recommendation that the Stimsonite 96 marker and recessed marker should be used. The first large-scale contracts for the installations of these two types of snowplowable RPM were awarded in 1984 and 1985. An evaluation of these installations was conducted in 1986 (7). Both the Stimsonite 96 marker and the recessed marker had performed effectively but the recommendation was made that the Stimsonite marker should be used on the majority of highways.

Installation of snowplowable RPM has continued with the establishment of a RPM highway system. The current system has 5,410 miles and is summarized in the following table. Snowplowable markers are installed on all of the interstate and parkway system and rural, four lane roads along with many major rural, two lane roads.

Summary of RPM Highway System

District	Interstate	Parkway	US	KY	Total
	Number of Miles				
1	67.3	57.9	300.7	113.4	539.2
2	26.1	211.8	317.3	72.7	627.9
3	54.0	72.1	241.2	99.0	466.3
4	49.4	93.2	226.3	165.4	534.2
5	179.7	0	186.5	138.0	504.2
6	117.0	0	70.8	51.1	239.0
7	119.7	26.3	280.5	168.2	594.7
8	22.6	52.4	207.3	185.8	468.1
9	75.9	0	95.0	192.8	363.7
10	0	8.1	68.5	259.9	336.4
11	50.8	51.0	224.8	70.9	397.5
12	0	0	196.7	142.3	338.9
Total	762.5	572.8	2,415.7	1,659.5	5,410.1

Recent research has questioned the effectiveness of RMS in reducing crashes (8). The analysis showed that RPM on two-lane roadways does not significantly reduce total or nighttime crashes, nor does it significantly increase these crash types. The installation of RPM on four-lane freeways showed neither a positive nor a negative overall safety effect on total and nighttime crashes but some significant reductions were recorded for wet weather crashes. There were indications that RPM are only effective in reducing nighttime crashes on four-lane freeways where the daily volume exceeds 20,000.

There have been questions concerning the durability of snowplowable RPM. A survey was conducted by Missouri in 2005 (9). The replies were not consistent with some responses indicating no problems while others indicated problems with the RPM coming loose from the pavement. Possible reasons for the markers coming loose included: pavement condition had deteriorated, installation problems (tabs not touching the top of the pavement, epoxy not mixed thoroughly, grooves wet when epoxy installed); design of the casting caused excessive energy to be absorbed by snowplow hits; wet-cut procedure prevented bond; and high frequency plowing.

Ohio has evaluated their use of snowplowable RPM which started in 1977 with about two million installed (10). It was estimated that, over the life of the program, nearly 5,000 nighttime crashes have been prevented. Given the recognition that RPM occasionally come loose from the pavement, the following process improvements have been implemented: increased construction/installation inspection; annual survey of the condition of all installations; improved pavement specifications; extensive training and guidance; and casting specification change.

Laboratory and field evaluations of snowplowable RPM are included in the National Transportation Product Evaluation Program (NTPEP). The most recent report describing the field testing was conducted by the Ohio Department of Transportation (11). The test deck is on Interstate 70 in Ohio. The markers were installed in 2005. The products installed included: Ray-

O-Lite Snow-lite 100; Nightline R-100; Stimsonite 96LP; and Ray-O-Lite Snow-lite 150. The Nightine marker is installed in a recessed groove with the other markers installed in a slot cut. The evaluation has shown that the castings for the Ray-O-Lite and Stimsonite markers and the housing for the Nightline markers have remained in place.

Kentucky standard specifications describe the installation of snowplowable RPM which is listed as a Type V Marker. It is noted that these markers are installed in slots cut into the pavement according to manufacturer's recommendations with the slots not cut until the pavement has cured sufficiently to prevent tearing or raveling. The markers are to be placed as much in line with existing pavement striping as possible but offset a minimum distance of two inches from a longitudinal joint. The surface is to be maintained in a clean condition. The adhesive is to be applied in sufficient quantity to force excess out around the entire perimeter of the marker. To be included on the approved list the markers must have been evaluated on the NTPEP test deck. The following markers are currently included on the approved list of Type V markers.

- Hallen H1010 HP
- Nightline B400
- Snowlite 100
- Stimsonite 101

The objective of this study was to evaluate the effectiveness and durability of snowplowable RPM installed on the RPM system in Kentucky. The durability evaluation dealt with the marker housing.

2.0 PROCEDURE

2.1 Crash Analysis for RPM System

A comparison was made between the crash history for roads on and off the RPM highway system. Since all interstates, parkways, and four lane roadways are on the system, the comparison was between rural, two-lane roads on and off the system. Initially all rural, two lane roads on the system were compared to all roads of that type not on the system. However, since the traffic volume is higher on two lane roads in the RPM system, another comparison was made using rural, two lane roads with an average daily traffic (ADT) of over 2,500. The comparison considered crash data for the five-year period of 2004 through 2008.

2.2 Crash Analysis of Centerline Rumble Strips

Centerline rumble strips have been installed on a few sections of two lane roads in Kentucky in the past few years. Use of shoulder rumble strips and centerline rumble stripEs (where the center stripe paint line is placed over the rumble strip) have been suggested as an alternate to the use of RPM. Shoulder rumble strips have been used for many years. A comparison of crash data before and after the centerline rumble stripE installations were made on a few of the longest sections.

2.3 Durability of Castings

Surveys were conducted to estimate the number of RPM castings missing on a variety of types of roads. Data were collected on two lane and four lane roads and on asphalt and portland cement concrete (PCC) pavements.

Observations were made while driving on a road with the number of missing or partially missing castings noted. Using the spacing for the installations of 80 feet on multi-lane roads and 40 feet on two lane roads, the percent of missing castings was estimated. A data file showing when roads was last resurfaced was used (along with a subjective rating of the surface condition) to analyze the durability on asphalt pavements as a function of the pavement age and condition.

3.0 RESULTS

3.1 Crash Analysis for RPM System

The data shown in Tables 1 and 2 compare crash data for rural, two-lane roads on and off the RPM system. All crashes on these roads were included in the analysis given in Table 1 with fatal crashes used in Table 2. A valid comparison could not be made on other road types since most of those roads (such as interstates and parkways) were on the RPM system.

An analysis was conducted using all roads with a separate analysis using only those rural, two-lane roads with an ADT over 2,500. The second analysis was performed due to the higher ADT on roads on the RPM system compared to all rural, two-lane roads. The number of miles and ADT for roads on and off the system was very similar when only roads with an ADT over 2,500 were used.

The data show the crash rate is lower on the RPM system compared to other roads. Also, the percentages of crashes occurring during nighttime and wet, nighttime conditions are lower on roads on the RPM system. It should be noted that the type of rural, two-lane roads included in the RPM system were typically roads with better roadway geometrics compared to the overall system.

3.2 Crash Analysis of Centerline Rumble Strips

Rumble stripEs have been suggested as a potential alternate to the installation of RPM. Shoulder rumble strips have been installed as part of resurfacing projects for many years. A few sections of centerline rumble strips have been installed on rural, two-lane roads (with 12-foot lane widths and wide paved shoulders) in recent years. Painting of the centerline over the centerline rumble strip creates a centerline rumble stripE. The edge line has not been painted over the shoulder rumble strip.

A survey of the highway districts was conducted to obtain the locations of centerline rumble strips and their installation dates. Sections of varying lengths were identified. A before and after crash analysis was conducted on the three longest sections (the Mountain Parkway extended, the Hal Rogers Parkway, and the AA Highway (KY 9 and KY 10)). Data were also obtained for a short section of a four-lane, undivided highway (US 31W in Hardin and Jefferson Counties). The short length of the other sections would not allow a sufficient sample of crashes for a valid before-and-after comparison.

It should be noted that the centerline rumble strips were installed as part of a resurfacing project on the Mountain Parkway extended and AA Highway with no durability problem with the rumble strips. The rumble strips were milled into the pavement for all the installations. There have been some durability issues relating to pavement deterioration with the Hal Rogers and US 31W installations which were installed on existing pavement. The data show that, to minimize durability problems, installations should be limited to new pavement with the rumble stripes milled into the pavement.

Centerline rumble strips were installed on approximately 32.5 miles of the Mountain Parkway extended in 2003 and 2004. This was conducted as part of a resurfacing project with RPMs also installed. Crash data for the three years before installation (2000 through 2002) were compared to the four years after (2005 through 2008). Following is a summary of the average number of various types of crashes per year.

	Crashes/year	
Category	Before	After
total	52	38
fatal	1.3	0.5
head on/opposite direction sideswipe	5.3	2.5
darkness	18	16
wet/darkness	5.0	3.5
snow/ice	4.3	6.2
motorcycle	1.0	0.3

The total number of crashes decreased after installation of the centerline rumble strips. There were also decreases in all the other crash categories except snow and ice. The increase in the snow and ice category resulted from several in 2008 with many of those on the same day. No crash report was located which noted that the centerline rumble strip contributed to a snow or ice-related crash. Centerline rumble strips have been proposed as a countermeasure for head on and "opposite direction sideswipe" collisions, and these types of crashes were reduced. The possibility of increased nighttime delineation, especially during wet conditions, was supported by reductions in crashes occurring during darkness and wet/darkness conditions. The one motorcycle crash was not related to the centerline rumble strips.

Centerline rumble strips were installed on existing pavement on the Hal Rogers Parkway in 2001. The length of the installation was about 54 miles. Crash data for the three years before (1998 through 2000) were compared to seven years after the installation (2002 through 2008). RPMs are also installed on the parkway. Following are the average number of crashes per year in the given categories:

	Crashes/year	
Category	Before	After
total	68.3	66.7
fatal	2.3	2.4
head on/opposite direction sideswipe	8.3	5.1
darkness	19.7	19.7
wet/darkness	4.5	5.9
snow/ice	5.0	7.9
motorcycle	0	0.4

The largest change in any category was the decrease in the number of head on and "opposite direction sideswipe" crashes. While the number of crashes during snow and ice conditions increased, a review of the police reports found no relationship to the centerline rumble strips. It should be noted that a large number of the snow and ice crashes occurred in one year with several on one day. A review of the crash reports found that the motorcycle crashes were not related to the centerline rumble strips.

Centerline rumble strips were installed on about 71.3 miles of the AA Highway (KY 9 and KY 10) in 2006. Crash data for the five years before (2001 through 2005) were compared to two years after (2007 and 2008). Following are the number of crashes per year in the given categories.

	Crashes/year	
Category	Before	After
total	156	128
fatal	3.2	3.5
head on/opposite direction sideswipe	7.4	5.0
darkness	46.1	39.5
wet/darkness	9.6	5.0
snow/ice	12.2	13.0
motorcycle	0.8	2.5

Total crashes decreased as well as crashes involving a head on or "opposite direction sideswipe" collision. Also, crashes during darkness (including wet pavement) decreased. While there was an increase in motorcycle crashes, a review of the police reports found that none were related to the centerline rumble strips. There was a very slight increase in crashes during snow or ice conditions but none of the crashes during these conditions were related to the rumble strips.

A short section of centerline rumble strips was installed on US 31W (about 5.2 miles) in Hardin and Jefferson Counties in 2003. This is a four-lane, undivided highway. Following is a summary of crash data for the three years before (2000 through 2002) and five years after (2004 through 2008) installation.

	Crashes/year	
Category	Before	After
total	59	29
fatal	0.3	0.7
head on/opposite direction sideswipe	2.0	0.4
darkness	12.3	6.8
wet/darkness	4.0	2.4
snow/ice	1.7	1.0
motorcycle	0.7	0.2

Total crashes decreased as well as crashes involving a head on or "opposite direction sideswipe" collision. Also, crashes during darkness (including wet pavement) decreased. Snow and ice related crashes decreased along with motorcycle crashes. The crashes occurring during snow and ice conditions and motorcycle crashes were not related to the centerline rumble strips.

The numbers of total crashes and "head on and opposite direction sideswipe" crashes decreased at the four locations. Crashes during darkness and on wet pavement during darkness also decreased at three of the four locations. A review of the police reports for the crashes involving a motorcycle found none where the centerline rumble strip was a factor in the crash. Also, the data did not show a problem with snow and ice related to the centerline rumble strips.

3.3 Discussion with Snowplow Operators

Attendees of Traffic Management classes taught through the Technology Transfer Program at the Kentucky Transportation Center have included many Cabinet employees who have operated snowplows for many years and have experience with the performance of snowplowable markers. Discussions were held with these individuals to determine their past experience and opinions concerning snowplowable markers.

A common complaint was the rough ride in the truck caused by the snowplow blade riding over the marker. The only advantage from this bump was that it enabled the operator to locate the lane or center line when the pavement was completely covered with snow.

Most operators reported that their plow had removed some markers from the pavement. The reported number of these instances varied dramatically. It was felt that numerous hits by the plow may loosen the marker from the pavement. It was noted that this occurred most often in areas with older pavement where there were cracks in the pavement around the marker. The consensus was that the condition of the surrounding pavement was the major factor affecting the durability of the marker casting. In the few instances where numerous markers were missing in a short section of road with none missing in adjacent sections, an installation problem was mentioned as the potential cause.

3.4 Durability of Castings

Data were collected on a large sample of roads on the RPM system. The number of missing or partially missing castings were counted while traveling on each of the roads. The percentage of missing castings could be estimated using the installation spacing of 80 feet on multilane roads and 40 feet on two lane roads.

The percent missing were summarized separately for asphalt and PCC pavements. For asphalt pavements, the percent missing was summarized using both the age of the pavement and a subjective rating of the condition of the pavement (new, good, fair, and poor).

Following are summaries of the results of the data collection. A total of 3,661 miles of roads were surveyed. This includes 1,002 miles of two lane roads and 2,659 miles of multi-lane roads. The miles for multi-lane roads are for each direction. For example, if 25 miles of multi-lane were surveyed in both directions, the summary would show 50 miles of road.

The following table shows the results of the evaluation as a function of the pavement condition.

Type of Pavement	Pavement Condition	Miles Surveyed	Percent Missing (Castings)
Asphalt	New	645	0.4
	Good	1,197	0.9
	Fair	1,211	5.0
	Poor	292	30.8
	All	3,345	4.5
PCC	All	316	5.5

The following table shows the results of evaluation showing the percent of castings missing as a function of the pavement age. It should be noted that the pavement age was obtained from a data file maintained by the Cabinet. Several instances were found were the driving survey showed the pavement had been resurfaced since the resurfacing date shown in the file.

Pavements were omitted from the analysis when the subjective rating was good but the pavement age shown in the file was 10 years or older.

Type of Pavement	Pavement Age (Years)	Miles Surveyed	Percent Missing (Castings)
Asphalt	Under 4	1,076	0.5
	4 - 6	485	1.6
	7 - 9	588	5.7
	10 - 12	522	5.8
	13 - 15	378	11.9
	Over 15	245	9.7

The data show an increase in the percent of marking housings missing on asphalt pavement as the pavement condition becomes worse and as the pavement age increases. Considering the pavement condition, the percentage of missing castings remains low until the pavement condition becomes poor where about 30 percent were missing. There were several sections of pavement in poor condition where well over one-half of the castings were missing. There is a substantial increase in the percent missing for a pavement in service for over 12 years.

The data show that there is a very small loss of markers for new pavement or pavement remaining in good condition. The durability problem occurs as the pavement around the casting starts to crack and fail. There were a few isolated instances where several markers were missing on a new pavement, but installation problems were not common. In some instances, more markers were missing in sharp curves with a large amount of superelevation which evidently resulted in a tab not being installed flush with the pavement surface. Durability issues which would be related to the epoxy were not found.

Durability versus pavement age was investigated for the PCC pavements. There was a higher percentage of older PCC pavements compared to asphalt. It appears that there has been some replacement of markers on the oldest pavements.

Pavement problems causing durability problems with the housing relate to longitudinal cracking in the area of the lane line on multi-lane roads or centerline on two lane roads. In an effort to alleviate this problem, in recent years the castings have been offset a minimum of two inches from a longitudinal crack or joint. Also, crack sealing has been used more frequently in an effort to reduce the possibility of failure of pavement in the area of the casting.

4.0 CONCLUSIONS

The analysis resulted in the following conclusions relative to the crash analysis and durability of marker castings.

1. An analysis of crash data on rural, two-lane roads with similar traffic volumes found that the crash rate is lower on roads on the RPM system compared to other roads. Also, the percentages of crashes occurring during nighttime and wet, nighttime conditions were slightly lower on roads on the RPM system.

2. A comparison of crashes before and after installation of centerline rumble strips (creating a centerline rumble stripE) found that total crashes decreased along with crashes involving head on or "opposite direction sideswipe" collisions. Also, crashes during darkness (including wet pavement) decreased. Considering all the installations, the number of snow and ice related crashes and motorcycle crashes did not increase, and a review of crash reports found that those types of crashes occurring after the installations were not related to the centerline rumble strips.

3. A survey of the durability of marker castings on over 3,600 miles found that about 4.5 percent of all the castings were missing. There was a large range in the percent missing with under one percent missing on roads with a new pavement compared to approximately 30 percent missing on pavements rated as in poor condition. There were several sections of pavement in poor condition with substantially over one-half of the castings missing. There was an increase in the percent missing on pavements over 12 years old. The performance on new pavements showed that the installation process did not result in a durability problem.

4. Durability problems for castings were primarily the result of the pavement condition with some problems found with the installation. No problem was found with the epoxy. The data show that it should be expected that some castings will be removed as a part of snowplow operation but this number can be kept to a minimum if the installation process is carefully monitored and the castings and pavement are routinely inspected to ensure the castings remain secure.

5. Using the installation cost along with the cost of lense replacement on a three-year cycle results in a total cost of about $30 per marker over a 15 year pavement life. Using the marker spacing results in a cost of about $4,000 per mile for the life of the pavement to install and maintain the markers. Comparing this cost with the typical paving cost of approximately $100,000 per lane mile shows that the installation and maintenance of RPM represents only approximately two percent of the paving cost on a two lane road and one percent on a four lane road.

5.0 RECOMMENDATIONS

The data show that continued use of the currently approved snowplowable raised pavement markers can be justified if the castings are properly installed on new pavements with a commitment that the pavement will be maintained. The cost of the marker over the life of the pavement is small when compared to the paving cost.

The installation process must be monitored to ensure the castings are placed properly. The marker should be installed a minimum of two inches from the pavement joint. Pavement maintenance should include crack sealing along the longitudinal joint which is the source of durability problems. When the lenses are replaced (on an approximate three-year cycle), the castings should be inspected with any unstable markers removed. Castings should also be inspected when any problem with surrounding pavement is observed.

Centerline rumble strips should be considered on rural, two-lane roads with 12-foot lane widths and paved shoulders. The rumble strips should only be placed on new pavements. The use of “rumble stripEs” (where centerline rumble strips are installed on two-lane roads) are a potential alternate to raised markers.

An evaluation of alternative snowplowable marker designs and wet reflective tape should be conducted to determine if they could provide adequate wet pavement reflectivity with improved durability compared to the currently used snowplowable markers.

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Table 1. RPM SYSTEM CRASH ANALYSIS
(2004-2008 Crash Data on Rural, Two-Lane Roads)

All Rural, Two-Lane Roads

	Miles	ADT	Rate*	Percent		
				Wet	Night	Wet/Night
RPM System	2,740	4,881	180	24.5	27.6	7.1
Other Roads	20,488	1,123	243	25.3	31.2	7.9
All	23,228	1,567	219	25.1	30.1	7.7

Rural, Two-Lane Roads (ADT > 2,500)

	Miles	ADT	Rate*	Percent		
				Wet	Night	Wet/Night
RPM System	2,115	5,793	175	23.8	27.2	6.8
Other Roads	2,128	4,383	222	25.6	27.5	7.3
All	4,243	5,086	196	24.7	27.4	7.0

* crashes per 100 million vehicle miles

Table 2. RPM SYSTEM FATAL CRASH ANALYSIS
(2004-2008 Crash Data on Rural, Two-Lane Roads)

All Rural, Two-Lane Roads

	Miles	ADT	Rate**	Percent Wet	Percent Night	Percent Wet/Night
RPM System	2,740	4,881	2.74	23.9	35.2	6.8
Other Roads	20,488	1,123	3.78	19.4	37.4	6.9
All	23,228	1,567	3.39	20.6	36.8	6.9

Rural, Two-Lane Roads (ADT > 2,500)

	Miles	ADT	Rate**	Percent Wet	Percent Night	Percent Wet/Night
RPM System	2,115	5,793	2.65	23.8	36.7	6.6
Other Roads	2,128	4,383	2.70	22.7	37.5	8.9
All	4,243	5,086	2.67	23.3	37.1	7.6

** crashes per million vehicle miles

For more information or a complete publication list, contact us at:

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