

# COMMENTARY TO AG:PT/T190 – SPECIFICATION FRAMEWORK FOR POLYMER MODIFIED BINDERS AND MULTIGRADE BITUMENS

## PREFACE

This Specification Framework for Polymer Modified Binders (PMBs) and Multigrade Bitumens has been produced by an Austroads Project Group. The specification is based on a set of test procedures that have been in use throughout Australia for several years. The intention of the specification is to achieve performance in the field for both sprayed seal surfacing and asphalt pavement applications. Specification limits are currently framed around the results of nationally coordinated field trials and laboratory studies, supplemented by Austroads Member Authority experience.

The first National *Specification framework for polymer modified binders* was released by Austroads in December 1992 and was replaced by a completely revised version in May 1997 titled *Austroads specification framework for polymer modified binders: APRG Report No. 19*. A minor revision was then published as AP-T04 in June 2000. A specification for multigrade bitumens was first published in 2000 as Austroads Report AP-T01 *Austroads provisional specification for multigrade binders*. A further update, combining framework specifications for both binder groups, was published in 2006 as Austroads Report AP-T41. A key recommendation in that specification revision was the use of Softening Point and Torsional Recovery as 'Point of Delivery' quality indicators. A similar approach has been adopted for the field manufactured crumb rubber classes where rubber concentration is recognised as the quality controlling property.

This further specification revision has resulted from a review of current polymer modified binder and multigrade bitumen manufacturing, testing and application experience.

## SCOPE

This specification framework outlines the requirements for PMBs, crumb rubber modified binders and multigrade bitumens free of polymer modifiers for use in both sprayed sealing and asphalt applications.

## FURTHER DEVELOPMENT

This specification framework is subject to regular review as further information and experience with the performance of different bituminous binders is obtained.

# SPECIFICATION FRAMEWORK FOR POLYMER MODIFIED BINDERS AND MULTIGRADE BITUMENS

## 1 REFERENCES

The following documents are referred to in this method:

Referenced documents	<p>AAPA 1998, <i>Guide to the safe use of SBS</i>, HS&amp;E Guide No. 5, Rev. edn, Australian Asphalt Pavement Association, Kew, VIC.</p> <p>AAPA 2004, <i>Code of practice: Manufacture, storage and handling of polymer modified binders</i>, Australian Asphalt Pavement Association, Kew, VIC.</p> <p>Austrroads 2000a, <i>Austrroads provisional specification for multigrade binders</i>, AP-T01/00, Austrroads, Sydney.</p> <p>Austrroads 2000b, <i>Austrroads specification framework for polymer modified binders</i>, AP-T04/00, Austrroads, Sydney.</p> <p>Austrroads 2002, <i>Guide to the selection and use of bitumen emulsions</i>, AP-G73/02, Austrroads, Sydney.</p> <p>Austrroads 2003, <i>Guidelines and specification for bituminous slurry surfacing</i>, AP-T26/03, Austrroads, Sydney.</p> <p>Austrroads 2006a, <i>Specification framework for polymer modified binders and multigrade bitumens</i>, AP-T41/06. Austrroads, Sydney.</p> <p>Austrroads 2006b, <i>Guide to the selection and use of polymer modified binders and multigrade bitumens</i>, AP-T42/06. Austrroads, Sydney.</p> <p>Austrroads 2008a, <i>Bituminous materials safety guide, 3rd edn</i>, AP-G41/08, Austrroads, Sydney.</p> <p>Austrroads 2008b, <i>Guide to Pavement Technology: Part 4F: Bituminous binders</i>. Austrroads, Sydney.</p> <p>Austrroads 2008c, <i>Guide to Pavement Technology: Part 4F: Bituminous binders – Appendix 1</i>, Bitumen. Austrroads, Sydney.</p>
Austrroads Test methods	<p>Refer Austrroads website for current test methods</p> <p>AGPT/T101 Method of sampling polymer modified binders, polymers and crumb rubber.</p> <p>AGPT/T102 Protocol for handling polymer modified binders in the laboratory.</p> <p>AGPT/T103 Pre-treatment and loss on heating of bitumen and modified binders (rolling thin film oven (RTFO) test).</p> <p>AGPT/T108 Segregation of polymer modified binders.</p>

AGPT/T109 Ease of remixing of polymer modified binders.

AGPT/T111 Handling viscosity of polymer modified binders (Brookfield Thermosel).

AGPT/T112 Flash point of polymer modified binders.

AGPT/T121 Shear properties of polymer modified binders (ARRB Elastometer).

AGPT/T122 Torsional recovery of polymer modified binders.

AGPT/T131 Softening point of polymer modified binders.

AGPT/T132 Compressive limit of polymer modified binders.

AGPT/T141 Laboratory protocol for the preparation of crumb rubber modified binders.

AGPT/T142 Rubber content of digested crumb rubber binders – Trichlor bath method.

AGPT/T143 Particle size and properties of crumb rubber.

AGPT/T144 Morphology of crumb rubber – Bulk density test.

#### Australian Standards

AS 2008 Residual bitumen for pavements

AS/NZS 2341 Methods of testing bitumen and related roadmaking products

AS 2341.2 Determination of dynamic (coefficient of shear) viscosity by flow through a capillary tube.

AS 2341.7 Determination of density using a density bottle

AS 2341.8 Determination of matter insoluble in toluene

AS 2341.11 Determination of ductility

AS 2341.12 Determination of penetration

AS 2341.14 Determination of the flash point of residual bitumen

AS/NZS 2341.20 Determination of sieve residue for bituminous materials

AS/NZS 2341.21 Sample preparation

## 2 SPECIFICATION STRUCTURE

Binders have been classified according to their intended application (Table 5.1 for sprayed sealing PMB classes, Table 5.2 for asphalt PMB classes, Table 5.3 for multigrade bitumen classes and Table 5.4 for field produced crumb rubber classes).

Within these tables, the PMB binder class is designated by application (e.g. S for sealing), a numeral designation and an alphabetical code denoting the broad polymer group represented. These classes refer to hot PMBs used specifically for sprayed sealing and asphalt work. PMBs may also be used in for other applications including bitumen emulsions for slurry surfacing and specialised hot binder crack sealing materials. Such materials are not covered by this Specification Framework. Further details on bitumen emulsion applications may be obtained by reference to the *Guide to the selection and use of bitumen emulsion* (Austroads 2002) and *Guidelines and specifications for bituminous slurry surfacing* (Austroads 2003).

Binder classes are coded as:

- S** For **S**ealing applications of polymer modified binders, followed by a 2 digit numeral and polymer code
- A** for **A**sphalt applications of polymer modified binders, followed by a 2 digit numeral and polymer code
- M** for **M**ultigrade bitumens, followed by a numerical description of apparent high and low temperature equivalence to conventional bitumen. The first number of the multigrade bitumen classification is an indication of the apparent viscosity of the unaged binder at 60°C and the second number is an indication of the nearest equivalent bitumen grade specified in AS2008 based on the penetration of the unaged binder at 25°C (e.g. M500/170 has a specified unaged binder viscosity at 60°C of 400-600 Pa.s and a penetration value at 25°C similar to that specified for Class 170 bitumen in AS2008).

Three specific polymer groups are coded as:

- E** For **E**lastomeric types such as SBS
- P** for **P**lastomeric types such as EVA
- R** for crumb **R**ubber materials, i.e. ground recycled vehicle tyres.

In addition, the code:

- RF** is used where the crumb Rubber binder is produced in the Field.

e.g. A35P is an asphalt class based on a Plastomeric polymer.

S10E is a sealing class based on an Elastomeric polymer.

S18RF is a crumb Rubber sealing class produced in the Field.

These are convenient labels and it is acknowledged that the definitions may not be absolutely correct in the literal meaning of the terms.

In sprayed sealing, identified general functional uses for PMBs and multigrade bitumens are:

**HSS** High Stress Seal

**SAM** Strain Alleviating Membrane

**SAMI** Strain Alleviating Membrane Interlayer.

In asphalt, identified general functional uses for PMBs and multigrade bitumens are:

- to enhance resistance to rutting
- to enhance resistance to fatigue
- to simultaneously enhance resistance to rutting and fatigue
- to increase durability in open graded asphalt mixes.

Selection criteria for the various functional uses are provided in the Guidelines for the selection and use of polymer modified binders and multigrade bitumens (Austroads 2006b).

## **3 SAMPLING AND TESTING BINDERS**

### **3.1 General**

Appropriate methods for sampling and testing PMBs are contained within the Austroads *Test Methods* (Austroads 2008d) and, for multigrade bitumens, in Australian Standard AS/NZS2341.

Representative samples of PMBs shall be obtained in accordance with AGPT/T101. Samples of multigrade bitumens shall be obtained in accordance with AS2008. The division of PMB samples into subsamples and test portions prior to testing shall be conducted according to AGPT/T102. The division of multigrade bitumen samples into subsamples and test portions prior to testing shall be conducted according to AS/NZS 2341.21.

Minimum testing frequencies specified for each test are listed in Table 5.1 and Table 5.2.

### **3.2 Testing at Point of Delivery**

The properties listed in Tables 5.1, 5.2, 5.3 and 5.4 refer to testing of samples taken at the point of manufacture. Modified minimum limits for Softening point and Torsional recovery may also be used as surrogates for 'point of delivery' control properties.

### **3.3 Rolling Thin Film Oven Test**

The properties critical to the performance of binders in asphalt are those obtained after pretreatment to simulate aging of binder through an asphalt plant. Values of viscosity and penetration after RTFO treatment are specified for multigrade bitumen class M1000/320 as this product is intended primarily for asphalt applications. Values after RTFO treatment are not specified for M500/170 as this product is also used in sprayed sealing applications. In both cases, the values before and after RTFO treatment should be reported in order to develop a data base to assist in future specification development.

The original Rolling Thin Film Oven (RTFO) Test (Australian Standard 2341.10) has been modified and the new procedure, including the procedure for determining loss on heating is described in Austroads test method AGPT/T103.

## **4 HANDLING AND OCCUPATIONAL HEALTH AND SAFETY**

### **4.1 General**

Users of PMBs and multigrade bitumens should familiarise themselves with the product suppliers' recommendations to ensure the materials are handled correctly. A general guide to the handling of PMB is provided in the AAPA *Code of practice: Manufacture, storage and handling of polymer modified binders* (AAPA 2004).

### **4.2 Occupational Health and Safety**

Users should familiarise themselves with Section 2 of the Austroads *Guidelines for the selection and use of polymer modified binders and multigrade bitumens* (Austroads 2006d), the AAPA publication: HS&E Guide to the safe use of SBS (AAPA 1998), and the Austroads *Bituminous materials safety guide* (Austroads 2008a).

## **5 PROPERTIES**

### **5.1 Selection of Binder Class**

The supplier must identify the appropriate class for each binder offered.

(a) Sealing Class Binders

The properties required of sealing class binders are given in Table 5.1 (Polymer Modified Binders) and Table 5.3 (Multigrade Bitumens).

(b) Asphalt Class Binders

The properties required of asphalt class binders are given in Table 5.2 (Polymer Modified Binders) and Table 5.3 (Multigrade Bitumens).

(c) Field Produced Crumb Rubber Modified Binders

The properties required of field produced crumb rubber modified binders are given in Table 5.4.

Table 5.1: Properties of Polymer Modified Binders for Sprayed Sealing Applications

Test method	Minimum testing frequency <sup>(1)</sup>	Class		S10E	S15E <sup>(11)</sup>	S20E	S25E	S35E	S45R <sup>(8)</sup>
		Binder property							
AGPT/T121	3-monthly <sup>(2)</sup>	Consistency at 60°C (Pa.s) min. <sup>(3)</sup>		250	700	700	5000	300	1000
AGPT/T121	3-monthly	Underlying viscosity at 60°C (Pa.s) <sup>(4)</sup>		TBR <sup>(6)</sup>	TBR	TBR	TBR	TBR	TBR
AGPT/T121	3-monthly <sup>(2)</sup>	Stiffness at 15°C (kPa) max.		140	140	140	95	180	180
AGPT/T142 <sup>(12)</sup>	Weekly	Rubber content by analysis (%) min.		NA <sup>(7)</sup>	NA	NA	NA	NA	10
AGPT/T132	3-monthly	Compression limit at 70°C, 2 kg (mm) min.		NA	NA	NA	NA	NA	0.2
AGPT/T121	3-monthly	Elastic recovery at 60°C, 100 s (%) min. <sup>(3)</sup>		NA	NA	NA	85	NA	25
AGPT/T111	Each batch	Viscosity at 165°C (Pa.s) max. <sup>(5)</sup>		0.55	0.55	0.55	0.8	0.55	4.5 <sup>(9)</sup>
AGPT/T112	Annually	Flash point (°C) min.		250	250	250	250	250	250
AGPT/T103	Annually	Loss on heating (% mass) max.		0.6	0.6	0.6	0.6	0.6	0.6
AGPT/T122	Each batch	Torsional recovery at 25°C, 30 s (%)		22-50	32-62	45-74	54-85	16-32	25-55
AGPT/T131	Each batch	Softening point (°C)		48-64	55-75	62-88	82-100	48-56	55-65
AGPT/T108	3 monthly	Segregation value (%) max.		8 <sup>(9)</sup>	8 <sup>(9)</sup>	8 <sup>(9)</sup>	8 <sup>(9)</sup>	8 <sup>(9)</sup>	8 <sup>(9)</sup>
AGPT/T109	3 monthly	Ease of remixing (%) max. <sup>(10)</sup>		2	2	2	2	2	2

Notes to Table 5.1

1. Testing frequencies provided are suggested minima. Different testing frequencies may be agreed between the purchaser and the supplier.
2. For classes S10E, S15E and S20E, this minimum testing frequency shall be 1-monthly.
3. For Consistency and elastic recovery, Mould B shall be used for S10E and S35E (breakpoint of 5 mm and a test speed of 1.5 mm/s). Other grades shall be tested using Mould A (breakpoint of 10 mm and a test speed of 1 mm/s)
4. Underlying viscosity is derived from the Elastometer data (i.e. tested under the same conditions as Consistency testing, refer to Note 3 above).
5. The shear rate involved in determining viscosity by AGPT/T111 shall be calculated and recorded. L series Brookfield is recommended together with spindle SC4-31, except in the case of S45R where spindle SC4-29 is recommended.
6. 'TBR' throughout = to be reported.
7. 'NA' throughout indicates that the property is considered not applicable for that PMB class.
8. To assist users in determining the quantity of added cutter oil required for spraying, the manufacturer shall report on the concentration and type of process oil used in the formulation.
9. Segregation values in excess of 8% are acceptable if product meets the requirements for ease of remixing (AGPT/T109).
10. Applicable only to products failing to meet the requirements for segregation value.
11. Properties for S15E are experimental, and are to be regarded as trial values for such period until manufacturing capabilities are proven.
12. Alternatively a soxhlet with toluene may be used.

Table 5.2: Properties of Polymer Modified Binders for Asphalt Applications

Test method	Minimum testing frequency <sup>(1)</sup>	Class		A35P	A25E	A20E	A15E	A10E
		Binder property						
AGPT/T121	3-monthly	Consistency at 60°C (Pa.s) min.		2000	600 <sup>(5)</sup>	600	5000	6000
AGPT/T121	3-monthly	Underlying viscosity at 60°C (Pa.s) <sup>(2)</sup>		TBR <sup>(4)</sup>	TBR	TBR	TBR	TBR
AGPT/T121	3-monthly	Stiffness at 25°C (kPa) max.		120	45	35	30	30
AGPT/T111	Each batch	Viscosity at 165°C (Pa.s) max. <sup>(3)</sup>		0.6	0.6	0.6	0.9	1.1
AGPT/T112	Annually	Flash point (°C) min.		250	250	250	250	250
AGPT/T103	Annually	Loss on heating (% mass) max.		0.6	0.6	0.6	0.6	0.6
AGPT/T122	Each batch	Torsional recovery at 25°C, 30 s (%)		6-21	17-30	38-70	55-80	60-86
AGPT/T131	Each batch	Softening point (°C)		62-74	52-62	65-95	82-105	88-110
AGPT/T108	3-monthly	Segregation value (%) max.		8 <sup>(6)</sup>	8 <sup>(6)</sup>	8 <sup>(6)</sup>	8 <sup>(6)</sup>	8 <sup>(6)</sup>
AGPT/T109	3-monthly	Ease of remixing (%) max. <sup>(7)</sup>		2	2	2	2	2

Notes to Table 5.2

1. Testing frequencies provided are suggested minima. Different testing frequencies may be agreed between the purchaser and the supplier.
2. Underlying viscosity is derived from the Elastometer data (i.e. tested under the same conditions as Consistency testing, refer to Note 5 below)
3. The shear rate involved in determining viscosity by AGPT/T111 shall be calculated and recorded.
4. 'TBR' throughout = to be reported.
5. Consistency at 60°C of A25E shall be determined using Mould B (breakpoint of 5 mm and a test speed of 1.5 mm/s). Other grades shall be tested using Mould A (breakpoint of 10 mm and a test speed of 1 mm/s).
6. Segregation values in excess of 8% are acceptable if product meets the requirements for ease of remixing (AGPT/T109).
7. Applicable only to products failing to meet the requirements for segregation value.

Table 5.3: Properties of Multigrade Bitumens

Property	Method	M1000/320	M500/170
Viscosity at 60°C (Pa.s) <sup>(1)</sup>	AS2341.2	report	400 – 600
Penetration at 25°C 100 g, 5 s, (pu) min	AS2341.12	report	65
Viscosity at 135°C (Pa.s) max	AS2341.2	1.5	1.0
Viscosity at 60°C after RTFOT (Pa.s)	AGPT/T103 AS2341.2	3,500 - 6,500	report
Penetration at 25°C after RTFOT 100 g, 5 s, (pu) min	AGPT/T103 AS2341.12	26	report
Matter insoluble in toluene (% by mass), max	AS2341.8, or AS/NZS 2341.20	1.0	1.0
Flashpoint (°C) min	AS2341.14	250	250
Density at 15°C (kg/m <sup>3</sup> )	AS2341.7	report	report
Ductility at 15°C after RTFOT (mm)	AGPT/T103 AS2341.11	report	report
Loss on heating (%) max	AGPT/T103	0.6	0.6

Note to Table 5.3

1. A schedule of Asphalt Institute vacuum capillary viscometer tubes is provided in Austroads test method AGPT/T161.

Table 5.4: Properties of Field Produced Crumb Rubber Binders

Property	Method	Minimum testing frequency	S15RF <sup>(1)</sup>	S18RF <sup>(1)</sup>	A27RF <sup>(2)</sup>
Nominal rubber concentration (%)			15	18	25 – 30
Rubber content by analysis (%) min.	AGPT/T142 <sup>(3)</sup>	weekly <sup>(4)</sup>	13	16	
Softening point (°C) min.	AGPT/T131	weekly	55	62	
Consistency at 60°C	AGPT/T121	weekly	report	report	
Torsional recovery (%) min.	AGPT/T122	weekly	25	30	

Notes to Table 5.4

1. Specification for two grades of crumb rubber (see Table 5.5) available for either sealing class.
2. 'Dry mix' asphalt is normally based on an asphalt mix design with the crumb rubber added at, typically, 25% crumb rubber in the total binder. Size 30 is normally used for the 'Dry mix' asphalt system. Refer to Austroads Guide to the selection and use of polymer modified binders and multigrade bitumens (Austroads 2006b) for more detail.
3. Alternatively a soxhlet with toluene may be used.
4. For sealing grades, the weekly sampling is from a sprayer load after digestion but prior to the addition of cutter oil. Samples must be free of diluents for subsequent testing to be meaningful. The agreed digestion period (at mixing temperature) must be completed before sampling.

Table 5.5: Properties of Crumb Rubber

Test	Method	Size 16	Size 30
<b>Grading</b>	AGPT/T143		
passing 2.36 mm		100	100
passing 1.18 mm		80 (min)	100
passing 600 $\mu\text{m}$		10 (max)	60 (min)
passing 300 $\mu\text{m}$		–	20 (max)
<b>Particle length (mm) max</b>	AGPT/T143	3	3
<b>Bulk density (kg/m<sup>3</sup>)</b>	AGPT/T144	report	report
<b>Water content (%) max</b>	AGPT/T143	1	1
<b>Foreign materials – other than iron (%) max</b>	AGPT/T143	0.1	0.1
<b>Foreign materials – metallic iron (%) max</b>	AGPT/T143	0.1	0.1

## AMENDMENT RECORD

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### Key

Format	Change in format
Substitution	Old clause removed and replaced with new clause
New	Insertion of new clause
Removed	Old clauses removed