P25 SPECIFICATION FOR HIGH SKID-RESISTANT SURFACINGS

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ABSTRACT

High Skid Resistant Surfacings (HSRS) are designed to be highly durable proprietary overlay treatments, usually applied to asphaltic or cementitious surfaces. Their purpose is to provide high skid resistance on the road's surface, at a specific location, over a long life.

However, over the past decade in New Zealand, poor installation work and/or inappropriate underlying asphalt substrates on the state highway network precipitated the need to develop a performance-based specification. After significant research, planning and specification development, NZTA P25 Specification for High Skid-Resistant Surfacings has been finalised. P25 requires an HSRS to surpass, for at least the first 30 months, the specified level of skid resistance, material retention and adhesion to the substrate.

Information about the installation and asset management of HSRS in a regional office are also provided.

INTRODUCTION

Since the mid 1990s the use of High Skid-Resistant Surfacings (HSRS), or High-Friction Surfacings as they are known in Australia, have been an increasingly popular method for increasing traction on the road surface, and consequently reducing significantly the number of crashes, on all categories of roads. It has proved to be the most effective technique for doing this.

HSRS are most commonly applied to areas where braking distances need to be reduced such as approaches to pedestrian crossings and intersections. HSRS is also very effective on dangerous bends, especially where there is a severe drop-off, or the geometry and lateral dynamics of the road are sub-standard.

This paper addresses issues relating to whole of life costs and high initial costs of HSRS, and explains where HSRS can be beneficial. It contains information about HSRS materials and performance requirements of the new NZTA P25 Specification for High Skid-Resistant Surfacings. The paper also covers typical failure modes, how to avoid them, and information on the real-world experiences of NZ Transport Agency (NZTA) Wellington.

Whole of life costs

Surfacing Costs

A common perception in the industry is that HSRS is expensive. In New Zealand, this perception has also become prevalent since many sites have failed and many disputes have arisen between Contractors and Clients regarding why the surfacing has not lasted the expected distance.

Although the initial price seems high at $40 to $60/m2 (especially when compared with other wearing surfaces at between $7.50 to $15.00/m2) a properly installed HSRS can last and perform for up to 15 years.

For Road Controlling Authorities (RCAs) with a skid resistance policy, the whole of life cost analysis easily comes out in favour of calcined bauxite in certain situations. E.g. where a natural aggregate polishes within 2 years and requires resurfacing (in a high-stress area). In addition, many layers of short-life chipseals (sprayed seals) can lead to "layer instability" where the upper layers of the pavement have a high binder to stone ratio. This leads to flushing, rutting, and ultimately the need for an area wide treatment of the pavement, or complete rehabilitation, at great expense.

However, if the surfacing is laid on a very thin or poor quality substrate which delaminates in a sort period of time due to increased stress, or if the surfacing is poorly applied and fails early, then the short-life HSRS can rightly be called expensive and poor value for money.

Saving Lives

Even a defective HSRS lasting only a very short time (say for a small number of years) could still be cost effective. The benefit-to-cost ratio calculation for the HSRS should include the financial benefits of saving lives. The number of crashes declines after HSRS installation and those savings usually make the investment in HSRS excellent value for money.

The current treatment cost to lay HSRS, including temporary traffic management, on a level 3 highway (e.g. motorway) is about $NZ60/m2.

The following Benefit/Cost analysis from the first calcined bauxite site laid in New Zealand shows the crash savings available:

The road under the State Highway (SH) 2 Petone Overbridge had 15 – 20 crashes per year. In 1997, at a cost of $NZ50/m2 (in 1997 dollars) a section 100 m x 8 m was surfaced with calcined bauxite at a cost of $40,000.

Prior to the installation of the HSRS there had been 15 – 20 crashes per year, with an economic crash cost of $2 million per year. After installation there were 0.5 crashes per year. The economic summary is as follows:

- Cost of resurfacing = $40,000
- Annual crash savings = $1.9 million
- First year rate of return = 48 (B/C ≈ 400)

At the time, the cost of applying calcined bauxite amounted to just two weeks' crash savings.

To update to 2011 dollars: At the current rate of $NZ100/m2 for the 100m x 8m section it would cost $80,000 in today's dollars.

From Table 4: Cost per reported injury accident in $ from the Economic Evaluation Manual

- Fatal (50 – 60 km/h) costs $3,350,000
- Serious (50 – 60 km/h) $360,000
- Minor (50 – 60 km/h) $21,000
- Non-Injury (50 – 60 km/h) $2100

In summary, it would need a reduction of just 4 minor crashes, or less than a quarter of one serious crash to justify the cost of applying HSRS using calcined bauxite.

Additionally, if we are able to get a performance life from each HSRS beyond 4 years then there has to be great financial and social benefits for both roading authorities and the public.
Alternative to Geometric Improvements

Another HSRS application with excellent benefit to cost ratios is where it is used instead of geometric improvements. That is, increasing the skid resistance rather than straightening dangerous curves. There have been numerous instances over the years, in Australia (Simpson, 2008), New Zealand (Owen et al, 2008) and the UK where placing HSRS on dangerous bends has proved more effective, in the prevention of crashes, and more cost-effective, than rebuilding the camber of the road. Please note that in severe circumstances it has been necessary to do both.

HSRS can be used on a high-risk curve as a stop-gap measure while funds are procured for geometric improvements. NZTA T10:2010 includes more information about curve risk analysis.

WHY SPECIFY HSRS

High Stress

Tyre or road interface stresses are those induced by vehicular traffic running on roads and turning and breaking stresses. It is therefore of great importance to design an optimum asphalt layer type and thickness in relation to the supporting road structure, and the expected axle or tyre loading and tyre contact stresses. This is particularly important for the final (top) substrate (wearing course) if it is planned to install an HSRS at identified crash-prone locations.

The sideways stress coefficient increases dramatically when specialist aggregates such as calcined bauxite are used. Apart from the superior micro-texture, the sheer number of tips from a typical 1-3mm road-grade bauxite aggregate, making contact with, and biting into the tyre creates excellent grip and resistant to skidding.

NEW SPECIFICATION

The new NZTA P25 Specification assumes the HSRS is applied to an appropriate substrate. The expectation is that the surfacing (including the substrate) will have a performance life of 6 to 8 years with zero or minimal maintenance, although the Defects Liability Period can only be specified as between 2.5 and 4 years under current contract practices.

The specification can be used when the substrate is provided by the Client or the Contractor.

Materials

Most of the surfacings installed to date in New Zealand have a base component of epoxy or polyurethane resin, predominantly from the U.K. but also from the Netherlands, Australia and most recently some local manufacturing in New Zealand has commenced.

The key component for the effectiveness of these systems has been the aggregate ‘bauxite’ due to its excellent resistance to polishing and its ability to provide new micro texture when new surface planes are exposed. To help achieve its high PSV (Polished Stone Value) of over 70 this material is artificially calcined under intense heat of over 1200ºc.

Calcined Bauxite is steadily becoming more expensive by the tonne (providing approximately 160m² of laid surfacing) due to the limited number of sources worldwide, namely just China, and Guyana in the north of South America. Another factor, more recently, has been the unfortunate closure of many of the mines in China by their government due to unsafe work practices and the unnecessary fatalities of miners.

HSRS comprise the following components:

- Binders
- Aggregates
- Compatible Primers (when appropriate)
- Catalysts (when appropriate)

Binders

Epoxy and polyurethane resin-based binders tend to be used. These two-part formulas have to be thoroughly mixed together by mechanical means to create the right chemical reaction for successful curing. Additionally there are other binders such as rosinester thermoplastic and methyl methacrylate which may be considered for use.

Aggregates

To date, worldwide, proprietary HSRS have included the use of calcined bauxite aggregate (naturally occurring or pigmented) of either Chinese or Guyanan origin providing a buff or grey colour respectively. Buff Chinese Bauxite has been preferred where a bright, highly visible surfacing is required, and Grey Guyanan Bauxite has been preferred where the local authority does not wish to ‘advertise’ to the motorists that a highly skid-resistant or ‘grippy’ material has been laid (e.g. on dangerous bends) or where the site is in an environmentally sensitive area.

In New Zealand, trials with melter slag aggregate as an aggregate in HSRS have shown that its on-road performance is superior to what would be expected of naturally occurring aggregates with a similar PSV (Wilson and Black, 2008).

Compatible Primers (when appropriate)

For applications on cementitious surfaces an appropriate primer (approved by the manufacturer of the binder) should be used.

Catalysts (when appropriate)

Catalysts are used to accelerate the curing process of the binder during colder months. Catalysts are normally available from the manufacturer of the binder however strict adherence to their advice on its use and how to manage its consequential significant reduction in the workable pot life of the binder is vital.

Performance requirements

The HSRS is required to achieve, for the period of the Defects Liability Period:

- the minimum specified level of skid resistance for both microtexture (Equilibrium SCRIM Coefficient or ESC) and macrotexture
- the minimum specified levels of material retention

The substrate shall be strong enough to resist failure planes through the substrate.

Defects Liability Period

A minimum defects liability period of 30 months is specified. This is to ensure that the final HSRS skid resistance survey by SCRIM+ methodology, undertaken annually within the NZTA High Speed Data Contract (HSDC), is as close as possible to 24 months after the application of the HSRS.

Measurement

Acceptance of the HSRS skid resistance shall be by SCRIM+ methodology as employed within the NZTA HSDC. During the Defects Liability Period the HSRS shall provide a minimum microtexture, measured by Equilibrium SCRIM Coefficient (ESC) of 0.65 across at least 95% of all 10 m sections, and shall exceed 0.60 across all 10 m sections. Interim testing may be undertaken once the new HSRS has been in-situ for at least one month. Ideally, interim testing uses a British Pendulum Tester.

The HSRS shall provide a minimum macrotexture of 0.9mm Mean Profile Depth (MPD) average over all 10 m sections and a minimum of 0.6mm MPD at any single location. Measurement macrotexture at single locations may be by sand circle or portable laser based texture measuring instruments. These checks shall only be undertaken where there are clearly areas of low macrotexture.

Binder and Aggregate Retention/Loss

Performance requirements cover the two main HSRS failure mechanisms (Failure of Aggregate to Adhere to Binder and Failure of Binder to Adhere to Substrate or Substrate Failure). The maximum levels of material loss are:

a) **Failure of Aggregate to Adhere to Binder**

   Aggregate Loss shall not exceed 50% on any 100 x 100 mm square within the Site. (The Engineer may interpret this requirement generously, as any excessive areas of aggregate loss will cause macrotexture and SCRIM measurements to be out of specification.) Any large areas of aggregate loss will fail the requirements of section (b) below.

b) **Failure of Binder to Adhere to Substrate or Substrate Failure**

   Areas where the binder has failed to adhere to the substrate or where failure planes extend through the substrate shall not exceed:

   – A total length of 250 mm in any 10 m section, measured longitudinally. (e.g. failure over both wheelpaths is counted twice)

   – An area of 0.15% of any 10m section (In a 3.5m wide lane, this equates to a square 21 cm x 25 cm. It is assumed this is small enough not to significantly impact skid resistance available to a breaking vehicle)

   – An area of 0.1% of the entire site. (this means only 2 or 3 of the 21cm x 25 cm squares are allowed on a 100 m site with 3.5 lane width)

Where the substrate is provided by the Principal, repair of the substrate and associated surfacing will be by the Contractor, with agreement of the Engineer and at the Principals cost.

Where the substrate is provided by the Contractor, repair of the substrate (and associated surfacing) will be with agreement of the Engineer and at the Contractor's cost.

Loose Aggregate

After temporary traffic management is removed the surface shall be maintained by the Contractor so that no more than:

- 150g of loose HSRS aggregate is left on any $1m^2$ area of the surface in the first two months of its service life.
- 50g of loose HSRS aggregate left on any 1m2 area of the surface, after two months.

Supporting Documentation

Internationally-Recognised Certification, if available (e.g. BBA/Hapas)

If available this must be current, and provided by and with the support of the binder manufacturer. A copy of an authorised supply and contracting agreement must be provided. If any other organisations are involved in the manufacturing and installing of the HSRS these must also be identified.

Test results from at least one HSRS site within New Zealand or overseas using the same system and its components.

This requirement is especially important if the HSRS does not have internationally-recognised certification (e.g. BBA/Hapas). Written references from clients are also desirable.

Quality Assurance documentation

To ensure the work is performed in accordance with the manufacturer's recommendations, the quality assurance documentation and subsequent operational records should be accurate, comprehensive and shall be retained for at least six years.

The Quality Assurance Plan shall include the manufacturer's material quality control requirements including comprehensive materials testing documentation, Health, Safety and Environmental Plan and Materials Safety Data Sheets (MSDS) which meet the NZ Code of Practice.

Installation Method Statement, approved by the HSRS system manufacturer

Approved and issued by the manufacturers (usually of the binder) to the Contractor the method statement should include specific information on storage requirements, handling procedures, pre-installation substrate condition, preparation requirements, recommended installation techniques of all components and environmental limitations of the system.

This method statement may be used by the Contractor to draft a NZ-version to cover variances such as climatic conditions and asphalt types.

TECHNICAL

The following additional technical information is not included in the specification:

High quality binders

When searching for long-lasting effective solutions 'value for money' is most often at the top of the priority list. In the Roading Industry, since the products we install on our road networks take such a pounding, cheap fixes rarely perform and the need for remedials soon follow.

Unfortunately, when the concept of coloured surfacing was implemented from the mid '90s in New Zealand our roading industry was attracted by the cheap prices (the m^2 rate) that acrylic paints offered. Consequently many 'traffic calming' sites such as green bus lanes and green or red cycle lanes, were treated with this 'microns thin' surfacing that subsequently only lasted for a year or two before 'grinning through' of the underlying road stone was evident.

High-quality resin binders provide far better value for money because they are much thicker than paint-based road marking products, they are manufactured specifically for roading applications and they are subjected to tough laboratory testing to ensure excellent in-situ performance (e.g. accelerated wear testing, tensile strength and elasticity).

Propensity of binder to cause different types of surface failure

The most common cause of substrate failure is when the substrate is not strong enough to support the HSRS, either due to its poor asphalt mix design, its thickness or its adhesive properties with its sub-base.

To avoid this event, Engineers should ensure that as part of the decision-making process for the possible application of High-Friction Surfacing on an existing substrate, its history is identified (e.g. its age, mix type, relative thickness, design life etc.) and for a combined contract when the HSRS will be applied to a new substrate, the Client and the Contractor must agree the appropriate substrate, and the Contractor ‘warranties’ both materials. There would also be an agreement that the High-Friction Surfacing would not be applied to the new substrate until at least one month has passed – preferably longer depending on traffic volumes.

In the case of concrete substrates this provides the appropriate amount of time for surface laitance to disperse and full mPa strength to be achieved.

In the case of asphalt substrates this provides the appropriate amount of time for surface oils and volatiles to disperse (allowing the High-Friction Surfacing binder to properly adhere to the road stones rather than a film of bitumen) and to enable optimal cohesive strength of the asphalt matrix.

Please note that if the High-Friction Surfacing delaminates from the substrate this can usually be attributed to Contractor’s installation error (e.g. poorly cleaned substrate, damp substrate, damp aggregate, incorrect mixing of binder components, poor thickness of binder, poor choice of binder and its quality etc).

How to get good application

- Working on a completely bone-dry substrate (with no likelihood of rain for at least three hours after the completion of works if epoxy or polyurethane resin used).
- Working within the atmospheric moisture dew point tolerance.
- Working on an ‘as clean as possible’ substrate i.e. remove by either air or water pressure road fines, detritus, loose road stones, oil spills, horse manure etc.
- Applying resin binder to a correct minimum thickness to be able to hold aggregate chips firmly in place.
- Avoiding laying on multi-layered chip seal (which has poor structural integrity).
- Strictly following all elements within the manufacturer’s Method Statement

REAL WORLD APPLICATION

Quality and Longevity

HSRS laid on a poor quality substrate can cause both to delaminate in a short period of time, making the HSRS expensive, costly and poor value for money.

What is needed for everyone to play their part is a strong substrate of at least 40-50 mm, and the Contractor to apply the materials strictly according to the approved method and with the correct spread-rate. Only then can the NZTA’s modest expectation of getting a 6 to 8 year HSRS life be achieved.

Data and on-road performance

It is important for the client to complete an assessment of the on-road performance of the HSRS at the end of the defects liability period. This is best done through a database assessment of the high speed data.

How to get good installations

As a client, we believe the best way to improve the quality of installations we have received in the past is to implement a stringent, workable performance specification whereby the Contractor takes whole ownership and responsibility for his materials and installation work and provides a warranty (which is stated as a ‘Defects Liability Period’) for a specific period, varying between 2.5 and 4 years.

This is also reinforced by our introduction of random auditing of installations, both during contracting works and periodically during the system’s Defects Liability Period and its expected performance life.

We have devised a specific ‘Condition Rating Audit’ system for this monitoring and will be implemented by NZTA Engineers and local authority Engineers at their discretion. The audit uses a percentage points scoring system and comprises the following components and analyses:

1. AGGREGATE/BINDER LOSS (in m²)

   (55%)

   - The amount of aggregate/chip loss (scabbing) caused by insufficient depth of binder, damp aggregate or incorrect mixing ratio of two-part binders.
   - The amount of delamination of binder (and therefore aggregate) caused by lack of adhesion of binder to asphalt or failure within the substrate.
   - The amount of ‘grin-through’ (of largest substrate road stones) caused by the wearing away of poor quality binder.

     NB: Any remedials already conducted in the form of reinstatement patches are included in the rating.

     NB: Scabbing which appears all over the area and is impossible to accurately measure in m² receives a score relating to 10% of the total area (e.g. 150 m² section = 15 m² scabbing = 4% score).

2. CRACKING (in linear m)

   (20%)

   - The amount of L & T cracking (longitudinal and transverse) across the HFS.
   - The amount of alligator cracking across the HFS.

     NB: Excludes perimeter cracking, which seems to be very typical in HSRS applied on New Zealand asphalts, and shows the HSRS is performing as expected.

3. JOINT CRACKING (in linear m)

   (10%)

   - The amount of cracking caused by the poor installation of previous remedial reinstatements.
   - The amount of cracking caused by poorly joint-sealed adjacent asphalt passes.

     NB: Also excludes perimeter cracking.

4. BINDER and AGGREGATE OVERSPILL/UNDERSPILL (in linear m)

   (5%)

- The amount of spread binder accidentally pushed over and beyond the perimeter masking tape, leaving unsightly ‘overspill’ patches.
- The amount of spread binder accidentally seeped under the masking tape when placed too close to a rough asphalt edge leaving unsightly ‘underspill’ patches.
- The amount of aggregate accidentally allowed to embed itself into ‘overspilt’ or ‘underspilt’ binder, allowing it to be permanently affixed.

  NB: 0 is scored if no tape was used at all.

5. EDGING (in linear m)

   (5%)
   - The level of accuracy of placing the masking tape in a straight line along all four edges of the HSRS, especially over a long distance.
   - The level of accuracy of creating straight edges with masking tape when “knitting” together two different colours, e.g. buff and white, or buff and grey.
   - The level of accuracy of “knitting” new HSRS to existing road marking lines.

6. RIDGES and JOIN MARKS (in linear m)

   (5%)
   - the amount of ridges on the final surfacing caused by:
     - Uneven thickness of binder when aggregate is broadcasted.
     - Aggregate being broadcasted over the edge of the binder (inside the masked area) during installation.
     - Reinstatement patches (around the perimeter).
     - Footprints.
     - Heavy vehicle tyre prints.
   - the amount of join marks on the final surfacing caused by:
     - Installing the HSRS in more than one visit (due to inclement weather or running out of materials during installation).
     - Aggregate ‘shading’ caused by the broadcasting of different batches of aggregate displaying different colour shades.

NZTA AUDITING OF HSRS SITES, UNDER THE P25 SPECIFICATION

Under the requirements within P25, contractors are responsible for monitoring their proprietary HSRS (High Skid Resistant Surfacing), however the NZTA reserves the right to conduct its own random impromptu inspections and/or auditing of completed HSRS works by commissioned contractors, on its state highway network.

Additionally, all HSRS sites will join the national list of sites subject to annual skid-resistance testing .This is conducted under the SCRIM regime and methodology.

Once the P25 Specification is issued, subsequent HSRS installations will be subject to auditing by NZTA engineers, or a commissioned independent HSRS consultant. The method implemented for auditing will be the ‘Condition Rating Audit System’ and the objective will be to identify and quantifiably rate, the condition of the HSRS.

Typical installations will mainly be motorway off-ramps, approaches to intersections, approaches to pedestrian crossings, dangerous bends, and in some cases bus and cycle lanes. The 'Condition Rating' is divided into categories where measurements are taken to assess specific components relating to the material and the workmanship conducted. A breakdown of what will be analysed is included in this paper. These measurements are converted into percentage points, contributing to an overall score. These scores can then be used to create several comparisons:

1. Future scores on the same site to show the rate of deterioration

2. Scores from other sites installed by the same contractor to show possible increases or decreases in material and/or workmanship performance, and,

3. Scores from other sites installed by the other contractors to identify strengths and weaknesses between contractors.

However, it is important to note that these ratings are not solely analysing the HSRS systems alone, but also the condition of the underlying asphalt supporting them. This will help the NZTA to draw conclusions as to the suitability of various asphalt types as appropriate substrates to support HSRS systems. Consequently the total '100%'rating is for the two components combined (the surfacing and the substrate).

Audits are important to assess asset condition and expected remaining life, to reinforce the client's desire for a quality, long-lasting solution and therefore to motivate the Contractor to deliver a quality job to the desired specification.

Defects Liability Period (Warranty)

As mentioned above in the section on *How to get good installations,* a Defects Liability Period (DLP) can only be specified as between 2.5 and 4 years under current contract practices. The option of a 4 year DLP is extremely attractive to a client desiring a 6 to 8 year life from their HSRS, with zero or minimal maintenance. However, in the real world, excessively high prices were received for a recent tender using P25 as a trial specification which specified a 4 year DLP. In this case a compromise was reached as follows:

Maintenance of the new surfacing for the first 30 months: as per the contract conditions.

Maintenance of any defects in the new surfacing in months 31 – 48: The successful tenderer was required to confirm in writing their willingness to "remain responsible for any defects in the new surfacing during months 31 – 48. This does not include any failures attributed to the existing asphaltic surfacings. It also does not include defects that may be caused by other parties e.g. cutting of traffic loops".

Another issue, with a 4 year DLP, is that with changes in personnel in road administration over that period, the knowledge could be lost (that the contractor should fix it if something goes wrong). This gives another good reason to have an independent third party auditing and completing regular condition rating audits of the HSRS. Retention of such institutional knowledge is important to ensure best asset management of HSRS and clients should consider producing documentation such as an "Asset Owner's Manual" for completed HSRS installations (as is required in capital works contracts) and handing this over to new staff.

Wellington's Experience with HSRS

The NZTA P25 Specification highlights the importance of all construction factors coming together to provide a premium surfacing that meets target design life expectations. As mentioned in the introduction these surfacings are applied on high stress, high demand sections of road networks, such as out-of-context curves, high speed approaches to intersections or where there is a high probability of 'loss of control' and 'run off the road' type crashes.

In Wellington, on the state highway network, one such 'out-of-context' curve exists, where on a section of the SH 2 expressway a 70/km hr speed environment approaches a 55km/hr speed advisory corner under the Petone overbridge. Before the premium surfacing was applied, there were on average 11 crashes per month on the 2-lane northbound section, as vehicles typically lost control on this curve. In March 1997 an HSRS using calcined bauxite and polyurethane was applied to increase the road surface friction values, and over the following 2 years, the crash rate dropped dramatically with only 2 crashes recorded over the entire period. This is an excellent example of a high-cost treatment addressing a high crash black spot, with outstanding success.

In another section, at the northern portal of the Terrace Tunnel (southbound) in Wellington, the HSRS has been in place for seven years. This site also had been having a lot of crashes (nose to tails) prior to the installation of an HSRS, and has provided a virtually nil record since. This clearly identifies that by the installation of this material there is a very real reduction in the number of crashes.

However, in the Wellington region, not all sites treated with these premium surfacings have been as successful. There have been a number of examples of early life surfacing failures, emphasising the need to have very tight tolerances on the materials used and application techniques, to ensure the required design lives are achieved. These experiences, while frustrating and costly, have reinforced the need to have a tight technical specification, underpinned by a robust surface warranty or Defects Liability Period. The specification requirements place the onus on the Contractor to closely control all aspects of the material quality and surface application.

Failures noted in some surfacings applied include:

- aggregate loss (see Figure 1)
- delamination of the HSRS (see Figure 2)
- failure and delamination of ‘weak' substrates and in some cases their underlying pavement layers

Key contributory factors to the failures include:

- variability of the polyurethane/epoxy binder application rates (especially as typically hand applied)
- incorrect mixing of the binder causing adhesion failure between HSRS and substrate
- underlying surface (substrate) quality
- Ambient air and road surface temperature during and immediately following application
- Air moisture content during and immediately following application
- dusty or damp aggregate causing poor adhesion to binder
- poorly cleaned substrate prior to application of binder, affecting adhesion of HSRS
- water ingress due to e.g. poor adjacent asphalt joint sealing

Figure 1: Calcined bauxite chip loss

Figure 2: Surfacing delamination

SUMMARY

HSRS commands a high initial investment but it can be justified where a skid resistance policy exists, especially in areas with out-of-context curves, high speed approaches to intersections or where there is a high probability of 'loss of control' and 'run off the road' type crashes. It can be used as a spot treatment in response to high wet-road crash rates, or as an alternative to geometric improvements, especially as a stop-gap measure while further funding for safety improvements is sought.

With any premium surfacing, it is imperative that all material and application practices are followed. After application, careful monitoring of the HSRS is vital, using both high speed data (for skid resistance and texture) and visual inspection (for binder and aggregate retention/loss and loose aggregate).

The NZTA intends to implement further monitoring in the future to confirm that HSRS quality improves after the implementation of the new specification.

A robust surface warranty or Defects Liability Period is essential for the protection of the Client's investment, and to ensure that the HSRS has the desired life.

The use of a specification for HSRS encourages quality product, protects the Client and the Contractor from unnecessary risk and enables ease of pricing for the Contractor once the specification is widely implemented.

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AUTHOR BIOGRAPHIES

Joanna Towler

Joanna Towler holds the position of Operations Engineer at the New Zealand Transport Agency's National Office in Wellington. Joanna is responsible for specifications relating to road surfacings and delineation for New Zealand state highways and has been involved in a wide variety of projects, ranging from performance based chipseal specifications, skid resistance, to road markings.

Joanna has also had local authority experience, working at Wellington City Council prior to joining Transit New Zealand (now the NZ Transport Agency).

Joanna holds the degree of Bachelor of Environmental Engineering and has a Masters of Pavement Technology.

Mark Owen

Mark is currently the New Zealand Transport Agency's (NZTA's) Operations Manager for the Wellington region. In this role, Mark is responsible for all operations and maintenance of the highways in the Wellington and Nelson regions and has responsibility for oversight of the asset management and maintenance of the wider Wellington Business Unit, covering the Central and Lower North Island. Mark has held this role for over 4 years.

Mark previously held the role of Asset Management – Team Leader for Transit for six years and was responsible for coordinating Transit's annual planning process, procurement of funding and allocation, for all state highway maintenance activities. Mark was also responsible for Transit's major thrust in developing skid resistance policies in the mid 1990's.

Mark originally joined Transit in 1996 in a technical role as part of their Engineering Policy team, having migrated from Local Authority experience.

Mark is a Technical Member of IPENZ and has completed a Master of Technology (Pavements) through the Deakin University in Geelong, Victoria.

Simon Fletcher

Simon Fletcher is an independent Coloured Surfacing Consultant. His specialist knowledge has been acquired over sixteen years, working with local authorities and private contracting companies across the U.K., Poland and New Zealand.

Simon has become most familiar over the years with the leading binders and the most appropriate internationally-recognised aggregates, relevant to each application – most notably the use of calcined bauxite for high skid-resistance.

His main areas of expertise include the precise design/layout of sites to be treated (for maximum effect), the training of operatives in the site preparation and meticulous installation of the materials, and their on-going in-situ performance and maintenance, consequently enabling Simon to create a 'Condition Rating Audit' system for High Friction Surfacing and coloured surfacing for NZTA Engineers and local authority Engineers to utilise, going forward.

Since 2006 Simon has been a member of the NZTA's Steering Group working on the development of the P25 Specification for High Skid Resistant Surfacings (HSRS).