SCRIM; A PROJECT TOOL !

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Abstract :

Can the Sideways force Coefficient Resistance Investigation Machine (SCRIM) output data be utilises as a project tool?

The annual SCRIM exception report for the New Zealand State Highways indicates at a network level that specific lengths of road may have a loss of microtexture and macrotexture and thus need further investigation leading to remedial works. The Auckland region has traffic volumes of up to 200,000 vpd, as well as some topographically constrained alignments, exposes surfacing aggregate to the highest wheel tractive forces nationally. Monitoring of average Equilibrium SCRIM Coefficient results over treatment lengths of lengths 500m to 2 Km has produced credible trend information, which has lead to sustainable accident reduction.

The paper will describe how this approach has lead to timely intervention, a process of back calculation to better determine the PSV formula environmental factor and confidence with specific aggregate micro texture performance.

References :

Transit New Zealand's T/10 Specification for Skid Resistance Investigation and Treatment Selection.

"Skid Resistance Management on the Auckland State Highway Network". (Paper presented at the Surface Friction Conference Christchurch 2005)

The 1998 " Investigation Into the Relationship Between Aggregate PSV and Wet Road Skid Resistance", carried out by WDM.

Skid Resistance Requirements for Auckland State Highway Network (Nov 2007)

"Porous Asphalt Mixes For All Seasons"; paper by J Verco and T Boyle for the 2000 Sydney Australia World of Asphalt Pavements

Key Words

Skid Resistance, Microtexture, Macrotexture

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INTRODUCTION

Does the macrotexture and microtexture information supplied by the annual high-speed data survey add value to the skid resistance management of individual sections of carriageway?

The introduction of the Transit New Zealand's T/10 Specification for Skid Resistance Investigation and Treatment Selection, not only produced a need for higher PSV aggregates in the Auckland Region, but also coincided with a change in aggregate source supply. This was further complicated by the introduction of mandatory macrotexture requirements.

This presentation sets out the background to these changes, the learnings from data analysis from individual sites and network practices which evolved from this.

BACKGROUND

Transit New Zealand has for the last 12 years utilised WDM's Sideways force Coefficient Resistance Investigation Machine (SCRIM) as a means of collecting high speed data, such as macrotexture and microtexture as well as roughness, rutting, geometry and recorded this against running distance and more recently GPS. This continuous supply of annual SCRIM data, has provided the opportunity to analyse aggregate polishing and asphaltic surfacing performance by location.

The Auckland Region is geographically constrained by both the sea and topography, which not only concentrates traffic volumes up to 200,000 vehicles per day (vpd), but also requires pavement surfaces to perform in tortuous locations, in terms of gradient and geometry. In addition there has been major changes in aggregate sources, plus mandatory macrotexture requirements introduced.

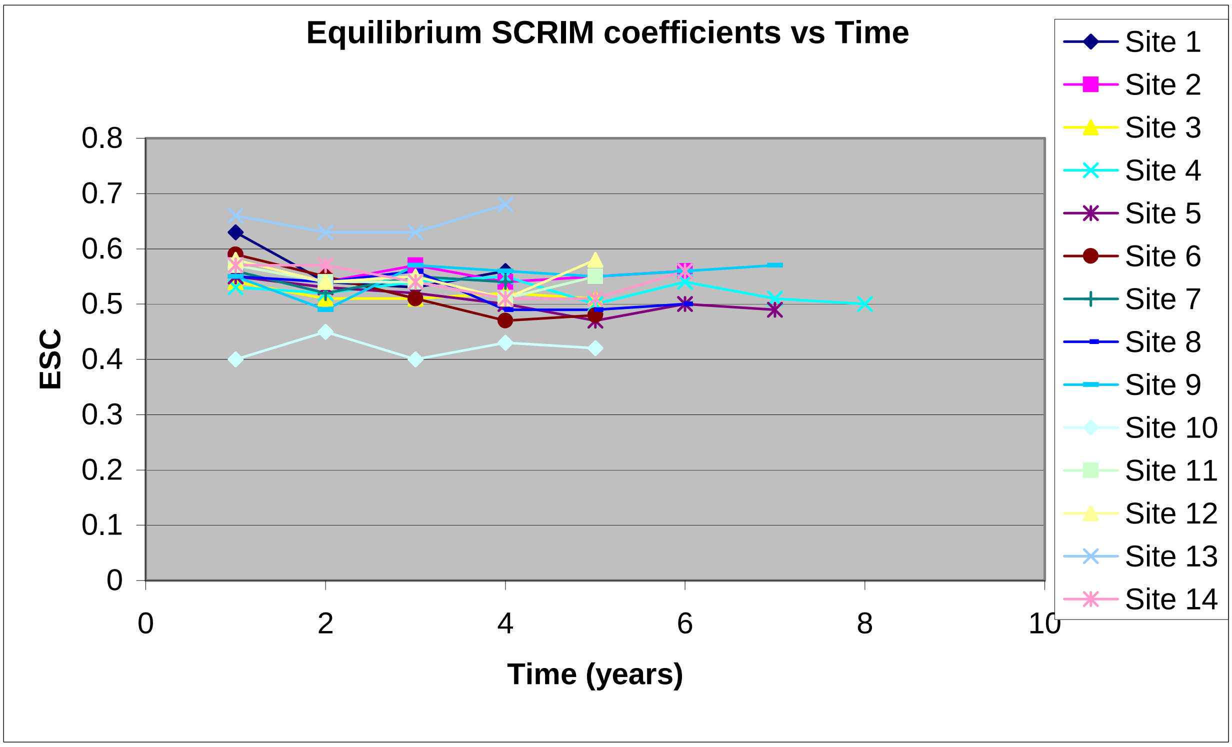
Another complication to skid resistance management, was the original establishment of the five skid resistance site categories as contained the Transit New Zealand Specification T/10. The five categories, which were determined by regression analysis, were carried out on chip seals only, as there was insufficient data from previous SCRIM surveys to draw conclusions, for pavements with Thin Asphaltic Surfacings (TAS). The absence of this analysis contributed initially to the lack of understanding of the nature of TAS skid resistance.

This has, over the last ten years, created a changing environment to proactively manage skid resistance within and has raised fundamental questions about the microtexture behaviour of new aggregates as well as new asphaltic surfacing mix performance.

Macrotexture data is measured in terms of Mean Profile Depth (MPD). New surfacings require a minimum of 0.9 mm MPD and a Threshold Level of 0.5 mm MPD. Microtexture requirements, as set out in the Transit New Zealand specification T/10, refer to an Investigation Level, which is that level when microtexture should be monitored, and a Threshold Level (TL), which is the level at which rectification is required.

DATA REPEATABLITY

The raw microtexture data is seasonally corrected and known as MSSC (Mid Summer SCRIM Coefficient). In 2003 the MSSC was adjusted to Equivalent SCRIM Coefficient (ESC), by a rolling average of the previous three years data. The advantage in the Auckland environment, where rainfall is more uniform, is that the MSSC adjustment to ESC is so minimal, that it does not affect the overall trend. So by taking the average MSSC or ESC, the trends on the 14 sites monitored for four or more years, have been reasonably consistent as shown in Graph 1. So for the purposes of this paper, MSSC and ESC are interchangeable for the Auckland Region



Graph 1: ESC v Time.

While this Graph 1 appears cluttered, it illustrates that average microtexture trend is usually relatively uniform (static or slowly deteriorating) From the 14 sites, 9 were within a range of 0.05 ESC and the remainder within 0.1 ESC.

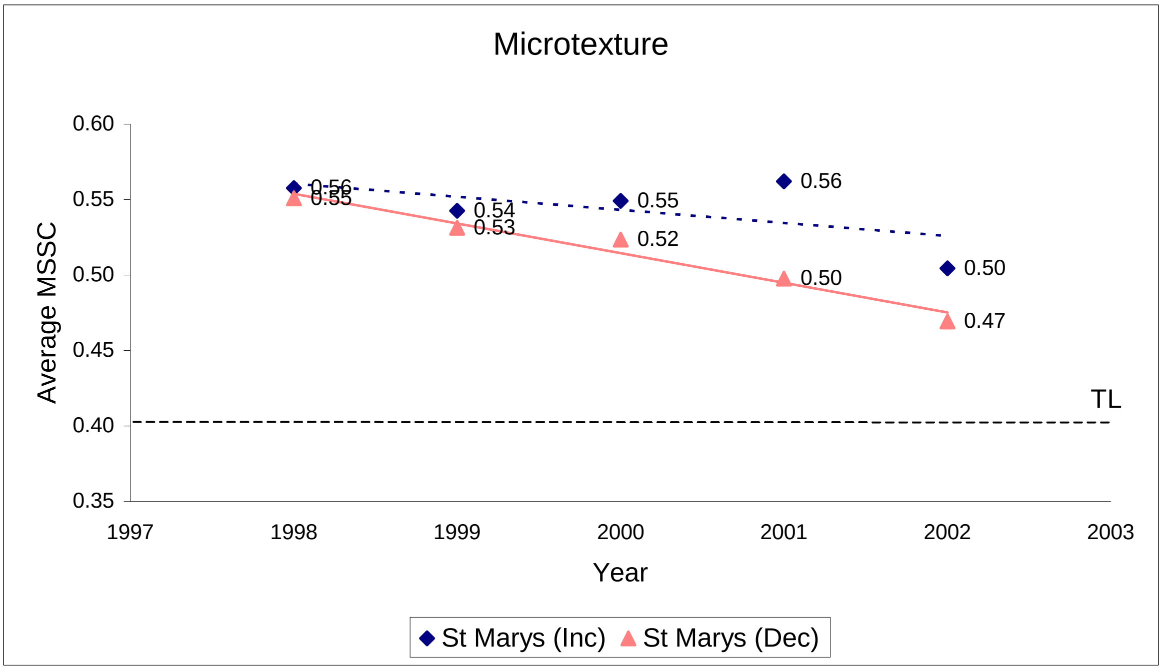
The measurement of SCRIM on the first year sites can be affected by binder masking the aggregate microtexture or freshly exposed aggregate , which may make the year one values lower and higher respectively.

CASE STUDIES

Intervention; Auckland Harbour Bridge Approaches

The use of average SCRIM trend information, assists the asset manager to proactively manage skid resistance, by determining when to intervene on a surfacing where the aggregate is gradually polishing. The approaches to the Auckland Harbour Bridge has an average traffic flow of 145,000 vehicles per day with three percent heavy commercial vehicles, on four lanes in each direction. In addition the southern approach has two curves with radii of 260 m and 300 m with an 80 Kph speed restriction. The former basaltic coarse aggregate contained in an Open Graded Porous Asphalt (OGPA) polished in two years, with a resultant surge in accidents. In 1998 the decreasing or northbound direction was resurfaced with a high PSV aggregate, which resists polishing by abrasion of the stone surface. (See 2005 paper Skid Resistance Management on the Auckland State Highway Network, for a description of this material called Motuohora aggregate) Since this aggregate had not been used before in an asphaltic concrete mix, its skid resistance performance was monitored for both macrotexture and microtexture.(see Graph 2 below). The microtexture deterioration led to the planned resurfacing in 2005, before the MSSC approached the Threshold Level of 0.4. A point of interest is that the MSSC for the increasing or southbound direction, which indicates a more gradual deterioration, demonstrating that an aggregate from the same source can behave differently in the same traffic environment.

Since 1998 the skid related accident rate has remained at 20% of the previous accident rate.

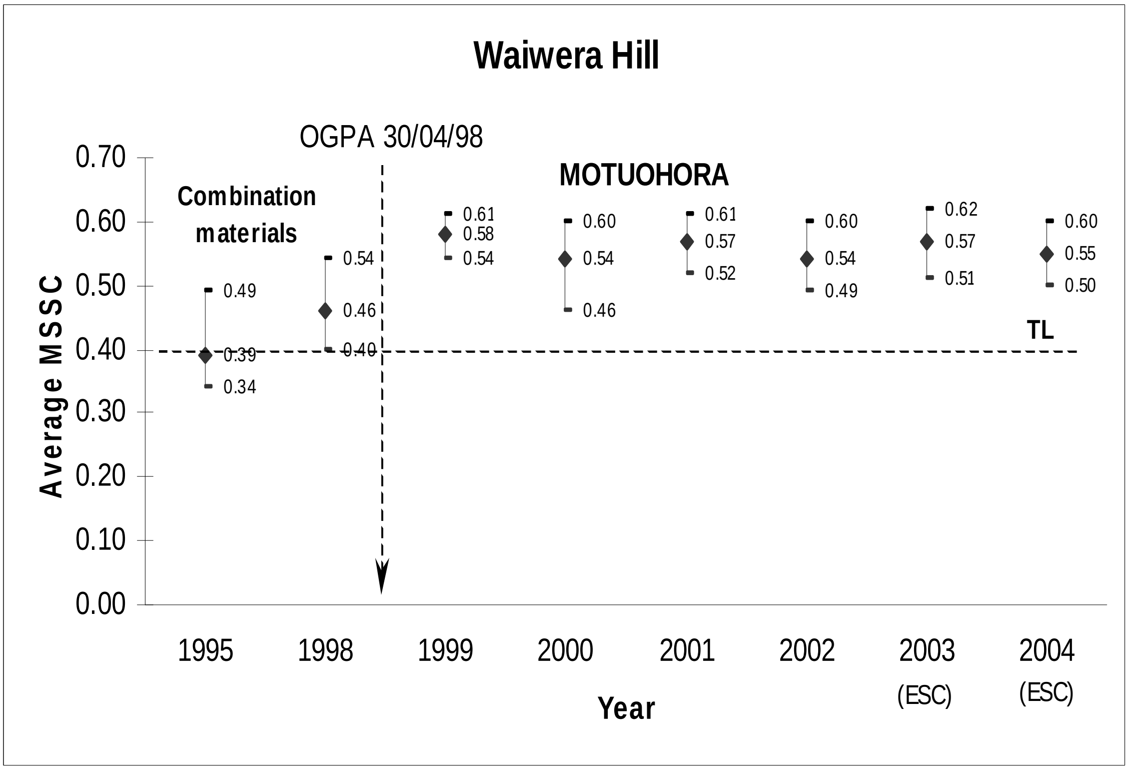


Graph 2: Plot of Average Microtexture Over Time
Inc is the increasing direction in terms of linear referenceing
Dec is decreasing in terms of linear referencing
TL stands for Threshold level as referred to in the TNZ specification T/10

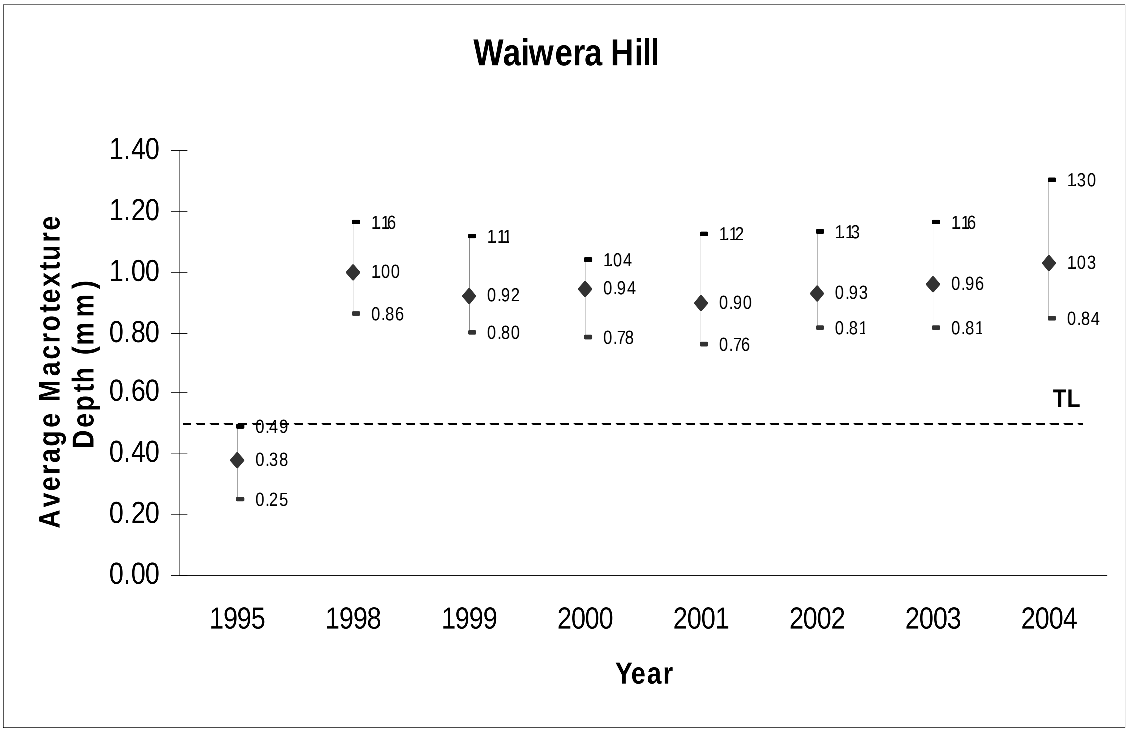
Thin Asphaltic Surfacing Mix Performance

The same Motuohora aggregate was used on State Highway 1 on Waiwera Hill, which is a tortuous alignment with 60 m and 70 m radius curves, a gradient of approximately 10% and has 15,000 vpd with 8% Heavy Commercial Vehicles (HCV). A High Strength Open Graded Porous Asphalt (HSOGPA) mix was used and the monitoring showed that both macrotexture and microtexture in excess of requirements for the eight years of the surfacing life before needing replacement due to ravelling (loss of coarse aggregate). The microtextuure and macrotexture measurements are shown in Graphs 3 and 4 below.

NB HSOGPA has a 10 mm aggregate size open grades porous asphaltic mix, with greater mastic and therefore reduced voids. See paper “Porous Asphalt Mixes For All Seasons”.



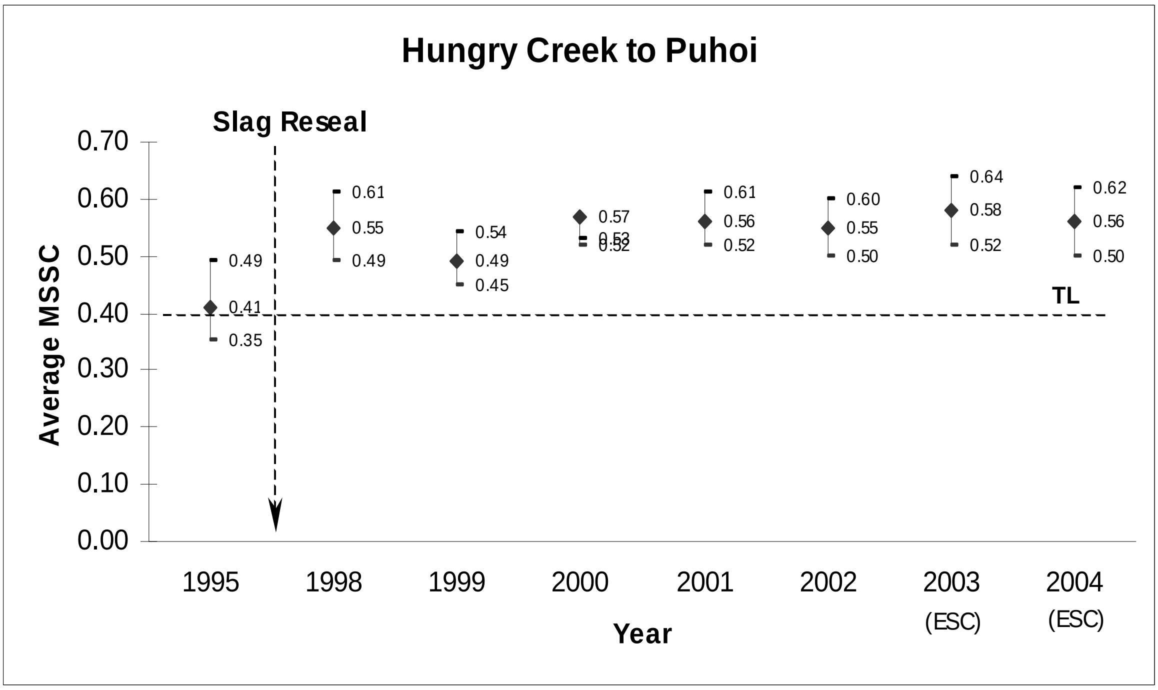
Graph 3: Plot of Average MSSC on SH 1 Waiwera Hill



Graph 4: Average Macrotexture SH 1 Waiwera Hill

Slag Aggregate

Slag as a waste product from local steel manufacture, was trialled as a 9 mm sealing chip on a reconstruction of an undivided section of State Highway between Hungry Creek and Puhoi, which had a high accident rate. Due to the high traffic volume (15,000 VPD) the practice at the time was to pre-coat sealing chip with bitumen to enhance adhesion. The selection of the slag aggregate was based on its Polished Stone Value of 60. However the accident rate did not decline as expected. The low MSSC average value in 1999 was consistent with the higher than expected accident rate. (See graph 5 below) However the MSSC did rebound and maintained that level of skid resistance for the next seven years. This experience resulted in banning slag use, although alterations in production and subsequent trials have permitted its recent reinstatement The vesicular nature of slag on this site was thought to enhance the adhesion of the binder, thus masking the microtexture.

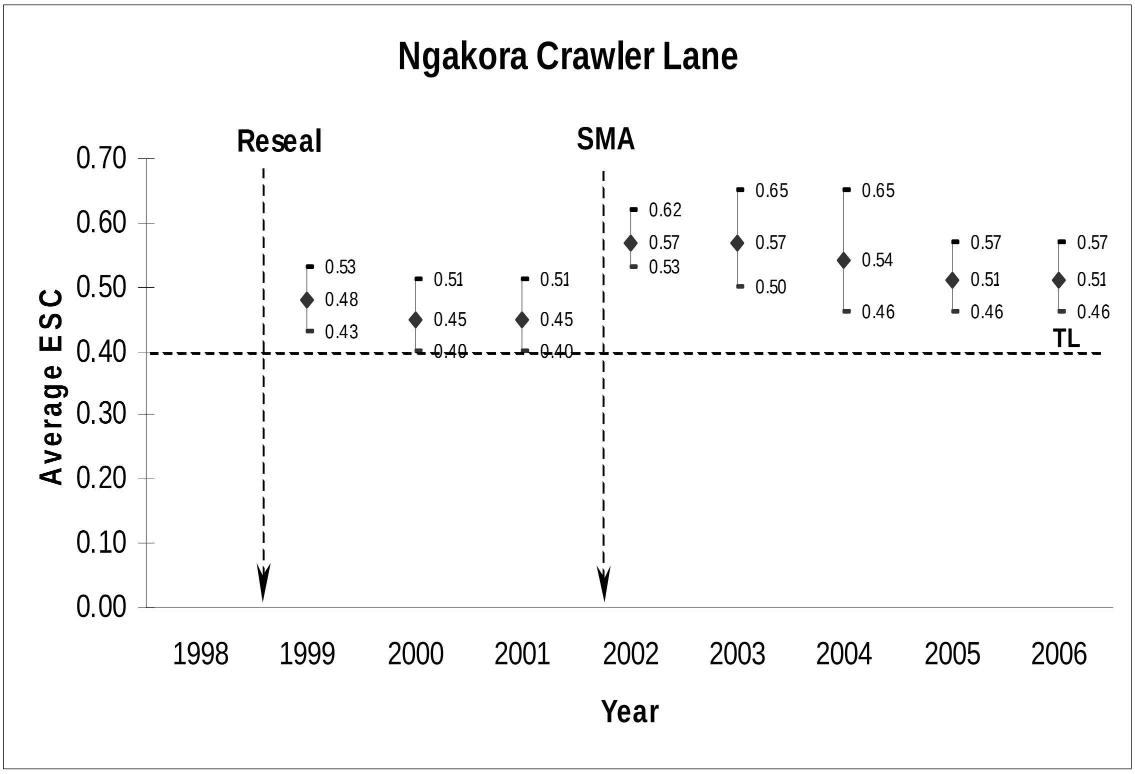


Graph 5 Average MSSC SH 1 Hungry Creek to Puhoi.

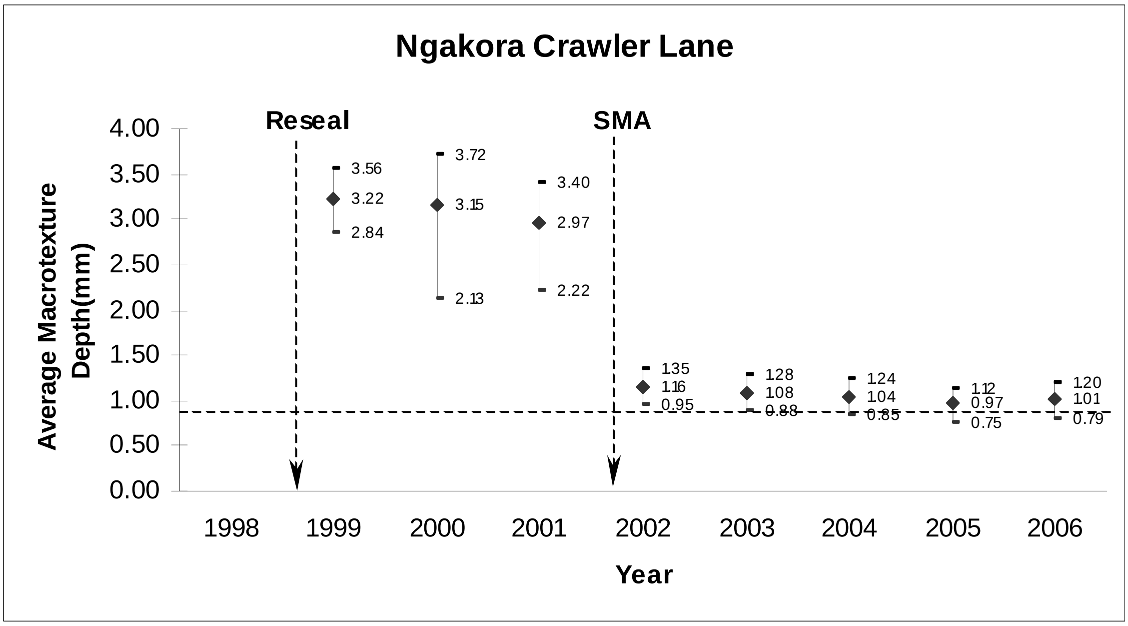
Ultra Thin Asphalt

The application of Ultra Thin Asphaltic (UTA) surfacings has been desirable in terms of economics and also reduced bridge deck loading, from the reduced layer thickness.

Graphs 6 and 7 below are from a section of SH 22, which has two out of context curves, in that the approach speed to the respective 120 m and 150 m radius curves is significantly higher than the design speed. In 1999 the section was resealed with a basaltic chip seal, which had good macrotexture. However the chip polished and an increase in loss of control accidents was detected. The opportunity was taken to place a UTA as a Stone Mastic Asphalt with a nominal 8 mm aggregate. The object of this monitoring was to ensure that the average macrotexture of this surfacing mix did keep above the 0.9 mm MPD requirement and captive water blasting has been carried out recently to maintain it.



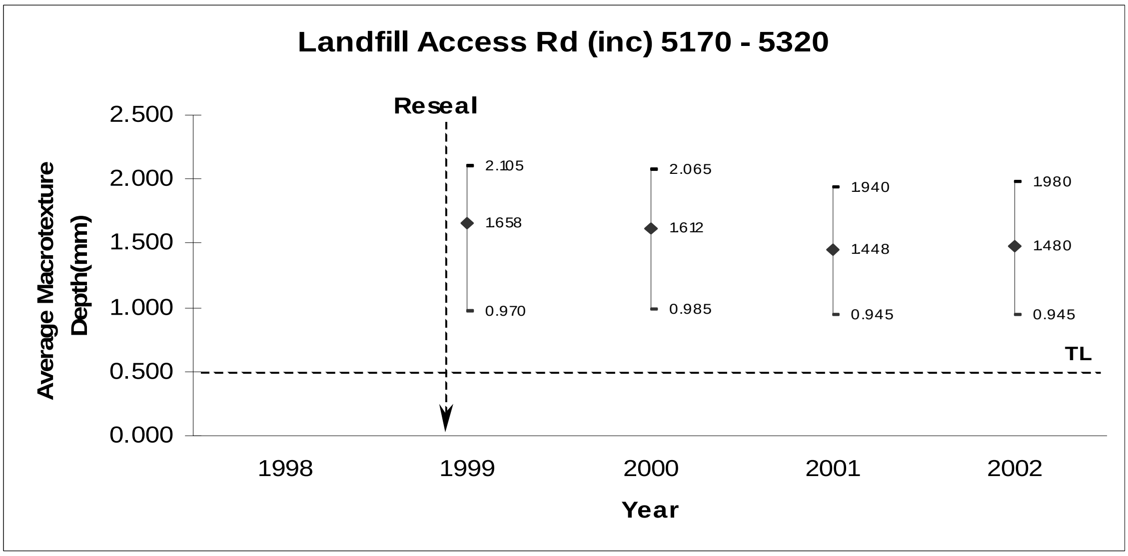
Graph 6 SH 22 Ngakora Crawler Lane Plot of Average Microtexture



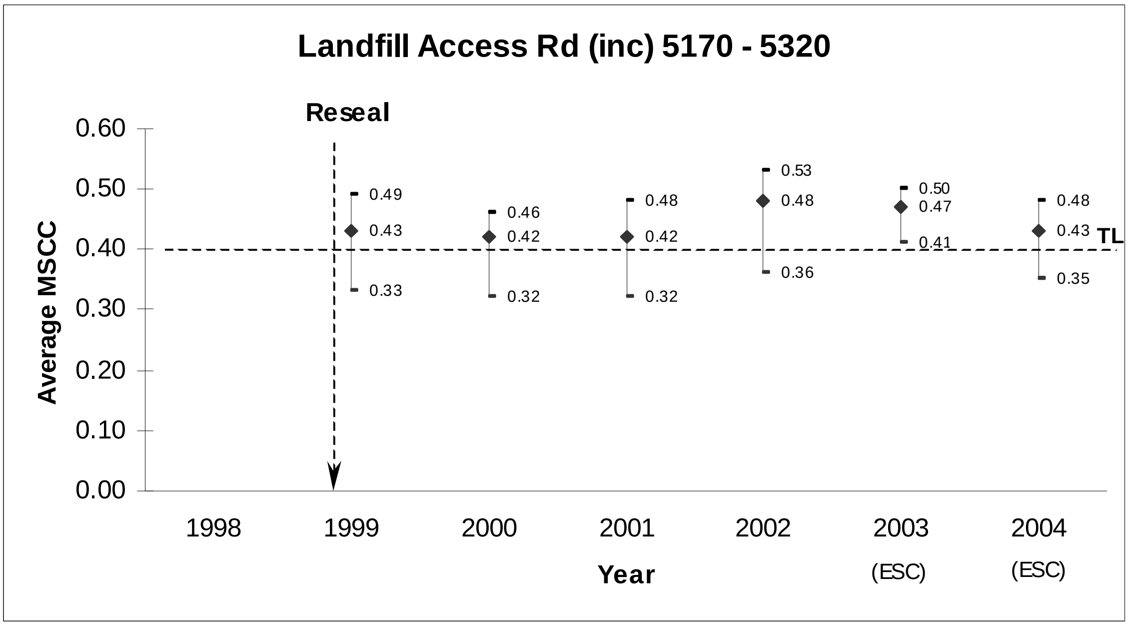
Graph 7; SH 22 Ngakora Crawler Lane Plot of Average Macrotexture

Contamination

A limestone quarry has access onto SH 17. The resource consent required a truck wheel wash, which from observation was not being used. Concern was raised that the lime, which was being spread along the highway, may adversely affect skid resistance. Graphs 8 and 9 below show that there were no skid resistance concerns as the MPD was well over 0.9 mm and the SC was over the 0.4 TL.



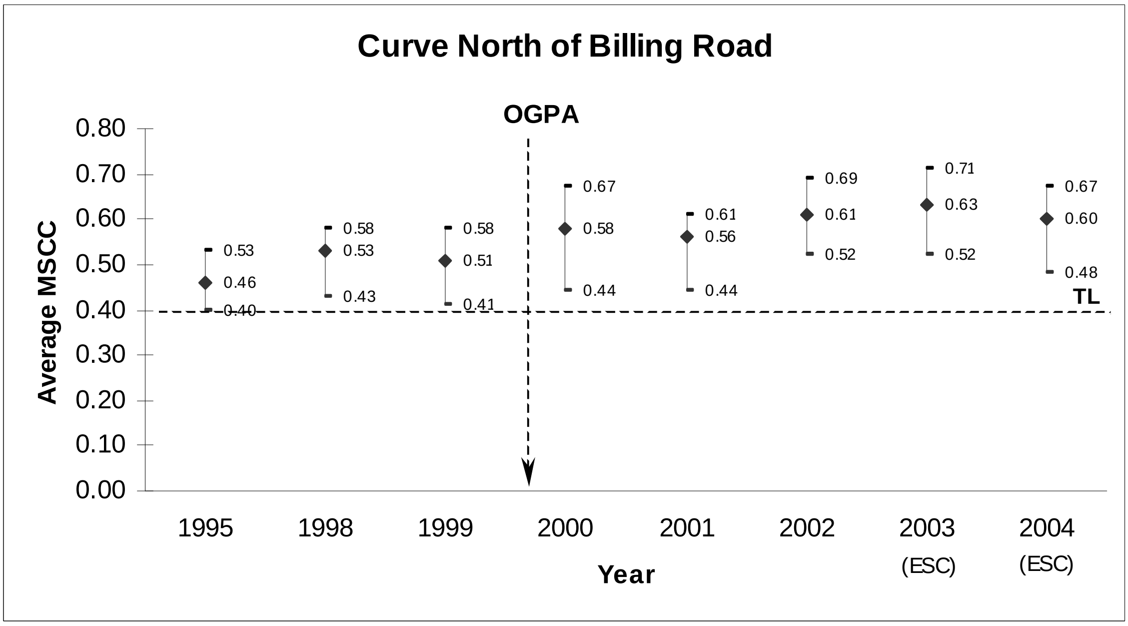
Graph 8: SH 17 Limestone Quarry Access Plot of Macrotexture



Graph 9: SH 17 Limestone Quarry Access Plot of Microtexture

Aggregate blending

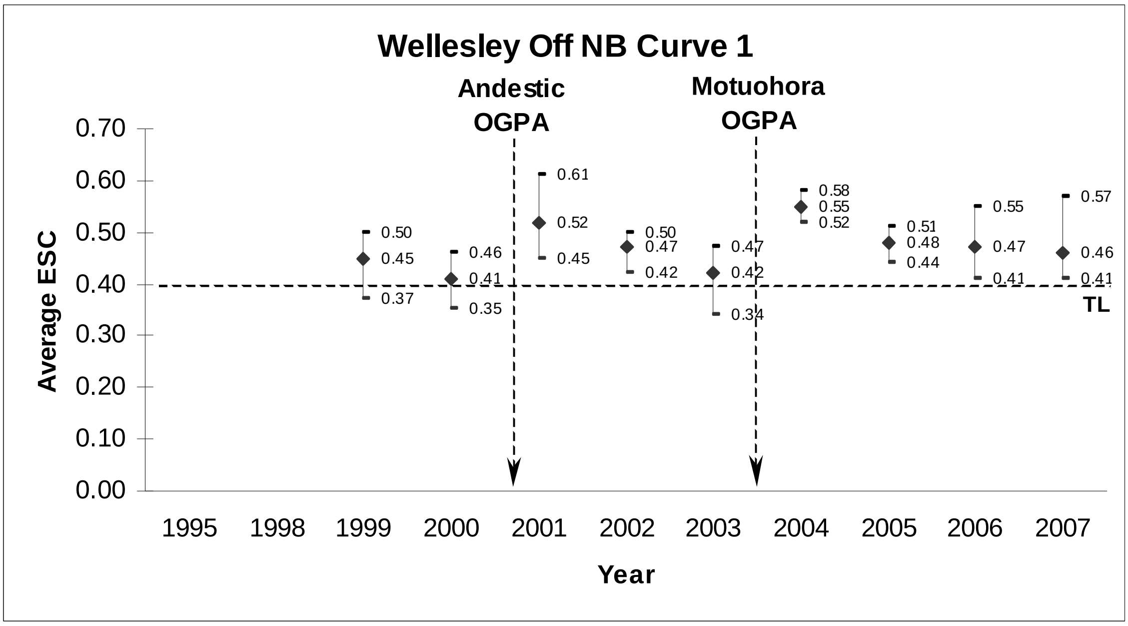
The need for high PSV aggregate exceeded supply in 2000, leading to a trial of blending weathered and unweathered greywacke (indurated sandstone) by targeting the weathering zone interface. The concern was that the weathered aggregate with a high PSV would wear down and leave exposed the unweathered greywacke, with a lower PSV, thus producing microtexture deterioration. State Highway 1 north of Billing Road is one of two sites, which were due to be reconstructed. As can be seen in Graph 10, the performance was very good with the MSSC keeping above the 0.4 TL.



Graph 10 SH 1 Blended Aggregate Trial

Back Analysis

Refer to Graph 11; In 2001 the basaltic OGPA was SCRIM deficient on this 150m radius curve, which has approximately 1500 heavy vehicles per day. At this time the PSV calculation from TNZ T/10 Specification indicated a minimum PSV of 59 so an Andestic aggregate was chosen for the coarse aggregate in the OGPA. However monitoring in 2003 indicated that the aggregate was polishing. By inserting the 2003 average ESC value of 0.42 as the SC value in the TNZ T/10 formulae, the aggregate appeared to have performed as PSV 55, indicating that the formulae was under valuing the PSV by 4 at this site, in that the PSV should have been 63 (i.e. 59+4) This practice of back analysis has now been included in Skid Resistance Management on the Auckland State Highway Network. The new surfacing, placed in 2004 is an OGPA with Motuohora high PSV as the coarse aggregate



Graph 11 SH 1 Wellesley Off Ramp

LOCAL PRACTICE

The monitoring of both macrotexture and microtexture by individual site has produced credible trend information, which has enabled the following:

- predetermine aggregate polishing allowing intervention
- recognition that individual aggregates are, or are not performing to their indicated PSV
- evaluation of the effectiveness asphaltic mixes skid resistance.
- an opportunity for the asset managers to refine knowledge on aggregate and surfacing performance, to the enhance the safety of their network

In addition the following skid resistance management practices have also been implemented:

- back analysis should be carried out to confirm PSV selection.
- for sites with heavy commercial vehicles exceeding 500 per lane per day, the T/10 formulae is under valuing PSV by 4 on thin asphaltic concrete mixes.

CONCLUSION

As an asset manager I contend that analysis of this SCRIM data taken from individual lengths of carriageway in conjunction with engineering judgement can supply confidence to appropriately manage skid resistance.

So to answer the original question is yes. Analysis of SCRIM data is a valuable input into selection of surfacings and aggregate and is a good project tool.