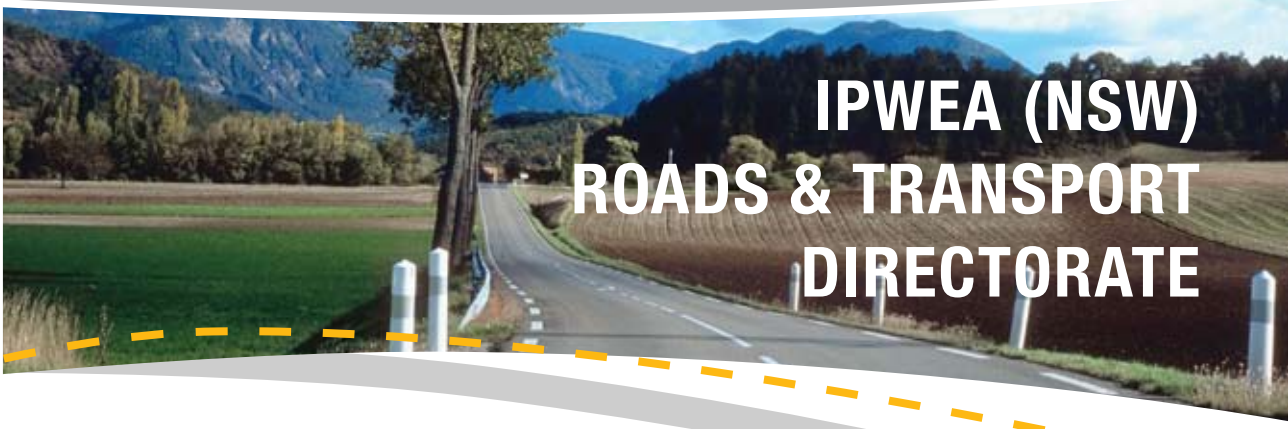
Institute of Public Works Engineering Australia (NSW Division)



IPWEA (NSW) ROADS & TRANSPORT DIRECTORATE

OXIDATION OF BITUMEN SEALS

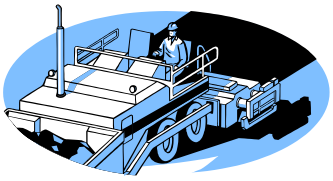
Information Sheet IS-01
February 2009

Information Sheet Purpose

This Information Sheet has been produced to assist road managers in reviewing the design and specification of new asphalt surfaces. Considerations of carbon footprint and sustainability will require seal designs which produce maximum lives which will in turn minimise whole of life costs.

The information presented suggests design parameters which should be considered in developing specifications for future bitumen seals for use on lightly trafficked local roads.

Design Issues covered:



The Problem

The majority of lightly trafficked local roads managed by Councils employs bitumen seals, and fails as a result of breakdown of the surface treatment, not as a result of excess loading. These failures are primarily caused by oxidation of the bitumen binder. Oxidised binder is defined as a binder which has become hard and brittle as the result of chemical attack by oxygen in the presence of heat and sunlight.

Road asset managers must understand the behaviour of road surfacings so that:

- **They can predict and manage the renewal of pavement surfacings to maximize the their lives and minimise the whole of life costs**
- **They can predict surface treatment failures and develop long term financial planning**
- **Improved surfacing designs can be developed to extend the life of surface treatments**

General Design Issues

For lightly trafficked pavements the oxidation of bitumen can cause environmental deterioration to become significant. Bitumen oxidises on exposure to air, becoming brittle. This process is accelerated by high temperatures and ultraviolet radiation (from sunlight). Brittleness leads to cracking of surface seals and ravelling of both surface seals and asphaltic surfaces. Trafficking has a beneficial effect by closing micro-cracks in bitumen films and surface voids in asphalt, hence constraining oxygen flow. In low traffic volume situations, especially in non-trafficked zones such as parking lanes, this beneficial effect is reduced, leading to earlier onset of the above-mentioned distresses. To counter this, the use of asphalt mixes which have lower air voids and higher bitumen contents at construction is recommended. Similarly, bitumen application rates for sprayed seal surfacings should be increased to allow for the accelerated deterioration.

Definitions

cracking **A pavement defect signified by vertical splitting of the pavement material due to the action of traffic loading, environmental stress or material characteristics. It is usually identified as visible discontinuities at the surface, not necessarily extending through the entire thickness of a member or pavement.**

crack sealing
The filling and/or bridging of cracks, usually in the pavement surface or in a concrete structure.

design traffic
The cumulative traffic, often expressed in terms of equivalent standard axle loads, predicted to use a road or bridge over the structural design life of the pavement or bridge.

lightly-trafficked road
A road carrying average annual daily traffic (AADT) of up to 500 vehicles or a design traffic of between 10^3 and 10^6 (ESA)

pavement design
A process to select the most economic pavement thickness and composition which will provide a satisfactory level of service for the anticipated traffic and environmental loading.

pavement distress
The deterioration of the pavement evidenced by visible surface defects.

rejuvenation
A light application of an emulsified bituminous material to replace part of the lost maltene fraction in oxidised bitumen.

rejuvenator (sprayed seal)
A liquid product in which a substantial amount of light petroleum product is suspended in water, or vice versa. This is applied in the form of a spray to asphalt or bituminous sealed pavement surfacings to restore the properties of the bituminous binder.

residential street
A road, the main function of which is to provide access to residential properties.

Design Considerations

Sprayed Seals

Assuming a sound underlying pavement, there are design considerations which may increase the effective life of sprayed seals. The items listed below should be investigated in determining the most appropriate seal design for local conditions.

Reseal only when necessary. Don't automatically reseal on an anniversary basis but carry out a visual inspection of all aged seals prior to listing for reseal.

Use larger size seals. The use of larger sized aggregate provides an increased bitumen film thickness, which in turn, reduces the rate at which the bitumen hardens. This can increase pavement lives between 10% and 50% depending on the aggregate variation. The downside is increased initial cost and increased road noise.

Use a softer bitumen grade. Consideration should be given to the use of Class 80 bitumen in place of existing Class 170 bitumen or Class 170 bitumen in place of Class 320 bitumen. Softer bitumen grades have a lower starting viscosity and must therefore harden over a longer period before distress due to hardening is reached. The downside is that increased scuffing of the seal may occur if softer bitumen is used.

Provide adequate rolling. It is essential that rolling of new seals is carried out in accordance with the specification since additional rolling by traffic will not be achieved on low traffic streets. Poor rolling will result in loss of aggregate and poor pavement performance.

Asphalt Pavements

Asphalts designed for lightly trafficked roads are generally more flexible and durable and less permeable than pavements designed for heavier traffic applications. The items listed below should be investigated in determining the most appropriate seal design for local conditions.

Reseal only when necessary. Don't automatically reseal on an anniversary basis but carry out a visual inspection of all aged seals prior to listing for reseal.

Reduce air voids. This can be achieved by a combination of:

- Finer aggregate grading
- Increasing binder content by between 0.5% and 1.0% by mass

Increase compactability. Compactability of thin residential asphalt mixes can be improved by:

- Increasing binder content.
- Using a gap graded aggregate specification

Use a softer bitumen. Use of a softer grade of bitumen such as Class 170 in place of Class 320. The downside is that increased scuffing of the seal may occur if a softer bitumen is used.

Provide adequate compaction. It is essential that rolling of new pavements is carried out in accordance with the specification since additional rolling by traffic will not be achieved on low traffic streets.

Pavement Temperatures. The achievement of optimum compaction of thin asphalt mixes is dependent on compaction being carried out at the correct temperature. Placement of thin asphalt layers on cold pavements will result in insufficient compaction and an increase in air voids. This, in turn, will lead to a greater rate of oxidation and accelerated ageing of the asphalt wearing course. This problem needs to be addressed at mix design stage so that optimum life can be obtained from the pavement.

Pavement Life Extension

Where pavements begin showing signs of distress due to ageing binder alone it may be possible to economically carry out repairs that will prolong the life of the seal by several years. This extension of life may significantly lower the whole of life cost of the pavement. Typical treatments available include:

Crack sealing. Providing the underlying pavement is sound and there are no problems with raveling the use of crack sealing may extend the life of the pavement by reinstating the waterproofing integrity of the seal. Due to the relatively high cost of crack filling, this approach is unlikely to provide an economical solution to seals displaying extensive cracking.

Pavement Rejuvenation. This treatment is also known as surface enrichment or fog spray. Rejuvenation can extend the life of a seal by several years. It works by softening oxidised bitumen, providing additional adhesion for the aggregate and resealing small cracks.

References

The information contained in this Information Sheet has been summarised from a number of sources. More detailed information should be sourced from the references listed below.

1. arrb Transport Research, July 1997, Austroads Pavement Research Group, Technical Note 4, *Light Duty Non-Structural Asphalt Surfacing and Overlay.*
2. Austroads 2004. *Pavement Design – A Guide to the Structural Design of Road Pavements*, Austroads, Sydney.
3. Austroads 2006, *Pavement Design for Light Traffic: A Supplement to Austroads Pavement Design Guide*, Austroads, Sydney.
4. Glynn Holleran, Tom Wieringa, John Tailby, *Rejuvenation Treatments for Aged Pavements*, Fulton Hogan Ltd, Opus International Consultants.
5. John W H Oliver and Susannah Boer, ARRB Group, *Optimising Sprayed Seal Life in Response to Global Challenges*, 1st Sprayed Sealing Conference, Adelaide 2008.

Good Design

- Extended Life
- Reduced Costs

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