Road Trials of Aggregate Blends for Chipseals

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AN IMPORTANT NOTE FOR THE READER

The research detailed in this report was commissioned by Transfund New Zealand.

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EXECUTIVE SUMMARY

This report describes the results of a Transfund New Zealand research programme to investigate the viability of blending high polished stone value (PSV) sealing chips with standard chips in two-coat seals and void fills, with particular emphasis on their physical performance with respect to abrasion and skid resistance. Higher PSVs mean higher skid resistance. This is achieved through abrasion, with the microtexture of the chip being maintained through the loss of individual grains of the rock and wear between grains. However, abrasion can mean loss of macrotexture, leading to reduced drainage, and potentially flushing – all factors that can significantly affect skid resistance. Consequently, a method for assessing abrasion of high PSV chips is required, together with investigation of the potential of combining standard and high PSV chips.

A range of standard and high PSV grade 3 and grade 5 chips was selected for a combination of laboratory testing and road trials over 1999 and 2000. The laboratory tests included several different types of abrasion tests. Road trials comprising combinations of standard and high PSV chips were laid at four sites. Skid resistance measurements and observations of the surface condition were made over a period of time.

The significant findings of the laboratory tests and on-road trials were:

- No strong relationships were found between PSV and any of the measures of abrasion that were investigated.
- A strong correlation was found between the PSVs of the aggregate blends and the individual PSVs of the components, with this being dominated by the PSV of the larger chip.
- Skid resistance at most of the sites remains generally quite high, with sideways force coefficient (SFC) equivalent values being much higher than the investigatory level specified in Transit New Zealand's T/10 specification. However, skid resistance has not yet stabilised, which means that the question of whether it is the high or the standard PSV chip that dominates cannot yet be answered.
- The road trials laid have stood up reasonably well to more than a year's traffic.

ABSTRACT

The viability of blending high polished stone value (PSV) sealing chips with standard chips in two-coat seals and void fills was investigated, with particular emphasis on their physical performance with respect to abrasion and skid resistance. Laboratory tests and on-road trials were carried out to investigate these properties, with the aim of identifying the most appropriate method of measuring abrasion, and establishing whether such blends would perform well physically and provide the desired levels of skid resistance. The results show that such blends have stood up physically over the relatively short time they have been laid, and that they have also provided a level of skid resistance over that time which is much greater than that specified in Transit New Zealand's T/10 specification. However, the road trials have not been down long enough to determine either the life of the surface due to abrasion or aggregate breakdown, or whether the skid resistance of the blends will stabilise to acceptable values.

1. Introduction

The skid resistance of a chipsealed road surface depends on both macrotexture and microtexture. Microtexture comprises features on the individual chips and provides adhesive friction. Polishing is wear of chip microtexture by vehicle tyres. Polished stone value (PSV) is a measure of the resistance to polishing of a type of sealing chip: high values mean greater resistance. Maintaining favourable microtexture means that skid resistance is also maintained. Prescribing high PSV sealing chips is, accordingly, a method of reducing accident risk.

In New Zealand, the PSV test was first incorporated into the Transit New Zealand (TNZ) M/6 Specification for Sealing Chip in 1993. Initially, PSV was recommended for high accident-risk sites and could be included in the specific contract requirements of a sealing contract. TNZ adopted the British classification system, which specifies PSV in terms of site categories and commercial vehicle volumes.

In 1997, TNZ released the T/10 Specification for Skid Resistance Deficiency Investigation and Treatment Selection. Site categories are stipulated with corresponding investigatory levels of skid resistance in units of sideways force coefficient (SFC). The treatment selection section incorporates PSV requirements. The investigatory levels are a factor in the equation used to determine the PSV necessary for sections of road that require treatment.

The emphasis on PSV testing revealed that high PSV aggregates were scarce in New Zealand (high PSV is defined as values greater than 60). However, research by Stevenson (1996), funded by the Foundation for Research Science and Technology (FRST), showed that a number of marginal quality materials could provide high PSV sealing chips. "Marginal quality" refers to a variety of source materials but the common factor is non-compliance with the requirements of the TNZ M/6 specification. Earlier versions of the TNZ M/6 had concentrated on strength and durability of the aggregate and had not considered polishing. In the recent revision of the TNZ M/6 (Stevenson, 1998) this research was incorporated to determine whether strength requirements could be reduced. A provisional stage was deemed necessary and the M/21P Specification for High Polished Stone Value Sealing Chips (Pilot) was introduced. The M/21P prescribes criteria for materials with lower strength, durability and cleanness. In addition to providing a basis for enhancing skid resistance, the specification facilitates the use of locally available chips for low traffic-volume roads.

Aggregate producers have applied the research principles to their own sources, with a consequent increase in the proportion of M/6-compliant chips with a PSV of approximately 60. There are still very few sources of M/6 chip with PSV in the mid-60s and higher.

Although the M/21P is undergoing trials, several issues remain about the use of high PSV aggregates. The key issues are:

- blending of chips with different PSV, as could be used in two-coat and void-fill seal design, and
- abrasion/breakdown.

High PSV chip tends to work by virtue of abrasion. On high PSV chips, microtexture is preserved through the loss of individual grains making up the rock and through differential wear between grains. However, rapid abrasion will result in loss of macrotexture, which is formed by the chips collectively and is responsible for providing hysteretic friction and drainage of water from the road surface. Chip types that experience high abrasion are also more likely to have particles subject to breakdown. Chip breakdown affects the seal mosaic by reducing shoulder-to-shoulder contact and could be a focal point for stripping.

Although the crushing and weathering resistance tests (criteria for aggregate strength and durability) should identify aggregates that are going to degrade in the short and long term respectively, a method for assessing abrasion is a desirable control for use of high PSV chips.

It is recognised that crushing resistance is not directly related to abrasion or necessarily to breakdown during service. For any particular rock type, crushing resistance is strongly influenced by aggregate shape. Use of a Barmac crusher during tertiary processing of sealing chips can increase crushing resistance by as much as 50% relative to impact crushing. Shape, however, has no influence on a chip's propensity to abrade. The Los Angeles abrasion test could form the desired method of abrasion assessment, although it is known that the Los Angeles Abrasion Value (LAAV) is not a pure measure of abrasion – as evidenced by its good correlation with crushing resistance and inconsistent correlation with PSV (Seddon, 1979). Other possibilities are using the PSV test itself or a standard block abrasion machine to determine abrasion loss of sealing chip specimens.

Blending high PSV sealing chips with standard chips holds the potential for widespread improvement of skid resistance and for significant cost efficiencies. Ghandi et al. (1991) tested 50:50 blends of aggregates with differing PSV and found that the results were dominated by the higher PSV material. However, no work had been done on the effect of using different PSV chips in a two-component seal design. There are several possibilities, which can be considered in two groups:

1. Use of high PSV small chip over standard large chip – for example, a void-fill or a two-coat seal with high PSV grade 5 chip as the second coat over standard grade 3 chip.
2. Use of high PSV large chip with standard smaller chip – for example, a two-coat seal with high PSV grade 3 as the first coat and standard grade 5 as the second coat.

1. Introduction

Throughout New Zealand's roading network, there are coarse (grade 2 and 3) single-coat chipseals that have become polished but still have adequate texture depth. Many such deficiencies are identified during the annual SCRIM network survey. Their treatment presents an engineering problem and can require considerable financial outlay for road controlling authorities.

The present research project was designed to investigate the viability of blending high PSV sealing chips with standard chips in two-coat seals and void fills, with particular emphasis on their physical performance with respect to abrasion and skid resistance. Fundamental questions were:

1. Would the high PSV chip increase skid resistance to the level of its PSV, to an intermediate level, or have no effect?
2. If the high PSV chip was of marginal quality (i.e. it came under the TNZ M/21P specification), how would chips of varying quality laid in contact with premium quality or standard chips perform physically?

It was possible that seal performance and longevity benefited from homogeneity of constituent parts of the seal and that the existence of strength differentials would weaken the stability of the system. While the effect on skid resistance of blends could be modelled using the PSV test, this performance question had to be evaluated by road trials. A range of standard and high PSV grade 3 and grade 5 chips was therefore selected for a combination of laboratory testing and road trials at four sites over 1999/2000, as detailed in the following sections.

The common thread to the research is the PSV test. PSVs are derived from friction measurement of samples subjected to simulated traffic wear, and numerous researchers (e.g. Hosking 1992) have documented the correlation between skid resistance and PSV.

2. Polished Stone Value (PSV) Testing

This test involves the random sampling of chips from a quarry, from which 35–50 stones are selected as being representative of the entire sample. These stones are embedded in a rectangular, slightly curved, polyester resin mould. These specimens are clamped to the road wheel of an accelerated polishing machine to form a continuous strip of 12 test specimens and two controls. The controls are made from chips from a specific quarry and have a known PSV. A solid rubber tyre is placed in contact with the specimens and a specified load applied. The wheel rotates at 320 rpm and polishing is achieved through the combined action of the loaded tyre and water, coarse grit and flour, which are fed into the system for specified times. After six hours the specimens are subjected to a skid test using a modified British pendulum tester, and the resulting values are modified in accordance with the control stones.

2.1 Aggregates – Single Chip Type

In a research project funded by FRST, aggregates covering a variety of sources, PSVs and geographical locations were sampled and tested. A number of these were selected for this project, with as wide a variation in PSV as possible. The PSVs of these aggregates are listed in Table 2.1.

Table 2.1 Aggregate types and characteristics

Chip source/type	Measured PSV
Kiwi Point – Standard	59
Kiwi Point – HPSV[1]	62
Waiotahi – Waimana	62
Prenters – Prenters Shingle	62
Winstone – Kakariki, Rangitikei (Puketapu)	56
Byfords – Rangitikei Bulls Metal	55
Taotaoroa – Taotaoroa Brown	64
Winstone – Whitehall	54
Pound Rd – Pound Metal	57

[1] HPSV = high polished stone value

2.2 Aggregates – Blends of Chips

Specimens comprising blends of high and low PSV chips were produced and submitted to the Fulton Hogan Laboratory in Christchurch for PSV testing. Measurements of the mass and thickness losses of the specimens were also made during testing, although this proved to be an awkward process. The measurements were made to assess whether the PSV test had potential as a measure of abrasion. Table 2.2 lists the aggregate blends, the measured PSVs, and the weight and thickness losses.

Table 2.2 Aggregate Blends

Chip source/type	Gr 3 PSV	Gr 5 PSV	Blend PSV	Weight loss (g)	Thickness loss (mm)
Kiwi Pt Standard Gr 3 + Kiwi Pt HPSV Gr 5[1]	59	62	60	0.21	0.11
Kiwi Pt HPSV Gr 3 + Kiwi Pt Standard Gr 5	62	59	62	0.20	0.11
Taotaoroa Brown Gr 3 + Whitehall Gr 5	64	54	61	0.35	0.11
Whitehall Gr 3 + Taotaoroa Brown Gr 5	54	64	57	0.30	0.07
Waimana Gr 3 + Rangitikei Bulls Metal Gr 5	62	55	60	0.20	0.13
Pound Gr 3 + Waimana Gr 5	57	62	59	0.36	0.06

[1] HPSV = high polished stone value

Figures 2.1 and 2.2 show plots of the measured PSVs of the blends against the measured weight loss and thickness loss. These two figures do not appear to show any significant trends between the measured PSV of the blend and the weight or thickness loss that occurs during the PSV testing.

Figures 2.3 and 2.4 plot the PSVs of the blends against the individual PSVs of the grade 3 and grade 5 component to see whether one is dominant. These two figures show that the PSV of the blends appears to be dominated by the PSV of the larger stone. A multi-variable analysis produced the following equation:

$$\text{PSV (blend)} = 0.84*(\text{PSV Gr 3}) + 0.43*(\text{PSV Gr 5}) - 15.84 \qquad R^2 = 0.97 \qquad (1)$$

This equation allows us to assess the PSV of blends not specifically tested.

Figure 2.1 Aggregate blends – PSV vs weight loss

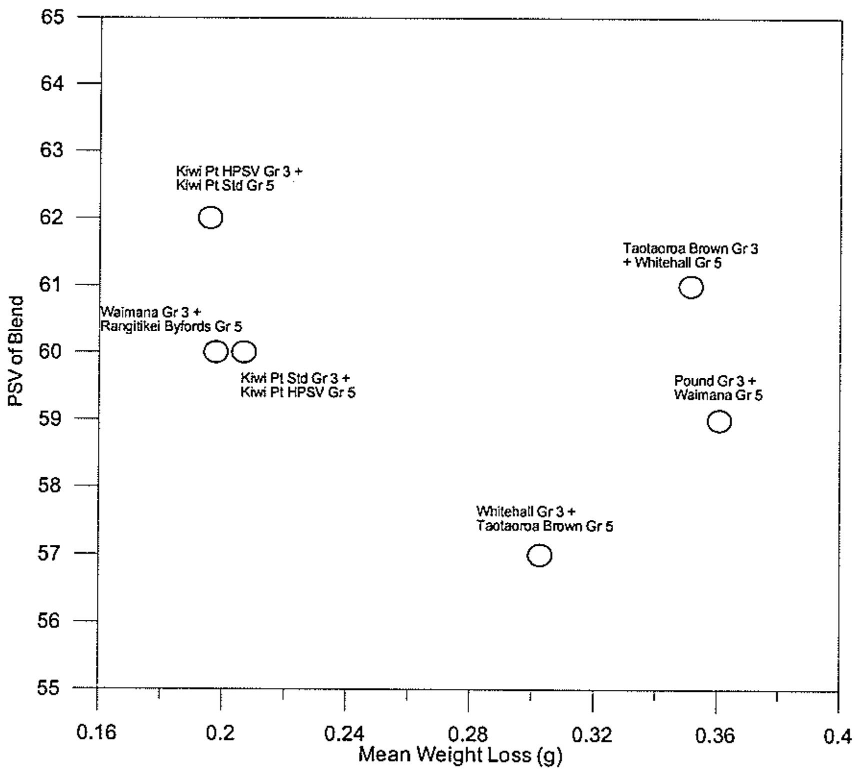


Figure 2.2 Aggregate blends – PSV vs thickness loss

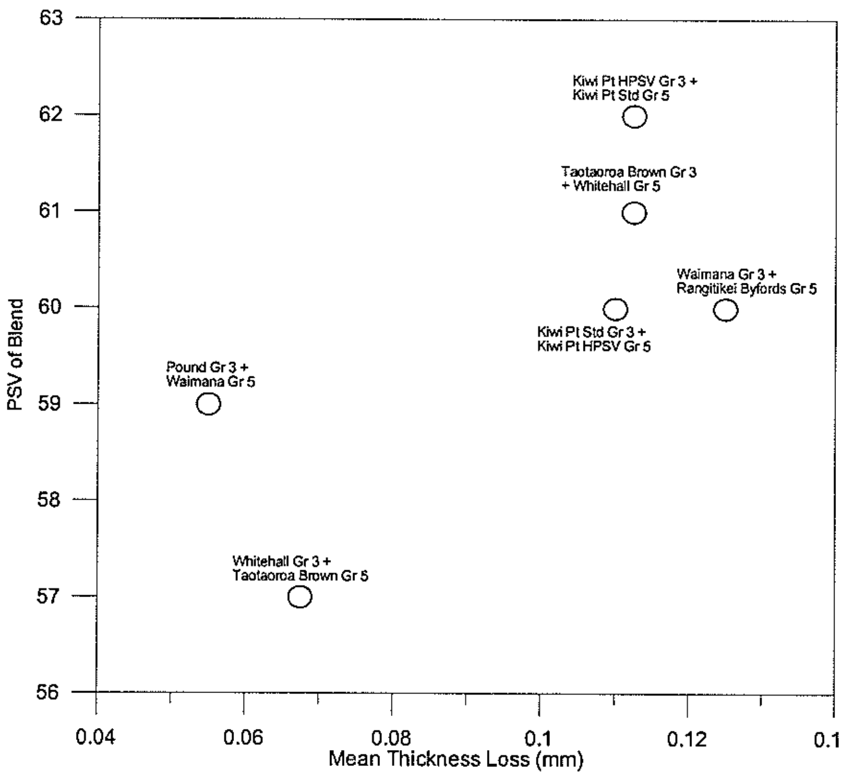


Figure 2.3 PSV aggregate blends vs PSV grade 5 component

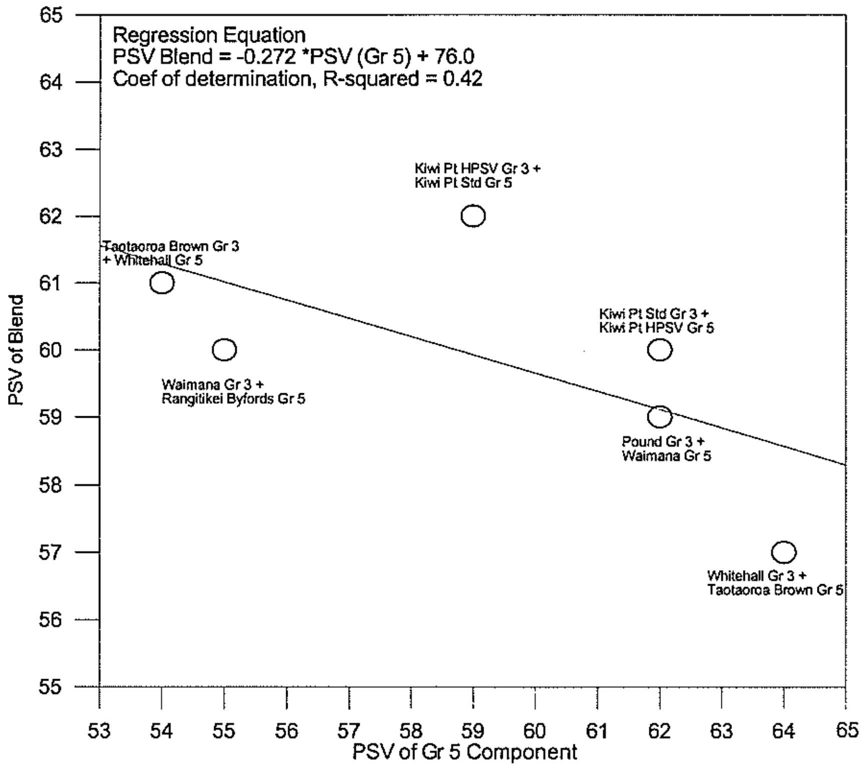
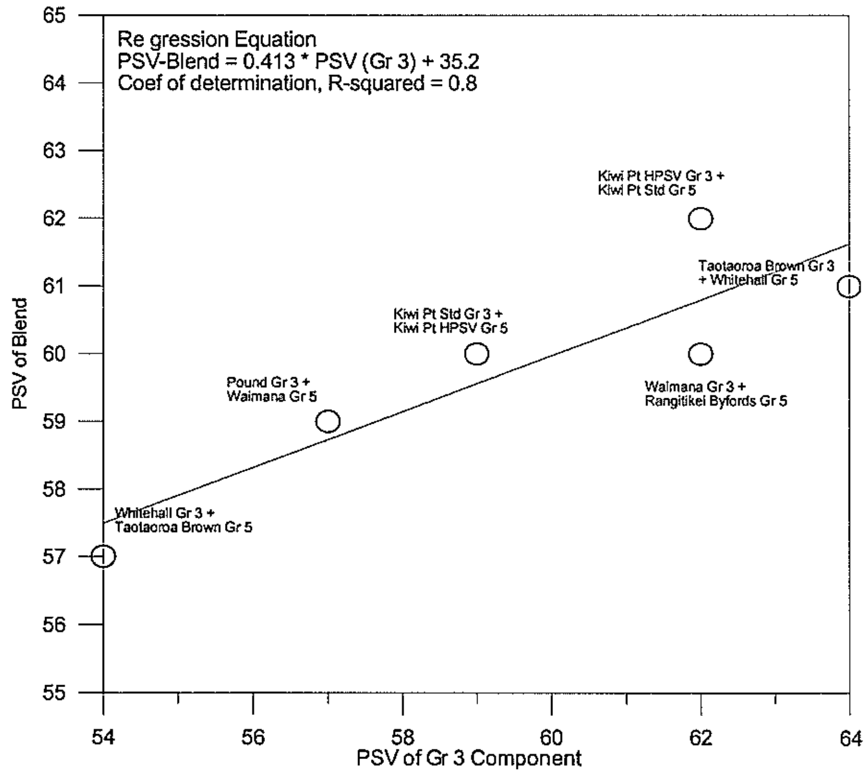


Figure 2.4 PSV aggregate blends vs PSV grade 3 component



3. Standard and Modified Measures of Abrasion

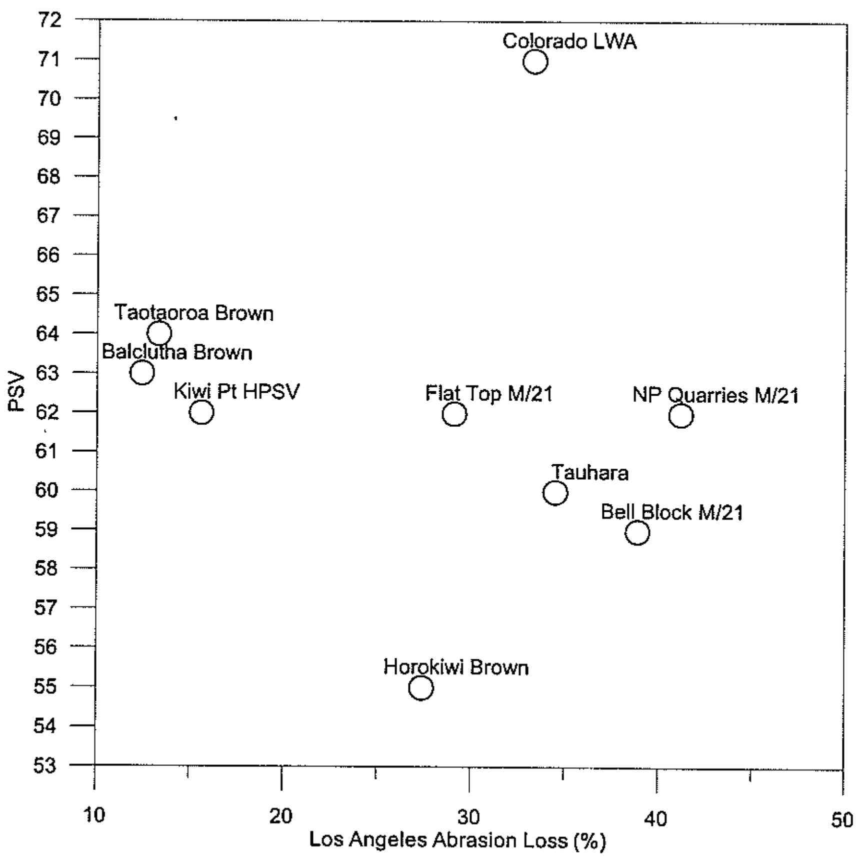
Two types of tests were employed to characterise the abrasion of the available high and standard PSV chip types. These were:

1. Los Angeles Abrasion Value testing using NZS 4407:1991, Test 3.12, "The Abrasion Resistance of Aggregate by Use of the Los Angeles Machine", on a range of high and standard PSV chip types.
2. Abrasion testing using a concrete block tumble abrasion tester, based on AS/NZS 4456.9:1997, "Masonry Units and Segmented Pavers – Method of Test, Method 9: Determining Abrasion Resistance".

3.1 Los Angeles Abrasion Value Testing

A total of nine different aggregates, with known PSVs, were submitted for testing at Opus International Consultants' Hamilton Laboratory. The samples were subjected to 500 revolutions, and the percentage abrasion measured. These abrasion losses are plotted in Figure 3.1 against the measured PSV values for the various chips.

Figure 3.1 Los Angeles abrasion loss vs PSV



The results show that the Los Angeles abrasion rate generally increases as the PSV reduces, although there were two significant outliers: the Colorado lightweight aggregate (LWA) and the Horokiwi Brown. These two materials have similar Los Angeles abrasion rates, but their PSVs differ by 16.

3.2 Concrete Block Tumble Abrasion Testing

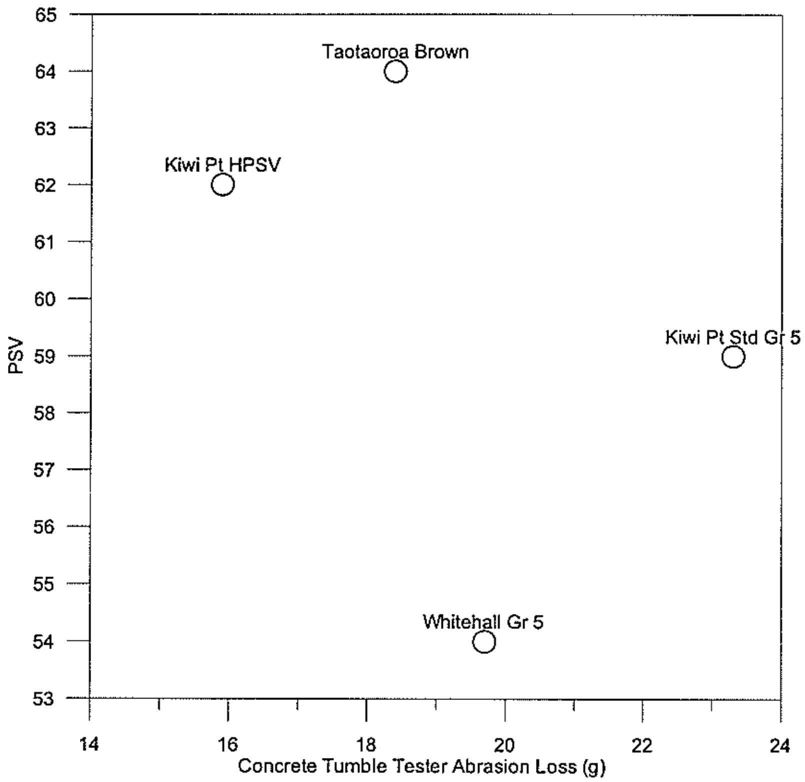
Four of the aggregates used in the aggregate blends described in Section 2.2 were chosen for testing using Opus Central Laboratories' concrete block tumble abrasion tester. These four chips were all grade 5, being (1) Taotaoroa – Taotaoroa Brown (PSV 64), (2) Winstones – Whitehall (PSV 54), (3) Kiwi Point – Standard (PSV 59), and (4) Kiwi Point – HPSV (PSV 62). These four were chosen to present the widest possible range of PSV for chips from different sources (54–64), and chips from the same source but with different PSVs.

The concrete block tumble abrasion tester comprises a square cylinder with four circular holes, 100 mm in diameter, spaced along each side. Samples to be tested are clamped in position over the holes. Inside the drum are 600 steel balls, each 16 mm in diameter and weighing approximately 16 g. This drum rotates at a rate of one revolution per second, causing the balls to tumble and roll over the exposed surface of the sample, thus abrading it. The tester is commonly used for concrete samples and concrete block pavers, with a standard test time of one hour.

Sample blocks of the selected aggregates were prepared by attaching a layer of chips to concrete block pavers using an epoxy resin. Approximately half of the chip was left exposed. The sample blocks were cleaned and weighed, then attached to the tester and tested for 10 minutes to assess the amount of abrasion. It was decided to continue testing for another 10 minutes. The blocks were then weighed again to measure the weight loss due to abrasion. The results of the tests are plotted in Figure 3.2 against PSV.

Figure 3.2 shows that the highest abrasion loss occurred for the chip with a PSV of 59, which falls in the middle of the range tested. Interestingly, the two chips having the largest difference in PSV – the Taotaoroa Brown (at 64) and the Whitehall (at 54) – resulted in similar abrasion.

Figure 3.2 Concrete block tumble tester abrasion loss vs PSV



4. Road Trials

4.1 Construction

Between 2/2/99 and 13/4/00 road trials involving blends of standard and high PSV chips, in the form of two-coat seals and void fills, were laid down at several locations on state highways and on roads around Wellington. These are listed in Table 4.1.

Table 4.1 Road trial sites – types and locations

Site name	Location, reference position	Chip types	PSV Gr3, Gr5, Blend	Type	Length (m)	Date laid
Tirau/ Tepapa	SH5, RS 08/ 5.15-5.35	1. Whitehall Gr 3 + Whitehall Gr 5	54, 54, 53	2-coat	105	13/4/00
		2. Whitehall Gr 3 + Taotaoroa Brown Gr 5	54, 64, 57	2-coat	85	13/4/00
Mangaweka	SH1, RS 780/ 0.8-1.9	1. Waoitahi Gr 3 + Bulls Metal Gr 5	62, 55, 60	2-coat	500	2/2/99
		2. Bulls Metal Gr 3 + Prenters Gr 5	55, 62, 57	2-coat	100	11/2/00
Seatoun Heights Rd	Wellington City	1. Kiwi Point HPSV Gr 3 + Standard Gr 5	62, 59, 62	2-coat	152	19/3/00
		2. Kiwi Point Standard Gr 3 + HPSV Gr 5	59, 62, 60	2-coat	98	19/3/00
		3. Kiwi Point Standard Gr 3 + Standard Gr 5	59, 59, 59	2-coat	100	19/3/00
Nairn St	Wellington City	1. Kiwi Point HPSV Gr 6	—, —, 62	Void fill	45	21/3/00
		2. Kiwi Point Standard Gr 6	—, —, 59	Void fill	75	21/3/00

4.2 On-Road Monitoring Programme

The on-road monitoring programme comprised measurements of skid resistance. At the same time observations of the general condition of the surface were made.

4.2.1 Skid Resistance Measurements

Measurements of skid resistance were made using Central Laboratories' GripTester, a trailer-based device that takes simultaneous readings of drag and load on a single treadless tyre skidding at around 15% of the survey speed. Tests comprised measurements at 50 km/h, and 100 km/h where appropriate, in both left and right wheel paths, in both directions. The data were then separated out into the different trial sections. Average values were calculated for each trial section from the data for both wheel paths and directions.

Surveys were carried out at selected times after the trials were laid. The results of the GripTester measurements are presented in Table 4.2. Figures 4.1 to 4.4 present the variation of grip number with time, for a test speed of 50 km/h, as this is common to each of the four test sites. Also shown in these figures are the PSVs of the blends, and an assessment of the measurement error in the grip number data. Unfortunately, the trial in Nairn Street was sealed over earlier in 2001.

Table 4.2 Skid resistance data – grip number

Site name	Section/chip types [PSV of Gr 3, Gr 5, Blend]	Survey date	Days since laydown	Grip number	
				50 km/h	100 km/h
Tirau/ Tepapa	1. Whitehall Gr 3 + Whitehall Gr 5	25/5/00	42	0.86	0.83
	[54, 54, 53]	27/9/00	167	0.76	0.73
		15/3/01	336	0.73	0.63
	2. Whitehall Gr 3 + Taotaoroa Brown Gr 5	25/5/00	42	0.85	0.80
	[54, 64, 57]	27/9/00	167	0.76	0.71
		15/3/01	336	0.71	0.60
Mangaweka	1. Waoitahi Gr 3 + Bulls Metal Gr 5	26/5/00	479	0.70	0.64
	[62, 55, 60]	26/9/00	602	0.79	0.75
		12/3/01	769	0.66	0.59
	2. Bulls Metal Gr 3 + Prenters Gr 5	26/5/00	105	0.76	0.71
	[55, 62, 57]	26/9/00	228	0.80	0.78
		12/3/01	395	0.66	0.64
Seatoun Heights Rd	1. Kiwi Point HPSV Gr 3 + Standard Gr 5	9/6/00	82	0.79	NA
	[62, 59, 62]	23/11/00	249	0.78	NA
		15/5/01	422	0.72	NA
	2. Kiwi Point Standard Gr 3 + HPSV Gr 5	9/6/00	82	0.80	NA
	[59, 62, 60]	23/11/00	249	0.79	NA
		15/5/01	422	0.73	NA
	3. Kiwi Point Standard Gr 3 + Standard Gr 5	9/6/00	82	0.79	NA
	[59, 59, 59]	23/11/00	249	0.80	NA
		15/5/01	422	0.73	NA
Nairn St	1. Kiwi Point HPSV Gr 6	15/5/00	55	0.86	NA
	[—, —, 59]	17/11/00	241	0.80	NA
	2. Kiwi Point Standard Gr 6	15/5/00	55	0.91	NA
	[—, —, 59]	17/11/00	241	0.85	NA

Perhaps most important, these figures show that the skid resistance on the trial sections has apparently not stabilised to a terminal value. Furthermore, they show that there are apparently only limited differences between the two-coat seals containing combinations of standard and high PSV chips, except on Nairn Street in Wellington, where the standard grade 6 chip resulted in better skid resistance than the higher PSV chip, when used in a void fill. However, this does not tell the full story, as the skid resistance has to be compared with the PSVs of the blends involved in the trials, and also the traffic on the surfaces. As the trials were conducted in tandem with the PSV tests, only some of the blends for which PSVs have been measured were used in the road trials. Table 4.3 lists the measured and calculated PSV values for the road trial sections.

Table 4.3 Road trial sites – PSVs of blends

Site name and details (AADT[1], % CVD[2])	Location, reference position	Chip types	PSV
Tirau/Tepapa (4650, 37%)	SH5 RS 08/5.15-5.35	1. Whitehall Gr 3 + Whitehall Gr 5 2. Whitehall Gr 3 + Taotaoroa Brown Gr 5	54 57
Mangaweka (4710, 23%)	SH 1 RS 780/0.8-1.9	1. Waoitahi Gr 3 + Bulls Metal Gr 5 2. Bulls Metal Gr 3 + Prenters Gr 5	60* 57*
Seatoun Heights Rd (800 est., 12%)	Wellington City	1. Kiwi Point HPSV Gr 3 + Standard Gr 5 2. Kiwi Point Standard Gr 3 + HPSV Gr 5 3. Kiwi Point Standard Gr 3 + Standard Gr 5	62 60 59
Nairn St (800 est., 12%)	Wellington City	1. Kiwi Point HPSV Gr 6 2. Kiwi Point Standard Gr 6	62 59

* = calculated
[1] AADT = average annual daily traffic
[2] % CVD = percentage of commercial vehicles per day.

As the PSVs of the blends are known, the terminal skid resistance can be predicted by reversing the following equation from the TNZ T/10 specification:

$$PSV = 100*SR + 0.00663*CVD + 2.6 \qquad (2)$$

where SR = terminal level of skid resistance (SFC = sideways force coefficient)
CVD = commercial vehicles per lane per day
PSV = polished stone value.

This equation can be reordered as:

$$SR_{terminal} = (PSV - (0.00663*CVD) - 2.6)/100 \qquad (3)$$

Using the data from Table 4.3, the terminal level of skid resistance (SR) can be calculated. The measured grip number (GN) data for a speed of 50 km/h from Table 4.2 can be converted into an equivalent skid resistance using the equation:

$$SR_{measured} = 0.78*GN \qquad (4)$$

Figure 4.1 Skid Resistance – Tirau/Tepapa (50 km/h)

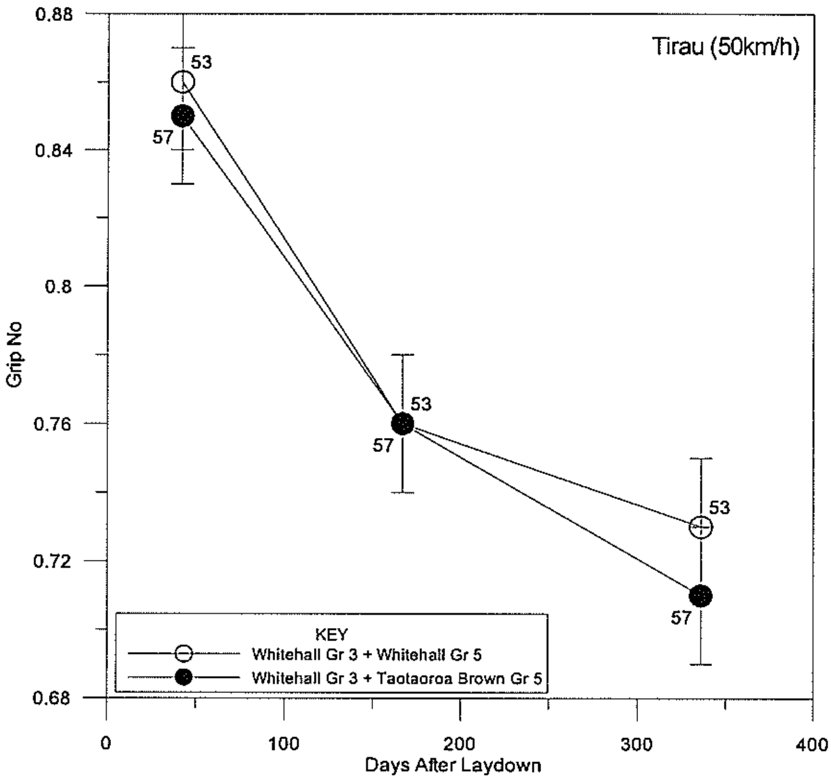


Figure 4.2 Skid Resistance – Mangaweka (50 km/h)

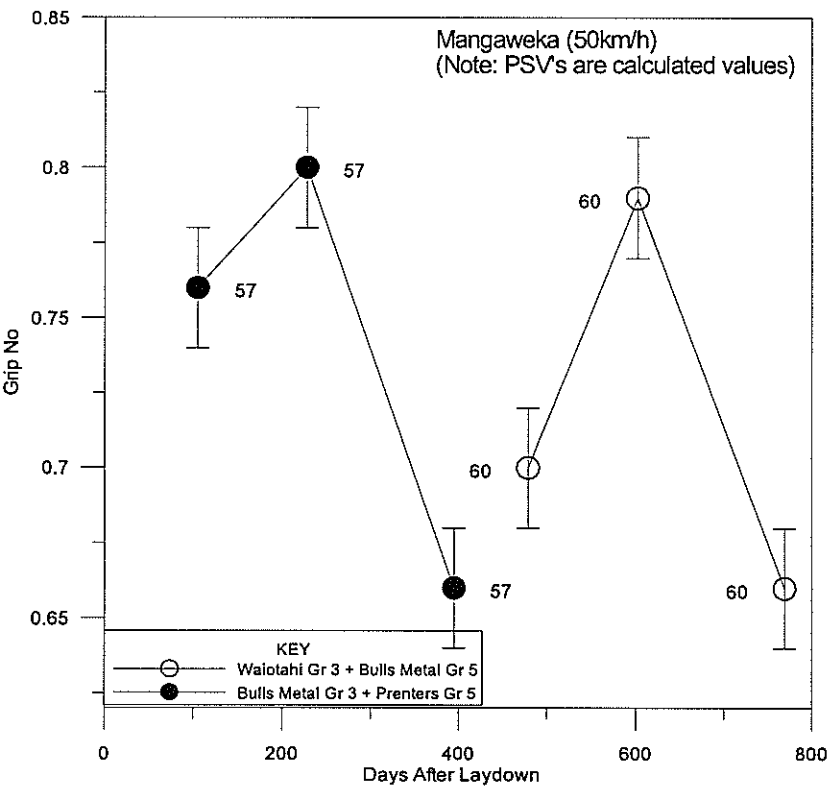


Figure 4.3 Skid Resistance – Seatoun Heights Rd (50 km/h)

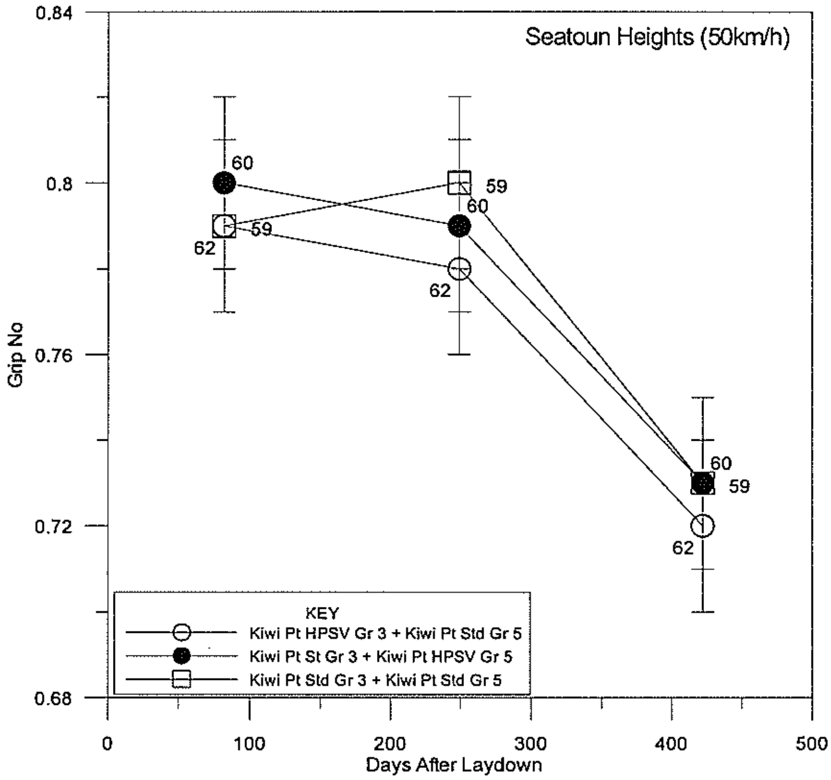
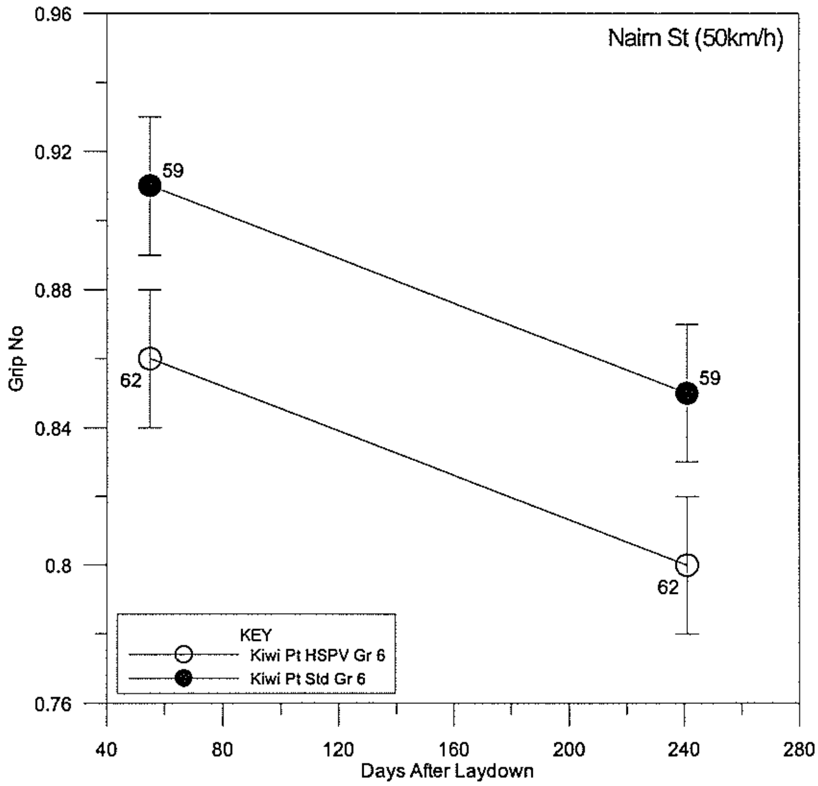


Figure 4.4 Skid Resistance – Nairn Street (50km/h)



The data are summarised in Table 4.4, including the PSV to which the measured skid resistance is equivalent, as calculated using Equations 2 and 4 above.

Table 4.4 Road trial sites – skid resistance and PSV

Site name	PSV	AADT[1]	% CVD[2]	$SR_{terminal}$ (SFC)	$SR_{measured}$ (SFC)	$PSV_{equivalent}$
Tirau/Tepapa	54	4650	37	0.46	0.57	65
	57	4650	37	0.49	0.55	63
Mangaweka	60*	4710	23	0.54	0.51	57
	57*	4710	23	0.51	0.51	57
Seatoun Heights Rd	62	800	12	0.59	0.56	58
	60	800	12	0.57	0.56	59
	59	800	12	0.56	0.57	59
Nairn St	62	800	12	0.59	0.62	65
	59	800	12	0.56	0.66	69

* = calculated
[1] AADT = average annual daily traffic
[2] % CVD = percentage of commercial vehicles per day.

Table 4.4 shows that on all sections the measured skid resistance is approximately the same or higher than that required according to the PSV. The PSV equivalent to this measured skid resistance is also the same or higher than the measured, or estimated, PSV of the blend. However, it is difficult to reach any definitive conclusion about whether the skid resistance behaviour of the blended chip trial sections tends towards the higher or lower PSV because the skid resistance has not stabilised.

4.2.2 Road surface conditions

Road surface conditions were assessed at the same time as the skid resistance measurements were carried out. In general the surfaces have performed reasonably well. Photographs of the test sites and the surfaces (except for Nairn Street, which has been resealed) are presented on the following pages in Figures 4.5 to 4.11.

Figure 4.5 Tirau – Whitehall Gr 3 + Whitehall Gr 5

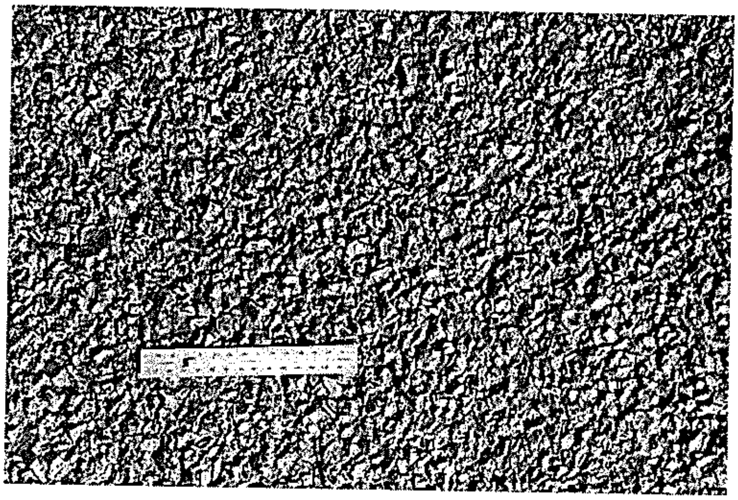


Figure 4.6 Tirau – Whitehall Gr 3 + Taotoaroa Brown Gr 5

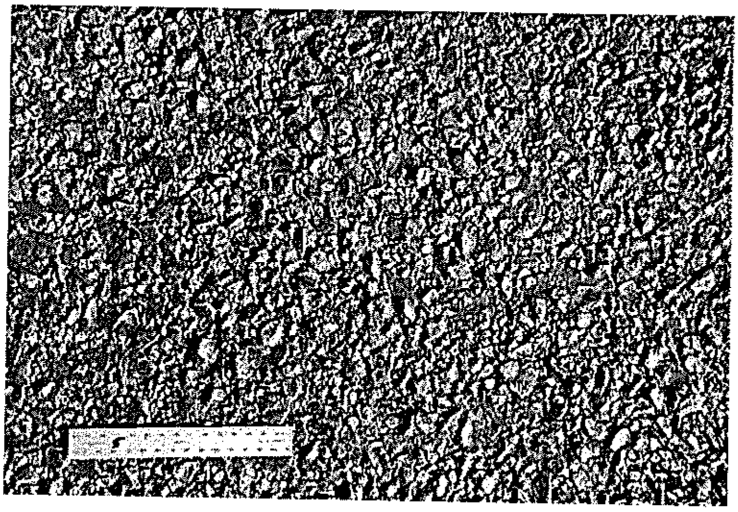


Figure 4.7 Mangaweka – Waiotahi Gr 3 + Bulls Metal Gr 5

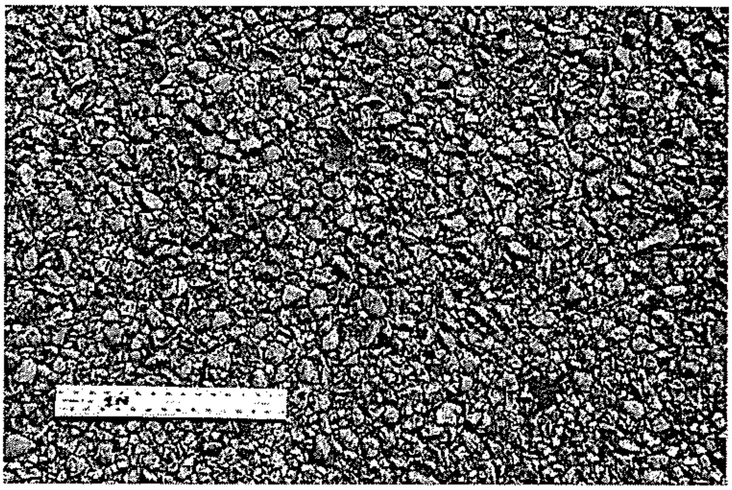


Figure 4.8 Mangaweka – Bulls Metal Gr 3 + Prenters Gr 5

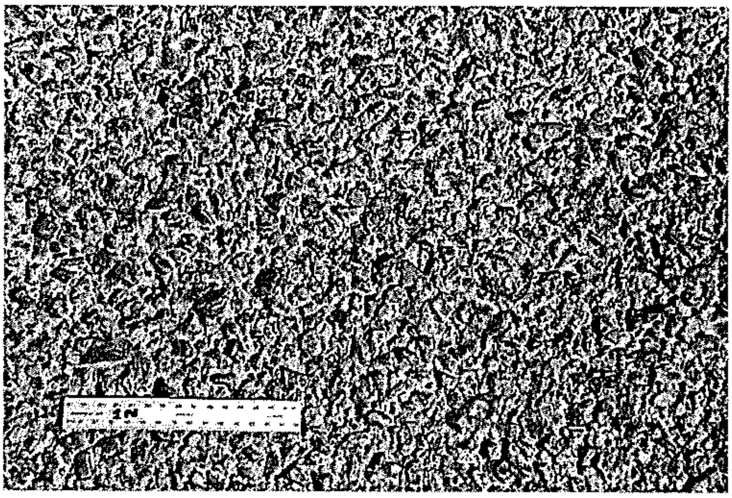


Figure 4.9 Seatoun Heights Rd – Kiwi Point HPSV Gr 3 + Standard Gr 5

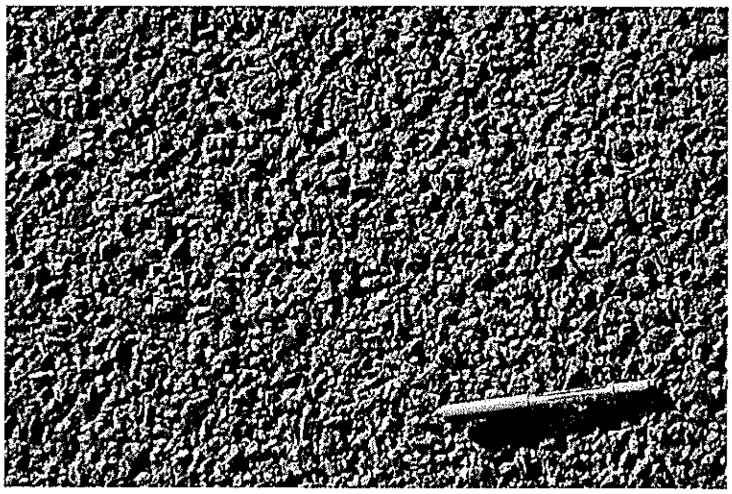


Figure 4.10 Seatoun Heights Rd – Kiwi Point Standard Gr 3 + HPSV Gr 5

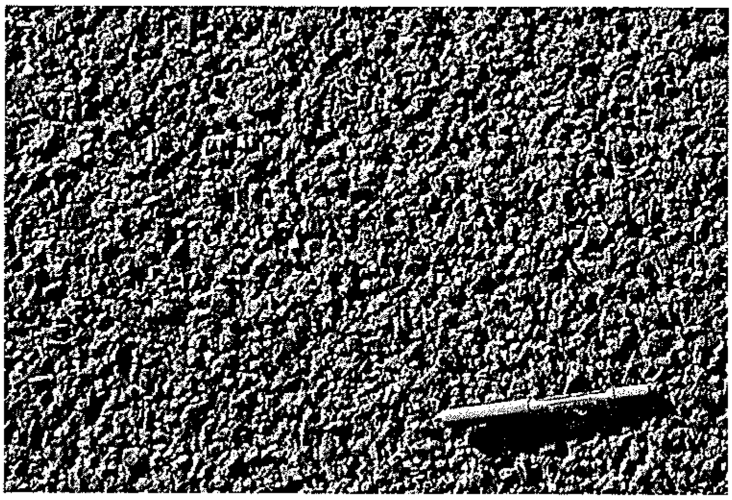
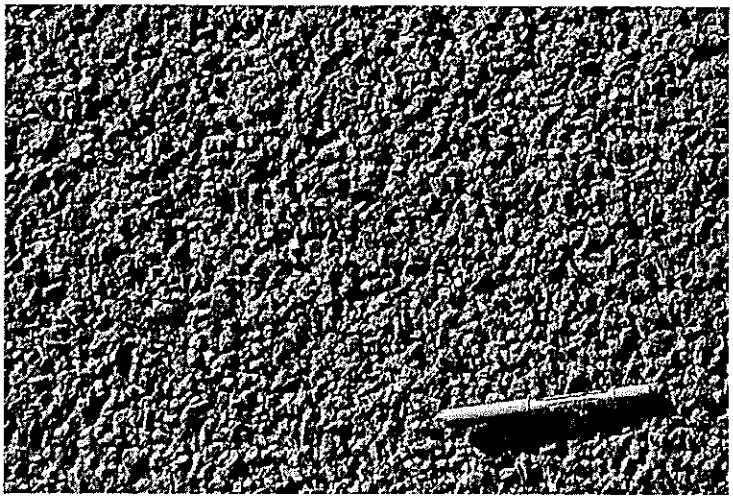


Figure 4.11 Seatoun Heights Rd – Kiwi Point Standard Gr 3 + Standard Gr 5



5. Abrasion in Service

A road trial of high PSV aggregates was undertaken in Wellington. This involved laying sections comprising five different chips on Massey Road. In an attempt to measure the abrasion in service due to traffic, over 1000 chips were extracted from 12 inch (30 cm) cores taken from the left wheel path (LWP) and between the wheel paths (BWP) in one direction. It was thought that the LWP samples would be representative of the trafficked surface, whereas the BWP samples would be largely untrafficked. The chips were separated from the cores and the average least dimensions (ALDs) determined. The distributions of ALDs (i.e. how many chips were in each mm size class) were recorded during the test. Similarly, ALD values were determined for samples of the chips taken prior to the trial laying. It was expected that, if significant abrasion had occurred, it would show up as lower ALD values in the LWP, compared with either the initial pre-trial values, or the BWP data. Table 5.1 lists the mean values for each of the chips, together with the standard deviations (Std dev.) of the distributions.

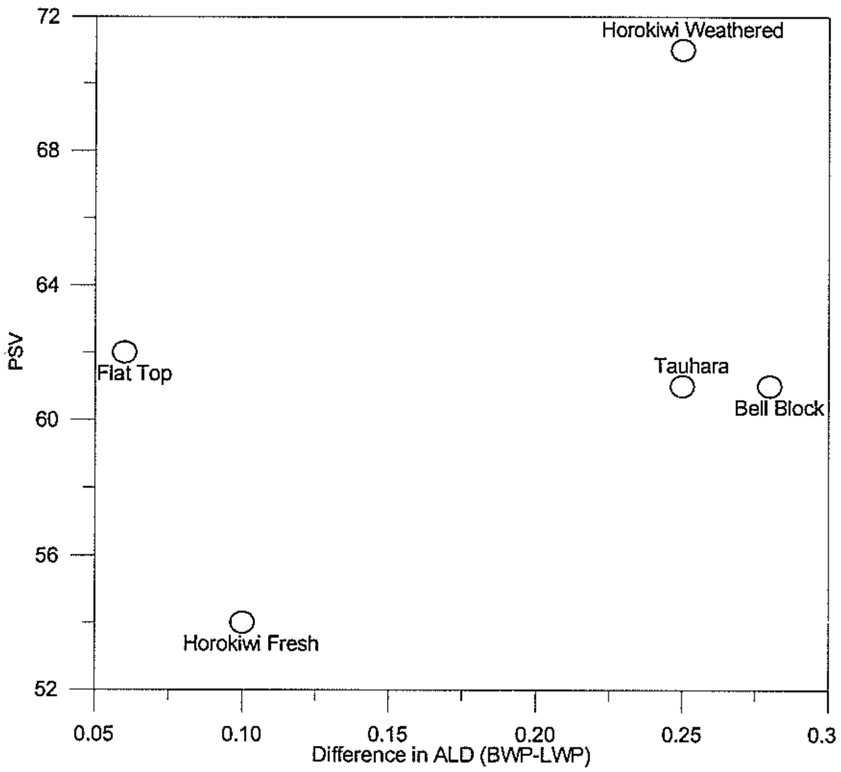
Table 5.1 Massey Road trial – average least dimension

Chip	PSV	ALD (pre-trial)		ALD (post-trial)			
				LWP		BWP	
		Mean	Std dev.	Mean	Std dev.	Mean	Std dev.
Horokiwi Fresh	54	6.38	1.63	6.40	1.31	6.50	1.47
Horokiwi Weathered	71	6.99	1.75	6.81	1.30	7.06	1.40
Flat Top	62	6.89	1.38	7.32	1.43	7.38	1.43
Tauhara	61	8.56	1.75	8.24	1.32	8.49	1.43
Bell Block	61	9.23	2.10	9.28	1.49	9.56	1.73

It can be seen from Table 5.1 that in some cases the pre-trial ALDs were actually smaller than either of the post-trial ALDs. The cause of this may have been either statistical error, given the size of the standard deviations, or that the extraction process had not removed all of the bitumen from the stones. Therefore, a statistical analysis was carried out to compare BWP ALD values with the LWP ALD values to determine whether there was any evidence of significant abrasion loss. This analysis showed that there was no significant difference between the LWP and BWP post-trial ALDs. Consequently, this suggests that the traffic was not sufficient to cause abrasion significant enough to be measured using this method.

However, to see whether there were any trends in the data, the differences between the LWP and BWP data were plotted against the chip PSVs. This is shown in Figure 5.1. No trends are evident in this plot of the data.

Figure 5.1 PSV vs difference in ALD (BWP–LWP)



6. Conclusions

This research project investigated the viability, through laboratory tests and road trials, of blending high PSV and standard PSV chips in two-coat seals and void fills with respect to abrasion, skid resistance and physical performance. The main conclusions of this study are:

- No strong relationships were found between PSV and any of the measures of abrasion that were investigated, including both the laboratory tests and the abrasion in use.
- A strong correlation was found between the PSVs of the aggregate blends and the individual PSVs of the components, with this being dominated by the PSV of the larger chip.
- Skid resistance at most of the sites remains generally quite high, with SFC equivalent values being much higher than the investigatory level specified in Transit New Zealand's T/10 specification. However, skid resistance has not yet stabilised, which means that the question of whether it is the high or the standard PSV chip that dominates cannot yet be answered.
- The road trials laid have stood up reasonably well to more than a year's traffic.

7. Recommendations

Although the road trials appear to be performing satisfactorily physically, there are questions about their durability and skid resistance performance over the longer term. Consequently, we recommend that:

- Monitoring the skid resistance of the trial sections be continued until skid resistance values have stabilised, to confirm the predictive equation from Transit New Zealand's T/10 specification.
- Monitoring the physical condition be continued to determine if any visible aggregate abrasion has occurred, at which time cores from the left wheel path and between the wheel paths should be taken to determine the degree of abrasion that has occurred, and to investigate whether this can be related to the properties of the chips, including the PSVs of the blends involved.

8. References

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