AAPA

14th INTERNATIONAL FLEXIBLE PAVEMENTS CONFERENCE

TYPICAL CAUSES AND SOLUTIONS TO BLEEDING SEAL COATS

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INTRODUCTION

Sustainability of the road network is a challenge for all road authorities and society is expecting improved performance of the network and at lower costs and minimal impact on the environment.

It is estimated that up to 10% (about 30 000km) of the national road network surfaced with a sprayed seal may not be satisfactory from the point of view of not maintaining adequate surface texture early in the service life of the seal.

Selection, design and construction of sprayed seals are a combination of good engineering and some “black art”, and there is no substitute for relevant practical experience.

To achieve a satisfactory and effective sprayed seal requires attention to detail and must take into account a risk assessment on the probability of the seal being appropriate for the conditions, and if it fails ‘can we live with the outcome’.

The success of a sprayed seals starts at the selection of an appropriate treatment(s) for the traffic and service conditions, followed by careful design of the rates of application of binder and aggregate, and construction of the treatment at the appropriate time of the year taking into account prevailing weather conditions and minimising risk of failure.

Early loss of service life in sprayed seals due to having inadequate surface texture is a major concern with regards to potential road safety issues. This cannot always be avoided but with careful attention to the selection, design and construction the incidence of bleeding seals can certainly be reduced, and there are proven remedial treatments available to restore adequate surface texture on bleeding seals.

This paper presents an overview and highlights important steps on how to minimise potential loss of texture early in the life of a sprayed seal, and practical remedial treatments available to re-establish adequate texture.

FLUSHING versus BLEEDING SEALS

On medium to heavily trafficked roads sprayed seals gradually loose texture over time and may only just have adequate texture by the time they require resealing. If in this condition they are generally referred to as ‘flushed’ seals’, with minimum texture of around 1mm. At that stage the binder has hardened, pick-up on tyres is not an issue, and a normal reseal will provide the required surfacing characteristics.

On average, new seals do not settle down for a period of about 2 years after construction and this is taken into consideration in the Austroads seal design method. If seals loose texture early in their life the binder is still lively and near the top of the aggregate, this condition is classed as 'bleeding' and there is the potential for the binder to be picked up on tyres and cause damage to the seal as shown below. The seals lack adequate texture for safety in wet weather, and binder pick-up will often result in a "rough" riding surface.

At age two years this "bleeding" seal had minimal texture. On a very hot summer's day the binder became very tacky and picked up resulting in damage to the seal. At this stage this damaged sealhas been repaired with cold mix, but needs major repair prior to resurfacing. We should ask ourselves three simple questions:

- Is this acceptable (not really)
- WHY did it happen
- HOW can we minimise the potential of this happening

TYPICAL CAUSES LEADING TO BLEEDING

Unfortunately, at times sprayed sealing is seen as a simple and low cost treatment for all occasions. To achieve a satisfactory and effective sprayed seal requires attention to detail and must take into account a risk assessment on the probability of the seal being appropriate for the conditions, and if it fails 'can we live with the outcome'

Typical causes identified that may result in bleeding include the following:

- Poor standard of pavement preparation
- The 'black stuff' is not what it used to be
- Selection of an inappropriate treatment
- Poorly executed design
- Poor standard of seal construction

- Timing of the treatment (weather)
- Unexpected increase in traffic

Or, as some believe, is it all hot air? That is, it is all due to HOT prevailing weather conditions.

POOR STANDARD OF PAVEMENT PREPARATION

On new works bleeding may be due to the granular pavement material not being of a satisfactory quality for the conditions. Another factor is the pavement preparation being aimed primarily at providing a smooth surface as required by many specifications. This is often achieved by heavy watering and rolling of the surface resulting in a fine and relatively soft “slurry” paste.

Not allowing sufficient time for ‘dry back’ of the pavement, together with the fine slurry on top, increases the potential for embedment of the aggregate to take place once opened to traffic.

On reseal work the standard of maintenance does not appear to differentiate sufficiently between normal routine maintenance and the pavement is being specifically prepared for a reseal. Of concern are the choice and type of patching materials and application, such as cold mix versus hot mix and lack of compaction of these materials. A better choice, if practical, would be to repair larger areas using granular material and applying an emulsion seal.

Also of concern is the lack of sufficient time allowed between maintenance patching and resealing. It is recognised budget constraints make it difficult but we have to convince the asset managers to try and provide dedicated funding for some of these works well in advance.

Loss of texture due to embedment of aggregate on new work where the pavement was not given sufficient time to cure. This may be prevented by:

- Adopting sound construction practices and achieve compaction
- Allowing pavement to dryback
- Checking potential embedment with embedment hammer (see section on Seal Design)
- Avoiding applying treatment in cold/wet conditions

THE BLACK STUFF IS NOT WHAT IT USED TO BE

It is popular among many practitioners to blame C170 as being too soft and the cause on many instances of bleeding. A number of trials have been carried out using different conventional binders, including one made up in the field of a 1:1 mixture of C170 and C320, with a viscosity of around 240 Pa.s at 60 °C.

These trials have proven that the binder is usually not the main reason a seal bleeds in warm to hot weather and there is visually little difference between the performance of trial sections constructed with C170, C240 and C320 bitumen.

There are a number of alternatives available such as using C240, C320 and multigrade bitumen M500/170. These lower the risk compared to C170 but the question is by how much, they have potential shorter life before requiring resealing and some supply issues at this point in time.

A further alternative is to use Polymer Modified Binders (PMB) but these are relatively expensive, more difficult to use at the cooler times of the sealing season but minimise the risk of bleeding. Low to medium PMB grades are considered to reduce risk at a reasonable cost.

SELECTION OF AN INAPPROPRIATE TREATMENT

One of the issues identified is the selection of an inappropriate treatment for the conditions, and also choosing the ‘cheapest’ seal option with a high risk of not performing as expected.

Primersealing treatments and practice

These have become accepted standard initial treatments prior to applying the final surfacing selection. Often, as a result, not a lot of thought is given to the selection and design of primerseals and the most common primerseal would be one with 10mm aggregate using a cutback bitumen primerbinder. This may lead to unsuitable primerseals being applied ot to them not being sufficient time to cure.

Not much thought is given to the next (FINAL) treatment to complete the works, such as what is it and when is it planned to be applied. There are many instances where a smaller aggregate would be more suitable, and greater consideration should be given to which is the more suitable primerbinder, cutback bitumen or bitumen emulsion.

FINAL sealing over cutback bitumen primerbinder

The primerbinder should be allowed to cure and harden. A minimum of 12 months is recommended with current types of cutback bitumen primerbinder. Harder, faster curing primerbinders are available and should be considered if there are concerns about the 12 months time interval. Using say C320 as the base binder for the cutback bitumen, and 7mm aggregate, would reduce the risk of the primerseal adversely affecting the performance of the final seal.

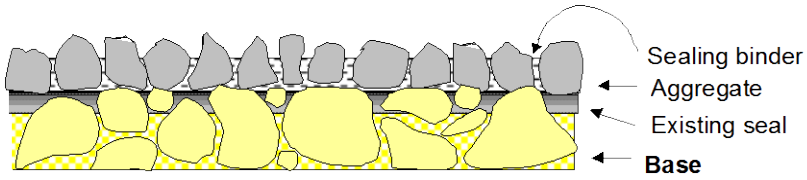
FINAL sealing over bitumen emulsion primerbinder

The cationic bitumen emulsion generally used as primerbinder contains only a very small amount of cutter and will cure faster than cutback bitumen. The recommended minimum time is 3 months, and there is less risk when 5 or 7mm aggregate is used.

Sprayed seal treatments

The following section provides a quick overview of the two common types of seal treatment. In Austroads we identify these two types of seals by the number of layers of bitumen and aggregate in the seal.

SINGLE/SINGLE SEAL (S/S)



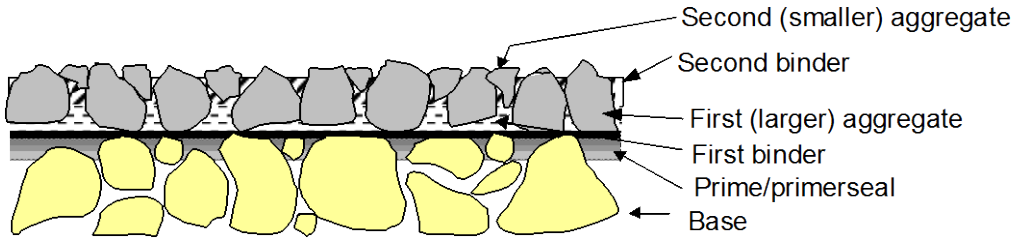
Single/single: Most common economical type of seal
New work and reseal treatments

Binder: C170, PMB, Multigrade

Aggregate: 7/10/14mm

Design: National Austroads design method

DOUBLE/DOUBLE SEAL



Double/double: More robust seal than a single/single for areas of high traffic loading and shear stress
2 layers of binder, and 2 layers of aggregate

Binder: C170, PMB, Multigrade

Aggregate: 1st layer is larger aggregate
2nd layer is ideally half size of 1st layer, or smaller

Combinations: 20/10, 20/7, 14/7, 10/5 mm

Design: National Austroads design method – updated 2011

Performance of D/D seal v S/S seal

- D/D more robust and reduces risk of stripping/bleeding
- D/D is a bit more expensive initially, but offset by longer life and reduced risk of not performing as expected
- D/D design using Austroads tended to give design rates at the higher end of the envelope. This has been reviewed, with a view to increasing texture on the completed seal, and an amended design procedure is to be published in late 2011
- Preferred construction is both applications applied with little or no traffic between applications

Updated guide for the selection of sprayed seal type

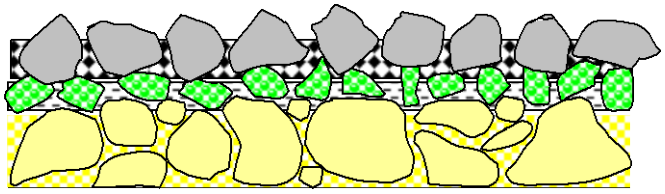
The performance of S/S and D/D seals can be greatly improved by using PMB or Multigrade instead of conventional bitumen in areas of high stress. In Austroads we have just completed an amended Seal Selection Guide covering a large range of traffic conditions, climatic conditions, areas of high traffic loading and shear stress, and cracked pavements, to assist in selecting the most appropriate type of seal for the conditions.

To deal with areas of extreme stress and high concentration of commercial vehicles we have introduced an Extreme Stress Seal (XSS) type using a highly modified PMB in both applications.

This new selection guide is expected to be published together with the update of the Austroads Seal Design method for D/D seals.

Inverted seal

This type of seal is made up of two separate S/S seals, a small aggregate as the initial seal followed by a larger aggregate seal some time later. ***NOTE: this is NOT an upside down D/D seal***



Use: Correct existing non-uniform texture prior to resealing;
minimize potential aggregate embedment on initial seals when sealing soft bases (e.g. limestone); resealing fatty seals

Binder: C170, PMB, Multigrade

Aggregate: Small - generally 5 or 7mm
Large - 10/14/16mm

AUSTROADS SEAL DESIGN (AP-T68/06)

The current Austroads seal design is still loosely based on the work done initially by F.M Hanson. It was developed from an extensive national sealing trial and when used correctly it provides appropriate design rates of application of aggregate and binder, taking into account life of the seal and providing adequate surface texture, for a large range of conditions and types of treatment.

Two issues identified and updated in the 2006 version is the influence of aggregate embedment and heavy vehicles on the performance of sprayed seals with regard to providing adequate surface texture.

Aggregate embedment

To determine potential embedment of aggregate on new granular pavements prepared for sealing we have adopted using the Modified Ball Penetrometer test, generally referred to as the 'ball embedment' hammer. The Austroads design is based on the original Republic of South Africa (RSA) concept and we have an arrangement to compare results with RSA with a view to further development and use of this test on assessing potential embedment when sealing over other surfacing such as say asphalt regulation.

The hammer costs about $1000 from the supplier in Queensland.

AAPA recommends that all companies engaged in spray sealing operations purchase and use this hammer to determine potential embedment as part of the seal selection and design process on new works.

Ball Penetrometer

The test is used:

- After compaction and dry back prior to priming/primersealing
- On primed surfaces prior to sealing

Recommended limits are:

- Ideally: 3mm or less
- Maximum: 4mm

If embedment is greater than 4mm consider the following options to minimise the risk of bleeding in the wheel paths:

- Allow more time for dry back
- Select an alternative treatment, say smaller aggregate primerseal or inverted seal
- If possible – defer the work

Design Traffic

Traffic volumes are based on AADT, and then apportioned to each lane or section of the pavement to be treated to determine the Design Traffic. Therefore, current accurate traffic volumes are essential, including at least the proportion of heavy vehicles and large heavy vehicles included in the AADT, to determine correct rates of application.

The Austroads design was developed with input from a national large scale sealing trial. During monitoring of this sealing trial it became evident that with the rapid increase in large heavy vehicles that some amendments were required to the seal design to compensate for these and minimise the risk of the seal not having adequate texture. A heavy vehicle is classed as a commercial vehicle of 3t or more, ranging from 2 axles up to 6 axles for a single semi-trailer. A large heavy vehicle is classes as a B-Double or large truck trailer combinations having a total of 7 axles or more. A typical B-Double has 9 axles.

From practical observations and statistical analysis of traffic data relating to heavy and large vehicles, it was concluded that large heavy vehicles have about three (3) times the effect of normal heavy vehicles.

This resulted in the concept of Equivalent Heavy Vehicles (EHV) to determine any adjustment required in the design for the percentage of heavy and large heavy vehicles in the design traffic, where:

EHV = (HV) + (3xLHV) % as part of the Design Traffic.

Often this is not considered adequately in the design, or done incorrectly. Including the correct adjustment for these vehicles may reduce the binder rate significantly, by as much as 30% from the standard design.

Large heavy vehicle (9 axles)

B-Double

Heavy vehicle (6 axles)

Truck-trailer combination

PMB Factors

When a seal treatment is selected as a High Stress Seal (HSS) or Extreme Stress Seal (XSS), or as a Strain Alleviating Membrane (SAM) a PMB Factor is used in the design to determine the appropriate binder rate for the specific treatment. Often designers will use the same PMB factor for all treatments and grades of PMB and this is not appropriate.

The PMB Factors range from a Factor of 1.0 (HSS) to as high as 1.3-1.4 (SAM). If say the SAM Factor is used for a HSS design this could result in a design with an excess of up to 30% of binder for the conditions.

It is therefore very important that the designer determines WHY the PMB is used and which type and grade of PMB in order to determine the correct PMB Factor for the design.

An unsatisfactory Final HSS Seal constructed using a PMB as part of the treatment. HV and LHV not considered adequately, plus incorrect PMB Factor, leading to early bleeding and pick-up of the binder. The major problem now is how to correct this to achieve a satisfactory long life sprayed seal surfacing.

Variable surface texture in existing surfacing

The design of binder rates of application is determined for the wheel paths. In many cases the texture outside the wheel path is much coarser and requires more binder. It is considered a normal S/S seal can provide a satisfactory seal if the difference in binder rate in the wheel path and outside the wheel path does NOT exceed 0.2 L/m².

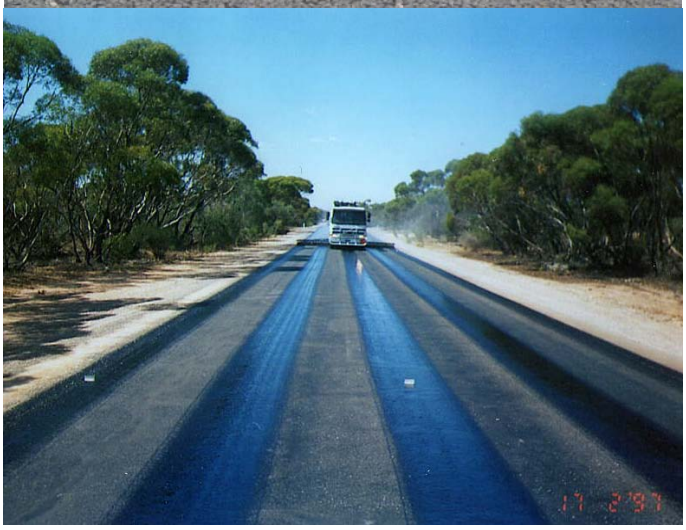
By taking into account the variable surface texture we can reduce the risk of early stripping in coarse areas/bleeding in the wheel paths.

If the difference is say 0.3L/m² or greater, than to achieve a satisfactory uniform textured seal, the following options should be considered:

- Apply a correction seal or micro-surfacing prior to resealing
- Spray different rates of application across the pavement. This can be done using a single sprayer doing 2 runs, 2 sprayers following each other or using a sprayer designed specifically to be able to apply variable transverse rates of application.

Variable surface texture on road planned to be resealed. Difference in binder design rate averages 0.4 L/m² from wheel paths to coarse textured areas

Option selected was to apply variable spray rates across the pavement surface



Note binder applied in coarse textured areas only on the first run at 0.4L/m²

Sprayer is returning immediately on 2nd run at full width, spraying at design binder rate of 1.0L/m² for wheel paths.

Job is then covered with aggregate and rolled as normal

CONSTRUCTION PRACTICES

Timing of the work

Sprayed seals are best done in warm and dry conditions. This is of course not always possible and some work has to be done in the cooler times of the sealing season. This increases the risk of failures such as stripping of the aggregate, particularly when using PMB binders, or bleeding in the next period of hot weather.

Primersealing

Although developed for all year use, primersealing in wet/cool/cold conditions increase the risk of loss of aggregate, or the treatment not bonding to a wet and cold pavement. This can be minimised to some extent by using an appropriate bitumen emulsion and some careful traffic control. It is preferable if the construction program can be amended to avoid the coldest/wettest conditions. Using dry and precoated aggregate can further reduce the risk.

Sealing

Higher risk of failure due to:

- Cooler weather - work done late in the season and then subject to sudden increase in temperatures in early summer can result in bleeding.
- Cooler weather – increased risk of stripping of aggregate. This is then often repaired using a small aggregate 'pin down' seal to prevent further aggregate loss. Generally the 2 applications of binder result in over-application and increases the risk of bleeding in hot weather
- Higher traffic volumes, and in particular a high percentage of commercial vehicles, increases the risk of failure. Short term traffic increases due to special events, crop cartage etc also increase the risk and it is preferable to defer the work if possible.
- Cutter content required – cool weather requires additional cutter to wet the aggregate and establish the bond. Cutter takes about 12 months for most of it to evaporate and leaves a soft binder in the warmer/hotter conditions
- Maintenance patching – patching/crack filling just prior to resealing
- At the start and end of the spraying season not allowing for the cooler conditions at night, usually resulting in stripping requiring remedial treatment
- Not changing work practices in general to reflect the cooler weather conditions

TREATMENT OF BLEEDING SEALS

Why treat bleeding seals

The main reasons bleeding seals require treatment are:

- Provide adequate skid resistance
- Reduce maintenance costs
- Avoid vehicle damage
- Avoid damage to the sprayed seal

Early treatment

In general, the earlier a problem seal is treated, the more effective the remedial treatment and the lower the cost. The worst condition is usually after several continuous hot days and nights resulting in a relatively soft binder allowing the aggregate to more closely packed together forcing the binder towards the surface and/or embedment of aggregate into a soft underlying surfacing. Effective treatments include:

- Apply water to cool down the seal
- Apply grit, size 5/mm precoated aggregate to avoid pick-up of the binder and damaging the seal
- If readily available, apply clean 'hot' aggregate from an asphalt plant

Longer term treatment

These include:

- Applying solvent and small aggregate
- High Pressure Water blasting or shot blasting

Applying solvent and small aggregate

This treatment can be applied by a small spraying crew using commonly available materials and equipment used in everyday sprayed sealing operations.

The solvent is applied and allowed to soften/wet the existing binder and then covered with precoated size 5 or 7mm aggregate, and rolled. Aggregate will only stick where there is sufficient binder to retain it, but it keeps the tyres out of the bitumen and prevents pick-up.

Solvents used successfully include kerosene (cutter), highly aromatic kerosene and proprietary materials (e.g. such as gilsabind)

The treatment is most effective when applied in warm to hot weather conditions.

High pressure water blasting

Special high pressure water blasting equipment has proven to be able to successfully remove excess binder from a bleeding or flushed seal to restore texture. Similarly shot blasting may be used but the binder to be removed must be relatively hard for this to work effectively.

The aim is to restore surface texture to about 1 to 1.5mm depending on the aggregate size.

Let the treatment settle down and resist resealing it too soon.

An example of texture restored in wheel paths of a road carrying medium traffic volume, with about 10% heavy vehicles and very few large heavy vehicles

Age of water blasting: over 2 years since surfacing was water blasted and still has adequate texture and is not expected to require any further treatment for at least another couple of years