LAND transport safety AUTHORITY

Reseal Pavement

Executive Summary

May 1996

Road maintenance includes periodic resealing of the road pavement. However, resealing the pavement is a frequent "treatment" included in recommended works for low cost engineering improvements at sites undergoing crash analysis in the joint crash investigation programme. Therefore, data on sites where the road pavement has been resealed appear on the crash investigation monitoring system.

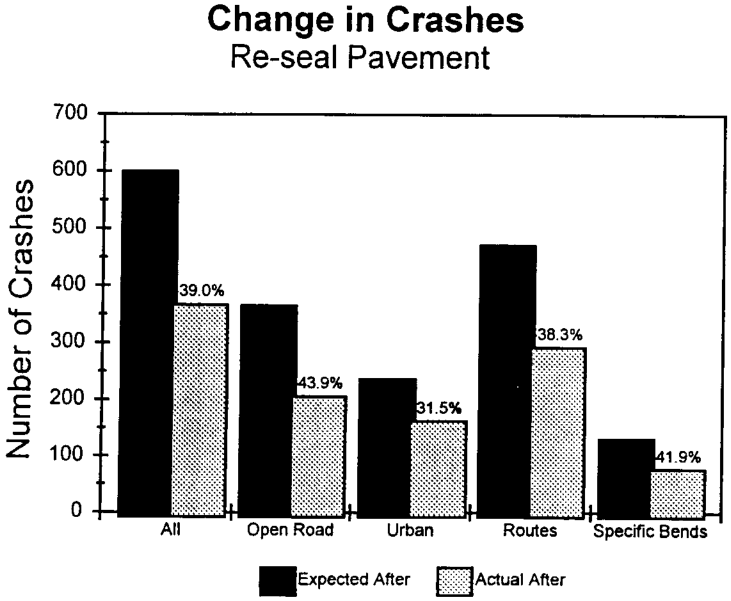
Loss of control crashes are expected to be reduced when a roadway is resealed because the friction of the road surface is improved at this time. However, other crash types may also be reduced by this treatment.

This paper is an analysis of the effect of resealing the road pavement on routes or at specific bends. The selected sites were in both urban and open road speed limits. The data used for analysis are from the Land Transport Safety Authority Crash Investigation Monitoring System.

It is recognised that other works implemented will also have contributed to the change in crashes at the sites.
Note that no distinction has been made between the type of surfacing used. In the context of this paper, "reseal" includes chip seal, friction course, slurry seal, etc.

Where the road pavement was resealed:

- crashes reduced overall by **39%**
- loss of control crashes:
  - on straights reduced **20 %**
  - on straights in urban areas *increased* **9 %**
  - on straights on open roads reduced **32 %**
  - on bends reduced **37 %**
  - on bends in urban areas reduced **10 %**
  - on bends on open roads reduced **42 %**
- head-on crashes:
  - on straights reduced **58 %**
  - on bends reduced **75 %**
- crashes in the wet reduced **49 %**
- crashes on dry pavement reduced **30 %**



At the sites where road pavement was resealed, the other most frequent work implemented was the installation of traffic signs. Installation of raised reflective pavement markers (rrpms) has also been a frequent treatment along with resealing the road pavement. This is most likely due to a Transit New Zealand (TNZ) policy to install rrpms on state highways. Of the 76 sites, 61 were on state highways and rrpms were installed at 28 of these.

Introduction

In 1985, the government approved a programme of systematic crash investigation. The Land Transport Safety Authority (formerly the Ministry of Transport, Land Transport Division) developed a Crash Investigation Monitoring System in 1989, which contains data on sites which have had works implemented as part of the joint crash investigation programme. The "after" data on this database is now sufficient to allow analysis of the effects of specific "actions" or treatments at sites.

Site Selection

This report is an analysis of the effect of resealing the road pavement. Routes and specific bends have bee included for analysis, in both open road and urban environments.

The criteria for selection were:

1. At the chosen site, the reseal work was completed.
2. No other works were implemented after the reseal work was complete.

Only routes and bends were selected.

Using the above criteria, there were 76 bend sites and routes in total where the road pavement was resealed.

Specific bends were se(arated into urban and open road sites, as were the routes. Urban is described as speed limits of less than or equal to 70 km/h, while open road refers to speed limits greater than 70 km/h.

Table 1 shows the distribution of sites by site type, speed environment, and road controlling authority.

	Open Road	Urban	Total	TNZ	LA	Total
Routes	29	21	50	39	11	50
Bends	23	3	26	22	4	26
Totals	52	24	76	61	15	76

Table 1.

Control Factor

Trends in crashes have been taken into account when calculating reductions at the monitored sites.

The "control" factor calculated for each site adjusts for urban or open road crash trends in the local authority (ie high, medium or low growth rate), depending on whether the site is urban or open road.

This factor is applied to the number of crashes before improvements were made ("before" data) to give the expected number of crashes if the improvements had no effect. Comparing this number with the actual crashes after improving the site ("after" data) gives the crash reduction.

Analysis

The overall crash change at each site was calculated as:

$$\text{Change} = -\frac{(\text{sum Expected} - \text{sum after})}{\text{sum Expected}} \times 100$$

Multiplying by the ratio of after to before years adjusts for the difference in before and after time periods.

$$\text{Expected} = \text{before crashes} \times \text{control} \times \frac{\text{after yrs}}{\text{before yrs}}$$

After = after crashes

where

- *Expected* is the expected number of after crashes, assuming the treatment had no effect.
- *Before crashes* is the actual number of before crashes.
- *Control* is the factor calculated by crash rate and urban/rural/regional location.
- *After* is the actual number of after crashes which occurred.
- *Before years* is the number of years in the before period.
- *After years* is the number of years in the after period (after works are complete/implemented).

Note that a negative "Change" is a reduction in crashes.

Table 2 summarises the reductions in crashes by speed limit, movement type, and crash type.

	Before	Expected After	After	Change	Confidence Interval	No. Sites
Overall (urban)	261	235.1	161	- 32 %	- 13 % to - 50 %	24
Overall (open road)	409	363.5	204	- 44 %	- 16 % to - 72 %	52
ALL	670	598.6	365	- 39 %	- 19% to - 59 %	76
Lost control (straight)	62	56.1	45	- 20 %		
Lost Control (bend	301	234.9	149	-37 %		
Head-on (straight)	22	18.8	8	- 58 %		
Head-on (bend)	75	81.2	20	- 75 %		
Wet	308	243.2	123	- 49 %		
Dry	443	391.5	276	- 30 %		
Day	480	396.1	264	- 33 %		
Night	248	216.8	120	- 44 %		
Twilight	31	24.3	19	-22 %		
Fatal	53	41.8	30	- 28 %		
Serious	237	233.4	86	- 63 %		
Minor	380	323.4	249	- 23 %		

Table 3 shows the changes in crash type by OPEN ROAD and URBAN split

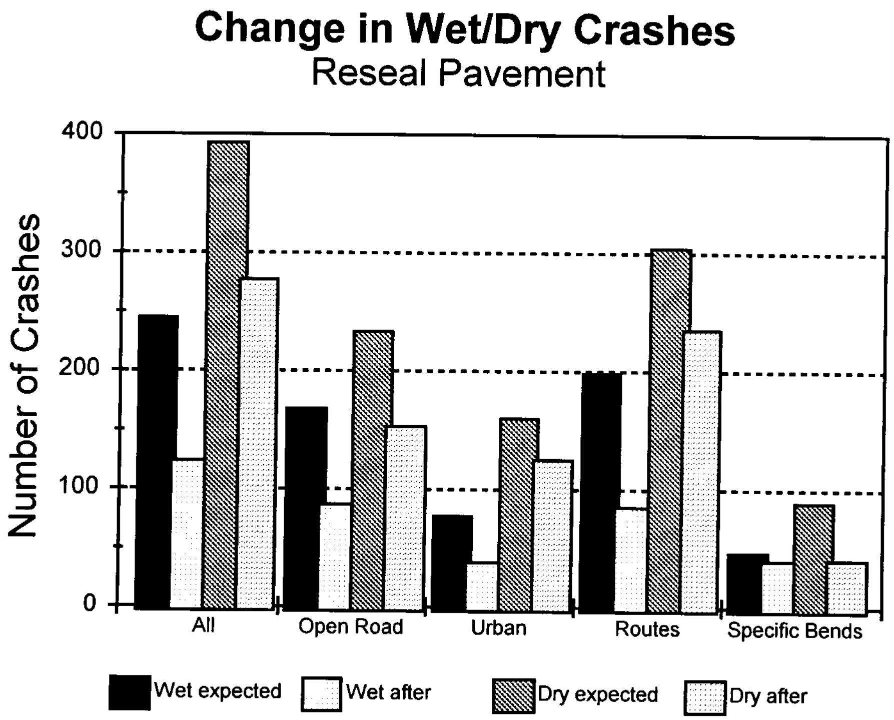
	OPEN ROAD N = 52				URBAN N = 24			
	Before	Expected After	After	Change	Before	Expected After	After	Change
ALL	409	363.5	204	- 44 %	261	235.1	161	- 32 %
Lost control (straight)	46	39.5	27	- 32 %	16	16.6	18	+ 9 %
Lost Control (bend	251	197.1	115	- 42 %	50	37.8	34	- 10 %
Head-on (straight)	13	11.1	4	- 64 %	9	7.7	4	- 48 %
Head-on (bend)	64	70.8	18	- 75 %	11	10.5	2	- 81 %
Wet	227	167.1	86	- 49 %	81	76.1	37	- 51 %
Dry	264	232.2	152	- 35 %	181	159.2	124	- 22 %
Day	333	265.7	167	- 37 %	147	130.4	97	- 26 %
Night	252	118.1	66	- 44 %	107	98.7	54	- 45 %
Twilight	23	18.1	8	- 56 %	8	6.2	11	+ 76 %
Fatal	37	28.6	18	- 16 %	16	13.2	12	- 9 %
Serious	152	159.5	57	- 64 %	85	73.9	29	- 61 %
Minor	220	175.4	129	- 27 %	160	148.0	120	- 19 %

Table 4 shows the changes in crash type by ROUTE and SPECIFIC BENDS

	ROUTES N = 50				BENDS N = 26			
	Before	Expected After	After	Change	Before	Expected After	After	Change
Overall (urban)	278	224.0	159	- 29 %	11	11.1	2	- 82 %
Overall (open road)	250	245.7	131	- 47 %	131	117.8	73	- 38 %
ALL	528	469.7	290	- 38 %	142	129.0	75	- 41 %
Lost control (straight)	40	34.7	37	+ 7 %	22	21.4	8	- 63 %
Lost Control (bend	230	172.1	99	- 43 %	71	62.8	50	- 20 %
Head-on (straight)	18	15.2	7	- 54 %	4	3.6	1	- 73 %
Head-on (bend)	42	57.1	15	- 74 %	33	24.2	5	- 79 %
Wet	244	197.2	84	- 57 %	64	46.1	39	- 15 %
Dry	236	303.3	236	- 22 %	93	88.2	40	- 55 %
Day	379	316.0	204	- 36 %	101	80.1	60	- 25 %
Night	195	163.6	103	- 37 %	53	53.2	17	- 68 %
Twilight	27	21.5	15	- 30 %	4	2.8	4	+ 43 %
Fatal	39	30.0	23	- 23 %	14	11.8	7	- 41 %
Serious	178	173.6	68	- 61 %	59	59.8	18	- 70 %
Minor	311	266.1	199	- 25 %	69	57.3	50	- 19 %

The average before period was 5.3 years, while the average after period was 4.4 years.

Graph 2 shows the change in wet/dry crashes by site type and speed environment.



Graph 2

Time Series Analysis

Sites which had at least three years of after data were used for time-series analysis. Crash reduction was calculated for time periods of 1 year after implementation, 2 years after implementation, and 3 years after implementation.

There were 59 sites which had three years of after data. No distinction was made between routes and bends for this analysis.

The following table (Table 5) shows the crash reductions by the number of years after implementation of the reseal work.

	Expected After	After	Change
Year 1	110	72	35 %
Year 2	220	153	30 %
Year 3	330	221	33 %

Table 5.

The results indicate that there is no real change in the percentage reduction of crashes over the three year time period at the selected sites.

Intuitively, it is expected that the effects of resealing road pavement will diminish over time. The data available show that three years is too short a time-frame to detect any reduction in positive effects experienced from resealing.

Regression-to-Mean

Regression-to-Mean is a recognised phenomenon inherent in before and after studies. At present there is no definitive method for coping with this effect. Evidence suggests that as the number of years of data increases, the effects of regression-to-mean decrease.

The monitoring system uses five years of before data in calculations "before" improvement. For the sites where road pavement was resealed, an average of 4.4 years is used for "after" improvement calculations. Therefore, regression-to-mean is not considered to have a major effect on the results and no correction has been used.

Other Works

There were other works implemented at the selected sites, and it is acknowledged that these works may also have contributed to the change in crashes at the sites.

There was an average of 6 other actions implemented at each of the sites where the pavement was resealed.

The most common other actions implemented on routes and at specific bends where the road pavement was resealed are:

Install RRPMS (34 sites)
Install chevron board (24 sites)
Install traffic signs (53 sites)