

Main Roads Technical Standard

MRTS18

Polymer Modified Binder

November 11

 **Queensland** Government

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Polymer Modified Binder

1 INTRODUCTION

This Technical Standard applies to the material requirements for polymer modified binder (PMB), including crumb (scrap) rubber, for use in both hot sprayed sealing and asphalt applications for road construction, rehabilitation and maintenance.

This Technical Standard shall be read in conjunction with MRTS01 *Introduction to Technical Standards*, MRTS50 *Specific Quality System Requirements* and other Technical Standards as appropriate.

This Technical Standard forms part of the Main Roads Specifications and Technical Standards Manual.

2 DEFINITION OF TERMS

The terms used in this Standard shall be defined in Clause 2 of MRTS01 *Introduction to Technical Standards*. Additional terms used in this Standard shall be as defined in Table 2.

Table 2 – Definition of Terms

Term	Definition
Bitumen	Bituminous material obtained by processing the residue from the refining of naturally occurring crude petroleum.
Compression limit (polymer modified binder)	That thickness lower than which a film of binder may not be compressed under the conditions of maximum pavement temperature and maximum traffic stress after infinite time.
Consistency (elastometer test)	An indicative viscoelastic response, expressed as the ratio of shear stress over shear strain rate as determined under defined test conditions.
Crumb rubber (scrap rubber)	Rubber particles manufactured from waste or reclaimed rubber products such as vehicle tyres and graded to conform to a specified size range.
Manufacturer	An organisation which has the necessary plant and equipment to manufacture polymer modified binder to this Standard. For supply only contracts, the Manufacturer shall be the Contractor.
Polymer	A predominantly organic substance comprising a very large number of chemical entities. These chemical entities may comprise identical segments (producing a homopolymer) or a combination of two or more different segments (producing a copolymer).
Polymer modified binder (PMB)	A binder consisting of polymeric material dispersed in bitumen with enhanced binder performance for particular applications.
Site	Where the polymer modified binder is used (includes asphalt manufacturing plant).

3 REFERENCED DOCUMENTS

Table 3 lists documents referenced in this Technical Standard.

Table 3 – Referenced Documents

Reference	Title
AP-G41/08	Bituminous Materials Safety Guide – Austroads
CP:PMB-1	Code of Practice: Manufacture, Storage and Handling of Polymer Modified Binders – AAPA
AP-T42/06	Guide to the Selection and Use of Polymer Modified Binders and Multigrade Bitumens – Austroads
AS 2475	Threaded hose connection fittings for bituminous materials
AS 2089.5	Road tank vehicles for dangerous goods

4 STANDARD TEST METHODS

The standard test methods listed in Table 4 shall be used in this Standard.

Further reference to test numbers and test descriptions is provided in Clause 4 of MRTS01 *Introduction to Technical Standards*.

Table 4 – Standard Test Methods

Property to be Tested	Method No.
Compression Limit	Q348 or AG:PT/T132
Ease of Remixing	Q346 or AG:PT/T109
Elastic Recovery, Consistency and Stiffness (ARRB Elastometer)	Q341 or AG:PT/T121
Flash Point (Pensky–Martens Open Cup)	Q333 or AG:PT/T112
Handling and Preparation	Q344 or AG:PT/T102
Pre-treatment and Loss on Heating (Rolling Thin Film Oven (RTFO) test)	AG:PT/ T103
Rubber Content of Digested Crumb Rubber Binders – Trichlor Bath Method	AG:PT/ T142
Segregation	Q345 or AG:PT/T108
Softening Point	Q334 or AG:PT/T131
Torsional Recovery	Q342 or AG:PT/T122
Viscosity (Brookfield Thermosel Viscometer)	Q343 or AG:PT/T111

5 QUALITY SYSTEM REQUIREMENTS

5.1 Hold Points, Witness Points and Milestones

General requirements for Hold Points, Witness Points and Milestones are specified in Clause 5.2 of MRTS01 *Introduction to Technical Standards*.

The Witness Point applicable to this Standard is summarised in Table 5.1.

Table 5.1 – Witness Point

Clause	Witness Point
10.3.3	Sampling at the point of delivery

5.2 Conformance Requirements

Materials supplied to this Standard shall be sampled and tested in accordance with Clause 10.

The conformance requirements which apply to this Standard are summarised in Clause 7.

6 PMB CLASSIFICATION

Classes of polymer modified binder within this Standard are based on an alpha-numeric-alpha code –

- a) the first alpha code denotes the binder application system –
 - i) A for asphalt classes (Table 7.1-A); and
 - ii) S for sprayed sealing classes (Table 7.1-B),
- b) the final alpha code denotes the polymer type to be used in the formulation of the PMB –
 - i) S for styrene-butadiene-styrene (SBS);
 - ii) B for polybutadiene (PBD);
 - iii) R for factory produced crumb rubber;
 - iv) RF for field produced crumb rubber; and
 - v) V for ethylene vinyl acetate (EVA),
- c) the central numeric code is an indication of the minimum consistency in kPa.s expected when measured at 60°C, except for RF classes where the numeric is an indication of the amount of crumb rubber mixed with the binder.

7 MATERIAL

7.1 General

Polymer modified binder shall comply with the property requirements of Table 7.1-A for asphalt applications or Table 7.1-B for hot sprayed sealing applications.

Table 7.1-A – Polymer Modified Binder (PMB) for Asphalt Applications

Property	Test Method	Unit	Limit	PMB Class				
				A0.6S	A5S	A10S	A0.6B	A2V
Consistency at 60°C	Q341 or AG:PT/T121	Pa.s	min	600	5000	6000	600 ⁽¹⁾	2000
Underlying Viscosity at 60°C ⁽²⁾		Pa.s	–	tbr	tbr	tbr	tbr	tbr
Elastic Modulus at 60°C ⁽²⁾		Pa	–	tbr	tbr	tbr	tbr	tbr
Stiffness at 25°C	Q341 or AG:PT/T121	kPa	max	35	30	30	45	120
Viscosity at 165°C ⁽³⁾	Q343 or AG:PT/T111	Pa.s	max	0.6	0.9	1.1	0.6	0.6
Flash Point	Q333 or AG:PT/T112	°C	min	250	250	250	250	250
Loss on Heating	AG:PT/T103	%	max	0.6	0.6	0.6	0.6	0.6
Torsional Recovery at 25°C and 30 s	Q342 or AG:PT/T122	%	min-max	38-70	55-80	60-86	17-30	6-21
Softening Point	Q334 or AG:PT/T131	°C	min-max	65-95	82-105	88-110	52-62	62-74
As proposed by supplier ⁽⁴⁾	Other	–	–	tbr	tbr	tbr	tbr	tbr
Nearest Austroads Equivalent Class ⁽⁵⁾		–	–	A20E	A15E	A10E	A25E	A35P

1. Consistency at 60°C of A0.6B shall be determined using Mould B with a breakpoint of 5 mm and a test speed of 1.5 mm/s.
2. Testing for this property shall be performed only after the test method has been revised to allow for its measurement.
3. The shear rate involved in determining viscosity by Q343 or AG:PT/T111 shall be calculated and reported.
4. Actual values for these production control properties are to be nominated in advance by the Manufacturer.
5. As defined in Austroads AP-T41/06.

tbr – To be recorded; min – Minimum; max – Maximum

Table 7.1-B – Polymer Modified Binder (PMB) for Sprayed Sealing Applications

Binder Property	Test Method	Unit	Limit	PMB Class						
				S0.25S	S0.7S ⁽¹⁾	S4.5S	S0.3B	S1.8R	S15RF ^(2,3)	S18RF ^(2,3)
Consistency at 60°C	Q341 or AG:PT/T121	Pa.s	Min	250 ^(4,5)	700 ⁽⁶⁾	5000	300 ⁽⁴⁾	1000	1000	4000
Underlying Viscosity at 60°C ⁽⁷⁾		Pa.s	–	tbr ⁽⁴⁾	tbr	tbr	tbr ⁽⁴⁾	tbr	tbr	tbr
Elastic Modulus at 60°C ⁽⁷⁾		Pa	–	tbr ⁽⁴⁾	tbr	tbr	tbr ⁽⁴⁾	tbr	tbr	tbr
Stiffness at 15°C	Q341 or AG:PT/121	kPa	max	140	140	95	180	180	180	140
Rubber Content	AG:PT/T142	%	min	n/a	n/a	n/a	n/a	10	13	16
Compression Limit at 70°C, 2 kg	Q348 or AG:PT/T132	Mm	min	n/a	n/a	n/a	n/a	0.2	0.2	0.2
Elastic Recovery at 60°C and 100 s	Q341 or AG:PT/T121	%	min	n/a	n/a	85	n/a	25	25	35
Viscosity at 165°C ⁽⁸⁾	Q343 or AG:PT/T111	Pa.s	max	0.55	0.55	0.8	0.55	4.5	4.5	4.5
Flash Point	Q333 or AG:PT/T112	°C	min	250	250	250	250	250	250	250
Loss on Heating	AG:PT/T103	%	max	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Torsional Recovery at 25°C and 30 s	Q342 or AG:PT/T122	%	min-max	22-50	32-62	54-85	16-32	25-55	25-55	30-60
Softening Point	Q334 or AG:PT/T131	°C	min-max	48-64	55-75	82-100	48-56	55-65	55-65	62-80
As proposed by supplier ⁽⁹⁾	Other	–	–	tbr	tbr	tbr	tbr	tbr	tbr	tbr
Nearest Austroads Equivalent Class ⁽¹⁰⁾		–	–	S10E	-	S25E	S35E	S45R	S15RF	S18RF

1. This is an experimental class of PMB for which all tabulated properties are to be regarded as trial values for such period until manufacturing capabilities are proven. The S0.7S class shall not be used on major or critical works until manufacturing capabilities are proven.
2. The properties of crumb rubber to be incorporated into these RF classes are provided in Table 7.1-C.
3. Sampling of these classes is after rubber digestion but prior to the addition of cutter oil. Sampling shall be free of diluents for subsequent testing to be meaningful. The agreed digestion period (at temperature) shall be completed before sampling.
4. Consistency of 60°C for S0.25S and S0.3B shall be determined using Mould B with a breakpoint of 5 mm and a test speed of 1.5 mm/s.
5. The Manufacturer shall aim for a target consistency of 450 Pa.s at 60°C for S0.25S within the range of 250–600 Pa.s.

6. The Manufacturer shall aim for a target consistency of 1100 Pa.s at 60°C for S0.7S within the range of 700-2000 Pa.s.
7. Testing for this property shall be performed only after the test method has been revised to allow for its measurement.
8. The shear rate involved in determining viscosity by Q343 or AG:PT/T111 shall be calculated and reported.
9. Actual values for these production control properties are to be nominated in advance by the Manufacturer.
10. As defined in Austroads AP-T41/06.

n/a – Not applicable; tbr – To be recorded; min – Minimum; max – Maximum

Table 7.1-C – Properties of Crumb Rubber

Property	Test Method	Unit	Value	
Grading ⁽¹⁾ :	passing 1.18 mm	AG:PT/T143	%	100
:	passing 0.600 mm	AG:PT/T143		70-100
:	passing 0.150 mm	AG:PT/T143		0-5
Bulk Density	AG:PT/T144	kg/m ³		350 max
Water Content	AG:PT/T143	%		< 1
Steel Content ⁽²⁾	AG:PT/T143	%		0.1 max

1. All crumb rubber particles shall be less than 3 mm in length.
2. The rubber shall not contain any foreign material such as sand, fibres or aggregate.

7.2 Homogeneity

Polymer modified binder shall be sufficiently processed to furnish a homogeneous product with a segregation value not exceeding 8% when tested in accordance with Test Method Q345 or AG:PT/T108. Where the segregation value is greater than 8%, the polymer modified binder shall exhibit an ease of remixing value not exceeding 2% when tested in accordance with Test Method Q346 or AG:PT/T109, and the Manufacturer shall implement such arrangements in handling logistics to assure product homogeneity.

7.3 Foaming

Polymer modified binder shall not foam when heated to a temperature of 180°C. The formation of a thin layer of bubbles on the surface of the binder shall not be regarded as foaming.

8 MANUFACTURE

Polymer modified binder shall be manufactured only by an approved Manufacturer.

An approved Manufacturer shall –

- a) operate a quality system certified to AS/NZS ISO 9001;
- b) operate to an inspection and test plan acceptable to Transport and Main Roads for manufacturing and supplying polymer modified binder which demonstrates compliance with this Standard. The inspection and test plan shall include testing of polymer modified binder, analysis of results (including run charts) and a requirement for a copy of the results to be forwarded promptly to Transport and Main Roads; and
- c) ensure all polymer modified material supplied can be traced to the production batch and associated test report.

9 DELIVERY OF POLYMER MODIFIED BINDER

9.1 General

The operators of all heating and transfer equipment shall be classified as competent for these tasks in accordance with the relevant industry standards and any procedures or other requirements defined in the Contractor's Safety Plan or in the Contract.

9.2 Handling

Where handling of polymer modified binder occurs, the procedures to be used shall be consistent with safe handling practices which apply to polymer modified binder based products as defined in the following publications –

- a) Austroads Bituminous Materials Safety Guide, AP-G41/08 (Austroads);
- b) Code of Practice: Manufacture, Storage and Handling of Polymer Modified Binders (AAPA); and
- c) Guide to the Selection and Use of Polymer Modified Binders and Multigrade Bitumens (Austroads).

9.3 Storage and Transport

Polymer modified binder shall be stored and transported in purpose-built containers in such a way that contamination does not occur. Containers shall comply with the following Australian Standards and be fitted with apparatus for heating of the binder within appropriate limits –

- a) bitumen sprayers and tankers – AS 2809.5; and
- b) hose couplings – AS 2475.

If contamination is suspected, additional testing may need to be carried out to check for contamination.

If it is necessary to change the type or class of material in a container, the procedures within Section 9 of AP-G41/8 shall be used in such manner that the properties of the resultant stored product comply with the relevant Standard and the performance of the stored product is not adversely affected.

9.4 Heating

Where heating is required for purposes of transfer of polymer modified binder between delivery vehicles and/or storage tanks, in no circumstances shall the temperature of the polymer modified binder be permitted to rise above the temperatures recommended by the Manufacturer for the particular product. The rate of heating shall not be allowed to exceed 15°C per hour.

Before any heating has commenced, at least 150 mm of binder shall cover the heating tubes at all points. Where necessary, the lower heating tube may be used on its own in order to comply with this requirement.

9.5 Transfer

During transfer of polymer modified binder into and between storage and delivery vessels and into bitumen sprayers, the polymer modified binder shall not be contaminated by other materials which affect its performance. As necessary, storage and delivery vessels, sprayers and hoses shall be flushed or cleaned with appropriate solvent before transfer of bitumen is commenced and residues from flushing and cleaning shall be removed.

9.6 Delivery Dockets

Delivery of polymer modified binder to the Site shall be accompanied by a delivery docket giving at least the following information –

- a) name of the Manufacturer;
- b) place of manufacture;
- c) polymer modified binder class;
- d) production batch number; and
- e) certification that production has been sampled and tested as stated in Clause 10 and the properties comply with Clause 7.

Delivery dockets shall be made available for inspection by the Administrator and shall be included in the quality records.

10 COMPLIANCE SAMPLING AND TESTING

10.1 General

Sufficient sampling and testing shall be carried out to ensure that the polymer modified binder complies with the property requirements of Clause 7.

Sampling and testing shall take place at the point of release from the Manufacturer and at the point of delivery. The minimum requirements are as follows –

- a) Sampling and testing at the point of release from the Manufacturer shall be in accordance with Clause 10.2. Subject to Clauses 11.1 and 11.2, product shall not be released from the point of manufacture for use on the Works unless it conforms to the specified requirements in Clause 7.1 when

tested in accordance with Clause 10.2. Sampling and testing costs shall be borne by the Manufacturer and incorporated into the pricing for the product; and

- b) Sampling and testing at the point of delivery to the sprayer or from the asphalt binder storage tank shall be in accordance with Clause 10.3.1 and Clause 10.3.2 or 10.3.3 as appropriate. The cost of testing shall be borne by the Contractor (eg. Where the project is using the MRS series, this cost is included in the appropriate MRS11 *Sprayed Bituminous Surfacing (Excluding Emulsion)* Item Number (5103, 5104, 5105 or 5106 as appropriate.))

10.2 Sampling and Testing at Point of Release from the Manufacturer

Sampling of polymer modified binder shall be undertaken in accordance with the procedures defined in AG:PT/T101: *Method of sampling polymer modified binder, polymers and crumb rubber*.

The minimum frequency of sampling and testing from production plant or depots to be performed by the Manufacturer, including field produced crumb rubber, shall be as stated in Table 10.2. In the event of any nonconformance being detected in any sample taken, additional tests shall be performed so that the sample is tested for other properties listed in Table 10.2, as appropriate.

Table 10.2 – Polymer Modified Binder Supply Testing Schedule

Properties to be Tested	Production Plant		
	Every Batch	Every Fifth Batch or 3 Monthly#	Every Tenth Batch or 6 Monthly#
Consistency at 60°C (Pa.s)		✓	
Stiffness at 25°C/15°C (kPa)			✓
Elastic Recovery at 60°C (%)		✓	
Rubber Content (%)	✓+		
Compression Limit at 70°C, 2kg (mm)			✓
Segregation (%)		✓	
Ease of Remixing (%)		✓	
Viscosity at 165°C (Pa.s)		✓	
Flash Point (°C)			✓
Loss on Heating (%)			✓
Torsional Recovery (%)	✓		
Softening Point (°C)	✓		

Whichever is the lower frequency

+ Crumb rubber binders only

All test results shall be forwarded to Pavements and Materials Branch.

10.3 Sampling and Testing at the Point of Delivery

10.3.1 General

Point of delivery is where the product is transferred to the sprayer for hot sprayed sealing work and from the asphalt binder storage tank for asphalt production.

Sampling and testing shall be undertaken on the basis of a lot.

Sampling shall be undertaken in accordance with Clauses 10.3.2 and 10.3.3 as appropriate, and testing shall be undertaken in accordance with Clause 10.3.4.

The frequency of compliance sampling for each class of polymer modified binder from each manufacturer shall be at the normal level. A reduced frequency may be adopted after no nonconformances have occurred in four consecutive lots. A reduced level shall revert to normal frequency or a normal level shall revert to tightened frequency once a nonconforming sample has been detected. For tightened frequency, a normal level may be adopted once no nonconformances have occurred in two consecutive tested lots.

Two 1 L samples of polymer modified binder shall be taken by the Contractor on each sampling occasion. The Contractor shall retain one of these samples and forward the other sample to the Administrator.

10.3.2 Sampling of Polymer Modified Binder for Asphalt Works

A lot shall comprise the discrete quantity of polymer modified binder in the Contractor's storage tank at the commencement of asphalt production. The polymer modified binder in the storage tank shall represent a new lot when either –

- a) polymer modified binder is added to the storage tank; or
- b) polymer modified binder has not been added to the storage tank for a period of 3 days.

Compliance sampling shall be not less than the following –

- a) Normal frequency Every second lot;
- b) Reduced frequency Every fifth lot; and
- c) Tightened frequency Every lot.

10.3.3 Sampling of Polymer Modified Binder for Sealing and Other Works

A lot shall consist of a homogeneous quantity of polymer modified binder of the same class.

The maximum lot size for sampling of polymer modified binder shall be –

- a) Normal frequency 60 tonnes;
- b) Reduced frequency 120 tonnes; and
- c) Tightened frequency 24 tonnes

Sampling shall be undertaken before or during the transfer of polymer modified binder to sprayers **Witness Point**.

10.3.4 Testing and Limits

Testing of polymer modified binder at the point of delivery shall be undertaken or arranged by the Contractor.

The testing undertaken shall be not less than every second sample taken from the lots. Samples shall be tested for torsional recovery at 25°C and softening point, and assessed for conformance with the requirements of Clause 7. In the event of any nonconformance being detected in any sample taken, additional tests shall be performed so that the sample is tested for other properties listed in Table 10.2, as appropriate.

All test results shall be forwarded to the Administrator and the Principal Advisor (Materials Testing), Pavements and Materials Branch.

Where testing for compliance and payment is specified at the point of delivery, any nonconformance shall be treated in accordance with Clause 11.

11 NONCONFORMANCE

11.1 General

A major nonconformance means a departure from stated properties for foaming, flashpoint or loss on heating. All other nonconformances shall be classified as minor.

All polymer modified binder which is represented by samples from which a major nonconformance has been detected shall be rejected.

In the event of nonconformance being detected, the Contractor shall test the adjacent samples and undertake corrective action.

11.2 Polymer Modified Binder Sampled by the Manufacturer

Polymer modified binder for which a minor nonconformance has been detected shall not be delivered to Site unless approved by the Administrator.

11.3 Polymer Modified Binder Sampled at the Point of Delivery

11.3.1 General

Where compliance and payment at the point of delivery has been specified, a lot of polymer modified binder which is represented by samples as taken under Clause 10.3.2 or Clause 10.3.3 as appropriate, for which a minor nonconformance has subsequently been detected may be assessed for utilisation with a reduced level of service.

11.3.2 Determination of Reduced Value

The reduced level of service shall be based on variations from particular specified properties listed in Table 7.1-A or Table 7.1-B as appropriate, and determined from Engineering Note No. 7.

An appropriate reduced level of service shall be as determined by the Administrator.