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Paper Title:

Transit New Zealand's¹ TNZ M/24 Specification for Audio Tactile Profiled Roadmarkings

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Abstract

Transit New Zealand's *TNZ M/24 Specification for Audio Tactile Profiled Roadmarkings* (or rumble strips) includes a material and a shape approval process. The M/24 approval process was developed in part from research which showed the relationship between the audio (noise) and tactile (vibratory) effect of profiled markings in New Zealand conditions.

The M/24 specification applies only to Audio Tactile Profiled (ATP) roadmarkings where the profile is formed within the roadmarking material itself. The specification excludes ATP roadmarkings formed by techniques such as paint over a textured road surface.

There are already three different designs of ATP roadmarkings approved. The issue and use of the M/24 Specification is expected to lead to better consistency and quality when using ATP markings on the state highway, and improved benefits for the road user and the asset manager.

Introduction

In the *Transit New Zealand Strategic Plan 2004* (Transit New Zealand, 2004), the Transit New Zealand board set a goal of increased use of ATP markings to improve safety performance of the state highway network. This was in recognition of the fact that ATP markings are a cost effective and proven method of reducing run-off-road crashes. International research in support of the effectiveness of ATP markings is summarised in *Review of Lane Delineation* (Bass, 2004).

The *Land Transport Management Act 2003* supports the aim of achieving an integrated, safe, responsive and sustainable land transport system. In support of this, the *Transit New Zealand Strategic Plan 2004* contained several Key Goals and Objectives in support of this. The Key Goals and Objectives relevant to ATP markings were:

¹ Footnote: With the formation of the NZ Transport Agency on 1 August 2008, it is expected that the specification descriptors will be changed in the future, to reflect the new Agency's role in their development.

Key Goal 2: Provide safe state highway corridors for all users and affected communities

Objective 4: Contribute to the Road Safety 2010 Strategy targets in accordance with achieving Transit's State Highway Safety Plan, by additional actions over 2003/04 levels of activity to

a) Reduce potential for vehicle crashes via profiled centrelines and edgelines at 200 km in 2004/05 and 400 km in 2005/06 at an estimated cost of \$4.5M.

As a consequence of this funding, from the 2004/05 year onwards a significant length of ATP markings was applied on the state highway network around New Zealand. Generally these delineation treatments were the initiative of local traffic safety engineers who used the ATP markings as the delineation component of Area Safety Treatments. Trials of ATP markings about this time in the Waikato area of New Zealand were undertaken by Colin Brodie and Alan Burkett of Transit Hamilton (Charlton, 2008). These and many other trials around New Zealand are well documented successes in terms of reduction of run-off-road crashes. By comparison with this crash reduction success, the ATP specification itself was lacking and in need of development.

The initial ATP specification for size, shape and spacing is contained in *Transit's Manual of Traffic Signs and Markings (MOTSAM)* (Transit New Zealand, 2007). However, many of the installations laid around New Zealand from 2004 onwards were not compliant with this format. These proprietary ATP markings were of unique shapes and configurations and were therefore considered trials. In response to the proliferation of trial ATP markings around the country, it became clear it was time to standardise. Standardisation and better specification of ATP markings was anticipated to have several benefits as outlined below.

M/24 Development

A project was started in 2005 to develop a new ATP roadmarking specification. The objective was the development and use of a new specification to achieve several desirable outcomes for Transit and the industry, namely:

- Standardisation of Audio Tactile Profiled Roadmarkings on New Zealand's state highways.
- Potentially reduced contract prices for Transit, as tenders would be competitively bid. (Previously all Audio Tactile Profiled Roadmarkings contracts were effectively "trials" and were not necessarily competitively bid, or constructed to standard shapes or sizes).
- An even playing field for tenderers when bidding for contracts for Audio Tactile Profiled Roadmarkings.
- Improved industry perception of Transit as being fair and transparent in the process of purchasing specialist roadmarking products.

- Ability for the suppliers of Audio Tactile Profiled Roadmarkings to gain recognition, through Transit M/24 approval, for their specialist roadmarking products.
- Assurances of roadmarking life and quality for Transit, as only Transit approved M/24 Audio Tactile Profiled Roadmarkings will be used on the State Highway Network.

The *TNZ M/24 Specification for Audio Tactile Profiled Roadmarkings* (M/24) was issued in July 2006.

Scope of M/24 Specification

The M/24 specification applies only to audio tactile profiled (ATP) roadmarkings. These roadmarkings include rumble strips and are those that provide all three of audio *and* tactile (vibratory) *and* visual information to road users.

M/24 applies only to longitudinal ATP roadmarkings applied alongside the traffic lane. The Specification excludes transverse ATP roadmarkings applied across the traffic lane.

M/24 applies only to ATP roadmarkings where the profile is formed within the roadmarking material itself. The specification excludes ATP roadmarkings formed by techniques such as paint over a textured road surface.

M/24 Approvals

Under M/24 approvals are granted for both the material and the configuration of the ATP Marking. E.g. Approval may be granted for

- The standard ATP marking design identified in *MOTSAM* using a particular material, or,
- A Profile-Design-and-Material combination, trialled using a unique ATP marking shape and a particular material.

Standard ATP Marking Design Material Approval

The specification requires suppliers of material for use as ATP roadmarkings under M/24 to seek Type-approval for the material from Transit New Zealand. Approved materials are then listed in the M/24 Notes. An Applicant seeking approval of a material submits to Transit New Zealand *either* of the following:

- (a) Documented evidence of a history of acceptable in-service use for the material.

The evidence should show that ATP roadmarkings formed from the material have maintained their skid-resistance, audio, tactile, and visual performance for at least 12 months on a particular and stated type of road surface in a high-wear situation.

The evidence shall include test results of the material after at least 12 months service.

or

- (b) Documented evidence of successful trialling of the material.

The evidence should give confidence that ATP roadmarkings formed from the material will maintain their skid-resistance, audio, tactile, and visual performance for at least 12 months on a particular and stated type of road surface in a high-wear situation.

M/24 Approvals are granted for a maximum period of ten years.

Profile-Design-and-Material Combination Approval

A profile-design for ATP roadmarkings, in addition to any identified in *MOTSAM*, may be approved by Transit and listed in the M/24 Notes. An applicant seeking approval of a profile-design must specify the material to be used in combination with that profile-design to form the ATP roadmarking. An applicant seeking approval of a profile-design-and-material combination shall submit to Transit New Zealand *each* of the following:

- (a) A drawing of the profile-design equivalent to that of the profile-design drawing in *MOTSAM* with the dimensional tolerances with which that profile-design would be achieved;

and

- (b) The material to be used in combination with that profile-design to form the ATP roadmarking;

and

- (c) Evidence that the profile-design-and-material combination does not create any adverse effect for road users (including road users such as cyclists and motorcyclists) greater than any adverse effect produced by the profile-design in *MOTSAM* on a particular and stated type of road surface

LTNZ Research Report 273: *Balancing the Needs of Cyclists and Motorists* describes one method by which cyclist stability may be assessed.

and

- (d) Evidence that the profile-design-and-material combination delivers levels of skid-resistance, audio, tactile, and visual effects at least equivalent to those levels produced by the profile-design in *MOTSAM* on a particular and stated type of road surface in a high-wear situation;

The evidence submitted by an Applicant under (d) shall be *either* of the following:

- (e) Documented evidence of a history of acceptable in-service use for the profile-design-and-material combination.

The evidence shall show that ATP roadmarkings formed from the profile-design-and-material had maintained their skid-resistance, audio, tactile, and visual performance for at least 12 months on a particular and stated type of road surface in a high-wear situation with this assessment being by measurement.

or

- (f) Documented evidence of successful trialling of the profile-design-and-material combination.

The evidence shall give confidence that ATP roadmarkings formed from the profile-design-and-material combination will maintain their skid-resistance, audio, tactile, and visual performance for at least 12 months on a particular and stated type of road surface in a high-wear situation.

Evidence shall include observations and measurements from periodic monitoring of the ATP roadmarking during the trial, for example at the time of the trial's initiation, 6 months after initiation, and then 12 months after initiation. The monitoring shall include measurement of skid-resistance, retroreflectivity, forward visibility distance, profile dimensions, and other elements relevant to the performance of ATP roadmarkings and shall include measurements of the audio, tactile, and visual effects produced by the ATP roadmarkings.

An approval granted by Transit New Zealand for a profile-design-and-material combination for use for forming ATP roadmarkings provides for ongoing approval of the profile-design. However, approval for the material of the profile-design-and-material combination only applies for a maximum period of ten years. When the material approval expires, prior to continuing use of that material for forming ATP roadmarkings, another application seeking material approval must be submitted to Transit.

Requirements for Both Standard and Profile-Design-and-Material Approvals

The application for approval of a material or material-and-profile-design combination shall include information on any known or likely incompatibilities with that material or profile-design and any specific requirements for re-marking either likely existing roadmarkings or previous ATP roadmarkings formed from that material or profile-design.

Opus International Consultants' Central Laboratories Report 03-527605: *Guidelines for Performance of New Zealand Markings* identifies suitable methods for measuring audio and tactile effects.

Transit New Zealand may suspend approval for a profile-design or material or profile-design-and-material combination at any time if concerns about performance arise.

Transit New Zealand will allow public disclosure of details of approved profile-designs.

Update to M/24 Approval Methodology

After the first two M/24 Approvals had been processed it became clear that more guidance was needed for applicants.

Firstly, it became clear that a photo of the trial area was required with the application. This is so that the consultant reviewing the application on Transit's behalf could assess if the trial was legitimate and observe any obvious constraints to the trial site. E.g. the trial might be on a particularly low-wear site, such as a wide road where the edgeline would not get much trafficking.

Secondly, it became clear that the applicant needed to contact Transit or their appointed consultant before beginning the trial. This is so the applicant could get advice on the trial set-up to make sure they had the best chance of meeting all the criteria at the end of the trial.

Thirdly, there was the question of how to measure and quantify the audio-tactile response. This process is outlined below.

Update to Test Methodolgy

One thing that needed to be solved quickly when assessing the first two ATP markings for M/24 Approval was how to quantify the audio and tactile response of the ATP markings. It was important to be able to measure the audio and tactile response, and define criteria for a pass and a fail. A research project conducted at the time of the gathering of results for the first two M/24 Approvals gave the answer. As reported in (Dravitzki et al, 2007) there is a direct relationship between audio and tactile properties of the ATP markings measured. Therefore it was decided that for future testing of trials for approval, only one of either audio or tactile response needed to be measured. Audio, using a microphone, is far easier to measure than tactile or vibratory response which requires an accelerometer. Therefore, for future M/24 Approvals, if it can be shown that the ATP marking has adequate audio response, then it may be assumed that the vibratory response is also adequate.

Plant and Equipment

Roadmarking applicators applying paint, long-life or audio tactile profiled markings on the New Zealand state highway network shall comply with the following requirements:

- Paint shall be applied with applications holding a current T/8 Certificate issued in accordance with TNZ T/8 Specification for Roadmarking Paint Applicator Testing.
- Long-life and audio tactile profiled markings shall be applied with applicators holding a current T/12 Certificate issued in accordance with TNZ T/12 Specification for Long-Life Roadmarking Applicator Testing.

The exception is in a performance-based contract where T/8 and T/12 certificates are not required, but a QA and Health & Safety system is required.

M/24 Today

As mentioned in the Abstract, we now have three ATP Profile-Design-and-Material combinations approved for use on New Zealand state highways. The dimensions are listed in M/24 Notes and reproduced in the table below.

ATP Marking Name	Block Height*	Block Width*	Block Depth*	Stripe Width*	Stripe Thickness*	Block Spacing*
GT Industries Thermoplastic Profiled White – New	7 mm	145 mm	50 mm	150 mm	1 mm	500 mm
GT Industries Thermoplastic Profiled White – Worn	4 mm	145 mm	50 mm	150 mm	1 mm	500 mm
Kestrel White Profile	10 mm	135 mm	50 mm	150 mm	1.5 mm	500 mm
Bascoplast Rumble Strips	10 mm	150 mm (also 100, 200 and 300 mm available)	55 mm	None	None	250 mm (or as specified)

* See note below for tolerances

The above dimensions are subject to the M/24 Requirements of:

Blocks:

- A block height target of 9 mm with a maximum ATP roadmarking height of 11 mm and a minimum ATP roadmarking height of 7 mm
- a block width not more than + 30 % and not less than – 20 % of the block width as per the approved profile-design, with a maximum ATP roadmarking width not more + 10 % and not less than - 5 % of the ATP roadmarking width specified
- a block length not more than + 30 % and not less than – 20 % of the block length as per the approved profile-design; and

Spacing (Pitch)

- a block pitch not more than + 5 % and not less than - 5 % of the pitch as per the approved profile-design.

Stripes:

- A maximum stripe height or thickness of 2.5 mm
- A stripe width not more than + 10 % and not less than - 5 % of the stripe width as per the approved profile-design, with a maximum ATP roadmarking width not more than + 10 % and not less than - 5 % of the ATP roadmarking

width specified.

Transit is currently developing the way in which these Type approvals are specified, and this approval may be re-issued in future to match the new format.

It may be confusing to see that approval for GT Industries mentions two different shapes. This is to indicate the intervention level, where the aged ATP marking has lost height and is still effective, but is about to fall to the level at which it is ineffective. It is unclear if this “worn” height intervention level would be the same for all configurations of ATP markings, but the results of research referenced below will give us this information in the near future.

Other configurations of ATP Markings

Early trials of ATP markings in New Zealand sometimes used a configuration where the ribs were placed in the shoulder, separate from the flat white edgeline. This configuration was used where there was a narrow (e.g. 3.2 m) lane width. The Traffic Design Manager at Transit National office only approved Traffic Control Devices (TCD) trials where the standard 3.5 m lane width was achieved. Where there was an existing 3.2 m lane width, the ribs were placed outside of the edgeline, in the shoulder, in order to present an effective 3.5 m lane width between ATP centrelines and ATP edgelines.

After trials, it was decided that if this ribs-beside-edgeline configuration is used, the ribs must touch the flat edgeline, so that the driver’s eye sees just a wide white line disappearing off into the distance (allowing for the effects of foreshortening of the ATP markings). Some early trials had the ribs physically separate from the edgeline, so the driver’s eye would just see two white edgelines beside each other, which is not a standard roadmarking configuration. The new issue of MOTSAM allows for the ribs-beside-edgeline configuration, provided the ribs touch the flat edgeline.

Standard High Performance Roadmarking In Combination With “Lumps Only” Profiled Markings

Where Transit’s Traffic and Safety Manager has given permission, a system of standard high performance road marking edge line in combination with “lumps only” profiled markings on the shoulder may be used. It is desirable that no gap should be visible between the profile and the line, and that the maximum overlap between the profile and the line not exceed 15 mm or 10% of the profile width.

Alternatively, with permission, a “lumps only” design with no solid line could be used.

On chip sealed surfaces the height of the stand alone audio tactile profile may be raised from 9 to 11 mm.

Compatibility

Tenderers are required to provide information in their tenders confirming which road marking products their marking materials are compatible with (for use in the case of a remark over existing road marking). Tenderers shall note any special preparation that

may be required of existing markings prior to remarking with the high performance road marking system proposed.

Asset Management of ATP Markings

Some of the key issues for management of these markings are:

- It is better for Transit and the industry if less ATP marking trials are undertaken. Standardisation is preferred, for the reasons outlined at the beginning of this paper. Only M/24 approved ATP markings should be used on the New Zealand state highway network.
- Clients and consultants in New Zealand are encouraged not to exclude one or the other of the available technologies without good reason. To achieve this:
 - The material should not be specified in contracts
 - Rather the contract documents should express to the contractors what outcome is desired, and therefore
 - All available technologies should have the ability to tender for high performance contracts
- Some believe that certain ATP markings may be installed more quickly after a reseal than others, but this is not the case. In fact, it is recommended not to apply long life products immediately after a reseal. Confidence is needed in the surfacing's integrity, which may take up to 3 months after a reseal.
- Whole of life costs: The Asset Engineer needs to include the costs of removal e.g. prior to remarking and resealing, in their cost analysis before installing ATP markings. The fact is, Transit could put a lot more ATP markings on their network (from a safety perspective), but it would be hard to justify the costs involved in maintaining these markings when the maintenance budget is already stretched.

M/24 in the Future

Research work is continuing into understanding the optimum shape and spacing of ATP markings to give maximum audio and tactile response. Also being investigated is the quantification of the deterioration of the ATP marking shape, and at what point it becomes ineffective and needs to be refreshed.

The results of ongoing work in this area by researchers at Opus Central Laboratories is presented in *Audio Tactile Profiled Roadmarkings: The Relationships of the Dimensions of the Marking to Noise and Vibration Generated* (Dravitzki et al, 2008), being presented by Tim Divett of Opus Central Laboratories at this conference.

Once the results of this latest round of research are accepted by the industry, M/24 will be reviewed. It should become clear for clients, contractors and suppliers what shapes are best for longevity, and hence value for money and good asset management. Once M/24 is updated, it is hoped that the whole industry can move towards these better value-for-money products in a co-operative manner.

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Author Biography

Joanna Towler holds the position of Roading Engineer at Transit New Zealand National Office in Wellington, in the Engineering Policy Section. Joanna is responsible for specifications relating to road surfacings and delineation for New Zealand state highways and has been involved in a wide variety of projects, ranging from performance based chipseal specifications, to skid resistance, to road markings.

Joanna has also had local authority experience, working at Wellington City Council prior to joining Transit New Zealand.

Joanna holds the degree of Bachelor of Environmental Engineering and has a Masters of Pavement Technology.