LAND transport safety AUTHORITY

Install Roundabout / Install Traffic Signals at Urban Intersections

Executive Summary

December 1995

An intersection is defined as a junction of two or more roads. The form of traffic control at the intersection may determine the types of crashes which are to likely occur. For example, crossing and turning movement crashes can be expected simply because of the nature of an intersection. By governing how the crossing and turning movements are performed (ie what traffic controls are present), some control can be exerted on crashes of those types.

This paper is an analysis of the effect of installing a roundabout or installing traffic signals at intersections. The selected sites were all urban intersections (ie. speed limit less than or equal to 70 km/h). The data used for analysis are from the Land Transport Safety Authority Crash Investigation Monitoring System.

There were 42 sites where roundabouts were installed and 14 sites where traffic signals were installed. Comparing the differences in reductions from the two treatments should be done with caution because of the difference in number of sites, and differences in coding practices for crashes at roundabouts vs crashes at other types of intersections.

Certain types of crashes are expected to be reduced by installing roundabouts or traffic signals, especially crossing and turning movement crashes.

Where roundabouts were installed:

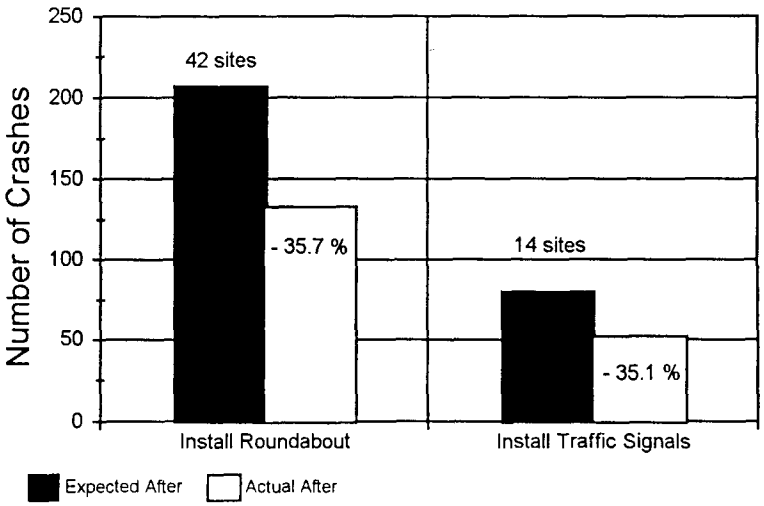
- overall crashes reduced **35.7%**
- crossing movement crashes reduced **30%**
- turning (J-type) crashes reduced **83%**
- turning (L-type) crashes reduced **64%**
- pedestrian crashes reduced **48 %**
- rear-end/obstruction crashes reduced **32%**
- merging crashes *increased* **38 %**
- cycle crashes reduced **29 %**

Where traffic signals were installed:

- overall crashes reduced **35.1%**
- crossing movement crashes reduced **70%**
- turning (J-type) crashes reduced **6%**
- turning (L-type) crashes reduced **37%**
- pedestrian crashes reduced **64 %**
- rear-end/obstruction crashes *increased* **1%**
- cycle crashes reduced **45 %**

At the intersections where roundabouts or traffic signals were installed, there was very little other work implemented, and the major effect on crashes would be expected to be that of installing those works.

Change in Crashes



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 installing a roundabout or installing traffic signals at an urban intersection. Specifically, reductions in crossing, turning, and merging crashes were calculated.

The criteria for selection were:

1. works at intersection fully implemented
2. roundabout installed or traffic signals installed

Urban intersections only were selected for this treatment.

Using the above criteria, there were 42 intersections where roundabouts were installed, and 14 intersections where traffic signals were installed.

Roundabouts were installed:

- at 4 T-intersection sites
- at 5 Y-intersection sites
- at 29 X-intersection sites
- at 1 right angle offset site
- at 2 skewed angle sites
- at 1 multileg site

Controls present prior to installation of the roundabout were:

- No control present at 2 sites
- Stop signs present at 15 sites
- Give way signs present at 25 sites

Traffic signals were installed:

- at 3 T-intersection sites
- at 9 X-intersection sites
- at 1 right angle offset site
- at 1 interchange site

Controls prior to installation of traffic signals were:

- No control present at 1 site
- Stop signs present at 6 sites
- Give way signs present at 7 sites

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:

Expected after
= before crashes x control x $\frac{\text{after years}}{\text{before years}}$
(muliplying by the ratio of after years to before years accounts for the smaller number of after years)

Actual After = after crashes

Change
= - $\frac{\text{(sum Expected after - sum Actual after)}}{\text{sum Expected after}}$ x100

where

Expected after is the expected number of after crashes, assuming the treatment had no effect.

Before ax is the actual number of before crashes.

Control is the factor calculated by crash rate and urban/rural/regional location.

Actual 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 implementation).

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

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 intersections where either roundabouts or traffic signals were installed, an average of 3.7 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 at Treated Sites

There were not may other works implemented at the intersections. The works completed included painting lane markings, etc. These would not be expected to have the major effect on crashes, in comparison to installing roundabouts and traffic signals.

There was an average of 3 other actions implemented at each of the intersections where roundabouts were installed, and an average of 4 other actions implemented at each of the intersections where traffic signals were installed.

The most common other actions implemented at where roundabouts were installed are:

Install Lighting (7 sites)
Install traffic signs (6 sites)
Paint edgeline (5 sites)
Move traffic signs (4 sites)

At intersections where traffic signals were installed, the most common other actions were:

Install traffic signs (6 sites)
Upgrade lighting (3 sites)
Install bulbous kerbs (3 sites)
Install pedestrian refuge (3 sites)

Table 1 summarises the reductions in crashes by treatment and movement type. Note that the design of the intersection changes when a roundabout is installed. Therefore, coding of crashes before installation may be different from crashes after installation ie the entry/exit movements of an intersection are different from the entry/exit movements of a roundabout intersection.

For the sites where traffic signals were installed, the sample shows a smaller number of LB crashes than might be expected, possibly due to the low number of sites. This results in a change in those crashes which is also different to what might be expected. The user should show caution in using these results out of the context in which they were obtained.

	Install ROUNDABOUT (42 sites)				Install TRAFFIC SIGNALS (14 sites)			
	Before	Expected	After	Change	Before	Expected	After	Change
Crossing	157	93.1	65	- 30.1 %	38	26.6	8	- 69.9 %
Lost Control (bend)	22	14.9	15	+ 0.8 %	8	6.3	5	- 21.0 %
Merging	7	5.8	8	+ 38.6 %	1	0.78	1	+ 28.3 %
Pedestrian	35	19.3	10	- 48.1 %	16	5.5	2	- 63.7 %
Rear-end	33	19.2	13	- 32.3 %	13	6.99	7	+ 0.09 %
Turning J	45	29.7	5	- 83.2 %	21	15.0	14	- 6.4 %
Turning L	40	22.1	8	- 63.8 %	15	14.2	9	- 36.6 %
Cycle	45	28.2	20	- 29.0 %	14	9.2	5	- 45.4 %
OVERALL	338	206.8	133	- 35.7 %	117	80.2	52	- 35.1 %

Table 1: Reduction in crashes by Movement Type

Figure 2 illustrates these numbers in graphical format.

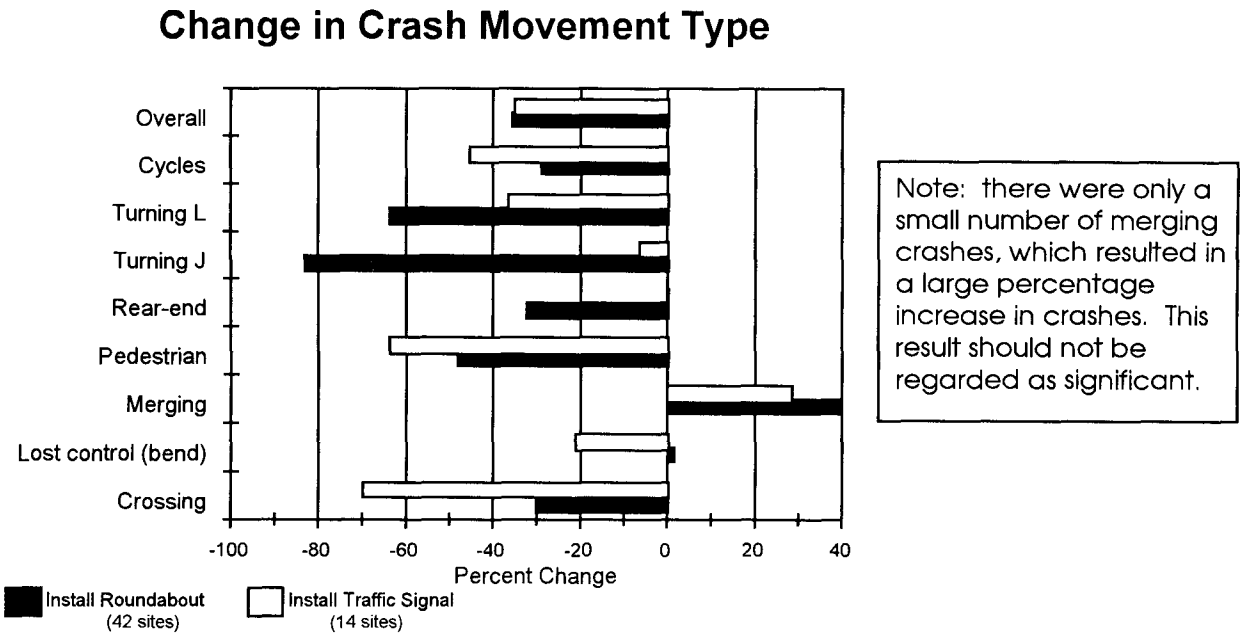


Figure 2: Change in Crashes by Movement Type and Treatment

Table 2 shows crash reduction by lighting condition for installing roundabouts or traffic signals.

	Install ROUNDABOUT				Install TRAFFIC SIGNALS			
	Before	Expected	After	Change	Before	Expected	After	Change
Day	248	154.6	93	- 39.8 %	87	62.6	29	- 53.7 %
Night	91	51.3	47	- 8.5 %	31	17.5	22	+ 25.7 %
Twilight	19	10.7	2	- 81.3 %	5	2.1	2	- 6.1 %

Table 2: Change in crashes by Lighting Condition

Table 3 shows crash reduction by crash severity - fatal, serious, and minor injuries. Note that there was only one expected fatal crash where installing traffic signal occurred, so the 100% reduction should not be treated as significant.

	Install ROUNDABOUT				Install TRAFFIC SIGNALS			
	Before	Expected	After	Change	Before	Expected	After	Change
Fatal	9	6.7	2	- 70.2 %	2	1.0	0	- 100.0 %
Serious	98	60.0	20	- 66.7 %	29	14	18.9	- 25.8 %
Minor	231	140.0	111	- 20.7 %	86	60.3	38	- 37.0 %

Table 3: Change in crashes by Crash Severity

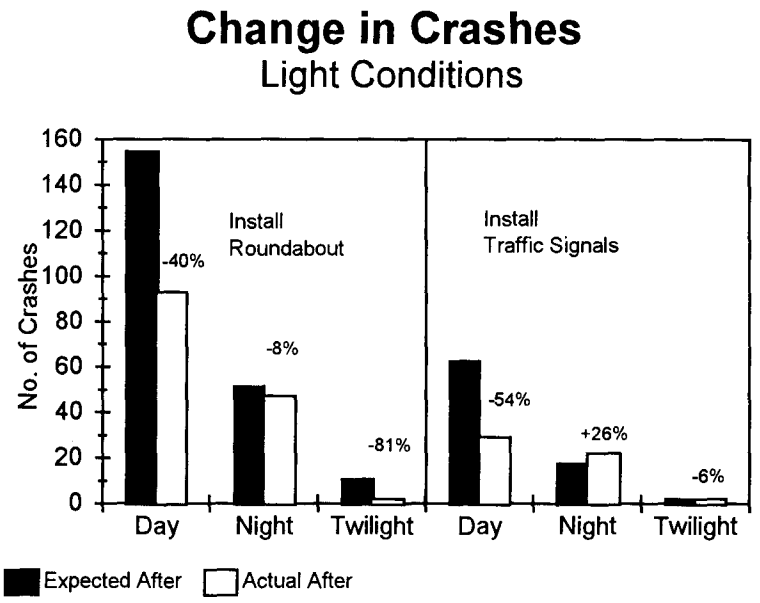


Figure 3: Change in crashes by Lighting Condition

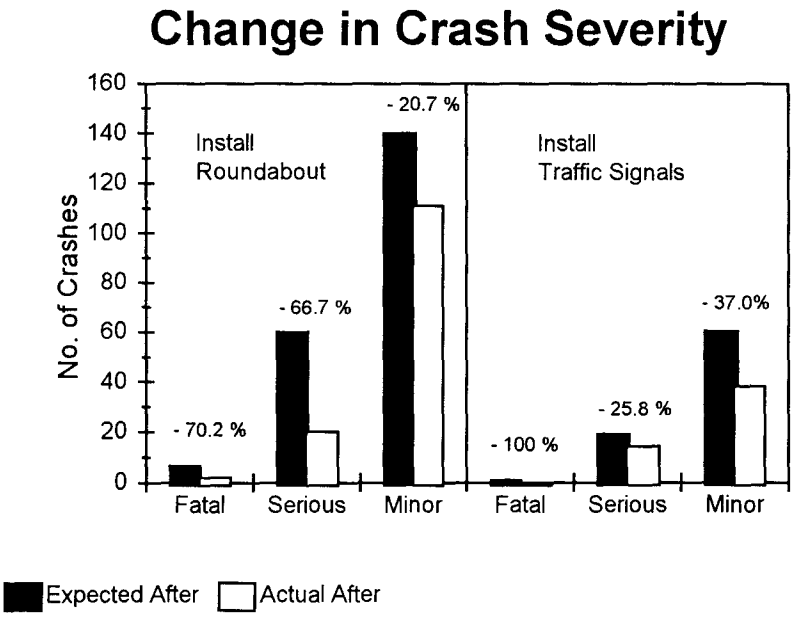


Figure 4: Change in crashes by Crash Severity

APPENDIX A

Treatment: Install Roundabout
CRASH MOVEMENT TYPES

OBS	MVMT	COUNTE	FREQE	COUNTA	FREQA	REDUC
1	Crossing	93.0169	157	65	65	-30.120
2	Head-on (bend)	2.4995	4	1	1	-59.992
3	Head-on (straight)	1.1959	2	1	1	-16.381
4	Lost control (bend)	14.8809	22	15	15	0.800
5	Lost control (straight)	2.9871	3	10	10	234.770
6	Merging	5.7728	7	8	8	38.581
7	Other	0.9284	1	2	2	115.434
8	Overtaking	5.1295	9	4	4	-22.020
9	Pedestrian	19.2827	35	10	10	-48.140
10	Rear-end/Obstruction	19.2061	33	13	13	-32.313
11	Turning J	29.6979	45	5	5	-83.164
12	Turning L	22.0712	40	8	8	-63.754

LIGHTING CRASHES

OBS	LITE	COUNTE	FREQE	COUNTA	FREQA	REDUC
1	Day	154.606	248	93	93	-39.8472
2	Nig	51.345	91	47	47	-8.4629
3	Twi	10.717	19	2	2	-81.3385

CRASH SEVERITY

OBS	AXSEV	COUNTE	FREQE	COUNTA	FREQA	REDUC
1	Fatal	6.720	9	2	2	-70.2369
2	Minor	140.041	231	111	111	-20.7377
3	Serious	59.996	98	20	20	-66.6644

CYCLE CRASHES

OBS	COUNTE	FREQE	COUNTA	FREQA	REDUC
1	28.1608	45	20	20	-28.9794

Treatment: Install Traffic Lights
ACCIDENT MOVEMENT TYPES

OBS	MVMT	COUNTE	FREQE	COUNTA	FREQA	REDUC
1	Crossing	26.5589	38	8	8	-69.878
2	Head-on (bend)	.	.	2	2	.
3	Head-on (straight)	1.3244	2	.	.	.
4	Lost control (bend)	6.3322	8	5	5	-21.038
5	Lost control (straight)	0.3376	1	3	3	788.565
6	Merging	0.7793	1	1	1	28.321
7	Overtaking	5.2295	8	2	2	-61.756
8	Pedestrian	5.5029	16	2	2	-63.655
9	Rear-end/Obstruction	6.9936	13	7	7	0.091
10	Turning J	14.9561	21	14	14	-6.393
11	Turning L	14.1889	15	9	9	-36.570

LIGHTING ACCIDENTS

OBS	LITE	COUNTE	FREQE	COUNTA	FREQA	REDUC
1	Day	62.5753	87	29	29	-53.6559
2	Nig	17.4972	31	22	22	25.7344
3	Twi	2.1309	5	2	2	-6.1416

CRASH SEVERITY

OBS	AXSEV	COUNTE	FREQE	COUNTA	FREQA	REDUC
1	Fatal	1.0291	2	.	.	.
2	Minor	60.2864	86	38	38	-36.9675
3	Serious	18.8622	29	14	14	-25.7775

CYCLE CRASHES