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Sustainable preservation surfacing treatments to extend the life of local roads

Nandini Mehta[1]

[1] *AUS-SPEC Manager, Construction Information Systems, Australia*

ABSTRACT: *Pavement preservation strategies and techniques, if applied at the right time, improve the pavement conditions and extend the pavement life and performance without increasing expenditure*. *Councils are increasingly adopting a range of preservation surfacing treatments to sustainably maintain their road network and contribute to lower the whole-of-life cost and increase the area of roads treated annually. Councils regularly assess the condition of their pavements and have a framework of preventive maintenance program to implement the best pavement preservation strategies.*

Sprayed preservation surfacing treatments are generally applied to low-volume roads where the primary distress mode is due to environmental factors resulting in binder oxidation. If roads are left untreated, potholes develop and eventually result in a localised pavement failure. The need for a generic specification on pavement preservation treatments to assist Councils to maintain their road network effectively was identified at various IPWEA events.

In response, AUS-SPEC, the national local government specification system, in conjunction with industry partners, developed a new generic specification '1147 Sprayed preservation surfacing' for the supply of materials and application of spray-applied preservation treatments to preserve, protect and prolong the life of existing wearing pavement surfaces. A new TECHnote 'Sprayed preservation surfacing treatments' has also been developed to help local governments determine when and where to apply the most appropriate sprayed preservation surfacing treatments, to maximise benefits and extend the life of their sealed road network.

This paper will highlight how Councils can use various AUS-SPEC generic documents to specify the surfacing treatments and provide case studies to preserve and prolong the asset life and minimise the whole-of-life costs of their road assets.

KEYWORDS: Data collection, enrichment, Pavement preservation, rejuvenation, sealed roads, treatment, unsealed roads

1 Introduction

Local government infrastructure assets must be maintained throughout their life cycle. The delivery, maintenance and repair of their roads network is a major challenge for local governments, with the responsibility to provide these services in a sustainable manner while maintaining the financial capital and the infrastructure capital over the long term. Local roads being the largest road network used by the community, Councils have a duty of care to deliver and maintain their pavements so that they are safe and provide the desired level of service. Appropriate pavement preservation strategies and techniques, if applied at the right time, will improve the pavement conditions and extend the pavement life and performance without increasing expenditure.

2 Need for Pavement preservation

Pavement preservation is a program employing a long term strategy at the network level that enhances pavement performance, by using an integrated, cost-effective set of practices that extend pavement life, improve safety and meet community expectations. It is an approach to preventive maintenance to place the right treatment on the right road at the right time. Preventive maintenance is a tool for pavement preservation and involves non-structural application to preserve the surface and prevent deterioration. Pavement preservation is the sum of all activities to provide and maintain serviceable roadways, including corrective and preventive maintenance and minor rehabilitation.

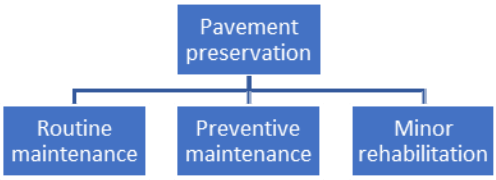

Figure 1: Pavement preservation program

Pavements deteriorate due to many factors – predominantly vehicle loading and environmental elements over the lifetime. However, Council roads are generally lightly trafficked and surfaced with sprayed seals or asphalt, or unsealed wearing courses. The deterioration of bitumen roads is due to the breakdown of the surfacing, primarily due to the oxidation. Early failures could be due to breakdown in the construction process of materials, site preparation or placement practices. These are avoidable if proper construction methods and placement techniques are used in conformance to the specifications. Quality construction and material practices apply to all types of pavements. For flexible sealed pavements, the quality construction and material practices include sprayed seals, slurry seals, microsurfacing, enrichments, asphalt overlay and pavement preservation treatments. Improved construction methods, appropriate treatment methods, and specifications all contribute towards improved pavement performance and safer roads and delay the need for costly rehabilitation. Therefore, the purpose of pavement preservation is to reduce ageing and restore serviceability without decreasing the capacity or strength of the pavement. The net result will be lower whole-of-life costs.

2.1 Pavement preservation program

Pavement preservation is work that is planned and performed, to improve or sustain the condition of the road, and restores the overall condition of the asset. Every Council needs to have a sustainable pavement preservation strategy and program based on the condition of their pavements. Councils using a pavement management system will be able to model pavement and surface deterioration due to the effects of traffic and environmental considerations, and have a record of their road inventory assets. Some pavement management systems can also generate maps based on the conditions and geometric data, including road hierarchy, pavement age and type, surface age and type, pavement condition index, pavement defects and treatment type.

2.2 Data collection

Road asset data collection and management is essential for a successful pavement preservation program. Data provides a means of assessing the condition of the road network and the implementation of appropriate pavement preservation treatments.

2.3 Treatment selection

The most appropriate treatments can be selected for each road type, depending on engineering suitability, life cycle costs, budget capacity and community expectations. Alternatively, IPWEA Practice Notes 9, 9.1 and 9.2 can be used for assessing the pavement condition and then selecting the most appropriate treatment options.

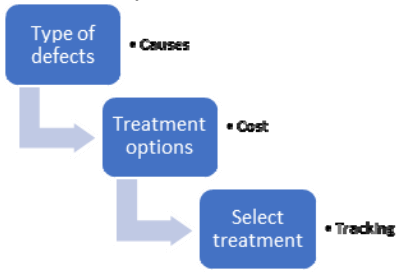

Figure 2: Pavement preservation decision flowchart

3 Preservation treatments

An effective pavement preservation treatment is applied while the pavement is still in good condition, and a cost-effective treatment used at the right time will restore the pavement to its original condition. When a pavement needs treatment, sometimes it is too late.

Pavement preservation is a proactive solution for maintaining roads. It involves implementing small-scale repairs on the road prior to structural degradation to avoid reconstruction. A proactive road asset management strategy utilises the full range of surfacing and pavement preservation treatment options to assist road managers maximise the number of road segments treated annually, whilst simultaneously improving the condition of their road network within existing budget constraints.

There are a range of available treatment options that conform to the *Sprayed preservation surfacing* specification. As most treatments are proprietary products however, it is incumbent on Asset Owners to ensure that

the selected product is suitable for the intended outcome.

Sprayed preservation surfacing treatments applied at the optimum time in the life cycle of low-traffic roads will preserve the pavement – the life of the bituminous surfacing of local roads is extended up to 40 years, subject to treatments being reapplied on a regular frequency of 5 to 7 years. Different climates can change the timing of treatments. Reseal intervention can vary from 10 to 20 years depending on the climate.

3.1 Types of treatments for sealed roads

Each surfacing type has particular characteristics; different types of treatments are required in different sets of service conditions. Appendix A provides a list of treatments and how AUS-SPEC documents can be used for specific treatments. Sprayed treatments have a thin layer of binder sprayed onto the surface with a layer of aggregate incorporated. The types of sprayed treatments used for sealed roads are:

Sprayed seal: A thin layer of bituminous material into which aggregate has been incorporated. It is impervious to water. This treatment seals the pavement surface and improves friction and is generally applicable to low-volume roads

Asphalt overlay: A mixture of bituminous binder and aggregate with or without mineral filler. It improves pavement friction and provides some structural capacity.

Slurry surfacing: A mixture of graded aggregates and bitumen emulsion produced as a slurry, and can be one of two types: slurry seal and microsurfacing. Slurry surfacing is applied as a thin wearing course as either preventative maintenance or as a corrective maintenance to restore surface texture, correct ravelling and loss of fines, and fill minor surface cracks.

Slurry seal: A thin layer of slurry, consisting of a mixture of sand and crushed rock and containing filler, cement and bitumen emulsion. The size of slurry seal varies from sand particles to 7mm aggregate. Slurry seals are effective in sealing low-severity surface cracks, waterproofing the pavement surface and improving friction at low speeds.

Microsurfacing: Similar to slurry seal, except polymer-modified bitumen emulsions are used to provide faster setting. Microsurfacing is used to inhibit ravelling and oxidation, and is effective in improving surface friction, filling minor irregularities and rutting, and provides greater durability and improved flexibility.

Sprayed preservation surfacing treatments

Sprayed preservation surfacing treatments include:

- Rejuvenation;
- Enrichment; and
- Polymer Modified Emastic (PME).

These treatments are generally applied to local low volume roads where the primary distress mode is due to environmental factors, which results in binder oxidation. Binder oxidation causes the fine surface matrix of an asphalt, or microsurfacing, to ravel and eventually lose the larger aggregate. If roads are left untreated, potholes will result and eventually develop into a localised pavement failure. In seals, binder oxidation is characterised by aggregate loss, resulting in stripped seals.

Rejuvenation: A sprayed treatment comprising emulsified oils (non-bituminous) intended to penetrate into the existing asphalt surface to maintain the viscosity and elastic properties of the binder, and chemically reverse or halt the aging of the bitumen binder. Rejuvenators will act to penetrate the existing surfacing to maintain the viscosity and elastic properties of the binder. Best results are achieved when the surface age is <8 years.

Enrichment: A sprayed treatment, incorporating bitumen and proprietary additives, applied to bituminous surfacing to provide a protective barrier against oxidation. Enrichment treatments are typically non-sand filled, and the nominal residual application rate ranges from 0.30 to 0.60 l/m^2. Materials used for surface enrichment include:

- Bitumen emulsion: Slow and medium setting emulsions (ASS, AMS, CSS and CMS) are generally used for enrichment work.
- Proprietary materials: Incorporating combinations of rejuvenating agents and bitumen provides both rejuvenation of hardened binder and additional binder volume. The best results are achieved

when enrichment treatments are applied when the surface age is <8 years.

Rejuvenation and enrichment treatments are applied to low-volume local roads in generally good condition and with no major visible defects. To minimise the environmental effects and maintain the surfacing in good condition, Rejuvenation and enrichment treatments must be reapplied every 4 to 7 years and must be applied in summer for drying efficiency. This will result in more than 40 years surfacing age achieved for the lowest whole-of-life cost. Where the existing seal has less than 3% stone loss, the seal would generally be suitable for enrichment treatment.

Polymer Modified Emastic: PME is composed of a mineral filler (usually sand or clay) mixed into a bituminous material. The mineral filler is intended to replace the fine aggregate matrix lost from the surface of oxidised asphalt surfaces. PME treatments:

- Are intended to be applied to any structurally sound bituminous surfacing exhibiting signs of oxidation, resulting in a ravelled surface texture.
- Applied at the optimum time in the life cycle of low-traffic roads will extend the life of the bituminous surfacing by a further 5 to 7 years. When applied to spray seals, PME treatments assist in preventing aggregate loss, and resultant reduction in surface texture aids in reducing traffic noise in residential areas.

3.2 Pavement preservation treatments using AUS-SPEC for sealed roads

AUS-SPEC national local government specifications, developed by IPWEA and updated by NATSPEC, can be used for different pavement preservation treatments.

1142 Cold mix asphalt worksection is applicable to the design, production and delivery of cold mix asphalt including supply of materials, sampling, testing and all other operations to provide a dense graded and open graded cold mix.

1143 Sprayed bituminous surfacing worksection is applicable to the supply of materials, design and application of bituminous seals, and roadway surfacing. It also covers environmental risk assessment.

1144 Asphalt (Roadways) worksection is applicable to hot mixed, dense graded, open graded, stone mastic, fine gap graded, ultra-thin asphalt and light traffic asphalt for roadways and other pavement-related applications.

1146 Slurry seals and microsurfacing worksection is applicable to the design, supply, mixing and placement of slurry seals and microsurfacing for surface correction and wearing surface applications on road pavements, carparks, cycleways and footpaths.

1147 Sprayed preservation surfacing worksection is applicable to the supply of materials and application of spray-applied preservation treatments to preserve, protect and prolong the life of existing wearing pavement surfaces.

NATSPEC TECHnote NTN GEN025 Sprayed preservation surfacing assists road owners to determine when and where to apply the most appropriate sprayed preservation surfacing to obtain the maximum benefit to their sealed road network.

4 Pavement preservation treatments for unsealed roads

Maintenance of unsealed roads
Unsealed roads, when maintained efficiently, are far more cost effective than sealed roads for low-volume roads. The dynamic and changeable nature of unsealed roads makes it difficult to forecast optimal expenditure and allocation of resources.

Surface performance
The deterioration of gravel is influenced by interdependent factors including material properties, road geometry and drainage, environmental influences and traffic conditions. Condition deteriorations may be categorised into surface types.

Material properties
The resheeting of unsealed roads has traditionally been dependent on the gravel from the closest farmer pit. The Australian Road Research Board has produced a spreadsheet that compares the grading coefficient with the shrinkage product. Each pit gravel needs to be tested with a sieve analysis and for shrinkage. When this information is entered into the spreadsheet, the defects can be identified as ravelling, corrugations, rutting,

slippery, dusty or gouging. The model allows trialling of different pit gravel blending to remove defects. The potholing defect can be eliminated by designing a high-density impervious mix with the addition of clay material.

4.1 Blending

Removal of defects on existing unsealed gravel roads can be an economical and effective alternative to:

- Frequent grading maintenance intervention.
- Frequent gravel resheeting.
- Full construction of a sealed road.

Preservation and reduced intervention
Improving an unsealed road by blending a combination or road materials for resheeting or using stabilants to mix into the existing road material should be considered to reduce construction and maintenance costs. The objective is to increase the time between grading interventions, and to increase accessibility after rain.

- With the right gravel blends the increase in density leads to a longer life cycle for the unsealed pavements, and reduced porosity of the denser product reduces the risk of subgrade pavement potholing.
- For unsealed roads, the use of granular blending or other binder stabilisation increases the time between grading interventions, reducing whole-of-life costs while increasing serviceability for road users.

There are many options for Councils to save money using stabilisation of existing road pavements. Councils should be exploring pavement development as ongoing initiatives for total asset management and to get better roads for less cost.

Forgotten Best Practices for Unsealed Roads, identifies blending of materials used to improve the useability, longevity and reduction of unsealed roads maintenance costs for the Cassowary Coast Regional Council (Tully, Cardwell and Innisfail). The Cassowary Coast Regional Council has directed substantially more budget funding into a new system of blended gravel resheeting in response to this material blending initiative for unsealed roads.

The new mix design incorporates three different materials. One job survived three cyclones.

For many years, Western Australia has used material blending for unsealed roads to overcome their widespread problem of marginal materials. Albany Council had an unsealed road that needed maintenance interventions 45 times per year. With material blending that intervention reduced to two times per year. The Eastern states have been slow to adopt blending technology.

Preservation treatments for unsealed roads using AUS-SPEC

Stabilisation
1113 Stabilisation worksection is applicable to materials and processes for stabilisation of subgrade and pavement courses of unsealed roads. Stabilisation binders include cement, quicklime, hydrated lime, cementitious blends, bitumen emulsion, foamed bitumen, granular materials and dry powdered polymer.

TECHnote *NTN GEN 023 Using AUS-SPEC for unsealed roads* provides guidance on using the specific worksections for the design, construction and maintenance of unsealed roads.

TECHnote NTN DES 034 Pavement stabilisation for unsealed roads provides an overview on factors affecting stabilisation of unsealed roads, and basic procedures for binder selections.

TECHnote *NTN DES 035 Improvement and stabilisation of unsealed roads* provides information on blending of gravels and a case sample from Cassowary Coast Council. More design, construction and maintenance documents are being developed for rural Councils, with a specific focus on unsealed roads.

A TECHreport *TR08 Management of Council gravel pits in country areas – A case study* has been drafted and can be used by Councils that operate licensed mine gravel pits to better comply with their duty of care and be compliant with the legal framework required by the State Governments. Councils can build and maintain better sealed and unsealed roads using a system of materials extraction, and blending from different pits to meet higher required performance standards. This report shows how Councils can achieve better whole-of-life costs

and reduce budget expenditure for both sealed and unsealed roads.

5 Conclusion and recommendations

Focus on improved pavement preservation highlights innovation in treatment materials, construction practices, improved specifications, and better equipment. A greater emphasis on construction quality will lead to long-lasting preservation treatments. Pavement preservation is a long-term strategy at the network level that enhances pavement performance by using integrated, cost-effective practices that extend the life of the pavement, improve safety and meet community expectations. The most important aspect of pavement preservation is to apply the right type of treatment to the right pavement, at the right time. AUS-SPEC provides a range of documents, as mentioned in Appendix A and B, which can be used by Councils to select the most appropriate treatments based on the pavement condition, expected performance, life cycle costs and environmental factors. Specifying the right treatments using the appropriate AUS-SPEC documents can help Councils to preserve and prolong the asset life and minimise life cycle costs of their road assets.

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5. *2017 AUS-SPEC Roadworks Package.*
6. Main Roads Western Australia, 2017, *Operational Guideline 96 Searching for Gravel* www.mainroads.wa.gov.au
7. Main Roads Western Australia, 2014, *Operational Guideline 95 Extracting Road Building Materials from Land in WA* www.mainroads.wa.gov.au

Appendix A

Pavement preservation treatments using AUS-SPEC

Treatment	When to apply	Benefit	Drawbacks	Relevant AUS-SPEC worksections
Cold mill and thin overlay	Applied to remove deteriorated pavement to a desired depth. Restores pavement surface profile.	Adds texture surface for skid resistance and improves bonding of an asphalt overlay		*1142 Cold mix asphalt*
Crack seal or fill	If numerous cracks appear a surface seal is provided. This can be used in combination with other treatments like rejuvenation and enrichment, spray seals and slurry seals.	Provides no structural benefit but reduces moisture intrusion. Can last up to 2-6 years and is a low cost way to extend the asset life	Only practical if there is little or no structural cracking	*1614 Crack sealing*
Rejuvenation and Enrichment	Applied to seal cracks and surface voids and inhibit ravelling	Seals the pavement and is used to liven bitumen binder affected by sun and oxygen	Not effective where the binder has hardened and become brittle.	*1147 Sprayed preservation surfacing*
Slurry seal	To reduce surface distress caused by oxidation of bitumen. It seals surface cracks, stops ravelling, makes open surfaces impermeable to air, water and improve skid resistance	Seals the pavement, thus reducing moisture, oxidation. Can also fill shallow rutting. Protects pavement surface from deterioration from the effects of sun/water	More expensive than treatments such as spray seals and enrichment treatments	*1146 Slurry seals and microsurfacing*
Microsurfacing	To fill ruts, utility cuts and depressions in the existing surface	Seals cracks, halts ravelling, improves skid resistance, reduces oxidation, longer lasting than slurry seal	More expensive than other treatments like sprayed seal	*1146 Slurry seals and microsurfacing*
Thin overlay with asphalt	To improve ride quality and correct surface deficiencies such as low skid resistance	Improves pavement friction, reduces moisture intrusion and provides structural support	More expensive than other treatments like sprayed seal	*1144 Asphalt (Roadways)*
Spray seal	Protects pavement from deterioration Effects of the sun/water as well as increase skid resistance of the pavement surface	Seals the pavement surface and improves friction	Does not perform well on high volume roads and accelerate stripping in susceptible	*1143 Sprayed bituminous surfacing*

			pavements	
Surface patch	Temporary repair applied on pavements in relatively good condition	Helps to stabilise the pavement structures and prevent water from entering the pavement and subgrade below	May require frequent application due to improper compaction in certain site conditions	*1618 Heavy Patching* *1619 Minor patching* *1620 Pothole repair*
Polymer Modified Emastic (PME)	To seal and enrich asphalt pavement surface and seal minor cracking	Improves visual aesthetics, resists oxidation from the sun, extends the life and overall value of the pavement. Prevents aggregate loss and resultant reduction in surface texture aids in reducing traffic noise in residential areas	Provides poor resistance to ultraviolet radiation and sunlight	*1147 Sprayed preservation surfacing*

Appendix B

Additional pavement preservation requirements in AUS-SPEC:

Worksections

- *1142 Cold mix asphalt*
- *1143 Sprayed bituminous surfacing*
- *1144 Asphalt*
- *1146 Slurry seals and microsurfacing*
- *1441 Bituminous surfacing repairs*
- *1613 Repairs to bituminous surfacing*
- *1616 Grading unsealed roads*
- *1617 Resheeting unsealed roads*
- *1618 Heavy patching*
- *1619 Minor patching*
- *1620 Pothole repair*

TECHguides

- *TG 405 – Guide to road reserve maintenance system and documentation*

TECHnotes

- *GEN 017 Using AUS-SPEC for asset management*
- *GEN 018 Using AUS-SPEC for asset maintenance*
- *GEN 023 Using AUS-SPEC for the management of unsealed roads*
- *GEN 025 Sprayed preservation surfacing*
- *DES 034 Pavement stabilisation of unsealed roads*
- *DES 035 Improvement and stabilisation of unsealed roads*

TECHreports

- *TR08 Management of Council gravel pits in country areas – A case study*