EVALUATION OF REMEDIAL TREATMENTS AT SKID ACCIDENT LOCATIONS

by

Charles W. Payne
Highway Materials Technician

Virginia Highway Research Council
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SUMMARY

The Virginia Department of Highways has for many years been concerned with the slipperiness of highway pavements, and has undertaken remedial action at numerous high wet accident locations. The purpose of this study was to evaluate the remedial action taken at 18 locations to determine if the percentages of wet accidents were significantly reduced.

The remedial action taken has always been either resurfacing or grooving. The findings of this study were that both resurfacing to increase skid resistance and grooving tended to reduce the percentage of wet pavement accidents, with resurfacing seeming to provide the greater benefit.

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INTRODUCTION

For years, Virginia has been aware of the necessity to maintain roads with skid resistance adequate for the safety of the traveling public. Minimum skid resistance standards have been established and the use of some polish susceptible aggregates has been proscribed on heavily traveled primary and interstate roads. Even so, some highways still become slippery and cause skidding accidents. When skidding accidents are reported, skid tests are performed at the accident locations and remedial action is taken where the average skid number is found to be less than 40 as measured by the stopping distance method or predicted by the Virginia Highway Research Council skid trailer. For the past four years most testing has been done with the skid trailer with skid numbers being reported as predicted stopping distance skid numbers based on the relationship between the car and trailer.

The determination of the skid resistance at accident locations is done by the Research Council, with the responsibility having been assigned to the Maintenance Section since its formation in 1967. Since 1967 numerous accident locations have been tested upon request, and at 30 of these sites remedial measures have been taken. Prior to 1969, pavement resurfacing was used to improve the skid resistance. Since that time, either resurfacing or pavement grooving has been used.

PURPOSE

The general purpose of this study was to evaluate the effectiveness of the corrective measures — resurfacings and grooving — used by the Highway Department to reduce skidding accidents.

SCOPE

Initially it was planned to include in the evaluation all 30 sites at which remedial action was taken. However, it was not possible to obtain either the accident or skid data required to make the desired analysis for all 30 sites, so only 18 sites were included in the study. The remaining 12 sites will be analyzed and reported on after the necessary data have been developed.

ANALYSIS OF RESULTS

Data for the 18 sites included in the study are shown in Tables 1 and 2, with Table 1 showing data for those sites that were resurfaced and Table 2 showing data for those sites that were grooved. In both tables the data are arranged in ascending order by the skid number in the traffic lane before any treatment. Also shown in Tables 1 and 2 are the skid data after resurfacing or grooving, as well as the total accidents, wet pavement accidents and percentage wet pavement accidents that occurred at each site prior to and after the resurfacing or grooving. For those sites resurfaced (Table 1), the data include accidents occurring two years prior to the resurfacing and two years after the resurfacing. These data were obtained from the automated accident data files maintained by the Data Processing Division and include all lanes in both directions throughout the site since the resurfacing included all lanes. For the grooved sites, the accident data were obtained from the report entitled "An Accident Evaluation of the Effectiveness of Longitudinal Grooving on Virginia's Interstate System", by the Traffic and Safety Division of the Virginia Department of Highways. These data are for varying time periods (as indicated in Table 2) before and after grooving and include only accidents occurring on the lanes grooved. It is the percentage wet pavement accidents that is used to determine if a site has relatively more wet pavement accidents than normal.* The percentage of wet pavement accidents does not indicate a high total accident site (a rate such as accidents per 100 million vehicle miles is the measure normally used for this purpose) but indicates only those sites having a larger proportion of wet pavement accidents than normal.

Results for Resurfaced Sites

As can be seen in Table 1, the percentage of wet pavement accidents decreased substantially after resurfacing on nine sites, the exceptions being sites 1, 6, 12, and 13, which are discussed below.

Site 1 was in a city and the traffic conditions are quite different from those of the open roadway. It is interesting to note that the total number of accidents dropped from 469 for two years prior to resurfacing to 259 for two years after resurfacing. Site 6 had too few accidents before and after resurfacing to permit a meaningful evaluation. Site 12 was on a two-lane secondary road segment having a poor cross section. Prior to resurfacing one lane was slippery (SN = 33) due to a flushing condition, while after resurfacing the situation was reversed; i.e., the once slippery lane had a higher skid number but the other lane by then had a reduced skid number due to flushing (SN = 43). For site 13, a decrease in the percentage of wet pavement accidents was not expected since the skid number was high prior to resurfacing and the percentage was approximately 20%, which according to Mahone and Runkle is normal for good conditions. This section was scheduled to be resurfaced for normal maintenance purposes and was included in the study as a control section to verify the 20% wet pavement accident figure mentioned previously.

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* In the paper "Slipperiness of Highway Pavements — Phase I" Mahone and Runkle of the Research Council reported the normal percentage of wet pavement accidents to be about 20%.

Table 1

Skid and Accident Data for Sites Resurfaced

Site	2 Years Before Resurfacing					2 Years After Resurfacing				
	Average Skid Number		Accidents			Average Skid Number		Accidents		
	Traffic Lane	Passing Lane	Total	Wet	% Wet	Traffic Lane	Passing Lane	Total	Wet	% Wet
1	28		399	70	18%	57		222	37	17%
2	29		7	2	29%	52		4	0	0%
3	33		87	25	29%	53		58	9	16%
4	34	45	44	12	27%	58	63	26	4	15%
5	36		9	4	44%	48		13	2	15%
6	37		5	1	20%	50		1	1	100%
7	38	43	75	20	27%	50	54	50	10	20%
8	39		70	22	31%	50		43	7	16%
9	40	43	19	9	47%	56	59	11	2	18%
10	40	50	44	21	48%	56	58	23	7	30%
11	42		43	11	26%	56		12	0	0%
12	42		37	5	14%	48		55	15	27%
13	54		179	37	21%	58		163	33	20%
TOTAL			443	132	30%			296	57	19%

Table 2

Skid and Accident Data for Grooved Sites

Site	Before						After					
	Average Skid Number			Accidents			Average Skid Number			Accidents		
	Traffic Lane	Center Lane	Passing Lane	Total	Wet	% Wet	Traffic Lane	Center Lane	Passing Lane	Total	Wet	% Wet
1 (a)	26 (d)			4	4	100%	58			2	1	50%
2 (b)	38	43	57	45	32	71%	44	48	58	35	14	40%
3 (c)	44	48	55	22	16	73%	46	48	52	14	6	43%
4 (a)	46	49	57	44	23	52%	48	51	59	52	26	50%
5 (a)	58		59	7	4	57%	56		57	4	0	0%
TOTAL				122	79	65%				107	47	44%

(a) Accident data 2 years before and after grooving

(b) Accident data 3 years before and after grooving

(c) Accident data 6 months before and after grooving

(d) Validity of this low skid number is questionable.

It is interesting to note that by totaling the accident data for sites 2 through 12 the percentage wet pavement accidents decreased from 30% prior to resurfacing to 19% after resurfacing. The 19%, of course, is about equal to the 20% indicated as being normal. Sites 1 and 13 were not included in the total because as stated above the percentages of wet pavement accidents on them were not normal and the large sample size for these two sites would greatly influence the results.

In order to determine the significance of decreases in the percentages of wet pavement accidents the chi-square test was used. However, because of small sample sizes, sites for which skid numbers were about equal before and after treatment were combined prior to running the significance tests. These combined groups are shown in Table 3 along with the results of the chi-square tests. As indicated in Table 3, most of these groups showed a significant decrease in the percentage of wet pavement accidents.

As mentioned previously, site 1 was unusual in that it was within a city and the traffic conditions are quite different from those of the open roadway. For this site the chi-square results indicate that there was no significant decrease in the percentage of wet pavement accidents. However, as also mentioned previously, the total number of accidents was somewhat less after resurfacing than it was before.

The second group tested consisted of sites 2, 3, and 4, for which the skid numbers before being resurfaced were in the low 30's. For this group the percentage of wet pavement accidents decreased from 28% to 15%, which was a significant decrease at a confidence level between 90% and 95%. Sites 5, 6, 7, and 8 make up the third group, which had skid numbers in the high 30's before being resurfaced. The percentage of wet pavement accidents for this group decreased from 30% to 19%, which was a significant decrease at a confidence level between 75% and 90%. The fourth group consisted of sites 9, 10, and 11, which had skid numbers in the low 40's before being resurfaced. After resurfacing the percentage of wet pavement accidents decreased from 39% to 20%, which was a significant decrease at a confidence level between 90% and 95%. Site 12 was not included in the fourth group for two reasons. As explained previously, there was an increase in the percentage of wet pavement accidents after resurfacing; and before resurfacing one lane was slippery whereas the other was not, and after resurfacing the situation was reversed. Also, the skid number after resurfacing was somewhat lower than for the other three sites in the fourth group. No test was run on site 12 individually since the percentage of wet pavement accidents increased after resurfacing and thus, obviously, no reduction was realized.

The final group is composed only of site 13. As explained above, no decrease in the percentage of wet pavement accidents was expected, and as indicated in Table 3 there was only a 1% decrease in such accidents, which was not significant.

Based on the results as discussed above and shown in Table 3, it seems quite obvious that reductions in the percentages of wet accidents did occur when the skid resistance was increased by resurfacing. Also, the percentages after the resurfacings and resulting higher skid resistance were equal to or less than the 20% figure stated earlier as being normal for good conditions.

Table 3

Percentage Increases in Skid Numbers and Results of Chi-Square Tests for Sites that were Resurfaced

Sites	Before			After				
	Total Accidents	Wet Accidents	% Wet	Total Accidents	Wet Accidents	% Wet	% Increase In SN	Chi-Square Significance Level
1	399	70	18%	222	37	17%	104%	Less than 2.5%
2,3,4	138	39	28%	88	13	15%	69%	Between 90 and 95%
5,6,7,8	159	47	30%	107	20	19%	32%	Between 75 and 90%
9,10,11	106	41	39%	46	9	20%	37%	Between 90 and 95%
13	179	37	21%	163	33	20%	7%	Less than 0.5%

Results for Grooved Sites

Referring again to Table 2, there seems to be a significant reduction in the percentages of wet pavement accidents after grooving at all sites, with the exception of site 4. Chi-square tests were run for sites 2, 3, and 4 with the results shown in Table 4. Tests were not run on sites 1 or 5 because the sample sizes were too small for the results to be meaningful. For site 2 the skid number was 38 prior to grooving and 44 after grooving. The percentage of wet pavement accidents decreased from 73% to 43%, which was significant at a confidence level between 50% and 75%. Since the sample sizes were fairly small for site 3 and since the before and after grooving skid numbers were about equal, the accident data for sites 2 and 3 were combined and the chi-square test for the combined group indicated a significant reduction in the percentage of wet pavement accidents at better than a 99% confidence level. For site 4 there was not a decrease in the percentage of wet pavement accidents after grooving. No explanation is apparent, except that the initial skid number was relatively high as compared to those at the first 3 sites. However, the same is true for site 5 and the limited accident data for this site showed a decrease in the percentage of wet pavement accidents.

As with resurfacing, the grooving of pavements tended to decrease the percentage of wet pavement accidents, with the exception of site 4. However, even after the reduction the percentages still average about 44%, as stated previously. Obviously, there are factors at work other than skid resistance, such as geometric conditions and water runoff. In fact, some of these additional factors have led to grooving. It is quite obvious that improvements seem to be best when the before skid number is low and is raised by the treatment.

Based on the results as discussed above it was concluded that grooving, as resurfacing to increase skid resistance, does tend to reduce the percentage of wet pavement accidents. However, it should be noted, as shown in Tables 2 and 4, that even after grooving the percentages of wet pavement accidents were high, and, in total, the percentage was 44% after grooving as compared to 19% after resurfacing. Thus, the question arises as to whether resurfacing would be of more benefit than grooving; i.e., would the percentage of wet pavement accidents decrease more if the pavement was resurfaced rather than grooved?

CONCLUSIONS

1. In general, sites which were resurfaced in order to improve skid resistance showed a significant decrease in the percentage of wet pavement accidents experienced. In total, the percentage of wet pavement accidents was 19% after sites were resurfaced, which is the percentage expected for good skid resistance conditions as reported by Mahone and Runkle.

2. Sites which were grooved also showed a significant reduction in the percentage of wet pavement accidents, but the percentage remained high (44%) even after grooving.

Table 4

Percent Increase in Skid Numbers and Chi-Square Values for Sites that were Grooved

Sites	Before			After				
	Total Accidents	Wet Accidents	% Wet	Total Accidents	Wet Accidents	% Wet	% Increase In SN	Chi-Square Significance Level
2	45	32	71%	35	14	40%	16%	Between 90 and 95%
3	22	16	73%	14	6	43%	9%	Between 50 and 75%
4	44	23	52%	52	26	50%	4%	Less than .5%
2,3	67	48	72%	49	20	41%	10%	Between 99 and 99.5%

RECOMMENDATIONS

It is recommended that further study be undertaken to better determine the relative effects of reducing the percentage of wet pavement accidents through resurfacing in lieu of grooving. Possibly one of the grooved sites which showed a significant reduction in the percentage of wet pavement accidents (site 2 or 3) could be resurfaced with a highly skid resistant mix to determine if a further reduction could be achieved.

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REFERENCES

1. Mahone, David C., and Stephen N. Runkle, "Slipperiness of Highway Pavements — Phase I", Virginia Highway Research Council, Charlottesville, Virginia, VHRC 70-R47, June 1971.

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