TNZ P17 Notes:2002

NOTES FOR THE SPECIFICATION FOR BITUMINOUS RESEALS

These notes are for guidance and should not be included in the contract documents.

1. SCOPE

This specification defines the performance requirements for bituminous reseals. The specification covers the use of single coat seals where the chip is Grade 4 or larger and multilayer seals where the larger chip is also Grade 4 or larger. Texturising seals and void fills are also covered by the specification.

2. QUALITY REQUIREMENTS

The standard contract documents (SOMAC) cover the requirements for the quality plan.

The Engineer is required to assess the seals at the end of the maintenance period, complete a performance criteria report and forward this to the Contractor within 20 working days to enable the Contractor to expedite any necessary repairs.

3. TREATMENT SELECTION

The P17 specification is intended to apportion responsibility/risk in a more equitable manner than provided for under the P4 specification, and to provide an environment to encourage innovation. This specification defines outputs and a reasonable warranty period.

Responsibility for the treatment selection process remains with the Engineer and the Contractor takes no responsibility for the adequacy of that process. The Engineer determines the correct treatment selection in relation to the existing pavement condition, and specifies a design life that is both reasonable and achievable. The treatment selection process determines what treatments will be carried out to ensure cost effective life cycle maintenance of the network. Definition of treatment will differentiate between for example, routine maintenance, resealing, recycling, rehabilitation etc. If the treatment selection process selects a reseal as the most appropriate treatment then the Engineer is responsible for selecting the most appropriate sealing system. This includes minimum chip size for matching previous seals and design life, need for a multilayer seal, and binder type. Through this process the resealing contract's cost estimation is prepared. The binder grade to be used *is* specified because this input has long term performance ramifications that extend well beyond the set maintenance period.

The consultant shall complete sufficient testing of the site to substantiate the treatment selection.

The design and construction of the specified treatment is the responsibility of the Contractor.

The Contractor shall be responsible for aspects such as binder application rates, binder formulation (cutter content, adhesion agent.), construction procedures, monitoring and maintenance if required.

The Contractor may consider that the site conditions are not appropriate for the treatment specified by the Consultant. Under these circumstances the treatment may be varied as described in Section 6 and 7 below and Section 4 of the specification.

It is expected that the Consultants treatment selection should be predominately correct and should not need to be challenged on a significant number of sites.

The contractor/consultant relationship further explained and illustrated in Appendix 1C of Transit New Zealand's "State Highway Asset Management manual".

4. SEAL LIFE

The basis of this specification is that those seals that comply with the specified performance requirements will have a design life as given in Table 1 and Table 2.

TABLE 1: Single Coat Seals Design Life Years

Chip Grade	**Traffic Volume (ADT)**						
	<100	**100-500**	**500-2000**	**2000-4000**	**4000-10000**	**10000 20000**	**>20000**
	YEARS						
2	16	14	12	11	10	9	8
3	14	12	10	9	8	7	6
4	12	10	8	7	6	5	4

TABLE 2: Multilayer Seals Design Life Years

Larger Chip Grade	Traffic Volume (ADT)						
	<100	100-500	500-2000	2000-4000	4000-10000	10000 20000	>20000
	YEARS						
2	18	16	14	13	12	10	9
3	16	14	12	11	10	8	6
4	14	12	10	9	8	6	4

The above Tables have been analysed to construct a best fit relationship between traffic volume, chip size and life. The proportion of heavy commercial vehicles was assumed to be typical of the State Highway system at 10% and the ADT was converted to equivalent light vehicle (elv). The best fit equations are given in the specification.

If there is evidence that the above design lives are inappropriate for the site then alternative design lives can be included in the specific contract requirements. This could occur where a holding seal is required on a section of road that is due for shape correction in 3 years. In this case a three year design life would be specified. The reseal history of the site must be taken into account in determining the most appropriate design life. If previous seals on the site have flushed before reaching the design lives given in the above tables then consideration must be given to reducing the design life from the default values. The design life must be included in the schedule.

5. PAVEMENT CONDITION

The pavement to be sealed is presumed to be in a condition that will allow the construction of a reseal in general accordance with the guidelines given in the Transit New Zealand (Transit) Bituminous Sealing Manual. The performance requirements would not apply to areas where:

(a) the texture depth variations were outside the guidelines given in the Bituminous Sealing Manual;

(b) the hardness of the surface of any repairs was such that when tested with the hardness test the indentation was more than 1 mm different from the average of the surrounding pavement;

(c) the area to be sealed is soft e.g. relatively new grader laid asphalt where the average hardness test value is greater than 5 mm.

Where any of the above three conditions exist then the Contractor shall inform the Client and either the area sealed to the Client's design or, if the areas are isolated, they shall be so located that they are not assessed during measurements for compliance with this specification.

The introduction of a hardness test is considered necessary as the sealing contractor does not always have control over presealing repairs. The application of a chipseal over a soft patch is known to lead rapidly to flushing due to chip embedment. There is limited experience of the test in New Zealand, and the recommended difference of 1 mm may need alteration as experience is gained. THE TEST WILL NORMALLY ONLY BE REQUIRED IN CASES OF DISPUTE.

The test method being used was developed in South Africa and is being used in Australia. It consists basically of measuring the indentation of a 19 mm ball bearing when subjected to one blow of a Marshall hammer. This hammer is normally used for compacting blocks of hot mix asphalt and is readily available.

6. HIGH STRESS AREAS (TRAFFIC STRESS)

In areas of high stress there may be a difference of opinion between the Contractor and Client on whether the specified treatment is appropriate.

Providing the Client is satisfied with an alternative sealing system, there is no need for a payment reduction. Whether an alternative treatment or the initial treatment is used there may be a need to agree on alternative acceptance criteria. This could include an allowance for some small areas of chip loss in the highest stressed areas.

If the Client takes responsibility for the section due to the Contractor not being willing to take the risk, then it shall be performed in accordance with TNZ P/4 Specification, i.e. method based. A reduction in payment of 15% for the section is made in order to cover the costs of the Client’s increased design and supervision. The payment reduction may also encourage the Contractor to take responsibility rather than attempt to persuade the Client to take over all areas where there is an element of risk.

The Engineer may request from the Contractor, copies of all investigation details required to design the seal in the event that sealing is carried out under the TNZ P4 specification.

7. TRAFFIC VOLUMES

The client shall detail in the contract documents the traffic volumes in terms of average annual daily traffic (AADT) and the estimated percentage of heavy commercial vehicles. It shall be stated if these volumes are measured or estimated. Where measured, the year of measurement shall be given.

If the pavement is subjected to seasonal fluctuations in traffic volumes, e.g. a beach resort, then this shall be stated.

Where the traffic volumes given in the contract documents are subsequently found to be significantly lower, the Contractor can claim for the extra bitumen based on the traffic factors given in the Bituminous Sealing Manual.

Where the traffic volumes given in the contract documents are subsequently found to be significantly higher, there is provision under NZS 3910 for a variation to the contract.

It is the Engineer's responsibility to supply traffic volumes for the road sections. As these volumes will be used by the Contractor for seal design and for testing for compliance, it is important that they are reliable.

8. ENVIRONMENTAL AND ECONOMIC CRITERIA

This specification is for all traffic volume roads but as yet the criteria for tyre wear and rolling resistance have not been included. It is considered that there is at present insufficient information available to enable realistic specification criteria to be incorporated at this time.

There is some control exercised by specifying a minimum Average Least Dimension (ALD) for the sealing chips. It would be expected that contractors would use a chip size close to this minimum and not use chip of a larger grade than is stated in Schedule A.

If a harsh surface texture is considered unacceptable due to noise or for aesthetic reasons, e.g. pedestrians, then a maximum texture depth could be included in Schedule A.

9. DESIGN

The consultant is to specify the minimum ALD in Schedule A in the tender documents based on life cycle considerations. The Consultant is responsible for the initial treatment selection and it is expected that the seal designs should reflect a realistic and achievable design life as specified in Schedule A. A new column has been included for the Consultant to include the reason for resealing to support the specified design life, along with additional factors which may have dictated why a particular treatment was proposed, to assist the Contractor when considering alternative treatment options.

10. MATERIALS

The Contractor is required to detail in his quality records the procedures that will be followed to ensure the materials used conform to the specification.

Testing frequency would be expected to be in accordance with the New Zealand Bitumen Contractors’ Association (BCA) guidelines.

Where the Client requires a fluxed binder, this shall be detailed in Schedule A. Flux is normally only used in colder areas where the normal bitumen grades are considered too hard. Ultimately it is desirable that the decision on the quantity of flux be made by the Contractor, but at this stage it is left as a Client decision.

In order to minimise the risk of bleeding and subsequent pick up by tyres some regions may wish to specify a polymer modified binder with a minimum Softening Point. There has been difficulty in determining that the required softening point is being obtained as in many cases a diluent such as kerosene is added to assist in obtaining initial adhesion. The clause in Section 12.3 of the specification allows the specifier to insert a minimum softening point in the schedule. As the contractor is responsible for maintenance for the first year the client is concerned that the minimum softening point is obtained from this point on. Research has demonstrated that after one year approximately 80% of the added kerosene has evaporated and thus the specification requires the contractor to demonstrate that the binder with 20% of the diluent added on the day of sealing will result in the minimum softening point being obtained.

As the contractor adds more diluent then more polymer will be required to comply with the requirements. It is hoped that this requirement will help ensure that polymer modified binders are applied during hot weather.

Where low temperature flexibility is a concern then some control can be maintained by specifying the bitumen grade to be used.

As the performance requirements are based on the ALD of the chip being used, assurance of the chip uniformity is required. The texture depth requirement at one year is sensitive to the chip ALD and a maximum variation in ALD of 0.5 mm between stockpiles is specified. A change in ALD of 0.5 mm will affect a change in the required texture by approximately 0.05 mm.

11. SURFACE TEXTURE

Surface texture appears as the performance requirement under a number of criteria. Although values for criteria such as skid resistance and light reflectance are lower than that given for texture uniformity, they are included as they are minimum values for these criteria.

12. REQUIREMENTS

12.1 Single Coat

The texture depth requirements given in the specification are based on the premise that the design lives given in Table 1 will be met. It is presumed that if sufficient bitumen of the specified grade is applied to ensure that the seal performs satisfactorily for 12 months, then subsequent chip loss will not occur before the end of the design life.
The main requirement is to ensure that excess bitumen has not been applied so that premature flushing occurs.

A background to the development of the acceptance criteria is given in the report "Background to the Development of the Transit New Zealand Performance Based Chipseal Specification P/17 Texture Requirements" by J Patrick, Opus Central Laboratories Report 99-526242.04.

The data has shown the following basic relationship holds for single coat seals.

$$\frac{\mathbf{V_V}}{\mathbf{ALD}} = \mathbf{A - B \log T} \qquad \textbf{(1)}$$

where

V_V	=	total volume of voids in a chipseal
ALD	=	average least dimension of the sealing chip
T	=	total traffic to date in equivalent light vehicles (elv)
elv	=	equivalent light vehicles where one heavy vehicle is equivalent to 10 light vehicles
A,B	=	constants

$$\mathbf{V_V = V_a + V_b} \qquad \textbf{(2)}$$

where

V_a	=	volume of air in l/m^2 which is numerically equivalent to texture depth in mm
V_b	=	volume of bitumen sprayed less any required to fill the existing texture

Equation (1) can be rearranged in terms of texture depth by substituting equation (2) into equation (1):

$$V_a = \text{ALD} (A - B \times \log T) - V_b$$

$$= (\text{ALD} \times A - V_b) - \text{ALD} \times B \times \log T$$

As V_a is in l/m^2 is equivalent to texture depth in mm, the above equation can be simplified to:

$$\mathbf{TD = k - ALD \times B \times \log T} \qquad \textbf{(3)}$$

where k is a constant dependent on chip ALD and bitumen spray rate used.

B is a factor that describes the rate of change in texture depth with the traffic. A value of -0.07 has been adopted.

The basic equation used to determine texture depth requirements is:

$$\mathbf{TD = k - 0.07\ ALD \times \log T} \quad \textbf{(4)}$$

12.2 Mutilayer Seals

For multilayer seals analysis of data has shown that the rate of texture change is similar to single coat seals when the ALD of the larger chip is used in the above equations. The acceptance criteria therefore uses the same methodology as single coat seals. Experience to date has shown that multilayer seals i.e. two coat and racked–in, comply with the acceptance criteria. For sandwich seals, which are normally used on flushed areas, an appropriate design life will need to be agreed. Currently a design life of up to 6 years has been used without major problems.

12.3 Texturising Seals

For texturising seals the objective is to reduce the texture variation on site so that the proposed future chip size can be used. Therefore at the end of the design life the variation in the e value as defined in the Bituminous Sealing Manual shall be less than ALD/80. The equations given in the specification are derived from the manual but put in terms of texture depth rather than e values.

The introduction of criteria for texturising seals require the Consultant to include the minimum chip size proposed for the next seal coat and may involve assessment to be carried out before the end of the 12 month maintenance period.

The intention of the clause relating to binder application rates is that the seal will be accepted if it has been constructed in accordance with “good practice” and within the tolerances given in the specification. The additional clause allowing alternative binder application rates to reflect local practice should be used only where the Engineer deems it necessary based on past experience and where these alternative application rates have proved successful.

Even though the seal will be accepted if the binder application rate has been applied in accordance with the “good practice” provision texture measurements must be taken by the Consultant after 12 months so that a database can be built up to assist in refining the acceptance criteria.

12.4 Void Fills

Void fill criteria are based on field results that demonstrate that a minimum texture of 1 mm is obtainable. No maximum texture is specified as it is believed that if the chips are still retained after one year then subsequent chip loss is unlikely.

13. REQUIREMENTS AFTER ONE YEAR

The life of the seal (as controlled by texture) is reached when it has dropped below the minimum for safety. For areas where speeds are greater than 70 km/h this is currently 0.9 mm (a sand circle of 250 mm).

The minimum texture depth at one year in order that the design life is equalled or exceeded is calculated as follows:

$$TD_1 = k - 0.07\ ALD \times \log(elv \times 365)$$

$$0.9 = k - 0.07\ ALD \times \log(elv \times 365 \times Y_d)$$

$$\therefore \mathbf{TD_1 = 0.07\ ALD\ [\ \log(elv \times 365 \times Y_d) - \log(elv \times 365)\ ] + 0.9}$$

$$\mathbf{= 0.07\ ALD \log Y_d + 0.9} \qquad \mathbf{(5)}$$

where TD_1 = texture depth after one year, in mm
Y_d = design life in years

In the specification the minimum texture depth is increased by a factor related to the statistics of the sampling scheme, as discussed in the Acceptance Testing section of these Notes.

14. DESIGN LIFE

The design lives given in Table 1 are adapted from RAMM and are the currently used estimate of life. A regression analysis was performed using the mid point ALD for each chip grade (4.5 mm for the grade 5 where ALD is not specified) and the highest traffic volume for each category. Vehicles per lane per day were also taken as equivalent light vehicles/lane/day.

For single coat seals, the regression analysis gave the following relationship:

$$\mathbf{Yd = 4.916 + 1.68\ ALD - \log elv(1.03 + 0.219ALD)} \qquad \mathbf{(6)}$$

The above equation gives the design life of the seal in terms of traffic volume and chip size.

For multilayer seals the relationship obtained was:

$$\mathbf{Yd = 14.87 + ALD - 3.719 \log elv} \qquad \mathbf{(7)}$$

15. EXPECTED LIFE

The equations given above can also be arranged to give the time to reach a texture depth of 0.9 mm given the texture depth after one year (TD_1).

From equation (4):

$$TD_1 = k - 0.07\ ALD \times \log(elv \times 365)$$

$$0.9 = k - 0.07\ ALD \times \log(elv \times 365 \times Y_f)$$

$$\therefore \frac{TD_1 - 0.9}{0.07\ ALD} = \log(elv \times 365 \times Y_f) - \log(elv \times 365)$$

$$\log(elv \times 365 \times Y_f) = \frac{TD_1 - 0.9}{0.07\ ALD} + \log(elv \times 365)$$

$$Y_f = \frac{\left(\text{antilog}\left[\frac{TD_1 - 0.9}{0.07\ ALD} + \log(elv \times 365)\right]\right)}{elv \times 365}$$

$$\boldsymbol{Yf = anti\log\left[\frac{TD - 0.9}{0.07ALD}\right]} \qquad \textbf{(8)}$$

Y_f is the expected life in years before the seal will flush.

For low traffic volume roads, equation (8) may give extraordinary long lives as typically the seal will fail for reasons other than flushing.

If the expected life is less than the design life, then the section is considered to be outside the specification and only a proportion of the tendered price will be paid.

16. ROADMARKING CONTRAST

Although the reflective properties of the sealed surface have not generally been considered in chipsealing specifications, they are considered as performance criteria. If a white aggregate was used, it is obvious that the white roadmarkings would be nearly invisible.

For lit areas, a desirable road surface is light coloured and reflective. Targets and obstacles are detected by negative contrast, i.e. dark on light background or colour contrast. There is an upper limit set with the need to avoid glare in sunlight.

For unlit areas a desirable road surface is dark and of low reflectivity. Targets and obstacles are detected by positive contrast, i.e. light object against a dark background. It would appear that an unstated lower limit would exist so that dark objects could also be detected.

There appeared to be insufficient information on which to base New Zealand specific criteria appropriate for all circumstances. However, work carried out in other countries, and confirmed in part by work in New Zealand, would provide some support for values being tentatively set for road surfaces in unlit areas of not more than 35 mcd/lux/m^2. These were based on a minimum contrast ratio of 2.6 and a minimum reflected value of the marking of 100mcd/lux/m^2

Or, alternatively, if the chip type cannot be changed then;

minimum value of markings = (value of road x 2.6)

The method of measuring the reflectivity is based on a reflectometer and is specified in TNZ M/7 and TNZ M/20 Specifications.

There is some concern that the small sample area of a reflectometer may not sample sufficient area of the road surface to be unaffected by the variation in colour and reflectivity of individual chips.

It is expected that there may only be one or two areas in New Zealand where light coloured aggregates that may not comply with this specification are used. Aggregates that are composed predominantly of quartz or limestone may result in reflectivity values greater than 35 mcd/lux/m^2. In these areas it is recommended that traditional techniques should continue until more definitive guidelines can be given.

The importance of the other attributes of colour, i.e. hue and saturation, have not been resolved at this stage.

17. ROAD SURFACE COLOUR UNIFORMITY

There is a need to minimise the visual "load" on drivers so that they can concentrate their efforts on processing the signs and markings. Frequent changes in background road colour will cause unnecessary rapid adjustments to accommodate the changing levels of contrast from differing surfaces.

Two possible approaches to control colour uniformity are:

— specify a range of road surfacing colours; and

— specify an allowable level of colour difference between adjacent areas.

There is a shortage of literature on the desirable road colour, intuitively drivers can accommodate a gradual change in colour from one region to another but accommodating a rapid colour change of background could present difficulties. Therefore the approach is to specify an allowable level of colour difference between adjacent areas.

A visual scale does exist for assessing colour change, which is BS 1006 A02, the grey scale. This compares the difference in colour to the colour difference between two grey colour chips. This method should be able to be applied to direct viewing of the road surface, or to comparison of video or photographic images.

In setting limits it is recognised that the aggregates weather and discolour with age. Aggregate selection should be made with a view to its likely worn colour, with a greater tolerance allowed for the new condition.

Therefore the following specification is proposed:

- The colour difference between a new and existing weathered surface should be no more than 2 on the grey scale.

- The colour difference between a new and an adjacent recent surface should be no more than 3 on the grey scale.

- The colour difference between two surfaces of the approximate equal age should be no more than 3 on the grey scale.

The method of assessment shall be in line with BS 1006 A02.

The above values should be regarded as tentative at this stage. Where aggregate of the same type, e.g. greywacke or basalt, is used in an area colour differences should not present a problem. There could be some areas in New Zealand where a mix of aggregates are used that exceed the above limits. In these areas the Engineer will need to decide for each site whether the colour difference could constitute a safety hazard and modify the specification accordingly.

At this stage this provision should only be used where sealing runs with different chip could lead to driver confusion. On straight sections colour differences would not normally be of concern.

18. ACCEPTANCE TESTING

Initial acceptance of the seal is based on the Contractor providing the specified material reports, complying with the requirements for cleaning up and sweeping, and an inspection by the Engineer to ensure that the chip is in place. This inspection is scheduled for two weeks after construction, by which time any major construction faults should be obvious.

Payment is intended to be made at this stage, but the release of the bond will not occur until after the 12 month inspection. Provision is made for the Engineer to extend the maintenance period if repairs were required.

Final acceptance is based on achieving the required texture depth without significant chip loss. The Engineer is responsible for inspecting the seal at the end of the maintenance period, conducting the texture measurements and compilation of the performance criteria report. This report details final texture measurements and individual lot assessment at the conclusion of the maintenance period. The Engineer may decide it appropriate to invite the Contractor to conduct the field inspection as a joint exercise.

Where the initial site conditions do not comply with the hardness or texture variation criteria or the stress level is such that both the Contractor and Consultant believe that there is a real risk that the proposed treatment may fail then alternative acceptance criteria can be agreed. This may entail identifying areas where some chiploss may occur on high stress sites and agreeing on the area involved. Where texture variation is high then the texture requirements in the wheel tracks may be required but some chiploss on the centreline might be acceptable. The development of acceptance criteria for sites or for the use of surface treatments not covered by this specification need to be agreed on a site specific basis, prior to construction.

In devising the texture depth acceptance criteria used in this specification, two factors were considered:

(a) the Client's risk of accepting a seal that is outside the requirements; and

(b) the Contractor's risk that a seal that is within the criteria is rejected.

As a starting point the Client's risk has been set at 10%. This means that there is a 1 in 10 chance of accepting a seal outside the specified limit. The Contractor's risk has been set at 5% - that is a 1 in 20 chance that a seal inside the specified texture limits would be rejected.

Only a minimum texture depth has been specified. This is to guard against premature flushing. It is considered that any gross under-application of bitumen will be indicated by chip loss after one year.

As with any testing regime there needs to be a balance between the size of the lot, the number of samples, the cost of testing, and the degree of confidence required.

A length of 200 m was considered a reasonable length for testing, and the performance of five sand circle tests a reasonable number of tests to determine texture depth.

Five sand circle tests are to be taken across the width of the seal. The specified locations are: outer wheelpath, between wheelpaths, centreline, inner wheelpath, and outer wheelpath. The five readings are to be alternated across the road every 200m to ensure a mean reading is obtained for the complete road width, thus avoiding bias to one lane. Where the pavement has edge marking, this is regarded as the pavement edge. On lightly trafficked seals the wheelpaths may not be obvious. The variation in texture will not therefore be great, and an estimate of the wheelpaths will not result in a significant error.

In order to ensure that the texture of the seal is above the required minimum, the mean of the five tests is reduced by a factor dependent on the standard deviation. The factor is taken from standard tables for an unknown attributes scheme at the Client's and Contractor's risk of 10% and 5% respectively.

While not included within the specification, where there are more than two lanes the extra lane may be assessed as an extra lot with the testing regime to be agreed with the Contractor. An accepted method is to consider the extra lane as an individual lot and to conduct three sand circle tests, one in each wheelpath and one between wheelpaths. The mean of three sand circle tests is then reduced by a factor of 0.335 (replacing 0.519 in Equation 4 of the specification) multiplied by the standard deviation for the three readings.

19. RETESTING

The sampling system given above does not guarantee that all “good” seals will be accepted and all “bad” seals will be rejected. Therefore provision is made to allow either the Contractor or the Consultant to retest the wheelpaths of the lot with a mini texture meter or other agreed method. Other methods could include the TNZ stationary laser profilometer. With the mini-texture meter as the whole wheelpath is being tested, the “real” mean is being obtained and the adjustment factor in Equation 4 of the specification based on the standard deviation is not needed. If another method is used the acceptance scheme may need to be modified to reflect the number of samples taken.

In the retesting the lot is divided into individual lanes and these are assessed separately.

20. TEST METHODS

This specification recommends two test methods: surface hardness and chip loss.

The surface hardness test, using the 19 mm ball bearing, was selected after trials comparing it with a British method using a spring loaded penetrometer. The British method was a 4 mm diameter spherical head and it was considered that on chipseal surfaces it tended to displace chips. The 19 mm ball bearing was considered to better model a sealing chip. In addition, the test is now being used in Australia and it is expected that its acceptance will grow as relationships between the test and seal performance is obtained.

The BCA has performed research into other methods to determine pavement hardness. Their research found a good correlation between the Transport Research Laboratory (TRL) probe the Coal Tar Research Ass (CTRA) probe and the method specified in this specification. Both the alternative methods could be used to assess the pavement hardness but in cases of dispute the standard South African Hammer (SAH) based method should be used. The relationship derived in the BCA research between the TRL probe and the SHA is:

TRL = 3.7 x SAH

A current research project has been investigating an alternative test to the sand circle test for measuring texture depth. It is hoped that this will result in a method that is more precise and would be able to be used for assessment of texture depths on higher traffic roads.

21. PAYMENT

Payment is based on two rates:

(a) square metre rate for the design and construction of the seal; and

(b) a binder supply and spray rate for texture filling.

For tendering, the Client specifies the area to be sealed and the minimum chip ALD. This does not give the Contractor an estimate of the surface texture of the site that would allow the Contractor to price the total binder requirements. Rather than each tenderer being forced to perform a seal design for each specified section, the tender is based on making no allowance for existing texture, i.e. a sand circle diameter of 500 mm.

The Client estimates the extra binder required for existing texture, and this is nominated as a binder supply and spray rate in litres/square metre. The Contractor shall submit the sand circle results that were used for the basis of the seal design and claims payment based on the 'e' values and traffic factors given in the Bituminous Sealing Manual.

In the tender documents provision should be made for prices of different treatments, e.g. smaller or larger chip. This is to cover the situation where subsequent inspection and testing reveals that the specified chip is not appropriate for the road section.

22. MAINTENANCE

It is the Contractor's responsibility to maintain the seal for one year unless otherwise specified. Although repairs within the first few days can often be made using the same size chip that was used initially, it is common practice to use the next smaller grade chip for later repairs. The Engineer should be reasonable in approving the use of a smaller chip (more than 0.5 mm) where it is considered that it is the best repair option.

Prompt response to maintenance is expected. If the seal distress is left too long then repair techniques that may have initially been appropriate may not be able to be used. For example spot repairs using kerosene and chip may be applied early in the life of the seal but if left could require the application of a locking coat over the whole area. Although the final product may comply with the specification the delay can cause annoyance to the public, a safety hazard and compromise the Engineers treatment selection.

22.1 Removal of Surplus Chip

The requirement for a maximum of 50 loose chips/2 m^2 is a tentative figure and it is expected that loose chip will be removed whenever it is regarded as a traffic hazard or is causing annoyance to the public, continuously throughout the 12 month maintenance period. This clause has been strengthened by including a requirement to restrict the “build up” of windrows either on the pavement or on the shoulders. Chip build up is most common where a multilayer seal has been used and the second chip can continue to be lost for weeks.

It is expected that the Contractor will have made allowance in tendering for more than one sweeping especially on multilayer seals.

Where a section has been repaired by the application of a second seal, e.g. if significant chip loss had occurred and the section was "locked" with a smaller chip, the acceptance criteria should be based on the requirements for multilayer seals.

22.2 Snow/Ice Gritting

The Engineer should discuss possible application of grit with the Contractor prior to construction and indicate the expectations for areas that may require grit to be applied during the maintenance period. Agreed performance criteria must be determined with consideration for the excess grit that may fill the interstices and thereby a possible reduction in the texture depth after 12 months. Information in currently being collated to develop performance criteria for sealed surfaces where grit is applied.

23. PROPORTIONAL PAYMENT

The predictive equations have been used to develop a proportional payment system. This is a rational method for determining the reduction in payment that should be made if the required texture depth is not obtained. Where chip loss has occurred, it is assumed that repairs will be made by the contractor in accordance with Clause 14 of the specification.

The difference between the design life calculated from equation (6) or (7) and the estimated life from equation (8) are used. Although it is recognised that seal lives cannot practically be considered in terms of fractions of a year, the use of a fraction does permit a smoother payment system. If the life calculations were based on whole numbers, a more stepped payment system would result.

The proportional payment system is based on Uniform Series Present Worth Factor (USPWF). These factors are developed on the basis that the cost of the seal is spread in equal payments over its life. If the life is shorter than the design then the number of payments is reduced and each payment would be greater. The payments are required to be discounted to present worth.

The basic equation for the calculation is:

$$\mathbf{PR} = \mathbf{R}\left[1 - \left(\frac{(1+i)^{Yf} - 1}{(1+i)^{Yd} - 1}\right) x\, (1+i)^{Yd - Yf}\right] \qquad \mathbf{(9)}$$

where I = the discount rate, normally taken by Transit New Zealand to be 10%

R = the square metre rate which is the sum of the tendered rate and the surface texture allowance

PR = payment reduction in $/m²

$$\mathbf{PR} = \mathbf{R}\left[1 - \left(\frac{1.1^{Yf} - 1}{1.1^{Yd} - 1}\right) x\, 1.1^{Yd - Yf}\right] \qquad \mathbf{(10)}$$

For a rate of $2.50/m² (R) for a seal with a design life Y_d of 10 years but with an expected life Y_f of 8 years, the reduction in payment would be $0.33/m² (13.2%).

Equation (10) should be used to give proportional payment for loss of expected life up to and including 25%. If the expected life has been reduced by more than 60% of the design life then no payment shall be made.

If the expected life has been reduced to between 25% and 60% of the design life the payment is reduced on a proportional basis rather than by using the USPWF formula.