SURFACING AGGREGATE SKID RESISTANCE PERFORMANCE

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ABSTRACT

To obtain the best whole of life aggregate selection to achieve appropriate skid resistance, the nature of polishing of individual aggregates needs to be understood. Polished Stone Value (PSV) testing, often does not provide an indication of on road performance. The requirement for PSV test contained in NZTA's aggregate specification M/6 references "BS EN 1097-8:2009 Tests for mechanical and physical properties of aggregates".

The objective of this presentation is to discuss the outcome of extending the second polishing stage in this test method. Existing test results and further ones to be completed by the middle of 2013, appear to confirm on road experience of aggregate performance in the Bay Of Plenty region of New Zealand. The presentation will examine any correlation with onsite skid testing with weathered and un-weathered sedimentary and igneous scoured aggregates as well as the use of this exercise to train practitioners.

1.0 INTRODUCTION

To obtain the best whole of life cost related to skid resistance from a surfacing, the nature and performance of the aggregate needs to be understood. The former specification, NZTA T/10 (Specification for State Highway Skid Resistance) used Polished Stone Value (PSV) for procuring pavement resurfacing by contract. The lack of criteria and guidance around micro texture polishing, has led to very little attention or understanding of how individual aggregates perform.

The inclusion of the “Aggregate Performance Method” in the 2010 revision of the T/10 specification allows some engineering decisions to override PSV. Therefore the basis for this presentation is to look at the role extended PSV polishing, the contribution of Out Of Context Curves (OCC) monitoring, plus mechanisms to raise surfacing designer awareness to better target surfacing aggregate selection.

1.1 Bay of Plenty State Highway

The investigation on polishing in terms of extended PSV and onsite monitoring of Equilibrium SCRIM Coefficient (ESC) was carried out on aggregates utilised on State Highways within the Bay of Plenty Region of New Zealand.

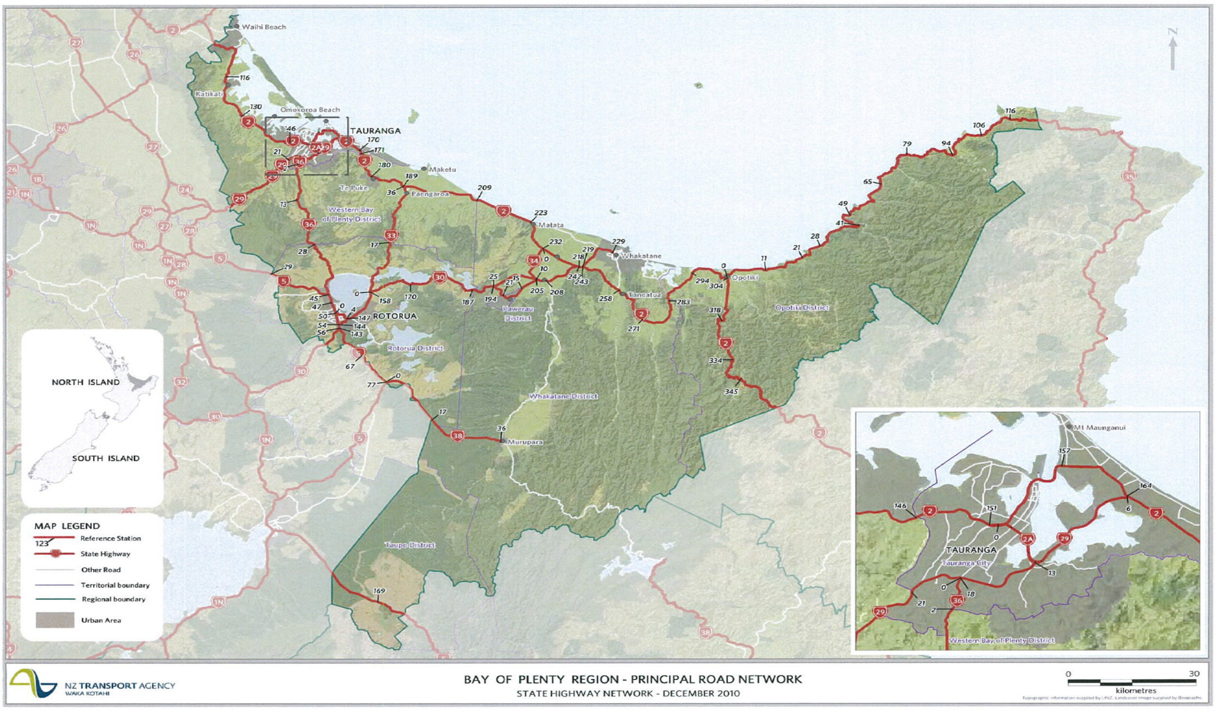
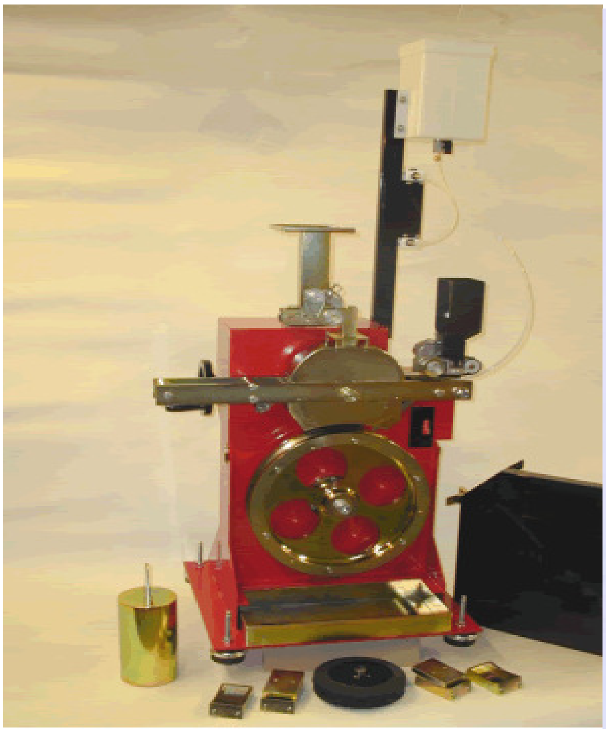


Figure 1: Bay of Plenty State Highway Map

Bay of Plenty SH 760 km’s of State Highway
Traffic volume range: 500 to 34,000 per day
Heavy Commercial Vehicle: 90 to 2300 per day
Terrain; plains to mountainous
NB Smaller scale version of figure 1 appended for better clarity

2.0 EXTENDED PSV POLISHING

The requirement for PSV testing contained in the New Zealand Transport Agency's specification M/6 Notes on Specification for Sealing Chip (NZTA 2011) refers to BS EN 1097-8:2009 Test for mechanical and physical properties of aggregates. The application of this test method to derive PSV for an individual aggregate, requires the mounting of the aggregate sample on a curved mould, the surface of which, is then subject to three hours of coarse polishing, followed by three hours of fine polishing. The friction of the polished aggregate is then measured by British Pendulum Number (BPN) method (refer to test standard; BS EN 1097-8:2009). However this PSV value, derived from BPN, is only indicative and the aggregate may well polish further. So a number of aggregate types were selected and subject to a fine polishing regime of between two and 12 hours. These fine polishing times were 2, 3, 4, 6, 8 and 12 hours and at each increment the BPN was measured and therefore a PSV derived.



Accelerated polishing testing machine

British pendulum tester

Generally there were three trends to this data, which can be associated to rock type.

3.0 ROCK TYPE

For the purpose of this study various rock types, from which surfacing aggregate is sourced for State Highways in the Bay of Plenty, are volcanic (andersite), unweathered greywacke (indurated sandstone) and weathered greywacke/mudstone from Waioeka River.

The averaged results are shown in Figure 2 below.

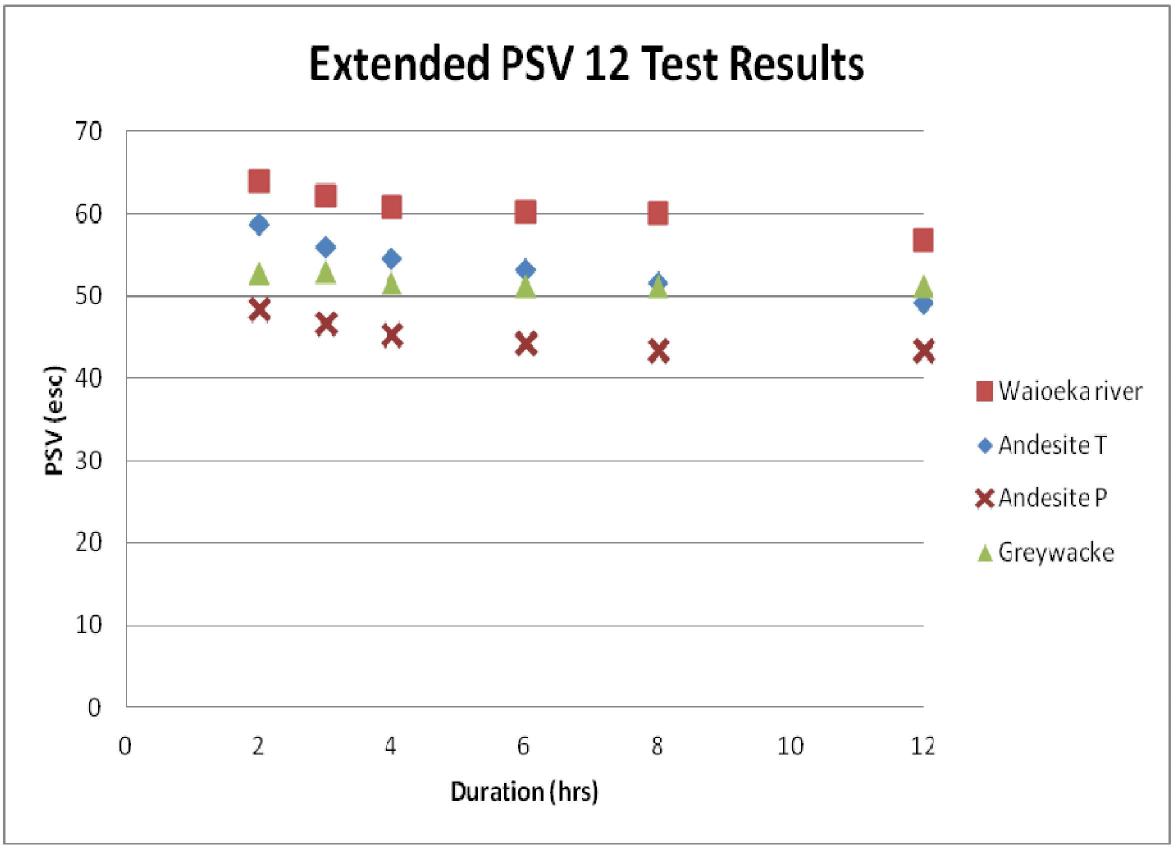


Figure 2: Graph of Extended PSV 12 hour testing. (NB the test results are appended)

3.1 ANDERSITE "T"

This aggregate can be defined as a fine grained Basaltic Andesite according to the NZ Geological Map 5 2010.

This volcanic Andersite aggregate had six extended polishing tests from the same quarry. The results showed an initial average polishing of 4.0 PSV units at four hours then a continuous decreasing polishing trend of another 5.4 PSV units at 12 hours, with no sign of the trend levelling off into a static state. This is consistent with the experience of this aggregate on onsite performance.

3.2 ANDERSITE "P"

Sourced from Waitawheta Quarry and Matatoki Quarry these aggregates can be defined as Uretara Formations according to the NZ Geological Map 5 2010. Uretara Formation is Andesitic Volcanic rock, is quarried from two sources and has six extended polishing tests.

The results showed an initial average polishing of 3.2 PSV units at four hours then a decreasing polishing trend of another 1.9 PSV units at 12 hours, with some sign of the trend levelling off into a static state.

3.3 GREYWACKE

Sourced from three quarries on the west side of the Hauraki Plains from un-weathered greywacke characterised by their well-indurated, massive poorly bedded course to medium fine grained volcaniclastic sandstone, minor alternating sandstone and mudstone sequences and conglomerate; sheared locally, with common quartz and zeolite veins (Philippa Black).

The three un-weathered greywacke samples and five test results showed an initial average polishing of 2.2 PSV units at four hours then a decreasing polishing trend of another 1.4 PSV units at 12 hours, with the trend levelling off.

3.4 WEATHERED GREYWACKE (FROM WAIOEKA RIVER)

The Waioeka River, which discharges into the sea at Opotiki, drains a mountainous area to the south. These mountains consist of fine to medium grained sand and silt stones, which weather, erode and are mechanically sorted by the river, resulting in only the more durable boulders being deposited at the mouth of the Waioeka Gorge, from where they are taken for aggregate production.

This source which has been tested five times, showed an initial average polishing of 1.6 PSV units at four hours then a decreasing polishing trend of another 0.9 PSV units at 12 hours, with a slight downward trend and levelling off into a static state.

This source of surfacing aggregate has only been used for three years so onsite performance has not been confirmed other than there has been an overall improvement in the average ESC. The aggregate maintains its microtexture by fretting of 0.5 mm to 2 mm particles, exposing fresh microtexture.

3.5 DISCUSSION

There appears to be a hinge point in all four rock types, which tends to indicate that the PSV test should include at least four or more hours of fine polishing.

4.0 ONSITE PERFORMANCE

An associated question this extended PSV polishing posed, was could this initial and ongoing polishing trend be substantiated from onsite performance monitoring?
Curves, which had been identified as Out of Context Curve (OCC), were investigated for change in their Equilibrium SCRIM Coefficient (ESC) over time. OCCs were established by the Risk Ranking of Curves on New Zealand State Highways for Skid Resistance Monitoring and Treatment by Colin Brodie of New Zealand Transport Agency. This provided a relatively consistent method of identifying OCC, in that its basis was that the approach vehicle speed over the preceding 500m, was greater than the design speed of the same curve. NB a difference of 25kph was considered a severe OCC.

Once the source of the aggregate was identified the ESC of these curves, which had been surfaced for at least four years, was averaged and plotted by year, as seen by example (figure 3) below.

An average ESC decay rate was derived from the site graphs.

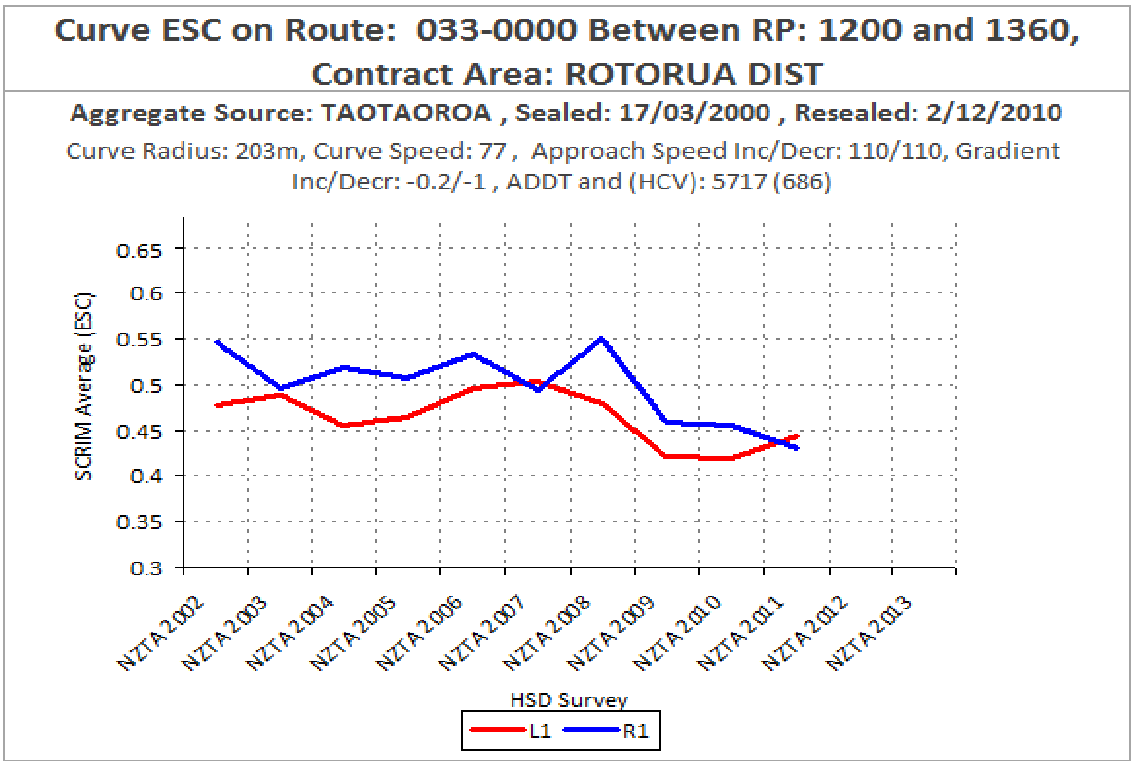


Figure 3 Example of OCC ESC average over time.

The rate of ESC decay per year was 0.006 and 0.014 for the left lane and right lane respectively..

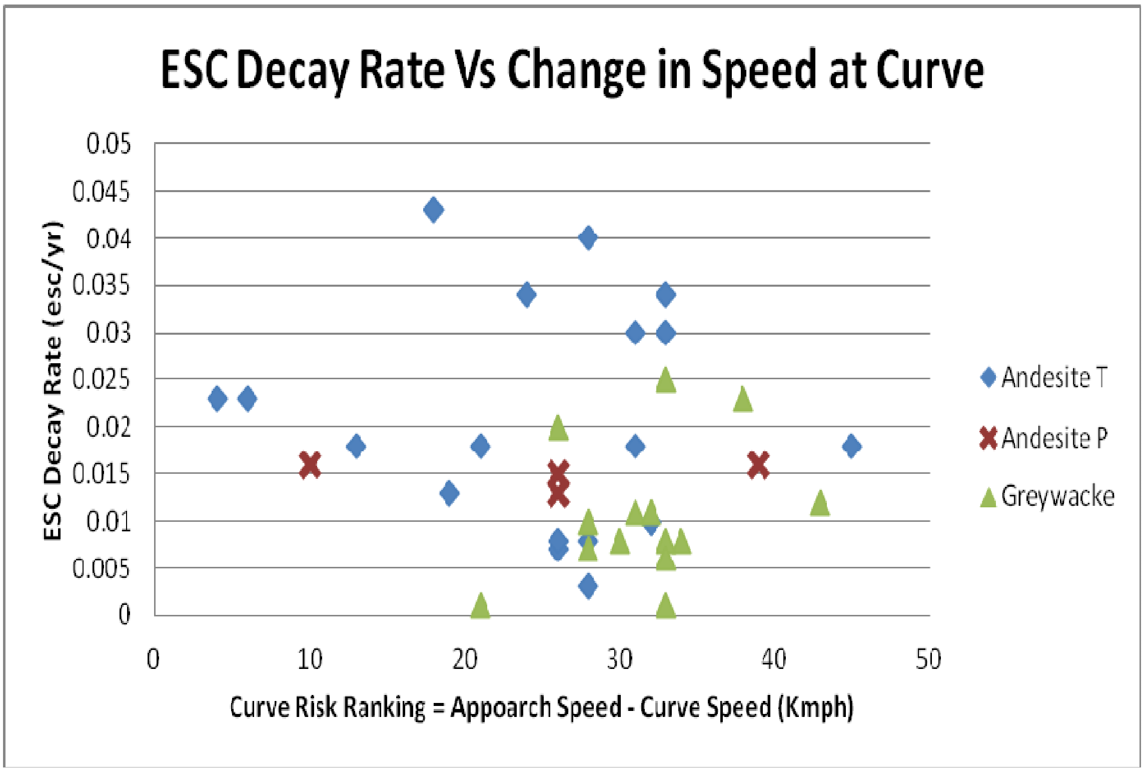


Figure 4: ESC Decay Rate Versus Approach/Design speed differential.

Of the 48 OOCs checked 10 showed erratic data with no clear deterioration trend.

Based on the above plot of decay rate of ESC versus speed change, there is no significant trend that can be derived, other than a general statement, that across the range of speed change, Andersite T appears to polish more than the other two aggregate types.

The data was re-examined by weighting each site by its heavy commercial vehicle count, however no significant trends were apparent.

More data capture and analysis is warranted.

5.0 RECOMMENDATIONS

- There is enough of an indication to warrant extending the PSV 12 testing to all aggregate sources.
- That the PSV value be based on at least four hours of fine polishing.
- The analysis of OOC may give some appreciation of how an aggregate will perform on the road.

6.0 PRACTITIONER UPSKILLING

While specifications can be changed as in the case with NZTA's T/10, and a road show was organised to highlight the changes by presenting to practitioners, there still appears to be a slow uptake of the concepts.

Exercises such as the extended PSV 12 testing plus the onsite monitoring as per the Aggregate Performance Method referred to, need and are reinforced by regional skid resistance reviews to develop practitioner competence and understanding.

7.0 CONCLUSION

While the extended PSV 12 testing, and the aggregate performance on OCCs does have potential to enhance engineering decisions on aggregate selection, ensuring that surfacing practitioners carry out this investigation work with in their network areas, will help ensure more appropriate aggregate selection.

8.0 ACKNOWLEDGEMENTS

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Neil Gumbley & Graham Huggins	OPUS BoP, Sampling for extended PSV data
Gary Bentley	OPUS Central Laboratories, Extended PSV 12 Testing Methodology

AUTHOR BIOGRAPHIES

Terry Boyle

Terry has over 40 years' experience with the management of State Highways in New Zealand, the last 25 of which has been spent in the asset management area. Since 2004, Terry has been a member of the NZTA's (formerly Transit New Zealand) Skid Technical Advisory Group (STAG). His special area of interest has been the on road skid resistance performance of surfacing aggregates.

Dave Whitehead

Dave has over 30 years of experience in a variety of roles within the highways engineering sector of which the last 25 have been in highway maintenance and asset management. He has worked largely in the UK in both the private and public sectors but prior to moving to New Zealand in 2008 had previous overseas experience in Sri Lanka.

Dave currently holds the position of Senior Pavements Engineer within the Pavement Group at the NZ Transport Agency's National Office in Wellington. He has been part of the team responsible for developing the T10 specification relating to skid resistance as well as involvement in a range of technical projects related to asset management. Dave recently stepped down as the chair on the Skid Technical Advisory Group (STAG) within NZTA but still retains membership on the group.