Skid Resistance Management On The Auckland State Highway Network.

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ABSTRACT

The paper sets out two practices in achieving appropriate skid resistance levels on the Auckland State Highway network. These practices involve the use of an unusual sandstone as a surfacing aggregate, an adaptation of PSV calculation based on field skid resistance measurement and the learnings from the associated monitoring of micro texture.

1. INTRODUCTION

The Auckland State Highway Network, which includes motorway as well as high capacity roads over near mountainous terrain, has a variety of conditions where surface friction demand is more intense than experienced nationally. Examples of these locations are sections of motorway with up to 200,000 vehicles per day, a two lane rural road with 13,000 vehicles per day, on low radius steeply inclined alignment.

The introduction of the Transit New Zealand Specification For Skid Resistance Investigation and Treatment Selection, (referred to as T/10; see Transit New Zealand's web site www.transit.govt.nz) in 1997 altered the selection of thin asphaltic surfacing (TAS) aggregate. Historically TAS aggregate was produced from local basaltic sources. However the region had in 1997 a number of known wet weather accident-prone locations and the polishing of the basaltic aggregate contributed the localised accident rate.

The first significant shift in practice came with the concept that an aggregate from a source called Moutohora had an unusual characteristic, in that instead of polishing it slowly abrades, thus exposing continual microtexture. So in 1997 the first of a number of sites were successfully resurfaced with this aggregate.

The second shift in practice, was the identification that the site categories in the T/10 specification, from which surfacing aggregate PSVs was derived, not always produced the correct answer for some sites and lead to premature polishing. This forced the practice of PSV back calculation.

Both these practices are now described in more detailed utilising monitoring of Sideways-force Coefficient Routine Investigation Machine (SCRIM) data.

2. MOUTOHORA AGGREGATE

The Moutohora Quarry, works an uplifted greywacke basement rock of the Waioeka Terrane and is described as hard fossiliferous sandstone, conglomerate, breccia with some mudstone, which is compounded by degrees of weathering . (ref G Fisher Nov 2003 Preliminary Resource Geology, Moutohora Quarry)

Refer to Appendix 1 Map of the North Island showing the quarry location

The aggregate has crushing strengths of over the required 230kN. However the aggregate is still over 80% greywacke, with an uncharacteristic large mineral size. This mineralogy allows the aggregate to fret under tyre wear and is evidenced in the release of small particles from the aggregate, which are in the order of 75μm to 1 mm. It is thought that this provides a constant exposure of fresh microtexture and has a Polished Stone Value (PSV) of 65.

Initial trials of this aggregate in high stress areas as a grade three sealing chip were unsuccessful, as the aggregate sheared leaving part of the stone behind in the sealing binder. However it has performed well in an asphalt matrix.

Appendix 2A shows the location of two of the sites where this aggregate has been successfully utilised on the Auckland Motorway. This section of SH 1 has a daily traffic volume 130,000 with curve radii as low as 250m. The Moutohora aggregate was utilised in an Open Graded Porous Asphalt (OGPA) , which was not polymer modified, and lasted seven years. In comparison, the former basaltic aggregate polished in three years. The replacement of this OGPA was primarily due to unravelling, so has recently been replaced with Moutohora polymer modified OGPA.

Appendix 2c show the dramatic reduction in wet road crashes.

3. HSOGPA WITH MOUTOHORA AGGREGATE

The use of Stone Mastic Asphalt (SMA) has been a recent practice. However the desire to have good macro texture lead to the development of high strength OGPA, which essentially had a greater binder film, with a resultant reduction in porosity. This surfacing mix was trailed in three extreme situations, two of which are shown in Appendices 3a and 3b. Both sites have curve radii of 60 to 70 metres and are on grades of approximately 10%, The Waiwera site has shown only slight reduction in micro texture as opposed to the Schedyws site, which had a dramatic micro texture deterioration and was resurfaced.

4. SMA WITH MOUTOHORA AGGREGATE

The strength of SMA comes from stone on stone contact, so the use of this aggregate, which frets, could be considered as a dichotomy. However given the experience of the Auckland Harbour Bridge approaches and the resultant confidence, this has been trialled recently as an SMA. Some wheel track flushing has occurred and remedied by captive water blasting. Initial whole of life analysis indicates that retexturising on a two yearly basis is economic. Also with exposed aggregate micro texture should be maintained by the fretting of the aggregate surface.

5. MONITORING

Having made some assumptions that the Moutohora aggregate would perform, it was appropriate to monitor its performance, thus tracking of both micro and macro texture over time has been carried out. From this the following was observed

With the HSOGPA Sites (Waiwera and Schedeyws) the two sites have similar speed environments and the same traffic loading. However the Schedyws site, which was a year older, did polish unexpectedly. The reason for this is subject to speculation and could be due to production problems or some vagary of traffic behaviour. What it does emphasis is that for any given accident blackspots that microtexture should continually be monitored enabling deterioration to be detected and timely intervention carried out.

As explanation to the micro texture graph, the average of the MSSC or ESC is shown with the 95 percentile above and below the average. The plotting of this average gives an indication as to when the deterioration trend line will cross the required Treatment Level (i.e. the level which some form of treatment is required), thus the intervention date predicted in advance. See appendix 4

6. DETERMINING PSV

While the practice of utilizing the Moutohora aggregate has proved successful, the 460km lead distance and the associated transportation cost, has ensured that the use of closer aggregate sources has also been considered. Initially PSV values were determined from the following formula contained in the T/10 specification.

PSV = 100*SR + 0.00663*CVD + 2.6

Where

PSV = Polished Stone Value
SR = Investigatory Level for the site
CVD = Flow of heavy commercial vehicles per lane per day, at the end of the expected surfacing life.

However after having used the formulae up to the year 2001, it was found to under value the PSV in some locations. An example of this was a ramp with a radius of 400m, with a daily traffic volume of 21,000, moderate HCV load, with a basaltic OGPA PSV of about 53. This failed after four years. There was no apparent cause for this site to develop a sudden increase in accident rate. This prompted the method of back calculating PSV , which can be done by substituting the actual measured friction on road surface for the SR. This gives the actual PSV as the aggregate behaved on site. The difference is then added to the T/10 derived value.
(See worked example appended)

7. CONCLUSION

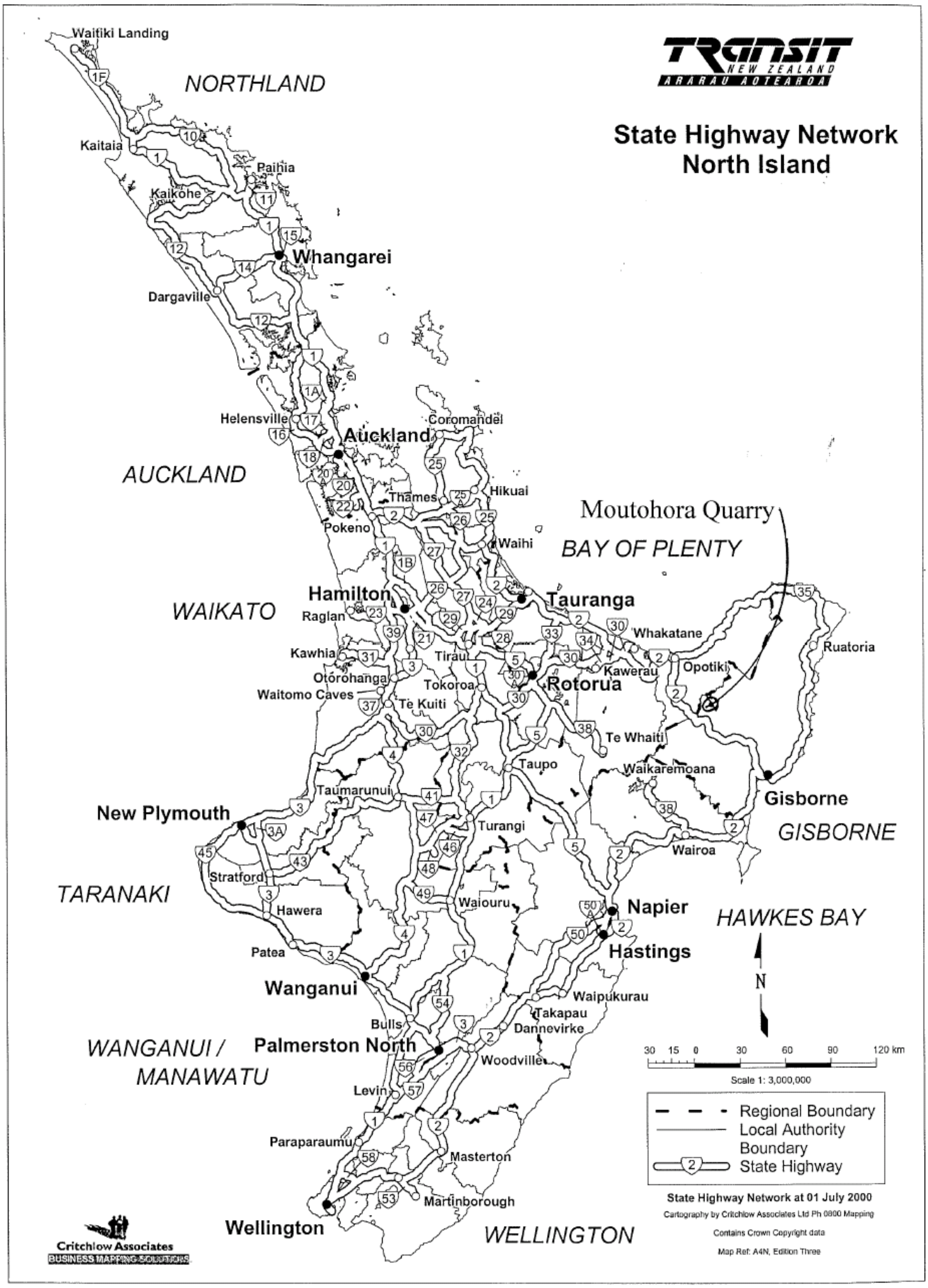
With in three years of the introduction of the T/10 specification in 1997, the Auckland motorway Police and then followed by Transit's own more extensive study, determined that an accident reduction, in the order of 30%, had been achieved.

Locally in Auckland the practice of utilising Moutohora aggregate and PSV back analysis have been the two most important practices in achieving this.

PostScript

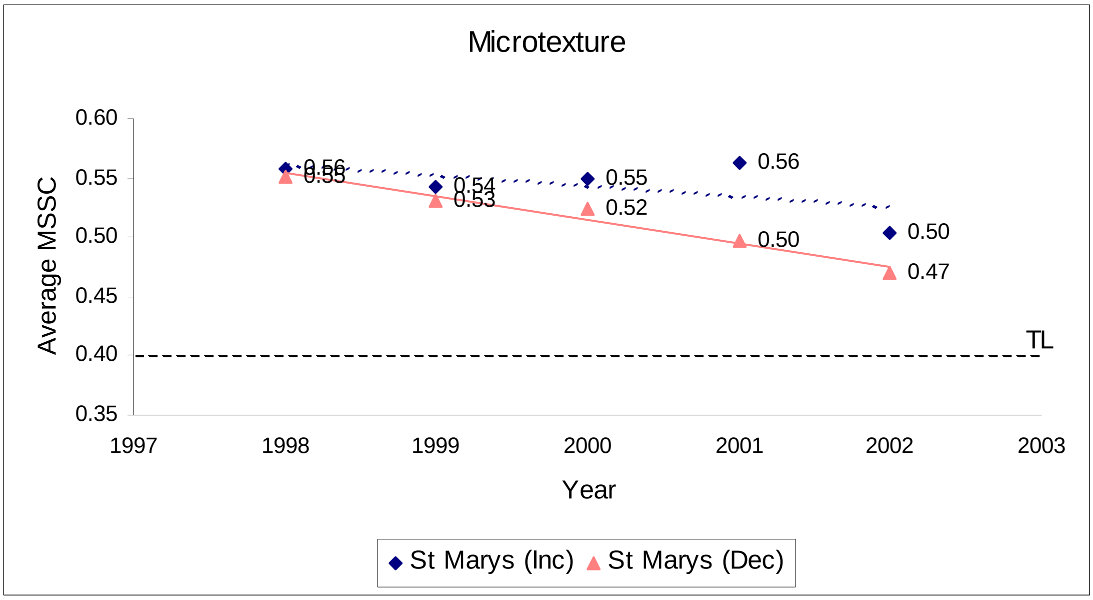
By understanding and management of microtexture we lessen the chance of our road users sliding into an unfortunate future.

Appendices

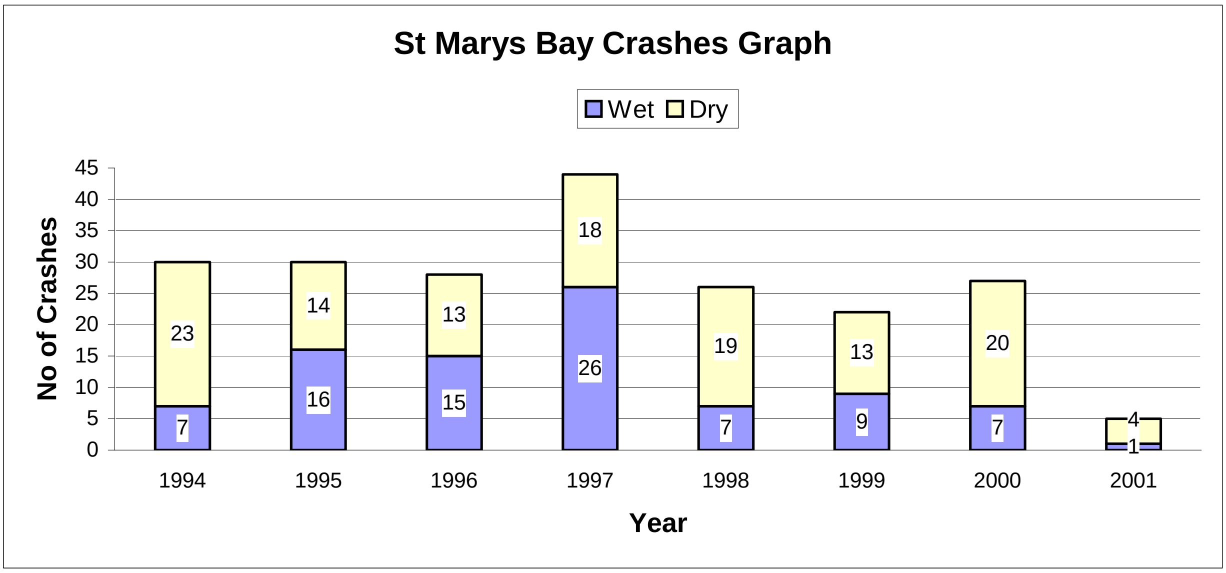


Appendix 1 Map of the North Island of New Zealand

Appendix 2a Approaches to Auckland Harbour Bridge



Appendix 2b Microtexture Plot Auckland Harbour Bridge

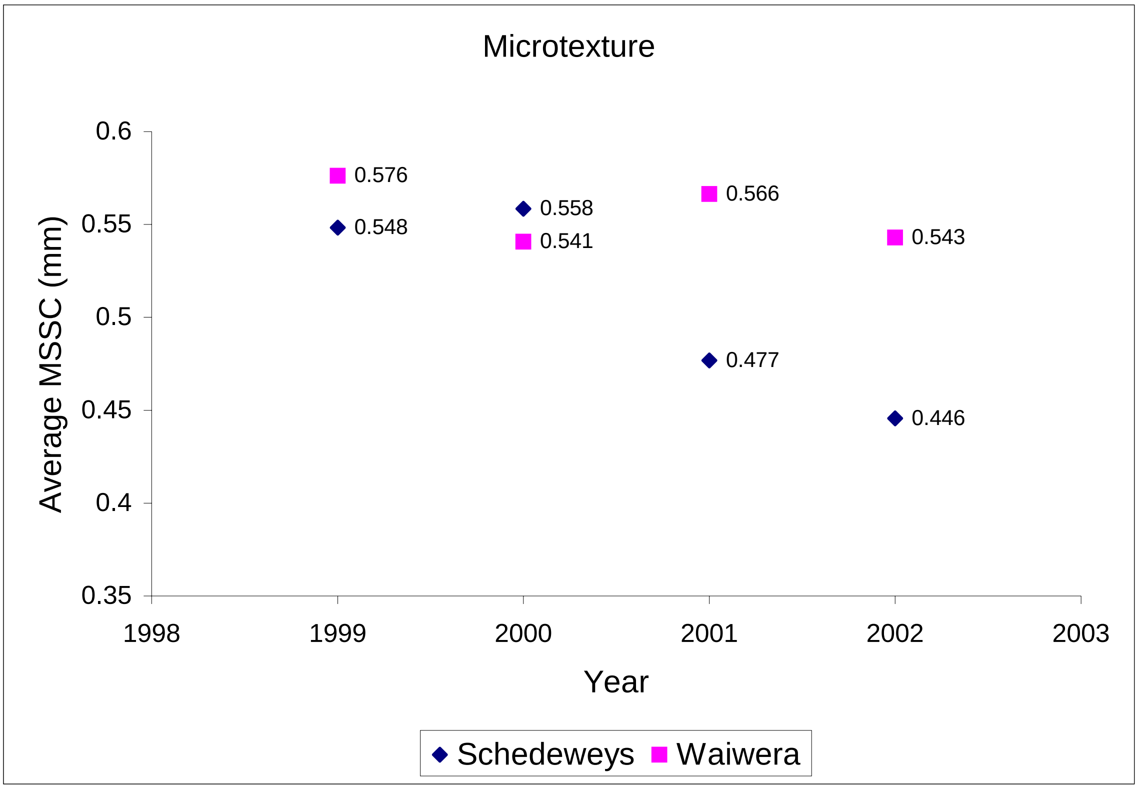


Appendix 2c Auckand Harbour Bridge Wet Road Crash Plot

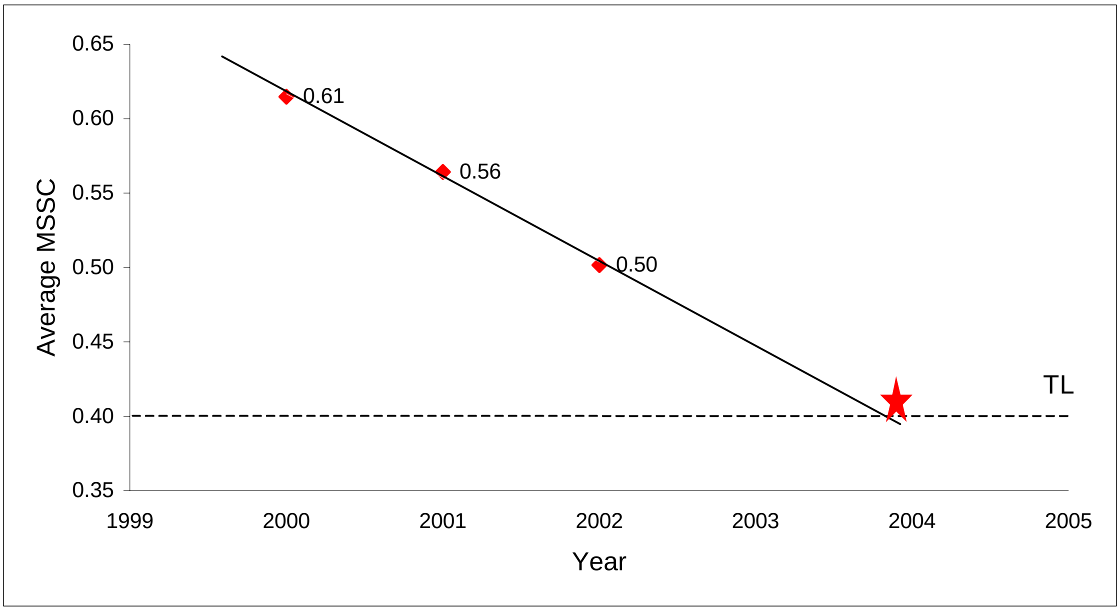
NB Significant reduction in wet road accidents after PSV 65 Motuohora aggregate OGPA, laid in 1997

Appendix 3a Waiwera Hill

Appendix 3b Schedewys Hill



Appendix 3c Waiwera and Schedewys Microtexture Plot



Appendix 4 Microtexture Deterioration Plot

PSV Back Calculation

PSV = 100*SR + CV* Factor + Stress Factor (from T/10)

Where:

SR is the investigatory level friction value from T/10 (or site measured)
CV = 200 Heavy Commercial Vehicles per lane per day (at the end of the surfacing life)
PSV from site testing = 50
50 = 100*0.46 + 200*0.00663 +2.6 (0.46 being the lowest SR as measured on site)
PSV calculated from the T/10 site category 2 = 54
54 = 100*0.5 + 200*0.00663 +2.6
Stress Factor is 2.6 + (54- 50) = 6.6

Therefore

Minimum PSV = 100*0.50 + 200*0.00663 +6.6 = 58