LAND transport safety AUTHORITY

SHOULDER IMPROVEMENTS

October 1995

Executive Summary

Adequate road shoulders provide a safety factor for recovery when drivers lose control of their vehicles. Lack of useable road shoulders can contribute to loss-of-control crashes, because there is no recovery area. Overtaking crashes and head-on crashes may also be reduced by the provision of widened shoulders.

This paper analyses the effect of shoulder improvements on open road routes and bends from the LTSA Crash Investigation Monitoring System. Improvements include installing, sealing or widening shoulders. Routes and bends were analysed separately and were also divided by speed limit into urban and open road categories. Because there were only 2 urban routes where shoulder improvements were fully implemented, urban routes were excluded from the analysis. There were no urban bends in the sites selected.

In the context of this paper, "open roads" are defined as roads where the speed limit is greater than 70 km/h.

Certain types of crashes are expected to be reduced by shoulder improvements on routes. These are loss-of-control crashes, overtaking crashes, and head-on crashes. From the 41 open road routes analysed, the following observations were made:

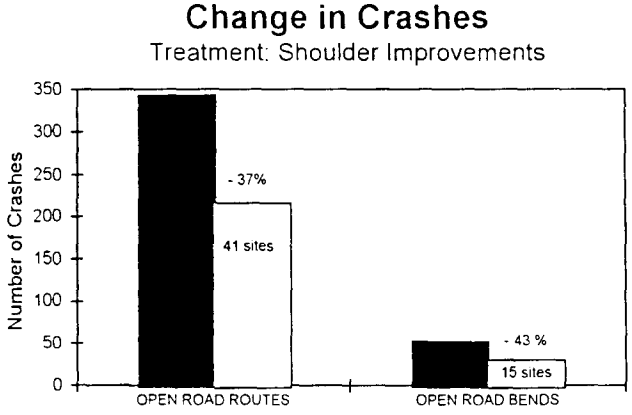
- loss of control crashes on straights were reduced by **55 %**
- loss of control crashes on bends (on the route) were reduced by **36 %**
- overtaking crashes were reduced by **61 %**
- head-on crashes on straights were increased by **2 %**
- overall there was a **37 %** decrease in crashes on open road routes where shoulders were improved

There were only 15 open road bend "sites" analysed. The following observations were made:

- loss of control crashes on bends were reduced by **33 %**
- overtaking crashes were reduced by **80 %**
- head-on crashes were reduced by **43 %**
- overall there was a **43 %** decrease in all crashes on open road bends where shoulders were improved

Other works may have been implemented at the treated sites, in addition to shoulder improvements. Sites where street lighting was installed and/or changed were not included in the site selection. The reduction calculations do not attempt to account for the contribution of other treatments.

Figure 1 summarises the reduction in crashes at open road sites where shoulder improvements were made.



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 shoulder improvements on open road routes and bends. Reductions in loss-of-control crashes, overtaking crashes, and head-on crashes were calculated.

The criteria for selection were:

1. works on route/bend fully implemented
2. shoulders improved (installed, sealed, or widened)
3. no lighting changes

Open Road routes and bends were excluded where changes to or installation of street lighting occurred. It was assumed that lighting changes may have a greater effect than shoulder improvements on crashe numbers.

Using the above criteria, 41 routes and 15 bends were selected. These were all open road sites, with speed limits of 80 - 100 km/h. There were only two routes in an urban speed area which met the criteria, so these were not included in the analysis.

Control Factors

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:

$$\text{change} = -\frac{(\text{expected} - \text{after})}{\text{expected}} \times 100$$

$$\text{expected} = \text{before} \times \text{control} \times \frac{\text{yearsa}}{\text{yearsb}}$$

where

expected	is the expected number of crashes after the site improvements, assuming the improvements had no effect.
after	is the actual number of crashes which occurred in the period after site improvements.
before	is the number of crashes which occurred in the period before site improvements.
control	is the factor calculated by crash rate and urban/rural/ regional location.
yearsa	is the number of years in the period after site improvement.
yearsb	is the number of years in the period before site improvements.

Note that:

- a negative "change" is a reduction in crashes
- multiplying by the ratio of after to before years adjusts for the difference in before and after time periods

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 routes, an average of 4.0 years is used for "after" improvement calculations, while for "bends" an after period of 3.1 years is used. Therefore, regression-to-mean is not considered to have a major effect on the results and no correction has been used.

Other Works

Other works were also implemented on the routes and bends where shoulders were improved. There was an average of 6 actions implemented at each of the treated routes and bends. The most common other actions implemented were:

OPEN ROAD ROUTES

Install chevrons (12 routes)
Install traffic signs (31 routes)
Install RRPMs (raised reflective pavement markers) (21 routes)
Upgrade edge marker posts (9 routes)
Paint edgeline (6 routes)

OPEN ROAD BENDS

Install signs (6 bends)
Install chevrons (6 bends)
Upgrade edge marker posts (5 bends)

Tables 1 and 2 summarise the reductions in crashes by speed limit and movement type.

Table 1 **OPEN ROAD ROUTES**

Movement	Before	Expected	After	Change
Nighttime	233	139.2	70	- 49.7 %
Daytime	309	172.6	126	- 27.0 %
Rear-end	97	66.6	34	- 48.9 %
Pedestrian	14	7.0	63	- 14.4 %
Overtaking	73	46.3	18	- 61.1 %
Merging	9	4.3	5	+ 16.5 %
Lost Control (s)	71	52.8	24	- 54.6 %
Lost Control (b)	196	114.3	73	- 36.1
Head On (s)	19	8.8	9	+ 1.8 %
Head On (b)	30	7.2	7	- 2.6

Table 2 **OPEN ROAD BENDS**

Movement	Before	Expected	After	Change
Nighttime	19	13.8	10	- 27.5 %
Daytime	58	39.0	23	- 41.0 %
Rear-end	2	3.1	5	+ 63.3 %
Overtaking	6	5.0	1	- 80.1 %
Lost Control (s)	13	11.6	3	- 32.8 %
Lost Control (b)	44	28.3	2	- 32.8 %
Head On (b)	8	3.5	2	- 42.8 %

Figures 2 and 3 show these in graphical format.

Conclusion

The reduction in crashes at sites where shoulders were improved cannot be attributed to that treatment alone. Shoulder improvement in conjunction with improved delineation is recommended for maximum benefits.

At bends, the addition of chevrons where necessary could also contribute to a reduction in crashes.

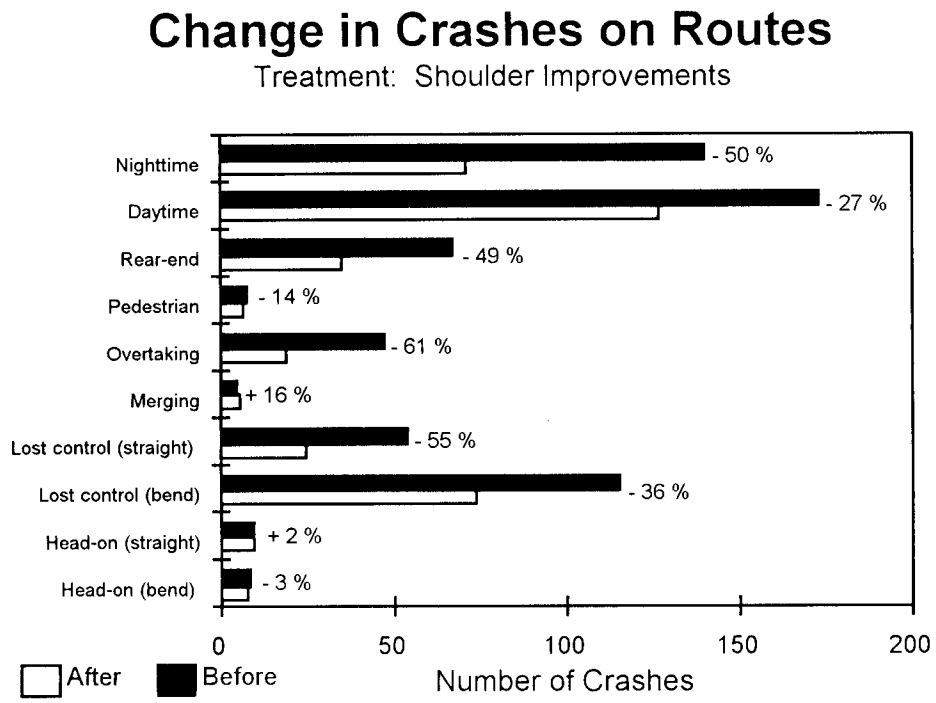


Figure 2: Change in Crashes on Open Road Routes

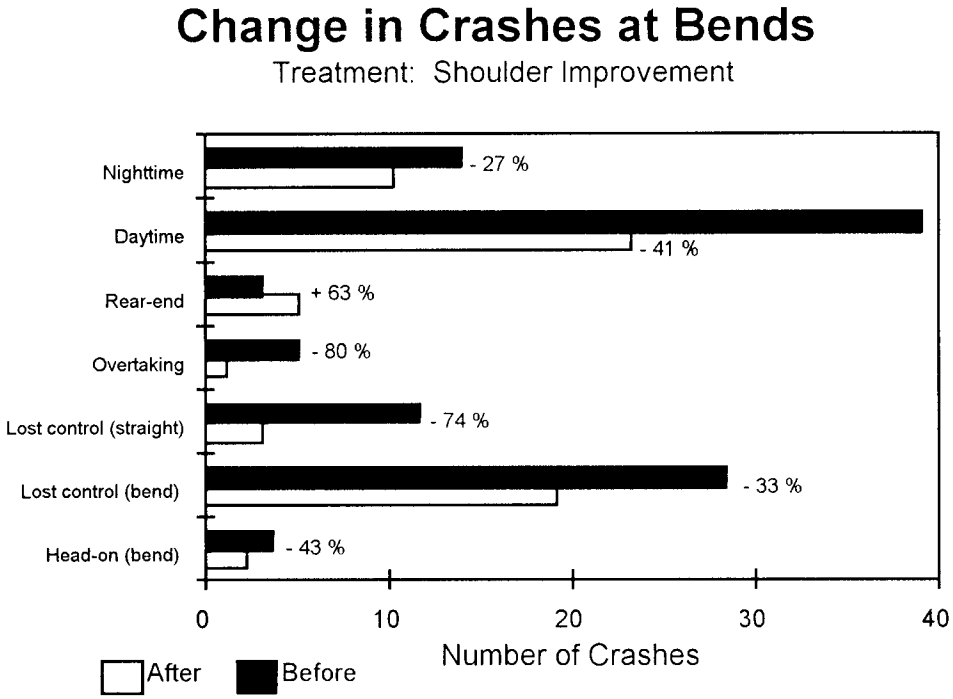


Figure 3: Change in Crashes on Open Road Bends

OBS	IDNO	STUDYNAM	SITENAME	ROADCNTL	SPEED	LALIN	BEFORE	DURING	AFTER	EXPAFTER	BYEARS	DYEARS	AYEARS	SITEREDU
SPEEDS=100														
		STUDYNAM	SITENAME	ROADCNTL	SPEED	LALIN	BEFORE	DURING	AFTER	EXPAFTER	BYEARS	DYEARS	AYEARS	SITEREDU
1	121	SH1 STUDY 2	BAWDEN ROAD SH18	2	100	1	27	135	7	6.538	5	9.332	0.667	7.063
2	3104	SH1 STUDY 25/1	PENCARROW ROAD	2	100	5	6	5	1	4.463	5	4.500	2.500	-77.592
3	4123	SH20 AI STUDY	MASSEY-MCLAUGHLINS (EXCL PUHINUI)	2	100	2	4	15	2	1.353	5	4.416	1.583	47.802
4	4609	SH16 AI STUDY	DON BUCK RD TO BRIGHAM CREEK R	2	100	5	27	18	0	1.008	5	4.833	0.167	-100.000
5	4612	SH16 AI STUDY	TRIGG ROAD TO 1 KM WEST OF MUR	2	100	5	43	25	1	0.847	5	4.916	0.083	18.022
6	4613	SH16 A1 STUDY	WOODHILL FOREST RD TO KIWITAHI	2	100	5	9	4	0	0.355	5	4.833	0.167	-100.000
7	6097	ROTORUA RURAL	SH30	2	100	5	28	6	10	13.607	5	1.667	2.333	-26.511
8	7007	SH22 REGION 3	R2 DRURY INTERCHANGE-GLENBROOK	2	100	5	24	32	3	0.881	5	3.833	0.167	240.478
9	7011	SH22 REGION 3	R6 BUCKLAND RD (STH KITCHENER)	2	100	5	6	1	1	2.046	5	2.500	1.500	-51.136
10	8201	SH25/25A	RS1: SH25 (SH2-WAITAKARURU)	2	100	5	10	.	3	8.087	5	-0.917	3.917	-62.903
11	9602	SH3 RUKUHIA	R2: RUKUHIA STATION RD	2	100	1	12	1	0	1.491	5	1.417	0.583	-100.000
12	40104	SH1 STUDY 1 LEVIN-PORIRUA	KUKU SECTION	2	100	.	19	5	8	28.484	5	4.000	6.000	-71.915
13	40205	SH1 STUDY 8 PICTON-WHARANUI	MOUNT PLEASANT	2	100	5	4	.	1	11.568	5	2.083	7.916	-91.356
14	40301	SH2 STUDY 5 NAPIER-WAIPUKURAU	ELLISON - MEEANEE RP 650/3.60-6.00	2	100	1	16	5	20	32.287	5	1.917	8.082	-38.056
15	40303	SH2 STUDY 5 NAPIER-WAIPUKURAU	TUCKERS CORNER RP 661/2.70	2	100	2	4	1	7	8.321	5	1.667	8.332	-15.880
16	40309	SH2 STUDY 5 NAPIER-WAIPUKURAU	KARAMU BRIDGE RP 661/6.07	2	100	2	4	2	5	7.990	5	2.000	8.000	-37.420
17	40313	SH2 STUDY 5 NAPIER-WAIPUKURAU	KENNELS CORNERS RP 675/6.9-7.3	2	100	1	4	2	5	7.990	5	2.000	8.000	-37.420
18	40318	SH2 STUDY 5 NAPIER-WAIPUKURAU	WAIPUKURAU OBR RP 707/11.3-11.5	2	100	1	1	2	5	1.645	5	3.417	6.583	203.978
19	40411	SH1 STUDY 7 TAIHAPE-BULLS	GREATFORD OVERBRIDGE - WELLING	2	100	.	7	7	17	11.951	5	3.167	6.833	42.245
20	40810	SH2 STUDY 13 OPOTIKI-GISBORNE	FARMERS RD RP 429/10.3-10.6	2	100	5	6	.	1	7.552	5	2.583	6.416	-86.759
21	40928	SH2 STUDY 16 PAHIATUA-U HUTT	TE MARUA	2	100	5	5	1	0	5.860	5	3.000	5.000	-100.000
22	40931	SH2 STUDY 16 PAHIATUA-U HUTT	SOUTH OF TOPAZ ST	2	100	5	5	1	4	6.972	5	2.000	6.000	-42.629
23	41007	SH6 STUDY 15 BLENHEIM-NELSON	SNEIDERS CREEK	2	100	5	4	1	2	7.091	5	2.500	5.500	-71.796
24	41817	SH1/3 STUDY 17 OHAKEA-FOXTON	PNTH - ASHHURST	2	100	5	12	5	12	22.240	5	2.250	5.750	-46.044
25	42404	SH57	POTTS HILL	2	100	5	9	3	4	9.151	5	2.500	4.500	-56.289
2642618		SH3 STUDY 28 INGLEWOOD-BULLS	SANTOFT ROD & WILLIAMSON LINE	2	100	5	6	2	1	6.213	5	2.417	4.583	-83.905
27	43312	RAIT 36 - SH45	NTHERN APPROACH TO OPUNAKE TOWNSHIP	2	100	2	3	.	1	1.459	9	3.250	2.750	-31.465
28	44001	SH1/2 GREATER WGTN	TAWA INTERCHANGE	2	100	3	19	7	9	12.390	5	2.417	2.583	-27.362
29	44101	SH1 STUDY 38 PUKEHOU-PORIRUA	TAYLORS ROAD	2	100	5	9	3	4	4.943	5	1.417	2.583	-17.398
30	44113	SH1 STUDY 38 PUKEHOU-PORIRUA	STEAM INCORPORATED	2	100	5	10	2	4	5.108	5	1.500	2.500	-23.190
31	44115	SH1 STUDY 38 PUKEHOU-PORIRUA	COAST ROAD	2	100	5	40	9	11	17.956	5	1.667	2.333	-38.741
32	44118	SH1 STUDY 38 PUKEHOU-PORIRUA	TAUPO SWAMPS	2	100	1	31	13	11	10.102	5	1.500	2.500	8.890
33	44616	HASTINGS RURAL PT2	PAKOWHAI RD	1	100	5	64	34	34	29.996	5	1.750	2.250	13.348
34	45312	PORIRUA NORTH	ROUTE A GRAYS ROAD	1	100	2	21	14	0	0.758	5	2.833	0.167	-100.000
35	70115	SH1 STUDY 4	CHERTSEY KYLE ROAD/MITCHAM CRE	2	80	.	3	.	0	5.992	5	2.000	8.000	-100.000
36	70204	SH1 STUDY 12	LANDON CREEK	2	80	1	1	.	1	3.178	5	2.250	6.750	-69.496
37	70206	SH1 STUDY 12	ALMA STRAIGHT	2	80	1	6	.	3	9.835	5	2.250	6.750	-69.496
38	70216	SH1 STUDY 12	LEITH SADDLE	2	80	1	8	8	1	4.000	5	6.333	2.667	-76.192
39	70617	SH1 STUDY 18	PIKES POINT	2	100	5	3	1	0	3.359	5	2.167	5.833	-100.000
40	71706	SH6 94 99 STUDY 29	MARAROA BRIDGE	2	100	.	3	1	2	0.881	5	2.500	1.583	127.092
41	72604	QTOWN LAKES SH CLUTHA C.OTAGO	SH8, COAL CREEK - ROXBURGH	2	100	5	6	1	1	2.812	5	1.750	2.250	-64.440
SPEEDS										429.063	209	114.410	162.660	

Widen shoulders - bends

SPEEDS=100

OBS	ID NO	STUDY NAME	SITE NAME	ROAD CNTL	SPED	LAL1	LAL2	BEFOR E	DURIN G	AFTER	EXPAF TER	BYEARS	DYEARS	AYEARS	SITERED U
1	138	SH1 STUDY 2	91 S8: BEND 1KM NTH OF HATFIELDS BR	2	100	5	5	9	.	4	10.1506	5	-0.0833	5.0830	-60.593
2	318	SH1 STUDY 11	TOPUNI BEND	2	100	5	5	4	.	0	1.3048	5	7.1660	1.3333	-100.000
3	5906	FRANKLIN DISTRICT PT2 1992	GLENBROOK RD(WIMER-GLENBROOK)	1	100	5	5	4	.	0	2.3519	5	1.5000	2.5000	-100.000
4	6804	SH30 ROTORUA - WHAKATANE	HELLS GATE	2	100	5	5	1	.	0	0.0648	7	2.5830	0.4166	-100.000
5	40405	SH1 STUDY 7 TAIHAPE-BULLS	MAKOHINE HILL NORTH	2	100	.	.	4	4	4	5.9637	5	4.0830	5.9160	-32.928
6	41111	SH2/3 STUDY 21 WAIPUK-W'VILLE	N OF BUSSTO BR	2	100	5	5	9	4	15	10.0336	5	3.3330	4.6660	49.498
7	41811	SH1/3 STUDY 17 OHAKEA-FOXTON	DEW CNR	2	100	5	5	4	2	1	5.3127	5	2.3330	5.6660	-81.177
8	42512	SH2 STUDY 26 NUHAKA - NAPIER	S OF SH2/5	2	100	5	5	9	5	3	6.0924	5	4.0000	3.0000	-50.758
9	43504	SH5 50 52 STUDY 31	TE HAROTO TO POPPLEWELLS	2	100	5	5	5	3	0	2.6083	5	3.5830	2.4165	-100.000
10	44813	SH1 WAIOURU TO UTIKU	NORTH OF TAOROA JUNCTION	2	100	5	5	3	.	0	1.6636	5	2.4165	2.5830	-100.000
11	45004	SH54 56, 57	SH57 200 M EAST CAMP ROAD	2	100	5	5	3	3	2	0.3855	5	3.4165	0.5833	418.864
12	46411	TARARUA (INCL SH2/SH3)	SH2 300M SOUTH OF HOPELANDS RD	2	100	5	5	3	.	0	1.8908	5	1.0000	3.0000	-100.000
13	70503	SH1 STUDY 20	GLENDORAN	2	100	5	5	3	.	1	1.6505	8	2.4165	4.5830	-39.411
14	70508	SH1 STUDY 20	DOWNS RD	2	100	1	5	5	.	0	2.7010	8	2.5000	4.5000	-100.000
15	72509	WEST COAST STATE HIGHWAY	CLIFF CREEK CUTTING	2	100	5	5	8	1	0	0.7392	7	4.5000	0.5000	-100.000
SPEEDS								73	22	30	52.9132	85	44.7472	46.7467	
								73	22	30	52.9132	85	44.7472	46.7467	