COMPARISON OF THE WEHNER - SCHULZE AND PSV TEST FOR ESTIMATING THE POLISHING RESISTANCE OF NEW ZEALAND CHIP SEAL AGGREGATE

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ABSTRACT

New Zealand research has shown that the prediction of the on road friction performance of a chipseal from the British Polish Stone Value (PSV) test on the aggregate is extremely variable, and aggregate source appears to be a better predictor.

The Wehner - Schulze test method, developed in Germany in the 1960s and commonly used in Germany, was investigate as a possible alternative to the PSV test. The Dresden University of Technology agreed to perform the Wehner - Schulze tests on New Zealand aggregates. Six materials were tested that ranged in PSV from 46 to 61.

Although the Wehner – Schulze test can be used to test asphalt mix samples taken from the road, the very coarse and angular nature of typical New Zealand chipseals was considered likely to be too harsh on the equipment and thus aggregate samples rather than road samples were tested.

It was found that the PSV and Wehner - Schulze test results were very highly correlated with each other. The conclusion is that the Wehner - Schultz method, when applied to aggregate samples, is not a better method than the PSV test in predicting the on road friction performance of an aggregate.

INTRODUCTION

The aim of this research was to determine whether the Wehner - Schulze (WS) test is a better and more appropriate method to identify surface friction properties of chipseals than the PSV test. Surfacing aggregate is currently selected according to the NZTA T/10 specification (Skid Resistance Deficiency Investigation and Treatment Selection) The specification of aggregates for use on New Zealand roads includes the PSV test. This test and acceptance criteria were adopted in New Zealand in the 1990s based on British experience, as the best available method to predict the road friction performance of aggregate.

Research performed by a number of people in New Zealand since then has shown that the prediction of performance by the PSV test is extremely variable. Current research by Cenek et.al. (2008) has also shown that the test is a poor predictor of on-road skid resistance performance, and aggregate source appears to be a better of SCRIM value predictor. If aggregate source became the main predictor of on- road skid performance an aggregate supplier would need to conduct trials covering a range of traffic and site conditions in order to get the material approved. The specifier would also face the risk that the source properties (that affect skid resistance) may have changed from those at the time of the trial, as the consistency of the source rock could not be assured.

The WS method, developed in Germany in the 1960s and commonly used in Germany, has the ability to test samples taken from the road. It therefore has the potential to measure aggregate polishing when the aggregate orientation is typical of a normal road surface. In contrast the PSV test relies on an operator hand placing stones so there are no sharp aggregate protrusions.

Road surface friction is often considered to be controlled by the macro and micro texture of the surface .In a chipseal the microtexture is related to the surface texture of the individual stones the macrotexture is related to the gap between the stones. The gap between stones and the gap in the tyre tread can help to release the water pressure. If the tread depth is low and the gaps between the stones are small, then any water between the tyre and the road surface is unable to escape. This will cause the tyre to slide on a water film and the road surface to lose friction during wet weather. The road surface can also lose friction when the stones are polished (loss of microtexture) due to traffic. Some types of aggregates are more prone to polishing than others.

Besides micro and macro texture, friction is affected by the hysteretic excitation of the tyre by the surface. This is affected by the shape and packing of the aggregate. The WS test has the ability to test road samples and thus the aggregate packing and hysteretic effect can be tested.

It was hoped that the test could be used on chipseals so that a realistic surface could be tested that would include the three factors given above.

DESCRIPTION OF APPARATUS

Wehner - Schulze test

The test was developed in the 1960s at the University of Berlin and had been used mainly as a research instrument. In the 1990s the instrument was further developed and became commercially available. It is now being considered as a European standard test for assessing the polishing resistance of pavement surfaces. The instrument is shown in Figure 1.

Figure 1: Wehner - Schulze (WS) test instrument

The instrument consists of two main parts: the accelerated polisher and the skid resistance tester. The polishing part consists of three conical rubber rollers (see Figure 2).

Figure 2: Accelerated polishing part

The skid resistance tester consists of three rubber pieces, (which is shown in Figure 3).

Figure 3: Main skid resistance tester

The method states that the specimens must be as flat as possible to avoid unbalancing effects.

For testing aggregate the chips were placed manually on the respective testing plates and then epoxied into position (Figure 4). The final specimens are 225mm in diameter.

Figure 4: Wehner - Schulze

The standard polishing operation involves the roller head rotating at 500 rpm for an hour giving 90,000 roller passes over the sample surface. Each roller is independently loaded to a contact pressure of approximately 400kPa and polishing is performed with a 5% quartz powder in 95% water.

Once polishing is complete the specimen is washed and placed on the skid resistance tester. Figure 3 shows the rubber pad (the third is not clearly visible). The disk can rotate on the specimen at a range of speeds. In the standard test, the rubber pieces are accelerated to rotate at 3000 rpm. This is approximately 100 km/h. Water is applied to the surface to approximate a 0.5mm film thickness and the tester lowered to the surface. The drum with attached rubber pads is allowed to decelerate whilst the sensor system measures the torque from the drum and the attached computer calculates friction continuously.

The coefficient of friction at 60km/hr is taken as the test result although other speeds could be used.

PSV Test

The PSV test was developed in Britain and has commonly been used in New Zealand and Australia.

The test consists of hand placing 10-7mm chips onto a curved plate using epoxy resin to secure them. (Figure 5)

In contrast to the WS test specimens, each plate is only 45mmx 90mm. the plates are mounted on a revolving drum and polished through the action of a loaded solid rubber tyre with water in two stages. The first stage consists of “conditioning” the specimens with coarse emery corn for three hours and the second ‘polishing” stage using a fine emery flour for a further three hours.

After polishing the specimens are removed washed and tested for friction using the British Pendulum Tester with a special rubber slider. In each test a control stone is also used and the final result adjusted if necessary. The results are reported as the British Pendulum number obtained on the surface.

LITERATURE REVIEW

Alan et. al. (2008) investigated and compared the prediction of skid resistance from the WS and PSV test methods for a range of UK asphalt surfacing mixes. The WS results suggested that ”optimum texture depth would appear to be 1.0 mm with further improvement achieved by decreasing the nominal aggregate size or increasing the PSV of the aggregate used”. Their test results show a decrease in WS friction coefficient with increasing PSV from 55 to 65 and then a sudden increase for the mix made with PSV 70. They also noted that their assessment was based on a limited number of asphalt types, aggregate types, and nominal size of the mix and bitumen type combinations possible in the UK.

It would be expected that generally, PSV values would increase as the WS friction coefficient increases but in Alan et.al. (2008) results show that friction of the first three asphalt mixtures decreased with PSV (see the figure 5).

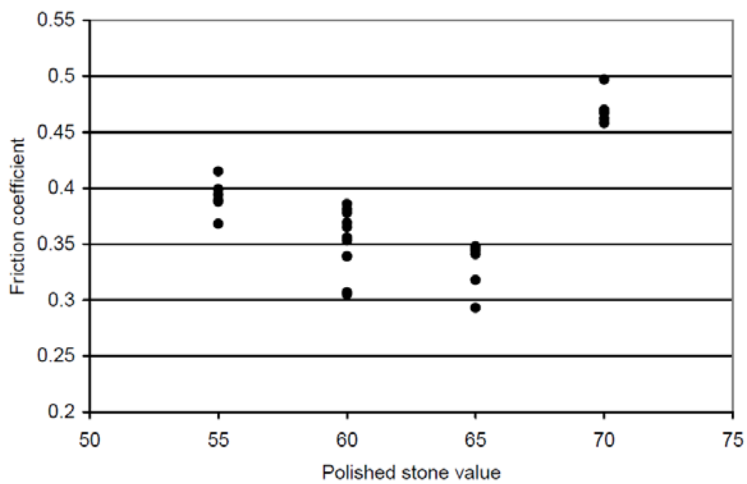

Figure 5: Friction coefficient from the WS test against PSV for a range of asphalt mixes (from Alan et. al. (2008)).

These results indicate that the WS friction coefficient is being influenced by factors other than the PSV. Alan et.al (2008) noted that the advantage of the WS machine is able to test asphalt mixtures of laboratory prepared and in-situ sample as well as crushed, uncoated aggregate.

Woodbridge et.al. (2006) in assessing the WS test noted that “the use of different coarse and fine aggregate in an aggregate mix has shown differences in skid resistance after polishing compared with specimen made from a single aggregate type”. This shows skid resistance is not only depend on PSV but also particle size in the mixture.

Wilson and Black (2008) noted that “the actual PSV of the aggregate sample generally predicts the same ranking order of the initial level of the three greywacke aggregates tested with the” dynamic friction tester “prior to any accelerated polishing, however it does not predict well the equilibrium skid resistance as reflected in field”. They noted that the time taken to polish and the ranking order of the equilibrium skid resistance for the greywacke and melter slag samples which they analysed were not the same as the PSV ranking.

All the literature notes that the WS test because it can test mixes and cores from the road has the potential to better predict road surface friction than the PSV test.

The use of the WS test on chipseal surfaces does not feature in the literature although Woodbridge et al (2006) noted that the hand placing of chips could be used as a method of assessing aggregate polishing in a chipseal.

DATA SELECTION

A current NZTA research project is looking at the relationship between quarry source, PSV and the SCRIM value achieved on the road. The research has found that quarry source is a better predictor of SCRIM value than PSV. Preliminary results for the Northland and Hawke Bay regions were presented in a paper at the New Zealand Transport Agency and NZIHT 9th Annual Conference (Cenek and Davies 2008).

The research has focused on the prediction of road surface friction (SCRIM Value) in terms of a range of geometric and traffic variables and with aggregate properties.

The basic form of Cenek and Davies relationship is:

SCRIM=Constant + f(macrotexture)+f(curvature)+f(gradient)+f(skid site category)+f(traffic adt) +f(age) + f(seal type) +f(urban/rural) + f(aggregate source)

The basic relationship can be considered as:

SCRIM = constant + f(geometry) + f(traffic) + f(age) + f(aggregate source)

The aggregate source estimate is therefore a value that can be adjusted to correct the rest of the relationship.

The analysis of the total RAMM data base (covering all New Zealand highways) has been completed. The aggregate source estimator for estimating SCRIM coefficient is plotted against the respective quarry PSV values in Figure 6.

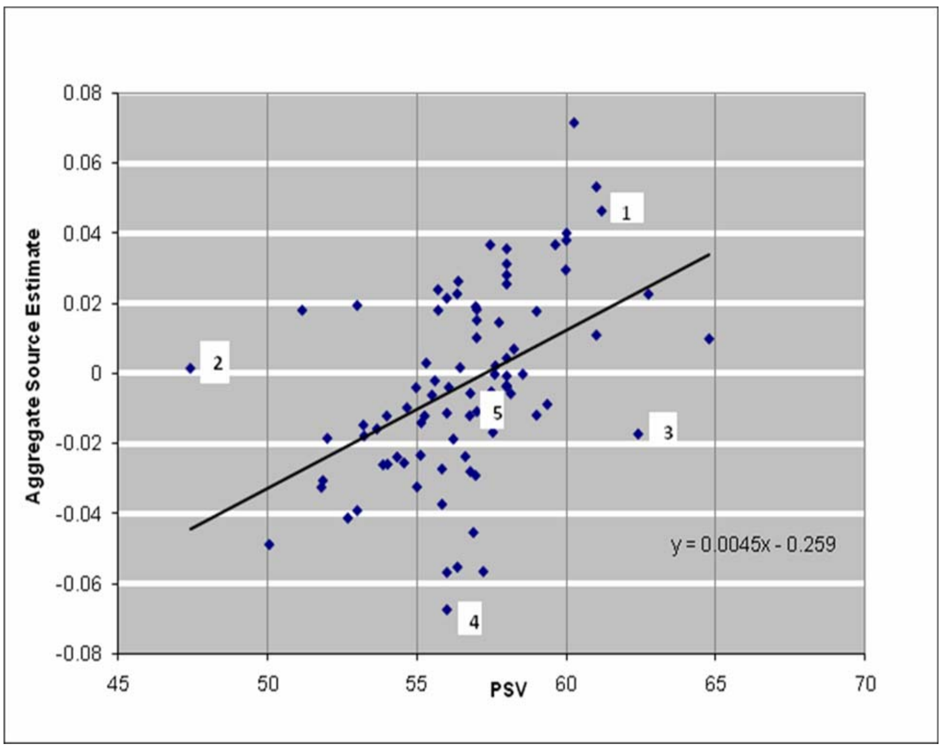

Figure 6: Relationship between PSV and Aggregate Source Estimate

The aggregate source estimate is the aggregate effect on the resulting equilibrium SCRIM value. The higher the number the greater the effect. It would be expected that if the PSV value was a good predictor of SCRIM values then there would be a strong correlation between the aggregate source estimate and PSV. It can be seen in Figure 6 that there is a trend but there is a lot of scatter.

This data was used to choose five material sources for comparison of their PSV and WS values. The five data points shown in the figures are either high, low PSV values or in the line. A sixth source that appears to be performing well on some roads was also selected –Melter slag, a by product of steel manufacture.

Table 1 gives details of the selected quarries.

Table 1: Selected quarries

Quarry No.	Pavement Source	PSV	Aggregate Source Estimate	District
1	Waiotahi	60	0.071482	Gisborne
2	Waotu Quarry	47	0.0014847	Hamilton
3	Balclutha	62	-0.01724	Dunedin
4	Gore_Gravel	56	-0.067292	Invercargill
5	Whitestone	57	-0.0052299	Christchurch
6	Slag material	-	-	Napier

TESTING

The WS tests were conducted at the Technical University Dresden. Two specimens were prepared and tested from each aggregate sample.

The PSV tests were performed at Opus Central Laboratories in accordance with BS EN 1097-8. The results are given in Table 2. The expected PSV is obtained from the respective quarries site office.

Table 2: Test results

Quarry No.	Sample No.	Aggregate Source	District	Expected PSV	Test results	
					PSV	Wehner - Schulze
1	6/10/19	Waiotahi	Gisborne	60	60	0.41
2	6/10/61	Waotu Quarry	Hamilton	47	51	0.31
3	6/10/21	Balclutha	Dunedin	62	61	0.42
4	6/10/22	Gore Gravel	Invercargill	56	54	0.37
5	6/10/28	Whitestone	Christchurch	57	55	0.36
6	6/10/18	Slag material	Napier		46	0.33

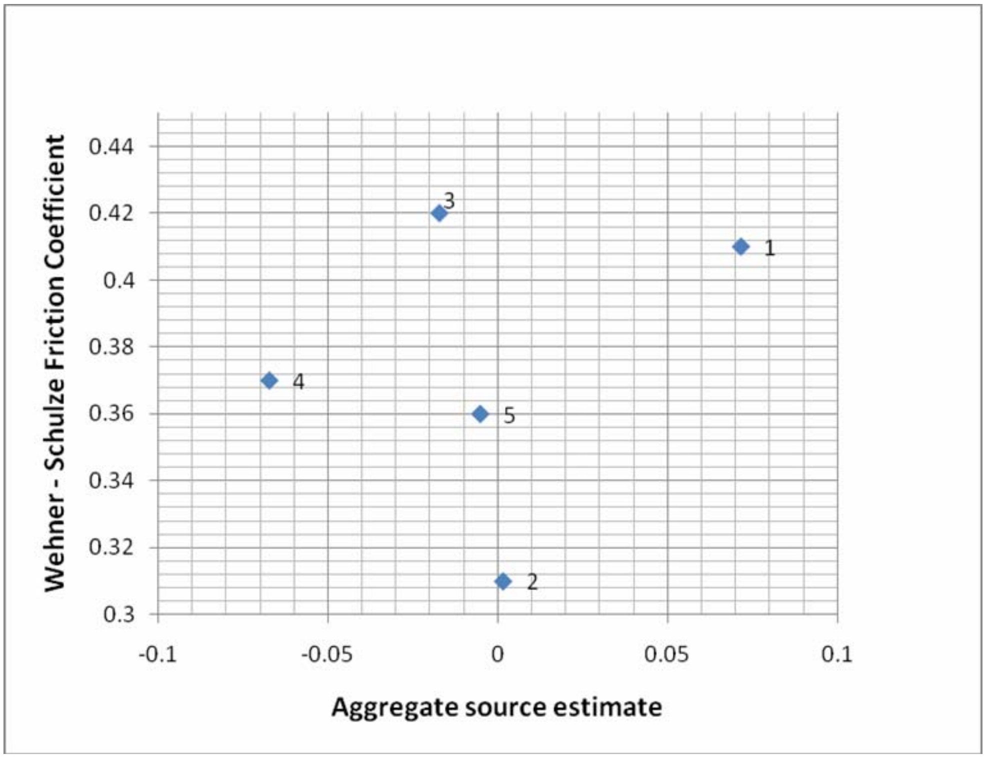

Figure 7: Relationship between WS and aggregate source estimate

Figure 7 shows the relationship between the aggregate source estimate and the WS friction coefficient. It can be seen that there is not good correlation.

Figure 8 shows the relationship between the WS value and the PSV. In this figure three test results on gritstone, granite and limestone from Woodbridge et.al. (2006) are also included.

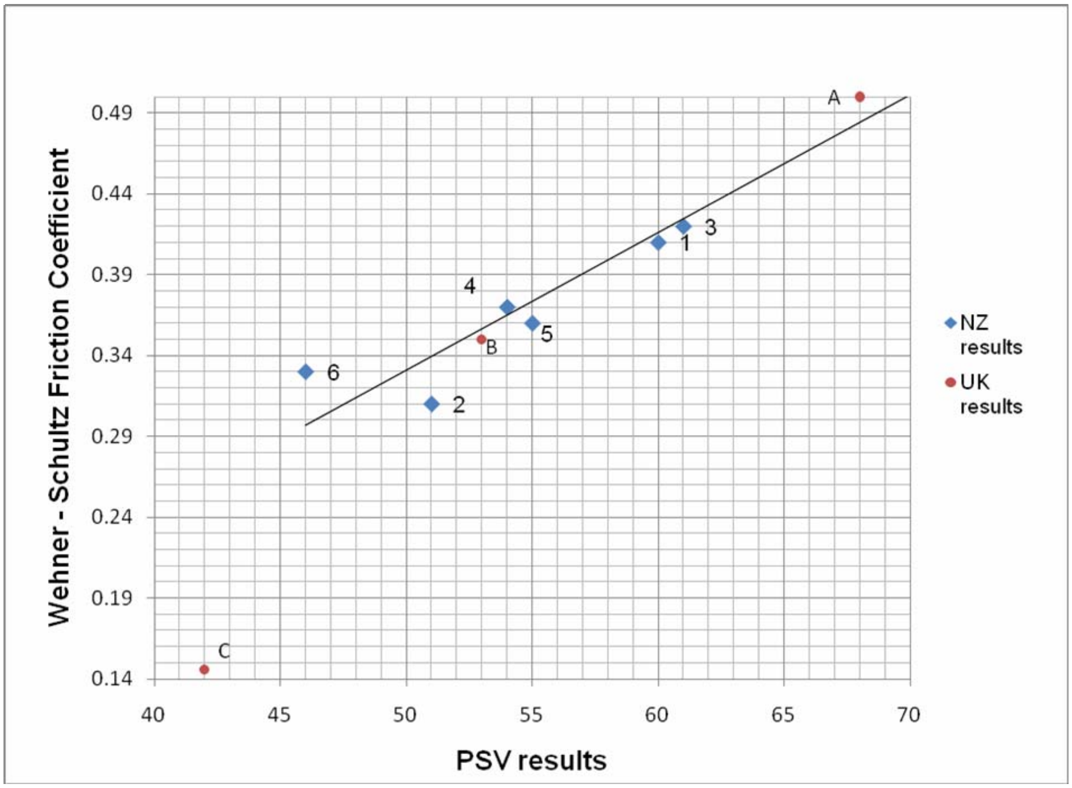

Figure 8: WS test results against PSV results (three points A, B and C from Woodbridge et. al. (2006))

DISCUSSION AND CONCLUSION

If the WS test correctly predicted the field SCRIM value then there should be a strong correlation in figure 8 between the aggregate source estimate and the WS value. The scatter in Figure 8 is similar to that in Figure 7 which is the PSV v WS value relationship. Both figures show that the tests are not good predictors of on road performance

There is a good correlation between the WS value and PSV as can be seen in Figure 9. Two of the three British materials have similar results to the New Zealand data which confirms that the testing performed has been consistent.

There is one significant outlier in Figure 8 (the British limestone, (pointC) which has a low PSV and WS value.

The slag (No 6) which is not a natural aggregate shows a similar relationship to WS values as the natural aggregates.

The test results have not confirmed that the WS is better than PSV test in terms of predicting the field performance of chipsealing aggregate.

The WS specimens were made by very closely packing the chips to obtain a flat surface. In reality the chips are not packed like this in a chipseal surface. The PSV specimens are also very similar in that the chips are hand placed to obtain a smooth surface.

Tyre road friction is affected by the hysteretic excitation of the tyre by the chip. By placing the chip in a flat position the degree of hysteretic excitation will be lower than when the chips are protruding.

From the literature the WS test is considered to have potential to evaluate bituminous mixes it was thus disappointing to find that we could not test high textured chipseals. If a core of a chip seal surface cannot be tested using WS test then the test in its present form is not appropriate for use in New Zealand.

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AUTHOR BIOGRAPHIES

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