DELIVERING FOR QUEENSLAND

Technical Note 222

Sprayed Seal Crumb Rubber Modified Binders

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Queensland Government

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1 Introduction

The purpose of this technical note is to provide guidance for practitioners such as planners, designers, contract administrators, project managers, construction contractors and maintenance personnel, to achieve required quality outcomes and avoid issues when using crumb rubber modified binders (CRMBs) for sprayed seals for Department of Transport and Main Roads projects. The content of this guidance relates to the use of CRMBs in hot sprayed sealing works that comply with *MRTS11 Sprayed Bituminous Treatments (Excluding Emulsion)* and MRTS18 *Polymer Modified Binder (including Crumb Rubber)*. Presently, CRMBs are not used in emulsions in Australia.

This technical note provides guidance on:

- CRMB background and key information (Section 2)
- plant-produced CRMBs (Section 3), including transportation
- field-produced CRMBs (Section 4), including blending procedures
- CRMB binder storage, handling and transfer procedures (Section 5)
- CRMB spraying operations (Section 6)
- environmental management (Section 7)
- workplace health and safety (Section 9).

Reference to the department's requirements for sealing in cold weather is included in Section 8.

2 Crumb rubber modified binders

2.1 Background

CRMB is bitumen blended with crumb rubber. The bitumen used is generally Class 170 (C170) bitumen that complies with MRTS17 *Bitumen and Multigrade Bitumen* and the crumb rubber (Figure 2.1) is generally obtained from the shredding and grinding of scrap rubber from vehicle tyres after the removal of other non-rubber components, such as textile fibres and steel cords. The crumb rubber used to manufacture CRMBs must comply with the requirements of MRTS18 *Polymer Modified Binder (including Crumb Rubber)*. This means that crumb rubber used to the manufacture of CRMBs must:

- be processed from waste tyres generated in Australia by a supplier accredited with Tyre Stewardship Australia (TSA) or another organisation approved by the Principal
- be free from cord, wire, fluff and other deleterious material
- meet the properties included in Table 8.2 of MRTS18.

The requirement is for vehicle tyres to be used. There is no requirement for specific types of tyres (e.g. truck tyres) or specific proportions of different types of tyres to be used. This detail is up to the manufacturer or contractor as relevant.

At this time the department does not have its own list of approved crumb rubber suppliers meaning suppliers accredited with TSA need to be used for the manufacture of CRMBs for departmental works / projects.

Figure 2.1 – From tyres to crumb rubber to CRMB



CRMB is a two-phase system, consisting of bitumen and dispersed crumb rubber particles, which tend to separate over time. This phase separation occurs because the crumb rubber particles, which are only partially digested, have different densities and viscosities compared to the bitumen. Managing the binder appropriately (including manufacturing, storage, transportation and handling) is crucial to maintaining the binder's performance and ensuring consistent properties from end-to-end.

For sprayed sealing applications, crumb rubber can be incorporated at dosages ranging from 5% to 18% by mass, with the most common dosage being 15% by mass and S15R and S15RF being the most commonly used grades of CRMB. CRMB may be manufactured in the field (e.g. S15RF) or at a fixed plant (e.g. S15R). Provided the manufacture, transport, storage and handling of the CRMB is appropriate, the addition of crumb rubber to bitumen can improve the binder properties such as adhesion, torsional recovery and softening point, which can have a positive impact on the longevity and performance of sprayed seals.

CRMB is used extensively in hot sprayed sealing, with MRTS11 *Sprayed Bituminous Treatments (Excluding Emulsion)* permitting Contractors to substitute a CRMB in many cases where a conventional bitumen or polymer modified binder (PMB) is specified.

2.2 Plant and field production

CRMB can be produced either at a fixed, dedicated plant (see Section 3) or blended on-site using specialised equipment (see Section 4) and is manufactured / blended at high temperatures.

2.3 Performance and capabilities

TN193 *Use of recycled materials in road construction* outlines the department's experience that CRMB:

- can be successfully transported for extended distances and still conform at the point of use without segregation problems
- performs as well as, if not better than, conventional binders when stored, handled and used correctly, and
- can often be a lower-cost alternative to conventional binders.

CRMB behaves differently to conventional bitumen and other PMBs, and there is a need to manage the manufacture, supply, transport, storage, handling, testing and site practices of CRMBs to ensure compliance with specifications and to meet performance expectations. CRMB is generally more viscous in comparison to other PMBs and has been shown to segregate when incorrect heating, storage and circulation practices are not implemented during transport and handling.

2.4 Documentation

2.4.1 Specifications

The requirements for the supply (including transport and storage) of CRMBs (and other PMBs) for use in both sprayed sealing and asphalt applications is specified by MRTS18 *Polymer Modified Binder (including Crumb Rubber), which*:

- adopts and modifies the requirements of ATS3110 *Supply of Polymer Modified Binders*, and sets out how ATS3110 applies in Queensland
- has precedence over ATS3110
- sets out the requirements for the supply (including transport and storage), sampling and testing of PMBs and CRMBs for use in both sprayed sealing and asphalt applications
- specifies the properties of the crumb rubber to be used in the manufacture of CRMBs
- includes the national guidance and Queensland-specific advice while following the format and structure established in ATS3110 (with respect to headings and clause numbering), and

- includes Queensland-specific advice which vary from national practice because of local environmental conditions (such as geography, soil types, climate), different funding practices, local research, local legislation requirements, and to expand instruction on particular issues.

Further, Clause 4.4 of MRTS18 *Polymer Modified Binder (including Crumb Rubber)* specifies that CRMB quality procedures shall address the following specific issues:

- the management of crumb rubber blending, digestion and storage times and temperatures
- the maximum time and temperature conditions that CRMB can be stored and/or transported without loss of its properties
- circulation of the CRMB during transportation and storage
- method for achieving a homogeneous product that can be sprayed to achieve a uniform application of binder across the pavement during sealing operations, free of streaking
- requirements for spraying plant and spraying practices including adjustments to nozzles (if required).

The requirements for the application of CRMB sprayed bituminous treatments are specified in MRTS11 *Sprayed Bituminous Treatments (Excluding Emulsion)*.

2.4.2 Technical notes and guides

The selection and design of all sprayed seals is undertaken in accordance with the following documents, in order of precedence:

- TN175 *Selection and Design of Sprayed Bituminous Treatments*
- Austroads *Guide to Pavement Technology Part 4K: Selection and Design of Sprayed Seals* (AGPT04K).

3 Plant-produced CRMB

Plant-produced CRMB is prepared by a binder manufacturer at a fixed, dedicated facility located away from the application site before being transported to site and used in road construction. Effective management of the manufacture, transport, handling, storage, sampling, testing and associated documentation is crucial for maintaining the desired properties and ensuring the quality and performance of these binders. Proper documentation and control of material properties, along with systematic sampling and testing, help maintain consistency, traceability, and compliance with departmental specifications.

3.1 Supplier documentation

For all sprayed sealing works, binder suppliers must provide documentation, such as National Association of Testing Authorities (NATA) accredited test reports from Construction Materials Testing Supplier Registration System (CMTSRS) registered laboratories (see Section 3.1.1). They should also provide Technical Data Sheets (TDS), to demonstrate that their products meet relevant quality standards and specifications.

3.1.1 Test reports

Contractors must supply test reports from laboratories registered under the department's CMTSRS for conformance testing. The CMTSRS forms part of a TMR program to assure the quality of materials, products and construction processes. It covers all facilities supplying compliance test results to departmental projects and includes, but is not limited to asphalt, soils, concrete, earthworks and bitumen. Some other departmental supplier prequalification systems also require testing to be performed using CMTSRS registered suppliers. A public list of CMTSRS registered testing suppliers is available on the departmental website via the *Pavements, materials and geotechnical* page.

Test reports are required for all binders to provide data on various properties of the bituminous materials enabling conformance to be assessed. These binder test reports include the following information:

- test methods and standards that apply (the specific methods and standards used for testing)
- test results (detailed results of the tests performed)
- compliance information (confirmation of whether the tests comply with contract specifications)
- NATA endorsement (an endorsement indicating that the tests were conducted by a NATA-accredited laboratory)
- comments / notes about the testing which need to be read and considered when interpreting test results (e.g. samples tested, test method variations).

As noted above conformance testing must also come from a CMTSRS registered laboratory.

3.1.2 Technical data sheets

Suppliers of plant produced binders are expected to supply a TDS for all bituminous binders.

Critical information for CRMB binders that should be provided in the TDS includes:

- recommended storage temperatures and durations

- recommended processes for transportation and storage (e.g. circulation)
- minimum and maximum spraying temperature for CRMB
- guidelines for re-heating (i.e. allowable degrees per hour heating rate) and circulation.

Additional information provided on the TDS may include:

- product description (an overview of the bituminous binder, including its intended use and key characteristics)
- technical characteristics (detailed technical data with binder property specification limits)
- safety information (safety precautions and safe storage, transportation and handling procedures to help ensure safe use of the product)
- quality assurance (accreditation under applicable ISO and Australian Standards).

3.2 Binder transportation requirements

To assure the homogeneity and quality of the CRMB during transportation, binder suppliers and transporters are expected to have documented procedures for their CRMB transportation practices. The following documents are also useful references:

- Australian Flexible Pavement Association (AfPA) Advisory Note 7 *Guide to the Heating and Storage of Binders for Sprayed Sealing* provides a general guide to heating temperatures and storage times of bituminous binders used in sprayed sealing applications.
- AfPA Advisory Note 10 *Loading Hot Bitumen Products* provides a general guide to loading bituminous products from delivery tankers.

For each binder load delivered to site, binder suppliers and transporters are required to provide documentation demonstrating compliance with their recommended procedures to site personnel upon delivery. At a minimum, these procedures should include the details outlined in the following sections.

3.2.1 Blending procedures and conditions

There should be procedures that demonstrate the appropriate management of crumb rubber blending, digestion and storage times and temperatures.

The time and temperature of binder storage both interact to affect the digestion of rubber into the binder, which can lead to a change of properties.

The rubber will be digested in the binder over time, so the blending procedures at the plant should anticipate the period of CRMB transport and storage before usage so that properties comply with specifications at point of delivery. Lower storage temperatures typically lead to longer possible storage times without degradation of properties.

3.2.2 Time and temperature during transportation and storage

Information should be provided on the maximum times and temperatures that the plant blended product can be stored and/or transported to ensure binder properties are maintained. This should include:

- Binder temperature at load out from the plant (typically expected to be 170 - 190°C).
- Binder temperature requirements during transport including:
  - The recommended range of temperatures (typically expected to be 170 – 190°C) and the time limits the binder be held at this temperature (typically expected to be 2 – 3 days). Manufacturers may recommend lower temperatures for 'low–viscosity' products. Longer term storage may be feasible if lower temperatures are maintained.
  - Procedures for monitoring of temperatures during transport.

3.2.3 Circulation and heating during transportation and storage

CRMBs should be regularly heated and circulated during transport, primarily to maintain homogeneity and prevent settling or segregation of the rubber particles from the binder. Temperatures of the CRMB need to be maintained within the recommended range and CRMBs need to be circulated during heating.

For circulation and heating during transport, the following should be detailed as a minimum:

- Frequency of circulation required (typically every 2 – 5 hours, for about 15 – 20 minutes). The frequency and length of circulation is dependent on the circulation capability of the tanker, binder type and temperature during transport, with higher temperatures (and thus lower binder viscosity) requiring more frequent circulation to limit segregation, and vice versa.
- Allowable heating rate (in degrees per hour). MRTS18 *Polymer Modified Binder (including Crumb Rubber)* specifies that the rate of increase in temperature shall not exceed 15°C per hour.

3.2.4 Spraying activities

To prepare for and conduct spraying activities with a CRMB, information should be provided for:

- Circulation duration and binder temperature before transfer at the point of delivery (before transfer to a sprayer the binder should be circulated to ensure the CRMB is homogeneous). The nominated period of time for this circulation should be sufficient to ensure the CRMB is homogeneous, and take into account variables such as the transport distance, delivery temperature, circulation procedures during transport, etc. Heating may be required to achieve a targeted delivery temperature.
- Procedures for discharging at the point of delivery including required equipment and connections, usage of filters / sieves, target transfer rates.
- Recommended spraying temperatures for the CRMB.

3.3 Sampling and testing

Sampling and testing of bituminous binders is conducted to ensure the material meets specification requirements.

MRTS18 *Polymer Modified Binder (including Crumb Rubber)* specifies that CRMBs and other PMBs shall be sampled and tested:

- prior to release from the manufacturer (for plant manufactured products), and
- at the point of delivery (for field blended CRMBs and plant manufactured products).

Over time, a reduction in torsional recovery and softening point can occur with some binder grades during transport and storage. Such changes do not have a significant detrimental effect on the performance of the binder and are detailed in MRTS18 point of delivery specifications. However, reductions in torsional recovery and softening point caused by other means (such as nonconforming binder properties at the point of release from the manufacturer, contamination or mishandling) can have a detrimental effect on the performance of the binder.

All properties, other than softening point, torsional recovery and consistency 6% at 60°C should not change between the point of manufacture and the point of delivery.

MRTS18 also:

- includes guidance about dealing with binder that does not conform with the requirements at the point of delivery but has been assessed by the Administrator as being suitable to remain in the Works (see Clause 8 of MRTS18)
- includes requirements for the minimum testing frequencies at the point of manufacture and the point of delivery (see Clause 9 of MRTS18)

- specifies sampling requirements (e.g. in Clause 6) including that representative samples of PMBs must be obtained in accordance with ATM-101 *Method of sampling polymer modified binders, polymers and crumb rubber* and that PMB samples must be prepared for testing using ATM-102 *Protocol for handling modified binders in preparation for laboratory testing*, and
- includes information about the labelling and identification of samples via a separate sampling form (See Clause 6.8 in MRTS18 *Polymer Modified Binder (including Crumb Rubber))*.

A Safe Work Method Statement (SWMS) should be implemented for the sampling of hot bituminous material to ensure the safety and health of personnel involved in bitumen sampling by outlining clear procedures and safety measures.

As a minimum, the SWMS should contain information on the following:

- activity description (details the purpose and scope of the sampling task)
- roles and qualifications (specifies the roles of people involved and their necessary qualifications, such as having a general construction induction card or dangerous goods driver's licence)
- equipment and personal protective equipment (PPE) (lists the equipment and PPE required for the task(s))
- emergency procedures (provides guidelines for handling emergencies, including the availability of Safety Data Sheets (SDS) and burn cooling facilities)
- legislative requirements (references relevant legislation, standards and codes of practice)
- process steps (a breakdown of the sampling process into steps, identifying potential hazards and control measures for each step)
- consultation and communication (describes the method of consultation and communication, including the need for workers to read, understand and sign the SWMS)
- environmental considerations (describes requirements for environmental spill response kits and proper waste disposal)
- site requirements (includes site-specific requirements such as traffic controls and no smoking policies).

4 Field-produced CRMB

Field-produced CRMB is created by mixing bitumen and crumb rubber just before the blended binder is used at a location nearby to the application site, which allows program flexibility and minimises transport distances for the CRMB and the risk of segregation. However, specialist equipment is needed, and it introduces unique challenges. Effective

management of on-site production, sampling, and testing, and associated documentation, is crucial for maintaining the desired properties and ensuring the quality and performance of field-produced CRMB. Proper documentation and control of material properties and the production process, combined with systematic sampling and rigorous testing, help maintain consistency, traceability and compliance with departmental specifications.

The following grades can be produced via field bending:

- bitumen blended with 5% crumb rubbers
- S9RF
- S15RF, and
- S18RF.

In addition to the above requirements, the C170 used in the field blending process must comply with the requirements of MRTS17 *Bitumen and Multigrade Bitumen*. Transport, handling, storage, sampling, and testing need to be effectively managed in accordance with the relevant specifications to ensure full traceability and conformance of the bitumen.

4.1 Supply and site storage of crumb rubber

Crumb rubber used in the manufacture of CRMB shall comply with the requirements of MRTS18 *Polymer Modified Binder (including Crumb Rubber)* (refer Section 2.1), and a compliance certificate shall be provided by the crumb rubber supplier for all supplied product.

Crumb rubber should be stored so that moisture is prevented from entering the product. If crumb rubber becomes wet, it can cause significant operational issues, including improper flow during blending and the risk of spontaneous combustion when exposed to oxygen.

4.2 Field-production procedure and equipment

The field-production process typically involves:

- delivery of bulk bags to the field blending site
- loading crumb rubber from bulk bags into a delivery unit with a hopper for storage and weighing
- transferring bitumen (typically C170) from a storage unit, usually a bulk tanker, through a pugmill mixing device that combines the bitumen with the crumb rubber
- transferring the blended binder into a bitumen sprayer or a storage vessel (a shear mill may be used between the pugmill and the bitumen sprayer or storage vessel to enhance blending)

- circulating the blended binder in the sprayer or storage vessel to ensure thorough incorporation of the crumb rubber, and
- adding cutter and adhesion agent when the CRMB is in the sprayer and incorporating them as per the requirements of MRTS11 *Sprayed Bituminous Treatments (Excluding Emulsion)*.

The binder should be used soon after manufacture and ideally on the same day of production. Binder can be stored overnight; however, it must meet specification requirements (e.g. meet point of delivery requirements).

4.2.1 Procedures

Contractors undertaking field-blending of CRMB should establish and follow operational procedures for the specific equipment being used. These procedures should describe the safe operation and the operational procedure to ensure the effective blending of the bitumen and crumb rubber to produce a conforming product.

At a minimum, it is expected these procedures will include guidance on:

- Setting up and connecting the components of the blending equipment.
- Instructions for correct use of all equipment including:
  - methods to ensure safe and effective operation of all components
  - requirements for transfer hoses / piping and filters / sieves, and
  - how to properly prepare for blending (for instance, before blending commences, the bitumen should be circulated through the pipework of the tanker for preheating to minimise the risk of blockages due to loss of heat).
- Blending and circulation requirements including:
  - Information about the time and effort required to transfer and blend CRMB such as:
    - the appropriate time that should be allowed for the bitumen and crumb rubber to be combined at an appropriate rate, and
    - managing the rate of rubber being added to bitumen to avoid issues (adding crumb rubber too rapidly can slow the blending process down and may cause blockages in the lines and machinery).
  - Addition of binder additives (e.g. cutter oil and adhesion agents).
  - Required circulation time for the CRMB and additives to ensure homogeneity.
  - Temperature of the bitumen during the blending and transfer processes. It is expected that 10 - 15°C of the initial bitumen temperature will be lost with the addition of 15 parts rubber, so the temperature of the bitumen and heating

required after the addition of the rubber should be considered as part of the blending process.

- Methods to calculate quantities of materials for batches and monitoring process during production.

4.2.2 Equipment

The equipment used to field blend CRMB may vary between Contractors with different methods being used, but a common set-up includes:

- Delivery unit (this includes a hopper for storing crumb rubber and a weighing mechanism to measure the amount of crumb rubber being added).
- Bitumen supply unit (typically, a bulk tanker that transports and heats C170 bitumen to around but not exceeding 200°C for optimal blending).
- Pugmill mixing device (this device combines the bitumen and crumb rubber). It provides initial mixing before the binder is transferred to a bitumen sprayer or storage vessel.
- Shear mill (optional but beneficial). It is used between the pugmill and the bitumen sprayer or storage vessel to enhance the blending process.
- Bitumen sprayer or storage vessel with agitation and/or circulation capabilities. This equipment circulates and/or agitates the blended binder to ensure thorough incorporation of the crumb rubber.
- Transfer hoses (these connect the bitumen tanker, pugmill, shear mill, and bitumen sprayer / storage vessel, facilitating the transfer of bitumen / binder).

The correct operation of these items of plant ensures efficient and effective field-production of CRMB.

4.2.3 Circulation and heating

Once the bitumen and crumb rubber have been combined, allowing an appropriate time to circulate and blend the product is crucial to ensure thorough incorporation of the crumb rubber to produce a homogeneous mixture. Contractors conducting the blending should understand and implement adequate circulation and blending times for the CRMB and this should be documented in their written work instructions. The specific time required can vary depending on the dosage of crumb rubber and the type of equipment used. For example, the:

- efficiency of the pugmill can affect the overall blending time
- use of a shear mill can reduce the required circulation time in the bitumen sprayer

- the design and capacity of the bitumen sprayer influences the circulation time. Larger sprayers may require longer circulation times to ensure homogeneity of the blended binder.

The CRMB may require heating to achieve the desired spraying temperature after blending. As per MRTS11 *Sprayed Bituminous Treatments (Excluding Emulsion)* any binder delivered to site at a temperature above 200ºC shall be rejected (meaning field blended CRMBs cannot be heated to temperatures greater than 200°C).

In addition, the rate of increase in temperature shall not exceed 15°C per hour.

4.2.4 Sampling and testing

Sampling and testing of bituminous binders are conducted to ensure materials meet specification requirements.

MRTS18 *Polymer Modified Binder (including Crumb Rubber)* specifies that representative samples of CRMB and other PMBs must be obtained in accordance with ATM-101 and be handled and prepared for testing in accordance with ATM-102.

As further described in Section 3.3, a SWMS should be implemented for the sampling of hot bituminous material to ensure the safety and health of personnel involved in bitumen sampling by outlining clear procedures and safety measures.

The required properties of field-produced CRMBs are specified in Table 8.1(c) of MRTS18. The requirements for weekly testing of field-produced CRMBs are provided in Table 9.6(b) of MRTS18.

MRTS18 specifies that for sealing grade field-produced CRMBs, sampling is to be undertaken from the mixing vessel after the digestion period designated in the Contractor’s procedures (at mixing temperature), but prior to the addition of cutter oil and adhesion agent (note that samples must be free of diluents for subsequent testing to be meaningful).

5 Binder storage and transfer procedures

MRTS18 specifies that the handling, storage, transport, heating and transfer of PMBs (including CRMBs) shall comply with the requirements and practices outlined in the latest versions of the following documents and relevant Contractor’s procedures and requirements:

- Austroads *Bituminous Materials Safety Guide*, AP-G41
- Austroads *Guide to Pavement Technology Part 4F: Bituminous Binders*, AGPT04F, and
- AfPA *Guide to the Heating and Storage of Binders for Sprayed Sealing and Asphalt Manufacture, Advisory Note 7*.

5.1 Plant-produced CRMB

Before transferring plant-produced CRMB, it should be confirmed that the CRMB in the delivery tanker has been properly circulated and heated during transport, to minimise blockages and maintain consistent binder temperature. Additionally, the transfer hoses and sieves / filters should be confirmed to be suitable for facilitating efficient material transfer.

5.2 Field-produced CRMB

Field-produced CRMB may be transferred directly into the bitumen sprayer as part of the blending process, as described in Section 4.2.

If the field-produced CRMB has been held in intermediary storage (which is typically in the form of bulk tankers or bitutainers) after blending, it should be confirmed the CRMB has been properly circulated and heated during storage, to minimise blockages and maintain consistent binder temperature. Additionally, the transfer hoses and sieves / filters should be confirmed to be suitable for facilitating efficient material transfer.

6 Spraying activities

6.1 Bitumen sprayers

All sprayers used for sprayed treatments on departmental works must have a current NATA accredited Sprayer Calibration Certificate and be registered by Transport and Main Roads.

6.1.1 Nozzles

All typical nozzles used with bitumen sprayers are suitable for use with CRMB. Requirements for spray bar nozzles are specified in MRTS11 *Sprayed Bituminous Treatments (Excluding Emulsion)*.

The selection of an appropriate nozzle type and size should be focused on the nozzle discharge rate, which in combination with the speed of the bitumen sprayer will achieve the required binder application rates and even distribution. Where issues such as tramlining are evident in the binder application rate, consider the use of larger nozzles, not the addition of cutter to lower binder viscosity. The purpose of cutter is not to reduce the viscosity of the product to facilitate the use of smaller nozzles, it is to improve aggregate adhesion during cold weather.

It is important nozzles are maintained / cleaned as required to ensure a uniform distribution of binder is obtained. Nozzle blockages may be caused by accumulated particles of crumb rubber in the CRMB becoming stuck in the nozzle orifice, or by other

detritus, such as dust, dirt and other small debris, which can adhere to nozzles due to the highly adhesive nature of CRMB. These blockages can obstruct the nozzle openings, leading to uneven spray patterns and reduced application efficiency. Regular cleaning and maintenance of the nozzles is essential to prevent blockages and ensure consistent performance.

Bitumen sprayers used on the road network administered by the department must undergo annual calibration testing and certification. Calibration involves specific methods to ensure the sprayer applies the binder at the correct design rates, which are detailed in Austroads AGPT/T530 *Calibration of Bitumen Sprayers – General Introduction and List of Methods*. Calibration is undertaken for each type of nozzle that is to be used by a bitumen sprayer.

6.1.2 Transverse distribution

Achieving a uniform application of binder is critical to maximising the life of a sprayed seal. The impact of non-uniform binder application can lead to premature flushing or aggregate loss from a sprayed seal and will not always become apparent during the first 12 months after application.

Higher viscosity sprayed seal binders, including CRMBs, can present more of a risk for poor transverse distribution where the sprayed binder forms uneven, corrugated longitudinal patterns (i.e. ‘tram tracking’ or ‘tramlining)’. These risks can be minimised by strict conformance to the requirements of Clause 12 of MRTS11 *Sprayed Bituminous Treatments (Excluding Emulsion)*, which specifies minimum requirements regarding spraying bituminous material, including guidance for spraying temperatures, nozzles, cutter usage and managing faults. In general, the risk of tramlining for higher viscosity binders such as CRMB can be reduced by managing viscosity by using spraying temperatures at the higher end of the allowable range and/or dosing with an appropriate rate of cutter as per guidance listed in Clause 12.7 of MRTS11.

The uniformity of binder application can be assessed visually at the time of application and examples of acceptable, marginal, and unacceptable binder uniformity are provided in Figure 6.1.2. In addition, the transverse distribution of the binder can be checked in the field, ideally using the Austroads AGPT/T533 T*ransverse distribution by field mat test* and a CMTSRS registered laboratory that can perform this test.

Figure 6.1.2 – Visual examples of binder uniformity

		
Acceptable binder uniformity	Marginal binder uniformity	Unacceptable binder uniformity

6.1.3 Pumps

Due to the abrasive nature of the crumb rubber, bitumen sprayer pumps are subjected to higher rates of wear when using CRMB when compared to conventional bitumen and other PMBs. This can subsequently reduce the effective lifespans of pumps and will necessitate more frequent replacements of pumps so bitumen sprayers can successfully deliver binder at desired application rates.

The volume of CRMB handled by a bitumen pump should be monitored, alongside observing the ongoing performance of that pump in the bitumen sprayer to ensure that adequate binder distribution is being achieved.

In accordance with Austroads AP-T262 *Performance Requirements for Bitumen Sprayers*, any repairs and/or modifications to a sprayer that may affect its performance necessitate retesting to ensure continued compliance with Austroads bitumen sprayer calibration test methods. Where the bitumen pump is replaced, regardless of whether the replacement is identical to the original or involves a different make and model, the sprayer must be retested to comply with AGPT-T531 *Volumetric Calibration of Bitumen Pumping Systems*. Following such modifications, the sprayer's existing calibration certificate is invalid, and a new certificate is issued upon successful retesting.

Major sprayer manufacturers supplying the Australian market have adapted their bitumen sprayers so that options are available that are compatible with the demands of CRMB, and the challenges associated with pumping and spraying these more viscous materials.

6.1.4 Spray width

MRTS11 *Sprayed Bituminous Treatments (Excluding Emulsion)* specifies that the spray bar width of the bitumen sprayer shall not operate beyond the width range for which the spray bar has been certified on the NATA accredited Sprayer Calibration Certificate. The nominal maximum effective width acceptable by AP-T262 is 8.0 m.

Additionally, superior results may be achieved when using CRMB products by limiting spray bar widths to 4 – 6 m, which limits the risk of exceeding bitumen sprayer pump capabilities and subsequently result in poor transverse distribution. The most appropriate width to spray CRMB to minimise these risks will depend on the capabilities of the sprayer and its components (e.g. pump), type of CRMB and its viscosity, and the type of nozzles and binder application rate being used.

6.1.5 Cleaning and maintenance

The crumb rubber particles in CRMB can obstruct filters and strainers, which may reduce efficiency, impact the spraying pattern and level of binder uniformity, damage equipment and lead to safety issues. Regular monitoring and cleaning of the filters and strainers is crucial to prevent blockages and adverse impacts.

As discussed in Section 6.1.3, when compared to other binder types, the use of CRMBs leads to accelerated wear of bitumen pumps and more frequent pump replacements due to the abrasive nature of rubber particles. Monitoring pump condition and timely replacements of pumps are vital for maintaining adequate sprayer performance.

Routine flushing of tankers and bitumen sprayers with a mixture of conventional bitumen and cutter helps dissolve and remove CRMB residue, keeping sprayer lines clear and functional. This practice preserves the integrity of sprayer components and extends their lifespan.

6.2 Operational considerations

6.2.1 Binder spraying temperatures

Clause 12.5 of MRTS11 *Sprayed Bituminous Treatments (Excluding Emulsion)* specifies that CRMBs are to be sprayed between 185 – 200°C. As discussed in Section 6.1.2, spraying temperatures at the higher end of the range allowed by MRTS11 may be beneficial to achieving satisfactory transverse distributions for CRMB.

CRMBs and other PMBs shall not be heated to temperatures greater than the maximum values listed in the latest version of AfPA Advisory Note 7 *Guide to the Heating and Storage of Binders for Sprayed Sealing and Asphalt Manufacture* and the binder manufacturer's recommendations.

6.2.2 Air and pavement temperatures

CRMBs can typically be sprayed at lower pavement temperatures than other PMBs.

MRTS11 *Sprayed Bituminous Treatments (Excluding Emulsion)* specifies that spraying shall not commence until the temperature of the pavement surface is above the temperature given in Clause 6.2 of Annexure MRTS11.1 or, if not so given, above:

- 20°C for S9R, S9RF, S15R and S15RF and S18RF binder classes
- 25°C for other PMBs unless the Administrator has given written permission to relax the temperature to a minimum of 20ºC.

Refer to Clause 11.2 of MRTS11 for minimum pavement temperatures for all binder grades / classes.

The enhanced adhesion properties of CRMB typically lead to good performance at the lower end of the allowable pavement surface temperature range.

6.2.3 Cutter usage

Guidance for the addition of cutter is provided in Clause 12.7 of MRTS11 *Sprayed Bituminous Treatments (Excluding Emulsion)*. Further to this, the appropriate cutter dosage for CRMB will vary depending on the nozzle size used and local experience. If quantities above those suggested in Clause 12.7 of MRTS11 are required to achieve satisfactory transverse distribution, spraying should be delayed if possible. Where it cannot be delayed, the longer-term effects of the cutter softening the binder and increasing the risks of poor seal performance should be monitored and managed.

MRTS11 highlights that experience has shown that inadequate circulation of CRMB following the addition of cutter oil can result in tramlining of binder when sprayed. It is therefore critical that the minimum circulation times stated in Clause 8.3.3 of MRTS11 and the contractor’s procedures are adhered to when spraying CRMBs.

6.2.4 Sweeping

The requirements for the removal of loose aggregate after rolling is specified in Clause 14.6 of MRTS11. This includes a requirement that loose aggregate shall not be removed until the aggregate is properly embedded into the binder by either trafficking or additional rolling. Aggregate dislodgement is more likely to occur when pavement temperatures exceed 40°C, and in such cases, it may be beneficial to defer sweeping activities until the following morning to minimise the risk of aggregate displacement.

6.2.5 Hand lancing

Hand lancing CRMB often causes equipment blockages. To mitigate this, reduce or eliminate hand lancing where possible. If hand lancing is necessary, careful monitoring of the process is required to ensure there are no blockages and the correct binder application is achieved.

7 Environmental management

CRMB should be handled in accordance with the Austroads AP-G41 *Bituminous Materials Safety Guide*, which describes safe working practices and disposal of waste materials to be used when handling hot bituminous products in sprayed sealing, asphalt and bituminous stabilisation operations. This document provides guidance for:

- managing work hazards such as fire and explosions, fumes and vapours, water contamination, and spills and leaks
- heating bituminous materials with mobile plant such as tankers and sprayers and fixed storage tanks that are fitted with gas or oil burners
- cleaning an accumulation of bituminous material, grease, oil, dirt and especially kerosene on equipment, and
- appropriate responses to a spillage or runoff incident.

In addition, AfPA Advisory Note 8 *Environmental Management when Spraying Bituminous Materials* provides advice on avoiding pollution by minimising the risk of environmental damage arising from wash-off of bituminous materials from road construction during wet weather.

TSA's *Tyre Particle Health, Environment and Safety Report* notes that the incorporation of crumb rubber into heated bitumen has the potential to emit fumes and emissions of volatile organic compounds (VOCs) and polycyclic aromatic hydrocarbons (PAHs); however, the levels of these pollutants are reported to be well below the Safe Work Australia Standards.

It also states that the leaching of CRMB binder to waterways and environmentally sensitive areas may be a minor risk, with no significant issues observed under most conditions investigated. Leaching of any sprayed sealing binders, such as unmodified bitumen, PMBs, cutback binders, and emulsions, can occur, thus the risk is not unique to CRMBs.

8 Sealing in cold weather

The department's Technical Note 186 *Sealing in Cold Weather Conditions* specifies additional requirements for managing and mitigating the risk of poor seal performance in cold weather conditions, identifying measures to reduce this risk, and determining when to adjust or delay sprayed sealing operations based on elevated risks due to cold weather conditions.

9 Workplace health and safety

Suppliers and Contractors need to manage workplace health and safety (WH&S) on construction sites, at plants and at field blending sites, and transporters need to manage WH&S during transport operations. As noted previously this includes having a SWMS for the sampling of hot bituminous material to ensure the safety and health of personnel involved in bitumen sampling by outlining clear procedures and safety measures.

Austroads' AP-G41 *Bituminous Materials Safety Guide* is a key WH&S reference for parties involved in supplying to and undertaking sprayed sealing works.

10 Referenced documents

Documents referenced in this technical note are listed in Table 10.1.

Table 10.1 – Referenced documents

Reference	Title
Advisory Note 7	*Guide to the Heating and Storage of Binders for Sprayed Sealing* *Australian Flexible Pavement Association Advisory Notes*
Advisory Note 8	*Environmental Management when Spraying Bituminous Materials*
Advisory Note 10	*Loading Hot Bitumen Products*
AGPT04F	*Guide to Pavement Technology Part 4F: Bituminous Binders* Austroads Publications
AGPT04K	*Guide to Pavement Technology Part 4K: Selection and Design of Sprayed Seals*
AGPT-T530	*Calibration of Bitumen Sprayers – General Introduction and List of Methods*
AGPT-T531	*Calibration of Bitumen Sprayers – Volumetric calibration of bitumen pumping systems*
AP-G41	*Bituminous Materials Safety Guide*
AP-T262	*Performance Requirements for Bitumen Sprayers*
ATM-101	*Method of Sampling Polymer Modified Binders, Polymers and Crumb Rubber*
ATM-102	*Protocol for Handling Modified Binders in Preparation for Laboratory Testing*
ATS3110	*Supply of Polymer Modified Binders*
CMTSRS	*Construction Materials Testing Supplier Registration System*
MRTS11	*Sprayed Bituminous Treatments (Excluding Emulsion)*
MRTS17	*Bitumen and Multigrade Bitumen*
MRTS18	*Polymer Modified Binder (including Crumb Rubber)*
TN175	*Selection and Design of Sprayed Bituminous Treatments*

Reference	Title
TN186	*Sealing in Cold Weather Conditions*
TN193	*Use of Recycled Materials in Road Construction*
-	*Tyre Particle Health, Environment and Safety Report* (October 2022, Version 2) *Tyre Stewardship Australia (TSA)*