The Safety Effectiveness of the Audio Tactile Profiled Markings Programme

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ABSTRACT

Over the period 2006 to 2012, the New Zealand Transport Agency installed significant lengths of Audio Tactile Profiled (ATP) markings. In general these markings were on higher volume, higher collective risk state highways used for long distance travel, with the primary focus on State Highway 1. Questions have been asked in some quarters regarding the value of this initiative, given the ongoing cost of maintaining these markings, and in particular replacement costs following resurfacing. This paper explores the effectiveness of this ATP strategy in reducing fatal and serious injury crashes. Given the safety benefit achieved there is a clear case for maintaining these installations going forward, and extending the programme further as funding becomes available.

1. INTRODUCTION

Audio Tactile Profiled (ATP) road markings are a type of long life road marking product, typically plastic "lumps" (called blocks or ribs). The ribs, which are usually 7mm in height, 50mm deep and 150mm long, are laid onto the road surface, at 250mm centres. When vehicle tyres run over the ATP, it provides an audible and tactile notification alerting the driver of a possible lane departure. The ATP markings also provide additional delineation, especially in wet and dark driving conditions.

The NZ Transport Agency (NZTA) has been installing ATP markings for many years at high risk rural locations. However, following successful trials in the Waikato/Bay of Plenty, a wider application of ATP markings was specifically funded in mid/late 2008. By the end of 2012, approximately 3,300 linear kilometres of ATP has been installed along 1,300km of the state highway network (approximately 12%), with a mixture of white edgelines and centrelines and yellow centrelines. Marsh (2009) looked at the decision to implement the profiled markings programme and provided an overview of associated background, trialling and research. This paper compliments the Marsh (2009) paper by providing evidence of the crash reductions throughout New Zealand where ATP has been installed to date.

2. BACKGROUND

The New Zealand road safety strategy from the last decade, *Road Safety to 2010* (Ministry of Transport, 2003) included a goal of no more than 300 deaths and 4,500 hospitalisations by 2010. The strategy was developed by the National Road Safety Council (NRSC) which was made up of representatives from Ministry of Transport, Accident Compensation Corporation (ACC), Local Government New Zealand (LGNZ), Police, Transit New Zealand, Transfund New Zealand and the Land Transport Safety Authority. The latter three agencies have since been incorporated into the New Zealand Transport Agency (NZ Transport Agency.

In the year previous to the release of the 2003 strategy there were 404 deaths and 6,670 hospitalisations; the lowest road toll in 40 years. In 2010, the road toll was 375 (Ministry of Transport, 2013): in 2011 it was 284. The rolling road toll actually got down to 300 deaths for the past 12 months in October 2011. This means the 2003 goal of no more than 300 deaths by 2010 was reached only 10 months late.

New Zealand's latest road safety strategy is called *Safer Journeys 2020* (Ministry of Transport, 2010). It does not contain any targets. Instead it has a long-term goal which is set out in its vision "A safe road system increasingly free of death and serious injuries". The strategy is based upon taking the safe system approach; acknowledging that while we cannot prevent crashes from occurring, we can stop many of them resulting in death or serious injury. This approach requires working across four elements of the road system; safe users, safe roads and roadsides, safe vehicles and safe speeds. ATP is used as part of safe roads and roadsides.

The safety performance of ATP markings has been the subject of a number of literature reviews (Mackie & Baas, 2007; KiwiRAP, 2008; Hatfield, Murphy, Soames, Wei Du, 2008; Marsh, 2009), and there is considerable variation surrounding the level of crash reductions claimed. In the case of edge (shoulder) rumble strips, these are reported as reducing run-off-road crashes by 20% to 80%, while centreline rumble strips have been found to reduce head-on and side-swipe crashes of between 21% and 37%. However, many of these findings came from studies in the United States (USA) where a different process is used to form the rumble strips.

KiwiRAP (2008) identified that ATP markings could bring about one of the greatest possible reductions in injury crashes (20% to 45%), while also assisting with the management of driver fatigue and inattention (Edgar, Mackie, Baas, 2009). An evaluation by the Australian Road Research Board (ARRB) of reported crash savings from studies of profile edge lines, noted the selection of a 20% injury crash reduction with a medium confidence level (Australian Road Research Board, 2006). Closer to home Mackie and Baas (2007) investigated the cost effectiveness of treating a larger proportion of New Zealand's roads with ATP edgelines and no overtaking centrelines, using a default crash reduction of 25% as the best estimate from reviewed literature.

Based on the significant safety benefits expected, the NZ Transport Agency developed a business case and a national strategy (Brodie, 2008) to increase the installation of ATP markings on New Zealand state highways from mid 2008. The business case took a conservative approach, assuming an overall injury crash reduction rate of 15%, the resulting BCR was 7.2 based upon installation and regular replacement costs. High risk corridors were targeted first by identifying roads with high incidence of crashes or higher volumes (Brodie, 2008). Treatment lengths were guided to a large extent by identifying the higher collective and personal risk routes outlined in KiwiRAP (2008). It was agreed that continuous installation of ATP markings along significant lengths of highway would be favoured over a series of localised or spot treatments at crash blackspots.

Guidelines for using audio tactile profiled (ATP) roadmarkings (2010) are a document produced by the NZ Transport Agency that includes the key specifications and recommendations for ATP roadmarking use. A 1m wide minimum shoulder width should be provided (ideally 1.5m) and kept clean to ensure effective space for cyclists. Narrower shoulders can be provided to include a continuous treatment, but careful consideration of cyclists must be carried out. The impact of noise must also be carried out where noise disturbance is likely. It is usual to not include ATP roadmarkings within 100m of a residential dwelling.

3. MAINTENANCE ISSUES

One of the greatest risks to the continued rollout of a national ATP marking initiative relates to the ongoing maintenance needs, particularly in a constrained economic environment. There is a need to ensure that relevant information about maintenance issues and the associated costs is readily available to those responsible for removing, maintaining and reinstalling ATP markings. Part of this also involves ensuring that operational managers are well informed of the associated safety benefits. The results of the safety benefits for the national installation of ATP markings included within this paper will be shared with those operational managers/asset managers. Previous research (Mackie & Baas 2007) has demonstrated that the benefits of ATP markings outweigh the cost of installation and maintenance except on very lightly trafficked roads. The business case model assumed the rumble strip replacement cycle averaged four years on busy highways and 10 years on lower volume highways (Mackie & Bass, 2007). Some existing ATP installations have been in place now for over six years and are still very effective.

A new research project has been commissioned by NZTA, entitled "Optimum renewal of audio tactile profiled markings", that will hopefully include greater analysis on the wear and tear of ATP and how to extend the life of it. This is due to be published is 2014.

4. METHODOLOGY FOR CRASH ANALYSIS

In order to provide a suitable period for analysis after the installation of ATP markings, it was decided to only focus on those installations that have been installed for over one year, so that enough crash data is available to analyse. Where ATP markings have been installed on at least 50% of any one route station, then the entire route station has been analysed for injury crashes. Each route station with ATP has been set up in the crash analysis system (CAS) as a "site of special interest". This allows for the site to be monitored; the data extracted from CAS is used to provide a before and after analysis. The CAS database was examined, and all injury crashes from 2003 to December 2012 inclusive were included in the monitoring analysis, so that at least 3 years of crash data was available before installation of ATP. The number of crashes before the installation date has been noted, together with the predicted number of crashes after the installation date of the ATP markings. This is then compared against the actual number of crashes after installation of the ATP to give either an increase or decrease in relation to predicted crash numbers. This is shown in the summary table as a percentage increase or decrease.

5. CRASH ANALYSIS RESULTS

Table 1 below shows the crash analysis results for the whole of the country where ATP is installed on at least half of the route station length.

	No. of crashes before installation of ATP	CAS predicted no. of crashes	Actual no. of crashes	% increase/decrease
Minor Injury Crashes	2,454	1,674	1,338	-20.1%
Serious Injury Crashes	796	559	419	-25.0%
Fatal Crashes	255	215	131	-39.0%
Total Injury Crashes	3,505	2,448	1,888	-22.9%

Table 1: Crash Analysis for all crashes

The results indicate that throughout New Zealand where ATP markings have been installed, an injury crash reduction of about 23% has resulted. At ATP sites, fatal crashes have reduced nationwide by 39% and serious crashes have reduced by 25%. It is noted that the majority of ATP was installed in early 2009, indicating the crash reductions achieved are significant over the past 3 year period. The breakdown of the individual state highways region by region is included in Appendix A.

In order to provide a comparison against the underlying crash trend, those lengths of rural state highways (roads 80 km/h and above) without ATP were analysed for injury crashes. The following graphs illustrate the number of injury crashes per year over the past 5 year period for those sections with and without ATP. This data is also presented in number form per year in Appendix B.

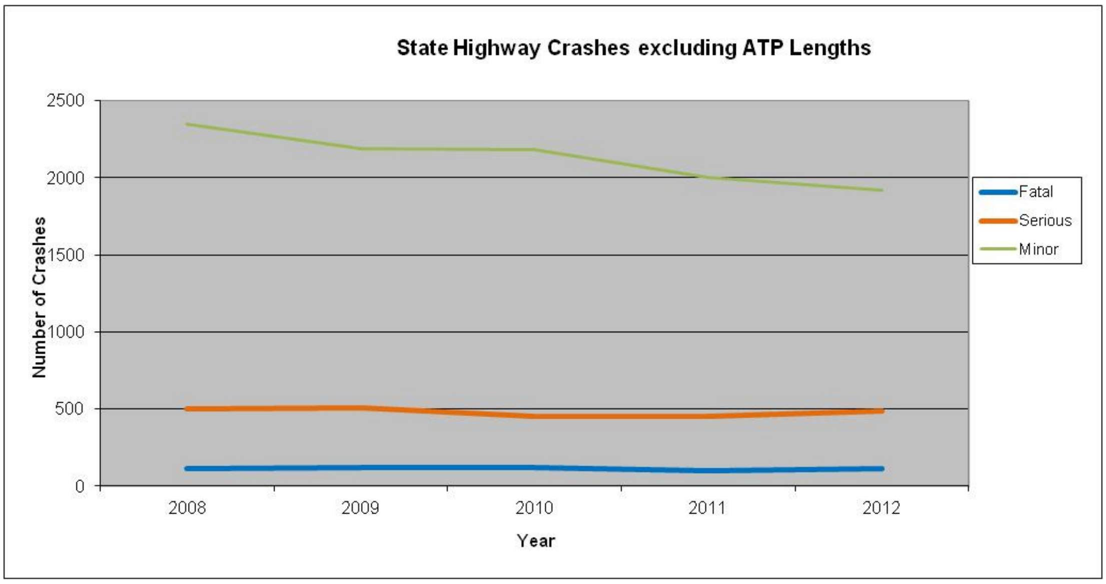

Figure 1: State Highway Crashes excluding ATP Lengths

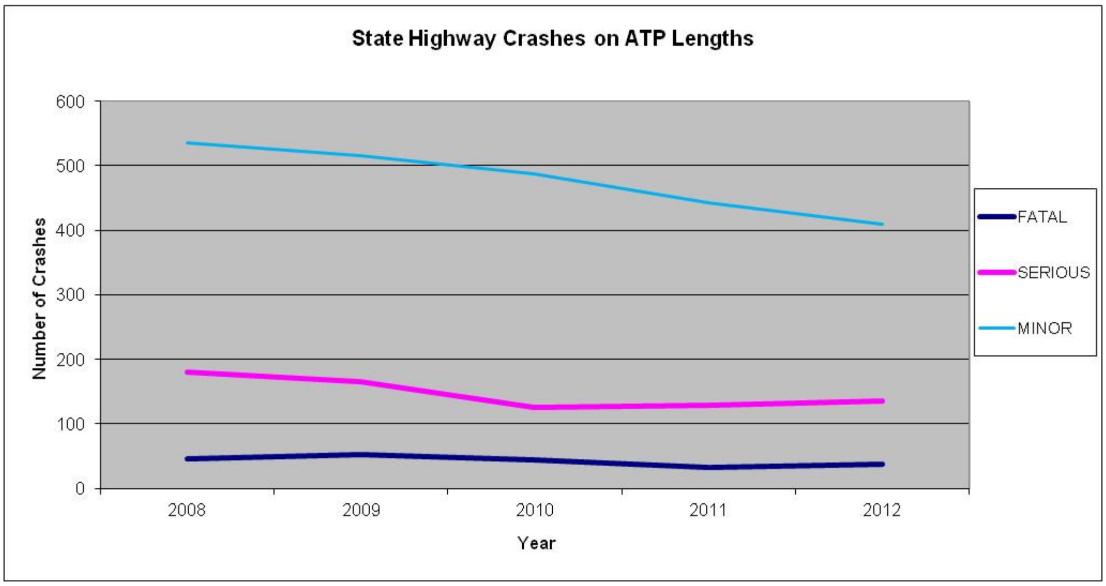

Figure 2: State Highway Crashes on ATP Lengths

As shown in Figure 1 (and in Appendix B), the number of minor crashes has reduced over the five year period on those lengths of state highway without ATP, although the fatal and serious crashes have remained static. While overall injury crashes have reduced by 15% over the period 2008 to 2012, serious and fatal crashes have reduced by only 2.4% and 2.7% respectively in the same period (average of 2.5%). On those lengths of state highway with ATP, the overall injury rate has reduced by nearly 24% between 2008 and 2012, while serious and fatal crashes have reduced by 25% and 17% respectively. It is noted that the crash data collected for 2011 shows that this year had the lowest ever number of recorded road fatalities, 285 for the entire New Zealand roading network. In 2012, this increased to 307 road fatalities. The current New Zealand road fatalities sits at 202, as at 21st October 2013, compared with 234 at the same time in 2012, and 218 at the same time in 2011.

Comparing the results of those state highway lengths with and without ATP (6% reduction of high severity crashes per year with ATP, 0.5% per year without ATP); this indicates the installation of ATP on the state highway is reducing the risk of a fatal/serious crash quite considerably, although ATP is only one method to address high severity run-off road and fatigue type crashes. Additional Police presence and other treatments such as surfacing and widened shoulders have also assisted in reducing the high severity crashes.

6. BENEFITS AND COSTS

In order to assess how effective ATP has been in regard to actual benefits and costs, the crash data was compared for the two periods 2003-2007 and 2008-2012 on those lengths that had ATP installed (majority of ATP laid in 2008 and 2009). The data shows that fatal crashes have reduced by 34%, serious crashes by 24% and minor injury crashes by 12%. The current social cost of crashes (NZTA, 2010) in regard to severity is $3.8M (fatal), $405K (serious) and $24K (minor). Using the simplified procedures for assessing the benefits of general road improvements (SP3 Spreadsheet; NZTA 2010a), the annual cost of injury crashes is estimated to be $400M. Using the above crash savings, the estimated annual injury crash cost savings are $110M. Over the current five year period (2008 to 2012), the total injury crash savings have been $550M on those lengths of state highway with ATP installed. There are 3,300 linear kilometres of ATP installed throughout New Zealand’s state highways. Using a robust average cost of $6.50 per metre installed (has been as low as $5 per metre in Bay of Plenty and Taranaki), the total cost of ATP is estimated to have been $21.5M. Therefore, the benefit cost ratio for the installation of ATP, over the past five years, is around 25.

If it is assumed that ATP is replaced every four years, as per the original business plan, and the current crash reduction continues as planned, then the overall BCR for the 30 year life of the project is calculated to be 17.

7. CONCLUSION

The crash analysis clearly indicates that there is an overall safety benefit for the continued installation of audio tactile profiled markings. This is confirmed by the crash reduction in the five years period 2008 to 2012 compared to the previous five year period. The extent of the installation of ATP has not yet achieved the levels of the business case, which indicated up to 2,000km of state highway should be installed in order to gain a 15% reduction in injury crashes. In keeping with the aims of the Governments Safer Journeys focus on reducing fatal and serious injuries, the installation of ATP markings is having a very positive effect on reducing fatal and serious injury crashes throughout New Zealand and should be continued, especially on those sections of rural state highways with a high collective risk (Kiwirap, 2013) and high volumes. There is evidence to suggest some ATP is not being reinstated after area wide treatments and resealing. Carriageway markings, raised reflective pavement markers and edge marker posts are all replaced after reseals and AWT, some of which do not have as high a safety benefit as ATP. It is therefore recommended ATP should also be re-installed as a natural part of reseals due to the positive safety benefits gained as indicated in this paper. There are other resealing strategies such as resealing between ATP lines or sealing over which can extend the life of the ATP markings and reduce costs, and these are being investigated as part of the new research project.

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APPENDIX A – PERCENTAGE CRASH REDUCTIONS PER STATE HIGHWAY REGION

	ALL INJURY			
	Before Installation	After installation		
SH Region	No. of crashes	Expected crashes	Actual crashes	Change
BoP	360	390.27	354	9.3%
Waikato	1208	696.78	484	30.5%
Otago	396	240.68	173	28.1%
Canterbury	390	239.75	173	27.8%
Manawatu	586	352.9	281	20.4%
Hawkes Bay	51	32.93	19	42.3%
Auckland	514	494.46	404	18.3%
TOTAL NZ	3505	2447.77	1888	22.9%

	FATAL				SERIOUS			
	Before Installation	After installation			Before Installation	After installation		
SH Region	No. of crashes	Expected crashes	Actual crashes	Change	No. of crashes	Expected crashes	Actual crashes	Change
BoP	37	44.94	26	42.1%	94	97.75	92	5.9%
Waikato	97	74.28	39	47.5%	254	156.82	100	36.2%
Otago	16	9.72	7	28.0%	94	57.13	29	49.2%
Canterbury	25	15.19	8	47.3%	103	63.96	43	32.8%
Manawatu	43	25.86	20	22.7%	140	84.27	70	16.9%
Hawkes Bay	3	1.92	1	47.9%	9	6.05	4	33.8%
Auckland	34.00	42.67	30.00	29.7%	102.00	92.99	81.00	12.9%
TOTAL NZ	255	214.6	131	39.0%	796	559.0	419	25.0%

APPENDIX B – PERCENTAGE REDUCTIONS PER YEAR

Crashes on ATP Lengths					
	Fatal	Serious	Minor	Total	% Reduction from 2008
2008	46	180	536	762	
2009	53	165	516	734	4%
2010	44	125	488	657	14%
2011	32	128	443	603	21%
2012	38	135	409	582	24%
Crashes Excluding ATP lengths					
2008	112	501	2350	2963	
2009	119	510	2189	2818	5%
2010	122	455	2184	2761	7%
2011	100	453	2004	2557	14%
2012	109	489	1921	2519	15%

Author Biography

Steve James is a Senior Safety Engineer with the NZ Transport Agency (NZTA), covering the Wellington region. Steve provides advice to customers on all aspects of road safety, including managing the block safety and minor safety works programmes for the region. Steve was a Senior Traffic Engineer at Traffic Design Group, where he undertook transportation impact assessments, crash reduction studies and road safety audits. Previously, he served as a traffic engineer for several companies in the UK.