

The Usability of Audio Tactile Profiled Roadmarkings

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1. Research Background

The objective of this project is to investigate the usability and safety of audio tactile profiled (ATP) road markings by motorists and cyclists and make practical recommendations for their use.

There is increasing evidence for the positive benefits associated with ATP road markings and it is likely that they will be increasingly used on New Zealand roads. In the future it is likely that demands on the transport system will grow and people will want faster, more convenient, safer and cheaper travel. The safety benefits of ATP road markings are starting to be realised and recent research has shown them to be very cost effective (Mackie and Baas 2007). Also, unlike many road safety countermeasures, the safety effects of ATP road markings do not diminish over time through driver habituation. Nevertheless, there may be some instances where the use of ATP road markings may be unsuitable or could be used more effectively, yet there is little objective evidence available to road controlling authorities on which to base their decisions. Currently, planners must subjectively judge whether the use of ATP road markings are suitable for road improvement projects, and how they are to be used, which may lead to their inconsistent use. This project follows three previous TERNZ projects, which have summarised overseas findings and examined ATP road markings in a New Zealand context. The three projects have demonstrated that ATP road markings have positive safety benefits, improved lane keeping and excellent cost effectiveness. However, one of our most recent projects (Mackie and Baas 2007) found that there are a number of practical implications for their use in some situations and that they are often used inconsistently.

Although decisions to use ATP road markings are often made in consideration of factors such as shoulder width, cyclist use and the surrounding environment, there is usually very little objective evidence to support these decisions. Although research is currently underway in the United States to evaluate the operational effects of shoulder and centreline rumble strips for motorists, there appears to be no such research in New Zealand. Also, rumble strips used in the USA are formed as part of the pavement surface, are much wider, and are usually located to the outside of the edge line, and therefore they might perform differently to ATP road markings in New Zealand.

Some New Zealand literature suggests that a continuous separation between cycle spaces and traffic lanes is not appropriate, yet the objective evidence for this is unclear. Furthermore, the entire hazard risk system has not been considered as the risk of accidents associated with cyclists losing control when riding over ATP lines has not been

compared with the benefit that ATP lines may bring by improving the separation between motorists and cyclists, especially where sufficient shoulder or cycle lane width is present.

Current best practice for the use of ATP road markings for motorists is also unclear. In 2001, ATP thermoplastic edge lines were laid on sections of State Highway 1, South of Christchurch and State Highway 8 between Omarama and Twizel.

For the SH 1 project, a minimum shoulder width of 1.5m was required before ATP edge lines were installed, whereas the same type of lines were installed on State Highway 8 where only a 0.75m shoulder exists.

Although MOTSAM states that ATP centre lines should not be used in conjunction with 'no overtaking' lines, there are many examples of their effectiveness (Agent et al. 1996, Charlton 2006). In Victoria, trials are underway to assess the effectiveness of ATP lines on standard single white dashed centerlines (Wooley and McLean 2006).

Anecdotally, drivers of heavy vehicles dislike ATP road markings, yet the substantial treatment of SH 1 in the central North Island with profiled edge and centerlines have caused no complaints to date.

2. Methodology

The project will consist of a number of themes, which will be addressed in three stages:

- 1) A review will be carried out in order to determine current best practice for ATP road markings in New Zealand and overseas.
- 2) A mixture of interview, questionnaires and focus group meetings will be used where existing information is inconsistent or non-existent, or to clarify literature based findings in a New Zealand context.
- 3) Where inconclusive findings still exist, a mixture of second-hand data and preliminary field measures will be used to address the issues within each theme.

For example, developing evidence for the shoulder width required for safe ATP edge line treatments in rural environments, the first step of the research process will be to review the New Zealand and international literature in this area. Secondly, an interview with representatives who have been directly involved in such treatments will be carried out. A structured approach to the surveys and interviews will require respondents to provide evidence (ranging from anecdotal to published research) for their statements. Further evidence for a minimum shoulder width for ATP edge line treatment could then be obtained by examining the crash rate histories of sites where ATP edge lines have been used differently. For example, comparison sites could include State Highway 1 south of Christchurch – where ATP edge lines were only laid with an existing 1.5m shoulder and State Highway 8 in Otago where ATP lines were laid with a 0.75m shoulder.

The relative time spent on the different research stages of each theme will differ, depending on the requirements and the information available for each theme.

Finally, recommendations for using ATP road markings will be made based on the evidence that has been gathered.

The themes for investigation include:

- **Shoulder width requirements for ATP edge lines:** There are differing opinions on, and a lack of systematic evidence for, the recommended shoulder width that should accompany ATP edge lines on rural roads. A current belief is that a minimum of a 1.5m sealed shoulder is required before ATP edge lines should be permitted, so that in the event that the edge line is crossed, the driver has plenty of space to correct their direction of travel without over-steering and crossing the centreline into on-coming traffic. Evidence for this needs to be obtained as the exclusion of ATP edge lines from roads with a shoulder of less than 1.5m would mean the exclusion of a large proportion of New Zealand's rural roads from ATP edge line treatment.
- **Lane width requirements for ATP edge and centre lines:** Although there is a lack of supporting evidence, it is often reported that ATP edge lines would move motorist's position towards the centre line, which may increase the risk of a head-on crash when lane widths are narrow. On the other hand there is evidence that an ATP centre line causes motorists to move away from the centre line. Narrow lanes are often accompanied by narrow sealed shoulders, and so the rationale for treating these roads with ATP edge and centre lines (or not) is complex. The presence of cyclists is a further complication. Clarification is required on the level of ATP edge and centre line treatment that is appropriate for rural roads where ATP treatments are cost effective through sufficient traffic volume, yet the shoulder and lane widths are not of State Highway standards.
- **ATP centre lines (white intermittent, rural):** ATP centre lines (single, white, intermittent) were trialled in Western Victoria by VicRoads in 2005. Currently, only ATP no-overtaking lines are permitted by MOTSAM, and used in New Zealand. Intermittent ATP white centre lines may provide additional safety for motorists who inadvertently cross the centre line due to fatigue. Ceramic raised pavement markers are currently used to separate lanes on motorways. However, it may be that ATP lines give a perceptual message that they shouldn't be crossed, which may not be suitable for intermittent single white centre lines.
- **ATP lines and cyclists:** Some New Zealand literature suggests that a continuous separation between cycle spaces and traffic lanes is not appropriate, yet the objective evidence for this is unclear, which is reflected by Newman (2002), who states that "The use of audible lines is a grey area in relation to cycle safety". ATP lines are currently being used in limited instances in New Zealand (SH 20A), but more so overseas (London) to separate cyclists and motorists. Furthermore, the

entire hazard risk system has not been considered as the risk of accidents associated with cyclists losing control when riding over ATP lines has not been compared with the benefit that ATP lines may bring by improving the separation between motorists and cyclists, especially where sufficient shoulder or cycle lane width is present.

ATP roadmarkings may also present a hazard to motorcyclists in some situations, particularly during cornering at high speed. This risk needs to be studied in more depth before ATP roadmarkings are used more comprehensively around New Zealand roads.

- **Use of ATP lines in residential environments:** It is widely regarded that ATP lines are not suitable for urban use (except on motorways and expressways) as the noise that is generated when a vehicle travels over them can be annoying for residents. In Australia, Department of Transport, Energy and Infrastructure, practice is to avoid installing profiled lines within 500m of a residence (Wooley and McLean 2006). In New Zealand, MOTSAM states that “...care must be exercised when considering the use of profiled line markings in urban situations, eg. urban motorways and rural township bypasses”. Although the focus of this report is on rural non-motorway roads, it is possible that rural residents may be affected by the noise that is created by motorists driving over ATP lines. The extent of this possible annoyance does not appear to have been formally investigated.
- **Public perceptions of ATP treatments in different situations:** Jayne Gale (Principal Advisor Motoring Policy, NZ Automobile Association), has noted that ATP lines often cause complaints from motorists and especially from truck drivers who often drive over them around curves. Any installation of ATP treatments on a large scale should be matched with an education campaign that makes the public aware of the purpose of ATP road marking treatments and their safety benefits. Motorists would also provide a useful source of information and feedback regarding the use of ATP road markings in various situations. For this theme, a gauge of motorists’ perceptions of ATP road markings will be obtained.

For all investigation themes, benefit/cost considerations (based on the tool and findings from our previous study (Mackie and Baas 2007) will contribute to decisions on treatments. The delineation cost management tool allows users to evaluate the benefit/cost ratio of delineation improvements such as ATP edge or centre lines.

The findings of this research will be added to the information that is provided with the delineation cost tool, so that users can make informed decisions regarding their use. Furthermore, the cost tool will be up-dated to incorporate the specific findings of this research. For example, if it were recommended that ATP edge-lines should not be installed within 50m either side of an intersection, then the number of intersections could be added as an input into the cost tool. The length of line that has not been installed before, across, and after the intersection could then be deducted from the overall treatment length.

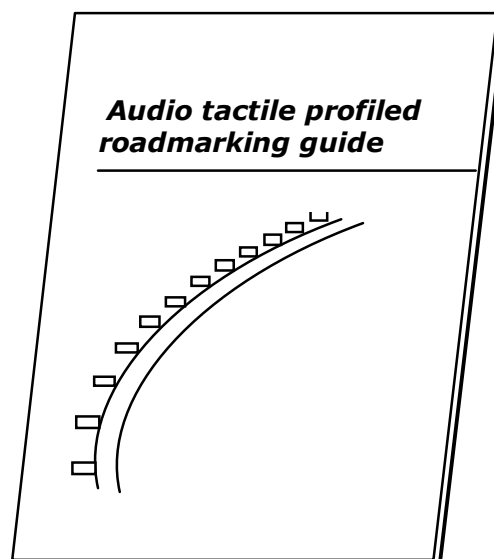
This work will directly complement the Australian Standards Committee survey CH-003-05 on developing a new standard for audio-tactile pavement markings. A survey has been sent to various organisations around Australian and New Zealand, which among other questions, asks them a number of questions pertaining to the appropriateness of using ATP road markings. The questions are:

- How do you decide what product is to be used in which location?
- What factors go towards making the decision?
- How are the levels determined for audio vs tactile, in car or in the surrounding environment?
- Is traffic density and speed taken into account?
- Is the pavement substrate surface taken into account?
- Does vehicle type (eg. Passenger car, heavy vehicle, motor cycle) have any influence on deciding to use or not use these markings?

This work will also complement a recently approved OPUS project titled "Improved effectiveness and innovation for audio tactile profiled road markings" This project aims to ensure that audio tactile profiled (ATP) road markings are established and maintained at dimensions that ensure their maximum effectiveness in terms of their auditory and vibratory response.

3. Practical outputs

The main output of this work will be a guide to the use of ATP roadmarkings. This document will be focussed at those who make decisions about the use of different roadmarking options. It is possible that some of the recommendations are outside the specifications of MOTSAM. In these cases, this will be noted and recommendations to have MOTSAM changed will be carried out in parallel. The guide will focus mainly on the locations of ATP roadmarkings but will also include references to other related work such as the OPUS project mentioned earlier



References

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