PERFORMANCE OF HIGH SKID RESISTANT SURFACES - CRASH TRENDS

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ABSTRACT

This paper relates to an investigation into the performance of high skid resistant road surfaces with regard to the impact on traffic crash trends.

This study built on previous work which investigated the total numbers of crashes and trends at specific sites. The investigation showed the high skid resistant treatments were effective in reducing the number of crashes, using up to 5 years of 'before' and up to 5 years of data 'after' placement.

The objective of this project was to investigate any trends for the types of crashes for 'before' and 'after' the high skid resistant surface was placed. The project investigated twenty-three high skid resistant treatments within Melbourne and Geelong, Australia.

The investigation found the following trends in crashes:

- An overall reduction in crashes of 39% on the treated areas,
- High friction surface treatments were very effective reducing loss of control crashes on high speed curves with free-flowing traffic,
- High friction surface treatments appear to be more effective when placed on the approach and centre of signalised intersections compared to sites with the treatment on the approach only,
- The sites in the project showed a slight increase to more serious injury crashes, and the high friction surface treatments followed this trend,
- A minority of sites displayed an increase in crashes and a larger increase in severity of injury,
- Although the total number of crashes was reduced, the proportion of different types of crashes remained the same,
- The skid resistant treatments altered the wet/dry road accidents ratio, and reduced the number of wet road crashes.

1. INTRODUCTION

This report details an investigation into trends in the type of crashes and severity of crashes at twenty-three high friction surface treatment sites in Melbourne and Geelong, Australia.

This report follows an investigation (Simpson 2005) into the skid resistance of high friction surface treatments for twenty-nine sites in Melbourne and Geelong, Australia. This report builds on the data and findings of Simpson (2005) and investigates trends in the type of crash, and trends in the severity of crashes, for the treated sites.

All high friction surface treatments investigated for this report consisted of specialised binders and calcined bauxite aggregate. Simpson (2005) found the calcined bauxite treatments provided consistent surface texture and a uniformly high level of skid resistance, and concluded the skid resistance was not affected by the age of treatment for the study period.

Simpson (2005) suggested better selection of sites with regard to crash numbers and types of crash may be the key to maximize the benefits of high friction surface treatments. This paper details the results of an additional investigation into the types of crashes, and trends in severity of crash for the same selection of sites.

2 METHOD

2.1 SELECTION OF SITES

Twenty-three sites from Simpson (2005) were investigated. All of the sites comprised a specialised binder and calcined bauxite aggregate system which provided a high friction surface treatment.

2.2 CRASH DATA

Crash data for the sites was retrieved from VicRoads Road Crash Information System (RCIS) and CrashStats, which contain crash information as provided by the Victorian Police. Crash data was recovered for a five years period prior to the application of high friction surface treatment, and all crashes after the treatment was placed. The crash data was extrapolated to provide pro-rata numbers as for five years, where the treatments had not been placed for a minimum of five years. The resulting data therefore represented the trends from the site, without any weighting from specific sites.

The RCIS and CrashStats data also included information for the type of crash according to VicRoads Definitions for Classifying Accidents (DCA codes), and the severity of any injuries that occurred in the crash, and road condition (wet/dry) at the time of the crashes.

3. RESULTS

3.1 LIST OF SITES

Twenty-three sites were investigated for this report. The list of sites are detailed in Table 3.1.

Table 3.1 List of Sites.

Site Number	Road Name	Intersecting Road	Suburb
1	Barkley Rd	Mitford Rd	St Kilda
2	Bayswater Rd	Canterbury Rd	Bayswater
3	Bourke Rd	Burwood Hwy (Toorak Rd)	Glen Iris
4	Buckley St (Sunshine Rd)	Princes Hwy West overpass	West Footscray
5	Burwood Hwy	Selman and Forest (two intersections)	Ferntree Gully
6	Dora St	Banksia St (Bell/ State Hwy)	Heidelberg
7	Eastern Fwy on-ramp	Hoddle St (Punt Rd)	Collingwood
8	Fitzroy St	Grey St	St Kilda
9	Greensborough Bypass	Metropolitan Ring Rd	Greensborough
10	Kings Way	Queens Pde	Southbank
11	Kings Way	West Gate Fwy onramp	Southbank
12	Lysterfield Rd	Wellington Rd	Rowville
14	Mountain Hwy	High St/ Valentine St	Bayswater
16	Nicholson St	Bell St	Coburg
17	Plenty Rd	Metro Ring Rd overpass	Bundoora
19	Princes Hwy East	Bourke Rd	Caulfield
21	Princes Highway West	North Shore Rd/ The Boulevard	Norlane, Geelong
22	Princes Highway West	Pioneer Rd	Highton, Geelong
23	Princes Highway West	Sparks Rd	Corio, Geelong
24	Princes Highway West	St Georges Rd	Corio, Geelong
26	Punt Rd	Alexandra Ave	South Yarra
27	Smith St	Alexandra Pde	Melbourne
28	Surfcoast Highway	Princes Highway West	Belmont, Geelong

Note the Site numbers are not continuous.

The sites consisted of various types of road environment, which are described in Table 3.2.

Table 3.2 Extent of Site.

Extent of Site	Site Number
Approach to Signalised Intersection	1 2 6 10 12 14 16 17 19 21 22 23 24 26 28
Approach and Centre of Signalised Intersection	3 5 8 27
Curve	4 7 9 11

3.2 CRASH DATA

The VicRoads RCIS and CrashStats were used to provide crash data for 'Before' and 'After' the high friction surface treatments were placed. The data was sourced from RCIS and was drawn from the individual Police Report (formally known as Road Crash Statistics: Victorian Crash Details) for each crash within 100m of the sites.

The Police Reports available through RCIS and CrashStats include information regarding weather conditions, time of crash, vehicle movement types, direction of travel of vehicles, diagram of crash, record of injuries and an assessment of signal operation. The data from the Police Reports was filtered to reveal only those crashes that occurred within the high friction surface area of the site, and therefore crashes that could have been affected by the improved surface. Over 700 crashes were assessed in this manner to reveal the influence of the high friction surface treatment. Details of the filtering are included in Simpson (2005).

Crash data for the five years prior to the date of application of high friction surface treatment was examined for the investigation. However, some sites were 'younger' than 5 years old and therefore five years of data for the crash history after treatment was not available. To compare the sites within the same timeframes, all data for 'After treatment' was increased on a pro-rata basis to estimate the five year period.

Table 3.3 provides a summary of the crashes for the 'Before' and 'After' data. The sites for this report provided 24% reduction of 'Total Crashes' (all crashes at the defined site) after the high friction surface treatment was placed. The data for the 'Treated Areas' (high friction surface treatment) showed a 39% reduction for crashes within the study period, with 17% reduction in the crashes not on the treated area. The data indicates a reduction in the number of crashes on the treated areas greater than the trend of the remainder of the sites, and indicates a benefit from the treatments.

Table 3.3 Summary of Crashes.

Site Data		Crashes Before Treatment		Crashes After Treatment (pro-rata calculation)		Percentage Change		
Site No.	**Road Name**	**Total Crashes**	**Crashes on Treated Area**	**Total Crashes**	**Crashes on Treated Area**	**Change in Total Crashes ***	**Change in Crashes on Treated Area ***	**Change in Crashes Excluding Treated Area***
1	Barkley St	18	2	11	5	-39%	173%	-66%
2	Bayswater Rd	25	5	24	4	-4%	-20%	-0%
3	Bourke Rd	19	13	11	5	-43%	-58%	-9%
4	Buckley St	14	7	4	0	-74%	-100%	-49%
5	Burwood Hwy	26	16	20	5	-19%	-67%	45%
6	Dora St	9	4	16	0	78%	-100%	220%
7	Eastern Fwy	5	5	0	0	-100%	-100%	0%
8	Fitzroy St	46	21	38	17	-17%	-21%	-13%
9	Greensborough Bypass	9	4	15	8	67%	100%	40%
10	Kings Way	34	13	13	4	-63%	-72%	-57%
11	Kings Way	14	7	10	1	-31%	-85%	22%
12	Lysterfield	10	7	6	2	-40%	-71%	33%
14	Mountain Hwy	14	0	7	0	-48%	0%	-48%
16	Nicholson Rd	2	2	12	0	511%	-100%	100%
17	Plenty Rd	44	10	43	3	-3%	-71%	18%
19	Princes Hwy East	21	5	22	8	3%	67%	-17%
21	Princes Hwy West	23	9	17	10	-25%	14%	-51%
22	Princes Hwy West	22	4	3	0	-89%	-100%	-86%
23	Princes Hwy West	19	4	7	2	-64%	-57%	-66%
24	Princes Hwy West	32	11	36	10	13%	-6%	22%
26	Punt Rd	24	8	24	12	1%	44%	-21%
27	Smith St	21	1	20	0	-5%	-100%	0%
28	Surfcoast Hwy	22	2	2	2	-91%	-3%	-100%
	TOTAL	473	160	360	98	**-24% ****	**-39% ****	**-17%****

-% represents a reduction in the number of crashes

+% represents an increase in the number of crashes

* 'Change in Total Crashes' refers to all crashes listed for the site (typically all four approach and departures and centre of intersection)

** The total percentage change were calculated using the total number of crashes for the entire set of sites (Not calculated from the average of the listed percentages for each site).

'Change in Crashes on Treated Area' refers to crashes only on the calcined bauxite part of the site

'Change in Crashes Excluding Treated Area' refers to all crashes listed for the site minus the crashes on the treated area

The data provided three trends for the treated area; increased crashes, no change, and reduced crashes. These trends are evident in the revised data, and were discussed in Simpson (2005). Table 3.4 shows the sites split into the three trends.

Table 3.4 Crash Trends by Site.

Crash Trend	Site Numbers
Increased crashes rate	1 9 19 21 26
No change in crash rate	14 24 28
Decreased crash rate	2 3 4 5 6 7 8 10 11 12 16 17 22 23 27

3.3 SEVERITY DATA

The crash data for the sites was taken from the Police Reports which include a record of the severity of an injured person for each crash. The Police Reports include the following categories for injury: Killed, Serious Injury, (Other) Injury, Not Injured. Where a crash included multiple injuries, the crash was listed for each category of injury.

It should be remembered the Police Reports represent only part of the crash history of the road network – crashes with recorded injuries. VicRoads RCIS and CrashStats do not normally include reports for crashes where no-one is injured, and these property damage only crashes are not represented.

The severity data was calculated to provide pro-rata of five years to ensure the trend of all sites was represented. Table 3.5 shows a summary of the crash severity data for crashes on the treated area of the sites.

Table 3.5 Summary of Crash Severity Data for Treated Area.

Data Before Treatment						Data After Treatment				
Site No.	**Killed**	**Serious**	**Injury**	**Unknown**	**Total**	**Killed**	**Serious**	**Injury**	**Unknown**	**Total**
1	0	0	3	0	3	0	0	5	0	5
2	0	1	5	0	6	0	2	3	0	5
3	0	2	13	0	15	0	2	4	2	7
4	0	2	10	0	12	0	0	0	0	0
5	0	4	19	0	23	0	3	5	0	8
6	0	0	5	0	5	0	0	0	0	0
7	0	1	5	0	6	0	0	0	0	0
8	0	4	20	0	24	0	3	11	3	17
9	0	1	6	0	7	0	2	13	0	15
10	0	3	12	0	15	0	0	7	0	7
11	0	1	7	0	8	0	0	1	0	1
12	0	0	7	0	7	0	1	1	0	2
14	0	0	0	0	0	0	0	0	0	0
16	0	0	2	0	2	0	0	0	0	0
17	0	2	13	0	15	0	0	3	0	3
19	0	0	6	0	6	0	8	3	0	12
21	0	2	10	0	12	0	0	22	2	24
22	0	0	5	0	5	0	0	0	0	0
23	0	0	6	0	6	0	0	3	0	3
24	0	3	19	0	22	0	2	14	0	15
26	0	1	14	0	15	0	5	12	0	16
27	0	1	0	0	1	0	0	0	0	0
28	0	0	0	0	0	0	0	2	0	2
Total	**0**	**28**	**187**	**0**	**215**	**0**	**27**	**110**	**6**	**143**
Total as Percentage	0%	13%	87%	0%	100%	0%	19%	77%	4%	100%

3.4 TYPES OF CRASH

VicRoads uses 'Definitions for Classifying Accidents' (DCA codes) to allow assessment and analysis of various types of crash. The DCA codes range from numbers 100 to 199 and include a single code for a specific type of crash, for example;

DCA110 Cross Traffic

DCA 111 Right Far

DCA 112 Left Far

DCA 170 Off Carriageway to Left

In addition, DCA codes are grouped with the same sort of movement, for example DCA 180 -184 all represent 'Off Path on Curve' crashes as follows;

DCA 180 Off Carriageway Right Bend

DCA 181 Off Right Bend into Object/Parked Vehicle

(with vehicle striking vehicle on left or right)

DCA 182 Off Carriageway Left Bend

DCA 183 Off Right Bend into Object/Parked Vehicle

(with vehicle striking vehicle on left or right)

The DCA codes for the sites were taken from the Police Reports which use the same codes. VicRoads uses approximately 80 DCA codes although not all codes were represented in this study. Table 3.6 provides a summary of the DCA code data.

Table 3.6 DCA Codes for Treated Area.

	Before Treatment *		After Treatment *	
DCA	**No. of Crashes**	**Percentage**	**No. of Crashes**	**Percentage**
100	5	3%		
101			2	2%
102	5	3%	3	3%
110	15	9%	2	2%
111			1	1%
113			2	2%
116			1	1%
120	7	4%		
121	12	8%	17	17%
123	1	1%		
130	62	38%	44	44%
131	15	9%	1	1%
132	4	3%	6	7%
133	1	1%		
134	2	1%		
135	2	1%		
136				
137	2	1%		
140	1	1%		
148	2	1%		
154	1	1%		
163			3	3%
167	1	1%		
170				
171	4	2%	5	5%
173	1	1%	5	5%
174	5	3%	4	4%
181	2	1%	2	2%
183	9	6%	2	2%
184	2	1%		
Uncoded			1	1%
Total **	**161**	**100%**	**99**	**100%**

Some of the uncoded crashes were assigned a DCA code where the Police Report clearly described the type of crash, and it could be matched to the VicRoads DCA.

* The ‘Before’ and ‘After’ data includes a ‘pro-rata’ calculation to ensure the trend of the data was maintained.

**The totals reflect the rounding of the above numbers.

The data showed only minor changes in the percentage of DCA codes between the 'Before' and 'After' crashes. Given the relatively small number of crashes at each site, the DCA code data was aggregated to provide an overall picture of vehicle movement changes for the 'Before' and 'After' period as shown in Table 3.7.

Table 3.7 DCA Group Codes for Treated Area.

DCA	Before Treatment *		After Treatment *		Percentage Change (based on the percentage of Before and After data)	Percentage Change (based on number of crashes)
	No. of Crashes	Percentage	No. of Crashes	Percentage		
100-109	10	6%	5	5%	-1%	-50%
110-119	15	9%	6	6%	-3%	-60%
120-129 (121)	20 (12)	13% (8%)	17 17	17% (17%)	+4% (+9%)	-15% (+42%)
130-139 (130-132)	88 (81)	54% (50%)	51 (51)	52% (52%)	-2% (+2%)	-42% (-37%)
140-149	3	2%	0	0%	-2%	-100%
150-159	1	1%	0	0%	-1%	-100%
160-169	1	1%	3	3%	+2%	+200%
170-179	10	6%	14	14%	+8%	+40%
180-189	13	8%	4	4%	-4%	-69%
Uncoded			1	1%	+1%	+100%
Total **	**161**	**1.00**	**99**	**100%**		

* The 'Before' and 'After' data includes a 'pro-rata' calculation to ensure the trend of the data was maintained.

**The totals reflect the rounding of the above numbers.

3.5 WET/DRY ROAD CONDITION

The Police Reports (and RCIS Summary Sheets) included a record of the condition of the road as either 'wet' or 'dry' at the time of the crash. Table 3.8 shows the summary of the road condition data.

Table 3.8 Ratio of Wet/Dry Crash Data.

	Before Treatment				After Treatment			
	Total Site		Treated Area		Total Site		Treated Area	
Site No.	Wet Crashes	Dry Crashes	Wet Crashes	Dry Crashes	Wet Crashes	Dry Crashes	Wet Crashes	Dry Crashes
1	1	17	0	2	5	5	3	3
2	10	14	4	1	5	15	1	4
3	6	13	5	8	0	11	0	5
4	8	6	7	0	1	3	0	0
5	1	27	1	16	7	13	2	3
6	0	9	0	4	1	15	0	0
7	2	3	2	3	0	0	0	0
8	10	33	7	14	8	28	3	11
9	2	5	1	3	2	13	0	8
10	15	18	6	7	0	13	0	4
11	8	5	5	2	4	5	0	1
12	2	7	2	5	1	5	0	2
14	2	11	0	0	4	4	0	0
16	1	1	1	1	12	0	0	0
17	13	31	4	6	6	34	3	0
19	3	16	2	3	2	17	2	7
21	5	17	2	7	2	14	2	7
22	4	18	3	1	0	3	0	0
23	4	13	1	3	2	5	0	2
24	6	24	4	5	12	21	5	5
26	7	16	2	6	6	17	1	9
27	5	16	1	0	6	14	0	0
28	4	17	0	1	0	0	0	0
TOTAL	**119**	**337**	**60**	**98**	**85**	**254**	**20**	**71**
Percentage	**26%**	**74%**	**38%**	**62%**	**25%**	**75%**	**22%**	**78%**

Ratios calculated using No. wet weather crashes/No. dry weather crashes.

The ‘Before’ data shows 26% of wet weather crashes on the total site, with 38% wet weather crashes on the (proposed) treated area. The data suggests the sites were selected for treatment due to the percentage of wet weather crashes on the proposed treated area.

The ‘After’ data shows 25% of wet weather crashes on the total site, and 22% wet weather crashes on the treated area. The data suggests the treatments have reduced the ratio of wet weather crashes on the treated area.

4. DISCUSSION

Data provided by Simpson (2005) showed all of the high friction surface treatments provided high skid resistance and consistent surface texture. The results showed the visual condition of the sites varied. The results indicated the skid resistance and surface texture were not affected by time for the study period.

4.1 CRASH TRENDS

The crash data shows a crash reduction of 39% for the sites in this project. The results showed three different trends for crashes for 'Before' and 'After' the treatments. The crash trends showed groups of sites with: reduced number of crashes, no change in the number of crashes, and sites with increased numbers of crashes. The three trends were surprising given the high skid resistance achieved at each of the sites. It was assumed that high skid resistance would lead to reduced crashes, but the data showed some sites did not provide the expected crash reductions.

The project did not include a comparison with control sites – untreated sites with the same traffic and crash characteristics to provide a 'do nothing' comparison. The project also did not include investigation of network changes and intersection improvements over the crash search period. This means improvement works or traffic flow changes have not been taken into account, and these works may account for some of the total crash reductions.

It should be noted the crash rates for all of the sites in this project were generally less than 10 crashes (on the treated area) within 5 years. Due to the low crash rate, the site data has been aggregated in an effort to investigate trends.

4.1.1 Type of Site

To investigate a trend for the type of site that will achieve a crash reduction as a result of high friction surface treatment, Table 3.2 Extent of Site and Table 3.4 Crash Trends by Site No. were combined to form Table 4.1.

Table 4.1 Crash Trends by Site.

Crash Trends	**Curves**	**Approach, and centre of signalised intersection**	**Approach to signalised intersection only**
	Site No.	**Site No.**	**Site No.**
Increased crashes rate	9		1 19 21 44
No change in crash rate			14 24 28
Decreased crash rate	4 7 11	3 5 8 27	2 6* 10 12 16 17 22 23 26

Site 6 (Dora St) may be considered both a curved and approach to signalised intersection

Curved Sites
Table 4.1 shows the three of the four curved sites (Site 4, 7 and 11) showed a reduction of crashes. The data for each of the curved sites showed the high friction surface treatment provided a reduction in 'loss of control' crashes.

The curved sites showed a 63% reduction of loss of control crashes. Removing some anomalous crashes from Site 9 (because these crashes did not occur on the curved part of the site) alters the total reduction to 95% for the curved sites. The treatment appears to be extremely effective on curved sites with free-flowing conditions.

Approach and Centre of Intersections
The sites with the treatment on the approach and centre of the signalised intersection (Sites 3, 5, 8 and 27) all displayed reduced crashes after the treatment.

The data for each of these sites indicated the high friction surface treatment provided a reduction for many types of crashes for these sites. The sites showed a 47% reduction of crashes, and all sites showed a reduction. The treatment appears to be effective when placed on the approach and centre of the intersection.

4.2 SEVERITY DATA

The data was investigated to determine if a change in the severity of injury had occurred with the high friction surface treatments. Table 4.2 shows the data for the severity of injury.

Table 4.2 Severity of Injury.

Description	Killed		Serious		Injured		Unknown	
	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage
All of Site								
All Crashes Before Treatment	4	1%	133	21%	501	78%	7	1%
All Crashes After Treatment	0	0%	136	27%	330	66%	31	6%
Comparison		-1%		6%		-12%		5%
Treated Area								
Crashes Before Treatment	0	0%	28	13%	187	87%	0	0%
Crashes After Treatment	0	0%	27	19%	110	77%	6	4%
Comparison		0%		6%		-10%		4%

-% represents a reduction

+% represents an increase

4.2.1 Crashes on Entire Site

Table 4.2 shows a 6% increase in the 'Serious Injury' crashes, and a 12% reduction in the number of 'Injured' crashes. The results must be tempered with the rise of 5% in the 'Unknown' category as this means the severity data was not available. The 5% 'Unknown' may belong in one of the other categories, or may be spread across two or more. Attempting to spread the 'Unknown' numbers into the remaining categories would give a worst case of 11% 'Serious' increase and a reduction of -12% 'Injured', to best case 6% increase in 'Serious' and -7% reduction for 'Injured'. The very low number of 'Killed' crashes through the data has been taken to mean the 'Unknown' should not be spread into this category.

Both the best and worst outcomes of spreading the 'Unknown', and the data in Table 4.2 indicates a shift in the severity of crashes from 'Injured' to 'Serious'. The reason for the shift could not be determined from the data.

4.2.2 Crashes on Treated Area

Table 4.2 shows a 6% increase in the number of 'Serious' crashes, and a -10% decrease in the 'Injury' crashes. Again, the results should be tempered with the rise of 4% in the 'Unknown' category as this means the severity data was not available. Attempting to spread the 'Unknown' numbers into the remaining categories would give a worst case of 11% 'Serious' increase and a reduction of -10% 'Injured', to best case 6% increase in 'Serious' and -14% reduction for 'Injured'. Again, the very low number of 'Killed' crashes through the data has been taken to mean the 'Unknown' should not be spread into this category.

Both the 'All of Site' and the 'Treated Area' data show the apparent trend from 'Injury' to 'Serious' crashes. The data appears to be consistent and may indicate a network change for the sites.

4.2.3 Sites with Increased/Decreased Crash Rates

The severity data was segmented into sites which showed an increase in crashes, and sites which showed a decrease in crashes, to determine if these sets included severity trends.

Sites with Increased Crash Rates
Table 4.3 provides a summary of the data for sites 1, 9, 19, 21 and 26, all of which reported an increased rate of crashes after the high friction surface treatment.

Table 4.3 Severity of Injury.

Description	Killed		Serious		Injured		Unknown		Total Crashes
	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.
All of Site									
All Crashes Before Treatment	1	1%	34	27%	90	70%	3	2%	128
All Crashes After Treatment	0	0%	28	21%	93	69%	14	10%	136
Comparison		**-1%**		**-6%**		**-1%**		**8%**	
Treated Area									
Crashes Before Treatment	0	0%	4	9%	39	91%	0	0%	43
Crashes After Treatment	0	0%	15	21%	56	77%	2	2%	72
Comparison		**0%**		**12%**		**-14%**		**2%**	

The results for the 'All of Site' data indicates a minor change in the crashes, and shows no trend of crash severity with only 6% reduction of the 'Serious' category.

However, the results for the 'Treated Areas' indicate a shift from 'Injury' to 'Serious' crashes, with a 12% increase in 'Serious' injuries even given the number of 'Unknown' crashes. The reason for this shift is unclear, and is strongly influenced by Site 19 (PHE and Bourke Rd) and Site 26 (Punt Rd and Alexandra Ave). These intersections provide high friction surface treatment for the approach of the intersection only, and as such are consistent with the extent of treatment for many of the sites. It should be remembered the number of crashes at all of the above sites was small (<20 crashes in five years).

The results indicate a rise in the number of 'Serious' injuries for sites which showed an increase in crashes after the high friction surface treatments was placed.

Sites with Decreased Crash Rates

The data for the sites which showed a decrease in crash rate (Sites 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 16, 17, 22, 23, 24, 27 and 28) is shown in Table 4.4.

Table 4.4 Severity of Injury.

Description	Killed		Serious		Injured		Unknown		Total
	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	
All of Site									
All Crashes Before Treatment	3	1%	91	19%	371	79%	2	0%	467
All Crashes After Treatment	0	0%	102	32%	206	64%	13	4%	321
Comparison		**-1%**		**12%**		**-15%**		**4%**	
Treated Area									
Crashes Before Treatment	0	0%	23	14%	143	86%	0	0%	166
Crashes After Treatment	0	0%	10	16%	51	78%	4	7%	66
Comparison		**0%**		**2%**		**-8%**		**7%**	

The results indicate a shift from 'Injury' to 'Serious' for the 'All of Site' data. The results for the 'Treated Areas' are more ambiguous as the percentage of 'Unknown' crashes has affected the data, and a trend cannot be demonstrated.

4.3 TYPES OF CRASH

Table 3.6 shows only minor changes for the types of crash using the DCA codes. Although the total number of crashes was reduced, the type of crashes has not changed.

Table 3.7 shows minor changes within the DCA groups (eg. DCA 110 to 119) when considered as percentage of the total number of crashes. The data shows only minor changes in the percentage of DCA groups for the 'Before' and 'After' crashes. It appears the high friction surface treatments have not affected the type of crash.

4.3.1 Crashes Involving Vehicles in the Same Direction

DCA group 130-139 represents crashes with vehicles travelling in the same direction, and DCA codes 130-132 represent the rear-end crashes within this DCA group. Table 3.8 shows the rear-end crashes account for 50% of all crashes in the 'Before' data, and 52% of all crashes in the 'After' data. Although the surface treatments have reduced the number of crashes by 39% on the treated area, the treatments have not reduced the percentage of rear-end crashes within the 'Before' and 'After' data sets.

The data also shows a 42% reduction in DCA group 130 to 139, which was mostly contained within the 37% reduction of DCA 130-132 (rear-end collisions). DCA 130-132

crashes account for about half of the 'Before' and 'After' crashes and the reduction of this group appears to be controlling the overall result.

Table 4.11 shows the Sites and movement in DCA codes 130 to 132 from 81 'Before' crashes to 51 'After' crashes.

The data showed that while the overall number of 'rear-end' crashes has reduced, some of the individual sites showed an increase in this type of movement.

4.4 WET/DRY ROAD CONDITION

Table 3.8 shows an interesting trend in the ratio of wet/dry crashes. The 'Before' data shows the wet crashes on the total site at 46%, with 83% of wet crashes on the (to be) treated area. The 'After' data shows 34% of wet crashes on the total site, and 20% of wet crashes on the treated area. The data suggests the treatments have reduced the ratio of wet crashes, and supports the use of wet weather ratios to select candidate sites.

5. CONCLUSION

This paper details an investigation into the type and severity of crashes at twenty-three high friction surface treatment sites in Melbourne and Geelong, Australia. The data for the sites in this project showed an overall reduction of crashes by 39% over a five year period on the treated areas, and this is considered a significant improvement.

The data also showed high friction treatments did not produce a reduction in crashes at each site – instead the data provided three trends of crashes for the treatment: increase, no change and decrease of crashes.

The investigation indicates high friction surface treatment is very effective in reducing loss of control crashes on curved sites with free flowing conditions, and very effective when placed on the approach and centre of signalised intersections. It appears these types of sites with loss of control crashes can be used to target candidate sites.

The crash severity data showed a minor shift from 'Injury' to 'Serious Injury' for the sites. Five of the twenty-three sites displayed an increase in crash rates after the high friction surface treatment. These sites also displayed an increased severity of crashes, although the reasons for the shift are not clear.

The crash data indicated rear-end crashes made up the bulk of the crashes. The data showed only minor changes in the types of crash for 'Before' and 'After' crashes. The high friction surface treatment does not appear to alter the types of crash, although it has resulted in a significant total reduction of crashes. The data suggests the total number of crashes should be considered as more important than the number of rear-end crashes when selecting candidate sites.

The wet/dry road condition data indicates the high friction surface treatment has significantly reduced the ratio of wet/dry crashes for the treatment area, and supports the use of wet weather ratios to select candidate sites.

6. REFERENCES

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