TRANSPORT FOR NSW (TfNSW)

SPECIFICATION GUIDE N3252

GUIDE TO SELECTION OF POLYMER MODIFIED BINDER

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Transport for NSW

SPECIFICATION GUIDE N3252

GUIDE TO SELECTION OF POLYMER MODIFIED BINDER

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CONTENTS

CLAUSE PAGE

FOREWORD

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The Guide is not a contract document. It has been prepared to provide readers with guidance on the use of the specification.

BASE SPECIFICATION

This document is based on TfNSW QA Specification 3252 Edition 10 Revision 0.

SPECIFICATION GUIDE N3252

GUIDE TO SELECTION OF POLYMER MODIFIED BINDER

1 GENERAL

1.1 SCOPE AND PURPOSE

This Guide is a guide to the selection of polymer modified binder and provides the PMB selection criteria for sprayed sealing and asphalt applications.

It is arranged by the applications and benefits of PMB for pavement performance.

1.2 PMB GRADES

The Polymer Modified Binders (PMBs) in Specification TfNSW 3252 have been graded according to their intended field use.

In TfNSW 3252, PMBs are numerically classified in Tables 3252.1 and 3252.2 for Sprayed Sealing grades and Table 3252.3 for Asphalt grades. The numerical classification is not necessarily indicative of the concentration of polymer in the PMB, but a code letter indicates the predominant polymer group on which the PMB is based.

The following code letters are used, viz:

E for elastomeric polymer types including SBS (styrene-butadiene-styrene), SIS (styrene-isoprene-styrene), SBR (styrene-butadiene rubber), natural rubber, PBD (polybutadiene), chloroprene and other similar polymer types.

P for plastomeric polymer types including EVA (ethylene vinyl acetate), EMA (ethylene methacrylate), APP (atactic polypropylene), various forms of PE (polyethylene) and other similar polymer types.

R for materials predominantly based on comminuted scrap rubber (granulated crumb rubber).

RF for field prepared materials predominantly based on comminuted scrap rubber.

Tables N3252.13 and N3252.14 in Clause 5 provide compositions of various PMB grades.

1.3 PMB APPLICATIONS

This Guide assumes that PMBs are used in accordance with best practice.

For PMB applications, this Guide provides, in tabular form, the primary field conditions which influence decisions in the selection of PMB, the properties perceived to be most significant in determining PMB performance and PMB materials believed to perform under prescribed conditions. Where necessary, explanatory notes are provided.

For sprayed sealing, PMBs are applicable to Strain Alleviating Membrane Interlayer (SAMI), Strain Alleviating Membrane (SAM) and High Stress Seal (HSS).

In asphalt, PMBs are used to enhance resistance to rutting and/or fatigue. In open graded asphalt and in stone mastic asphalt, PMBs can also be used to provide asphalt modulus.

PMBs are not a solution to all problem situations. However, PMBs provide a wide range of performance properties to complement conventional binders.

Many classes of PMBs are provided in specification TfNSW 3252 because, for the same application, different generic types, which have different profiles of test properties, are believed to perform similarly (refer tables in Clauses 2 and 3).

Different products within the same polymer group are suggested due to the diversity in environmental and service conditions and local design and construction practices across NSW. The suggestion of different products is beneficial to TfNSW as it encourages competition between suppliers and the use of the most cost effective products.

1.4 MULTIGRADE BITUMEN

Multigrade bitumen is not a PMB. However, it is currently performing well as a lower cost alternative in sealing applications where a binder with improved temperature susceptibility is required and in asphalt applications where resistance to both fatigue and rutting is required. Further use of multigrade bitumen is encouraged.

2 PMB SELECTION CRITERIA FOR SPRAYED SEALING APPLICATIONS

2.1 PMB FOR SPRAYED SEALING APPLICATIONS

For sprayed sealing applications, ‘aggregate retention’ depends largely on the ability of the sealing binder to hold the aggregate particles in place after adhesion is established.

To improve the aggregate retention of a seal under specific service conditions, the use of a PMB, such as S35E, is suggested.

On the other hand, to improve aggregate retention during early sweeping of a seal, either a PMB or a bitumen binder containing a small amount of added synthetic polymer (1 to 2%) or scrap rubber (5 to 10%) may be used.

For sprayed sealing works, PMBs should only be used in the warmer months between October and April.

2.2 STRAIN ALLEVIATING MEMBRANE INTERLAYER (SAMI)

SAMIs are seals used to absorb strains that can cause reflection cracking in applied asphalt overlays (refer Note 1 to Table N3252.1).

Table N3252.1 - Strain Alleviating Membrane Interlayer

	Type of Cracking		
	Slow Rate of Movement (Environmental)[2][3]	**Rapid Rate of Movement (Traffic induced)**	
Cracking Severity	All	All	
Traffic Loading	All	Heavy[4]	Other[4]
Suggested PMB	S50R S55R S20RF	S55R S60R S20RF	S20RF S55R

Notes to Table N3252.1

(1) Prior to using SAMIs, perform a program of crack sealing treatment on existing cracks > 1 mm in width.

(2) Slow rate of movement cracks are induced by volumetric changes due to diurnal temperature changes, seasonal changes (temperature or moisture) or chemical changes (e.g. cement stabilisation). Where large cracks are present and where crack movement is > 0.5 mm, a PMB alone is unlikely to provide a long term solution, and PMB should be used in conjunction with a geotextile. If fatigue (traffic induced) cracking is not evident in such circumstances, a lightly modified or unmodified binder may be used with the geotextile.

(3) Where geotextiles are used, care should be exercised to ensure that the application temperature for the PMB does not exceed the melting point of the geotextile material type. For this reason, it is inappropriate to use scrap rubber binders with polypropylene geotextiles.

(4) For SAMI purposes, heavy traffic loading is defined as $> 5 \times 10^6$ ESA (> 500 HV/lane/day) and other loadings are $\leq 5 \times 10^6$ ESA (≤ 500 HV/lane/day).

(5) For SAMI applications which are expected to accommodate slow rates of crack movement, it is perceived that a maximum limit on elastic recovery may be required to provide suitable materials.

(6) Where more than one set of conditions prevail and none of the selection criteria described cover the circumstances, judgement should be made as to which PMB class is most suitable. If uncertain, the practitioner should seek specialist advice.

(7) For aged and cracked pavements, SAMIs may be used prior to overlay,to waterproof the surfacing, delay reflection cracking and extend the service life of the pavement. Justify the use of SAMIs over old cracked pavements by life cycle costing.

(8) PMBs should be sprayed at the manufacturer's recommended temperature. Spraying temperatures should be monitored in view of OH&S concerns regarding the fuming of some products. Seek advice at the time of purchase.

(9) For sprayed sealing work, always check the delivery documentation to confirm the generic type of material. Where SAMIs are applied, only carry out the work in the summer months so that the use of cutter oil is minimised or avoided.

(10) PMBs generally have enhanced properties, but, at higher concentrations of polymers, tend to be less adhesive, and hence are prone to stripping. The best sealing practice for PMBs is described in Sections 4 and 6 of the TfNSW Sprayed Sealing Guide. Always check the proposed aggregate/precoat/binder/adhesion agent system for Initial Adhesion (TfNSW T238) and Stripping (TfNSW T230) before the work is undertaken.

(11) Do not place a SAMI within 80 m of either side of a heavily trafficked intersection.

2.3 STRAIN ALLEVIATING MEMBRANE (SAM)

SAMs are used to absorb strains that can cause reflection cracking in the applied sprayed seal (refer Note 1 to Table N3252.2).

Table N3252.2 - Strain Alleviating Membrane

	Type of Cracking		
	Slow Rate of Movement (Environmental)[2][3]	**Rapid Rate of Movement (Traffic induced)**	
Cracking Severity	All	High[5]	Low[5]
Traffic Loading	All	All	All
Suggested PMB Materials	S20E S45R S15RF	S20E S25E S55R S20RF	S20E S45R S15RF

Notes to Table N3252.2

(1) Prior to using SAMs, perform a program of crack sealing treatment on existing cracks > 1 mm in width.

(2) Slow rate of movement cracks are induced by volumetric changes due to diurnal temperature changes, seasonal changes (temperature or moisture) or chemical changes (e.g. cement stabilisation). Where large cracks are present and where crack movement is > 0.5 mm, a PMB alone is unlikely to provide a long term solution, and PMB should be used in conjunction with a geotextile. If fatigue (traffic induced) cracking is not evident in such circumstances, a lightly modified or unmodified binder may be used with the geotextile.

(3) Where geotextiles are used, care should be exercised to ensure that the application temperature for the PMB does not exceed the melting point of the geotextile material type. For this reason, it is inappropriate to use scrap rubber binders with polypropylene geotextiles.

(4) For SAM applicationswhich are expected to accommodate slow rates of crack movement, it is perceived that a maximum limit on elastic recovery may be required to provide suitable materials.

(5) High cracking severity is defined by conditions where some crack widths are > 2 mm and/or the incidence of surfacing defects (patches, etc) is frequent, whereas low cracking severity is applicable where almost all crack widths are ≤ 2 mm and the incidence of surface defects is isolated.

(6) Aggregate retention refers to the binder tenacity to hold the aggregate in place under traffic and does not imply improved adhesion.

(7) Where more than one set of conditions prevails and none of the selection criteria described cover the circumstances, judgement should be made as to which PMB class is most suitable. If uncertain, the practitioner should seek specialist advice.

(8) For new pavements with modified or stabilised bases, after the initial treatment, i.e. prime (2 to 4 days) or primerseal (12 months), has cured, apply a SAM incorporating a PMB. Where premature cracks appear in the SAM, repair before applying the next treatment.

(9) For aged and cracked bound pavements, SAMs may be used to waterproof the surfacing, delay reflection cracking and extend the surface life of the pavement. Where an unbound pavement is reaching the end of its service life and early reconstruction is not an option, the use of a SAM should be considered for waterproofing. Justify the use of SAMs over old cracked pavements by life cycle costing.

(10) PMBs should be sprayed at the manufacturer's recommended temperature. Spraying temperatures should be monitored in view of OH&S concerns regarding the fuming of some products. Seek advice at the time of purchase.

(11) For sprayed sealing work, always check the delivery documentation to confirm the generic type of material. Those classes with last letter E (elastomers) or R (rubbers) may be used with the addition of cutter oil in accordance with either the manufacturer's recommendations or the Appendix in Section 6 of the TfNSW Sprayed Sealing Guide. Field produced scrap rubber bitumen binders, e.g. S15RF and S20RF, should be used with at least 4% cutter oil and this may be increased to 7% depending on pavement temperature. For details, refer to Section 6 of the TfNSW Sprayed Sealing Guide.

(12) PMBs generally have enhanced properties, but, at higher concentrations of polymer, tend to be less adhesive, and hence are prone to stripping. Best sealing practice for PMBs is described in Sections 4 and 6 of the TfNSW Sprayed Sealing Guide. Always check the proposed aggregate/precoat/binder/adhesion agent system for Initial Adhesion (TfNSW T238) and Stripping (TfNSW T230) before the work is undertaken.

(13) Do not place a SAM within 80 m of either side of a heavily trafficked intersection.

2.4 HIGH STRESS SEAL (HSS)

HSSs are used in situations where high traffic related stresses are applied to the sprayed seal due to tight curves, steep grades, heavy load intensities and other factors.

Table N3252.3 - High Stress Seal

	Site Stress Severity		
	Severe(1)(3)	**Moderate(2)**	
Traffic Loading	All	Heavy(4)	Other(4)
Suggested PMB Materials	S20E S35E S45R S15RF	S20E S35E S45R S15RF	S20E S35E S45R S15RF

Notes to Table N3252.3

(1) Severely stressed sites are typified by grades > 5% and/or curves < 50 m radius, and/or intersections, T junctions and heavy traffic entrances involving severe degrees of braking, acceleration or turning motions.

(2) Moderately stressed sites are typified by grades ≤ 5% and/or curves ≥ 50 m radius and/or intersections, T junctions and heavy traffic entrances involving moderate degrees of braking, acceleration or turning motions

(3) It is generally necessary to use a double/double seal to treat severely stressed sites. In such circumstances, the suggested PMB applies to the first binder application. An unmodified binder is appropriate for the second binder application.

(4) For HSS purposes, heavy traffic loading is defined as > 500 HV/lane/day whereas other loadings are ≤ 500 HV/lane/day.

(5) Aggregate retention refers to the binder tenacity to hold the aggregate in place under traffic and does not imply improved adhesion.

(6) Where more than one set of conditions prevails and none of the selection criteria described cover the circumstances, judgement should be made as to which PMB class is most suitable. If uncertain, the practitioner should seek specialist advice.

(7) Where aggregate retention is the sole reason for selecting a PMB as an alternative to 'racking in' or the use of single/double or double/double conventional bitumen seals, a Class 35E binder may be used.

(8) PMBs should be sprayed at the manufacturer's recommended temperature. Spraying temperatures should be monitored in view of OH&S concerns regarding the fuming of some products. Seek advice at the time of purchase.

(9) For sprayed sealing work, the delivery documentation should always be checked to confirm the generic type of material. Those classes with last letter E (elastomers) or R (rubbers) may be used with the addition of cutter oil in accordance with either the manufacturer's recommendations or the Appendix in Section 6 of the TfNSW Sprayed Sealing Guide. Field produced scrap rubber bitumen binders, e.g. S15RF and S20RF, should be used with at least 4% cutter oil and this may be increased to 7%, depending on pavement temperature. For details, refer to Section 6 of the TfNSW Sprayed Sealing Guide.

(10) PMBs generally have enhanced properties, but, at higher concentrations of polymer, tend to be less adhesive, and hence are prone to stripping. Best sealing practice for PMBs is described in Sections 4 and 6 of the TfNSW Sprayed Sealing Guide. Always check the proposed aggregate/precoat/binder/ adhesion agent system for Initial Adhesion (TfNSW T238) and Stripping (TfNSW T230) before the work is undertaken.

Example of binder selection

Existing pavement:	Heavily bound base. 10 mm seal. Shrinkage cracking - crack widths < 0.5 mm.
Traffic:	3,200 v/l/d, 15% commercial vehicles.
Selection of Treatment:	According to Section 3 of the TfNSW Sprayed Sealing Guide, a suitable treatment would be a SAM seal.
Selection of binder:	According to Table N3252.2 of this Guide, suggested PMBs are S15RF, S20E and S45R.

3 PMB SELECTION CRITERIA FOR ASPHALT APPLICATIONS

3.1 PMB FOR ASPHALT APPLICATIONS

The design of asphalt is always a compromise between fatigue and rutting characteristics. In addition to providing the basic skeletal structure of an asphalt mix, PMBs can also be used to modify asphalt characteristics. PMB is not intended to be used for compensating poor material quality or inadequate mix design.

Normally, polymer modified asphalts should only be used in:

(i) rehabilitation works, where high deflections and high curvatures are expected, on the grounds of economy and performance.

(ii) thin layer asphalt (defined as less than 50 mm thick).

Polymer modified asphalts should not normally be used for the construction of new roads as proper control of deflections and curvatures do not warrant their use. However, in special cases, such as roundabouts where high shear stresses exist, consideration may be given to their use .

If it is decided to use a polymer modified binder in asphalt, refer to the guidance in Table N3252.4 regarding the performance criteria to be addressed.

Table N3252.4 - Guide to Use of Polymer Modified Asphalt

Situation		Applications				
		D	**E**	**F**	**G**	**H**
Over concrete pavement/structure					1	
Over bridge decks	Timber	3	3	3	3	3
	Concrete					
Over asphalt	< High/Heavy					
	≥ High/Heavy				2	
Over stabilised + seal						
Over unstabilised + seal						
At signalised intersections	< High/Heavy					
	≥ High/Heavy					
At slow or kerb lane	< High/Heavy					
	≥ High/Heavy				2	

Legend

D = Rutting Resistance

E = Fatigue Resistance

F = Rutting and Fatigue Resistance

G = Open Graded Asphalt

H = High Modulus Asphalt

high/heavy = high/heavy traffic volume/loading (refer Clause 3)

= Recommended

= May be used

= Not applicable or not recommended

1 = over correction course

2 = Freeway/Motorway only

3 = seek expert advice

Notes to Table N3252.4

(1**)** The traffic loading has been specifically tailored for PMBs and does not reflect structural design requirements.

Caution:

(1) Consideration should be given to the use of SAMIs or interlayer slabs which can inhibit the movement of moisture, resulting in possible stripping of the overlay asphalt.

(2) The ‘traffic loading’ and ‘pavement temperature’ quoted in this Guide specifically relate to the application of PMBs and are intended to enhance the design and performance of an asphalt.

3.2 RUTTING RESISTANCE

PMBs with enhanced rutting resistance are used to minimise permanent deformation (plastic flow) in asphalt under severe service conditions where unmodified binders are unlikely to ensure reasonable performance.

Table N3252.5 - Rutting Resistance

	Pavement Condition/Curvature & Traffic Loading					
	Marginal Pavement(1)			**Adequate Pavement**(2)		
	Very Heavy(3)		**Heavy**(3)	**Very Heavy**(3)		**Heavy**(3)
Pavement Temperature	High or Medium(4)	Low(4)	All	High or Medium(4)	Low(4)	All
Suggested PMB Materials	A10E A40R* (5)	A10E A15E A40R* (5)	A10E A15E A40R* (5)	A10E A30P A40R* (5)	A10E A15E A30P A40R* (5)	A10E A15E A30P A40R* (5)

* Not to be used at signalised intersections

Notes to Table N3252.5

(1) **Non structural overlay**. "Marginal" pavements are defined as pavements which, after the asphalt surfacing treatment, are anticipated to produce a deflection bowl curvature function at or above the tolerable design limit for an asphalt overlay containing unmodified binder.

(2) **Structural overlay**. "Adequate" pavements are defined as pavements which, after the asphalt surfacing treatment, are anticipated to produce a deflection bowl curvature function below the tolerable design limit for an asphalt overlay containing unmodified binder.

(3) For asphalt purposes, the following definitions for traffic loading apply:

Very heavy traffic:

(i) $> 2 \times 10^7$ ESA or > 1000 HV/lane/day which is generally moving at a speed > 25 km/h; or

(ii) $> 5 \times 10^6$ ESA or > 500 HV/lane/day which involves stop/start, in climbing lanes or generally moving at a speed ≤ 25 km/h.

Heavy traffic:

(i) 5×10^6 to 2×10^7 ESA or 500 to 1000 HV/lane/day which is generally moving at a speed > 25 km/h, or

(ii) 5×10^5 to 5×10^6 ESA or 100 to 500 HV/lane/day which involves stop/start, in climbing lanes or generally moving at a speed ≤ 25 km/h.

(4) For asphalt purposes, the following definitions for pavement temperature apply:

High temperature: areas where the maximum pavement temperature is > 58°C

Medium temperature: areas where the maximum pavement temperature is 52 - 58°C

Low temperature: areas where the maximum pavement temperature is < 52°C

The procedure for determining maximum pavement temperature is given in Clause.4 of this Guide.

(5) The suggested use of A40R is based on the addition of dry scrap rubber directly to the asphalt mixing plant. Under this system, the total modified binder content by mass (i.e. bitumen plus scrap rubber) of the asphalt mix is much higher than normal, and needs to be confirmed through a laboratory mix design simulative of this addition process which addresses the need for a higher VMA of the mix. For a suitable initial formulation, seek expert advice. Different R materials may also prove to be suitable once the wet process has been fully evaluated under service conditions.

(6) Where more than one set of conditions prevail and none of the selection criteria described cover the circumstances, judgement should be made as to which PMB class is most suitable. If uncertain, the practitioner should seek specialist advice.

3.3 FATIGUE RESISTANCE

PMBs with enhanced fatigue resistance are used to minimise asphalt cracking under severe service conditions where unmodified binders are unlikely to ensure adequate performance.

Table N3252.6 – Fatigue Resisitance

	Traffic Loading			
	Very Heavy(1)		**Heavy(1)**	
Pavement Temperature	High or Medium(2)	Low(2)	High or Medium(2)	Low(2)
Suggested PMB Materials	A10E A40R* (3)	A10E A15E A40R* (3)	A10E A15E A30P A40R*(3)	A10E A15E A40R* (3)

* Not to be used at signalised intersections

Notes to Table N3252.6

(1) For asphalt purposes, the following definitions for traffic loading apply:

Very heavy traffic:

(i) > 2 x 10^7 ESA or > 1000 HV/lane/day which is generally moving at a speed > 25 km/h, or

(ii) > 5 x 10^6 ESA or > 500 HV/lane/day which involves stop/start, in climbing lanes or generally moving at a speed ≤ 25 km/h.

Heavy traffic:

(i) 5 x 10^6 to 2 x 10^7 ESA or 500 to 1000 HV/lane/day which is generally moving at a speed > 25 km/h, or

(ii) 5 x 10^5 to 5 x 10^6 ESA or 100 to 500 HV/lane/day which involves stop/start, in climbing lanes or generally moving at a speed ≤ 25 km/h.

(2) For asphalt purposes, the following definitions for pavement temperature apply:

High temperature: areas where the maximum pavement temperature is > 58°C

Medium temperature: areas where the maximum pavement temperature is 52 - 58°C

Low temperature: areas where the maximum pavement temperature is < 52°C

The procedure for determining maximum pavement temperature is given in Clause 4 of this Guide.

(3) The suggested use of A40R is based on the addition of dry scrap rubber directly to the asphalt mixing plant. Under this system, the total modified binder content by mass (i.e. bitumen plus scrap rubber) of the asphalt mix is much higher than normal, and needs to be confirmed through a laboratory mix design simulative of this addition process which addresses the need for a higher VMA of the mix. For a suitable initial formulation, seek expert advice. Different R materials may also prove to be suitable once the wet process has been fully evaluated under service conditions.

(4) Where more than one set of conditions prevail and none of the selection criteria described cover the circumstances, judgement should be made as to which PMB class is most suitable. If uncertain, the practitioner should seek specialist advice.

3.4 RUTTING AND FATIGUE RESISTANCE

PMBs with enhanced rutting and fatigue resistance are used to simultaneously minimise both permanent deformation and cracking in asphalt overlays under severe service conditions where unmodified binders are unlikely to ensure reasonable performance.

Table N3252.7 – Rutting and Fatigue Resistance

	Pavement Condition/Curvature & Traffic Loading					
	Marginal Pavement(1)			**Adequate Pavement(2)**		
	Very Heavy(3)		**Heavy(3)**	**Very Heavy(3)**		**Heavy(3)**
Pavement Temperature	High or Medium(4)	Low(4)	All	High or Medium(4)	Low(4)	All
Suggested PMB Materials	A10E A40R* (5)	A10E A15E A40R* (5)	A10E A15E A40R* (5)	A10E A40R* (5)	A10E A15E A30P A40R* (5)	A10E A15E A30P A40R* (5)

* Not to be used at signalised intersections

Notes to Table N3252.7

(1) **Non structural overlay**. "Marginal" pavements are defined as pavements which, after the asphalt surfacing treatment, will produce a deflection bowl curvature function at or above the tolerable design limit for an asphalt overlay containing unmodified binder.

(2) **Structural overlay.** "Adequate" pavements are defined as pavements which, after the asphalt surfacing treatment, will produce a deflection bowl curvature function below the tolerable design limit for an asphalt overlay containing unmodified binder.

(3) For asphalt purposes, the following definitions for traffic loading apply:

Very heavy traffic:

(i) $> 2 \times 10^7$ ESA or > 1000 HV/lane/day which is generally moving at a speed > 25 km/h, or

(ii) $> 5 \times 10^6$ ESA or > 500 HV/lane/day which involves stop/start, in climbing lanes or generally moving at a speed ≤ 25 km/h.

Heavy traffic:

(i) 5×10^6 to 2×10^7 ESA or 500 to 1000 HV/lane/day which is generally moving at a speed > 25 km/h, or

(ii) 5×10^5 to 5×10^6 ESA or 100 to 500 HV/lane/day which involves stop/start, in climbing lanes or generally moving at a speed ≤ 25 km/h.

(4) For asphalt purposes, the following definitions for pavement temperature apply:

High temperature: areas where the maximum pavement temperature is > 58°C

Medium temperature: areas where the maximum pavement temperature is 52 - 58°C

Low temperature: areas where the maximum pavement temperature is < 52°C

The procedure for determining maximum pavement temperature is given in Clause 4 of this Guide.

(5) The suggested use of A40R is based upon the addition of dry scrap rubber directly to the asphalt mixing plant. Under this system, the total modified binder content by mass (i.e. bitumen plus scrap rubber) of the asphalt mix is much higher than normal, and needs to be confirmed through a laboratory mix design simulative of this addition process which addresses the need for a higher VMA of the mix. For a suitable

initial formulation, seek expert advice. Different R materials may also prove to be suitable once the wet process has been fully evaluated under service conditions.

(6) Where more than one set of conditions prevail and none of the selection criteria described cover the circumstances, judgement should be made as to which PMB class is most suitable. If uncertain, the practitioner should seek specialist advice.

3.5 OPEN GRADED ASPHALT

The primary objective of using PMB in open graded asphalt is to achieve a thicker binder film without drainage during transport and hence to improve resistance to abrasion loss and reduce binder oxidation (refer Note 1 to Table N3252.8). The use of PMB in open graded asphalt does not include thin (TOGAS) or ultra-thin applications.

Table N3252.8 – Open Graded Asphalt

	Traffic Loading		
	Very Heavy or Heavy (2)		**Less than Heavy (2)**
Pavement Temperature	High(3)	Medium or Low(3)	All
Suggested PMB Materials(5)	A15E A30P	A15E A20E A25E A30P	A15E A20E A25E A30P

Notes to Table N3252.8

(1) Open graded asphalt is normally used as a wearing course and is not recommended for use at approaches to and through intersections, roundabouts, ramps or areas where vehicles need to stop/start and the shear strains from braking, acceleration and turning may cause failure. These areas are also subject to binder softening from oil drippings. PMBs are affected by oil droppings to the same extent as conventional bitumen binder.

(2) For asphalt purposes, the following definitions for traffic loading apply:

Very heavy traffic:

(i) $> 2 \times 10^7$ ESA or > 1000 HV/lane/day which is generally moving at a speed > 25 km/h, or

(ii) $> 5 \times 10^6$ ESA or > 500 HV/lane/day which involves stop/start, in climbing lanes or generally moving at a speed ≤ 25 km/h.

Heavy traffic:

(i) 5×10^6 to 2×10^7 ESA or 500 to 1000 HV/lane/day which is generally moving at a speed > 25 km/h, or

(ii) 5×10^5 to 5×10^6 ESA or 100 to 500 HV/lane/day which involves stop/start, in climbing lanes or generally moving at a speed ≤ 25 km/h.

(3) For asphalt purposes, the following definitions for pavement temperature apply:

High temperature: areas where the maximum pavement temperature is > 58°C

Medium temperature: areas where the maximum pavement temperature is 52 - 58°C

Low temperature: areas where the maximum pavement temperature is < 52°C

The procedure for determining maximum pavement temperature is given in Clause 4 of this Guide.

(4) No suitable method has yet been developed to test the adhesion characteristics of PMBs in open graded asphalt. Abrasion loss is clearly a potential mode of failure in open graded mixes. Where binder-

aggregate systems appear to be vulnerable to abrasion/adhesion loss, practitioners should consider the incorporation of about 1% of hydrated lime and/or the use of a suitable adhesion agent.

(5) Where more than one set of conditions prevail and none of the selection criteria described cover the circumstances, judgement should be made as to which PMB class is most suitable. If uncertain, the practitioner should seek specialist advice.

3.6 HIGH MODULUS ASPHALT

High modulus asphalts may be used where pavement thickness is limited by level constraints or where the costs involved justify their use.

Table N3252.9 - High Modulus Asphalt

Suggested PMB Material	A30P

Notes to Table N3252.9

(1) High modulus asphalt should be chosen on the basis of structural design and must never be used where the curvature function is > 0.06 mm. PMB is not the only material for the production of a high modulus asphalt. Other materials, such as gilsonite and hydrated lime filler, may be used. The use of multigrade binders does not produce particularly high modulus asphalt.

(2) Where more than one set of conditions prevail and none of the selection criteria described cover the circumstances, judgement should be made as to which PMB class is most suitable. If uncertain, the practitioner should seek specialist advice.

(3) Minimum thickness of high modulus asphalt is 100 mm unless, as preferred, it is placed directly over heavily bound or concrete pavement.

3.7 STONE MASTIC ASPHALT

The primary objective of using PMB in stone mastic asphalt (SMA) is to assist in reducing binder drain-off in conjunction with, or in lieu of, mineral or organic fibres (refer Note 1 to Table N3252.10). PMB may also be used in SMA to enhance flexibility or to improve rutting resistance. Selection criteria for improved flexibility and rutting resistance are similar to the criteria for dense graded asphalt mixes.

Table N3252.10 - Stone Mastic Asphalt

Suggested PMB Material	A15E

Notes to Table N3252.10

(1) There is no method to directly measure the binder drain-off of PMBs. However, binder drain-off may be measured by Asphalt Binder Drain-Off Test (AG:PT/T235) on the asphalt mixes.

Example of binder selection

Existing pavement: Dense graded asphalt.
Fatigue cracking - crack widths < 1 mm.

Design traffic loading: 5×10^7 ESA.

Maximum pavement temperature (T_{max}) is 60°C

Selection of binder: According to Table N3252.6 of this Guide, suggested PMBs are A10E and A40R.

4 DETERMINATION OF MAXIMUM PAVEMENT TEMPERATURE (T_{MAX})

Determine maximum pavement temperature (T_{max}) as follows:

(i) Refer to "Climatic Averages of Australia" published by Australian Bureau of Meteorology. (also available on the INTERNET at **http://www.bom.gov.au/** Australian Climate Data)

(ii) Determine T_{86} (the 86^{th} percentile of maximum air temperature) for December, January and February for one (1) to three (3) weather stations near the site.

(iii) Select the maximum T_{86} from (ii) above.

(iv) Determine the latitude of the site.

(v) From Table N3252.11, derive the T_{max} for the site.

Table N3252.11 – Maximum Pavement Temperature (T_{max})

Latitude	Maximum Pavement Temperature (T_{max})
> 41°S	T_{86} + 21°
35°S to 41°S	T_{86} + 22°
27°S to 35°S	T_{86} + 23°
24°S to 27°S	T_{86} + 24°
< 24°S	T_{86} + 25°

For convenience, Table N3252.12 provides T_{max} values which have been determined for the following sites in New South Wales.

Table N3252.12 – Maximum Pavement Temperature (T_{max}) for Sites in New South Wales

Site	Latitude	T_{86}	T_{max}
Adelong	35.3	35.9	58
Armidale	30.5	31.1	54
Balranald	34.6	38.9	62
Bankstown	33.9	32.9	56
Bathurst	33.4	33.3	56
Bega	36.7	32.3	54
Bombala	36.9	31.7	54
Bourke	30.1	40	63
Broken Hill	32.0	38.1	61
Camden Airport	34.1	34.4	57
Canberra	35.3	33.5	56
Canberra City	35.3	34.2	56
Canberra Forestry	35.3	32.8	55
Casino	28.9	35.3	58
Cobar	31.5	38.9	62
Coffs Harbour	30.3	29.1	52
Cooma North	36.2	31.1	53
Coonamble	31.0	38.4	61
Cootamundra	34.6	36.4	59
Cowra	33.9	36.8	60
Deniliquin	35.6	37.3	59
Dubbo	32.2	36.7	60
Frogmore	34.3	35.4	58
Glen innes	29.7	30	53
Griffith	34.3	36.4	59
Gunnedah	31.0	36.7	60
Hume reservoir	36.1	35.7	58
Ivanhoe	32.9	40	63
Katoomba	33.7	28.9	52
Kiandra	35.9	25.6	48

Site	Latitude	T_{86}	T_{max}
Lake Cargelligo	33.3	39	62
Lismore	28.8	33.3	56
Lithgow	33.5	31	54
Macquarie University	33.8	33.5	57
Moree	29.5	37.2	60
Mudgee	32.6	35.5	59
Murwillumbah	28.4	32.9	56
Narrabri	30.3	37.6	61
Narrandera	34.7	38	61
Newcastle	32.9	28.1	51
Nyngan	31.6	38.9	62
Orange	33.3	32.8	56
Parkes	33.2	36.7	60
Parramatta	33.8	33.5	57
Port Macquarie	31.5	27.3	50
Prospect Dam	33.8	33	56
Pt Perpendicular	35.1	27.5	50
Richmond	33.6	35.6	59
Sydney (CBD)	33.9	28.9	52
Tabulam	28.8	31	54
Tamworth	31.1	35.4	58
Tenterfield	29.1	31.1	54
Thredbo	36.5	25.7	48
Tibooburra	29.4	41	64
Wagga	35.2	36.7	59
Wilcannia	31.6	41.1	64
Williamtown	32.8	32.9	56
Wollongong	34.4	29.1	52
Wyalong	33.9	37.8	61
Yass	34.8	35.2	58

5 COMPOSITIONS OF PMB GRADES

Table N3252.13 - Compositions of PMB Sealing Grades

	Sealing Grades in TfNSW 3252 Ed 10 Rev 0								
	S15E*	**S20E**	**S25E**	**S30E***	**S35E**	**S45R/ S15RF**	**S50R***	**S55R/ S20RF**	**S60R***
Approximate composition of PMBs	4% SBS	5% SBS	6% SBS	6.5% SBS	2 to 3% SBS, SBR or PBD	15% Scrap Rubber	17% Scrap Rubber	20% Scrap Rubber	21 to 25% Scrap Rubber

* Not in TfNSW 3252 Ed 10 Rev 0

Table N3252.14 - Compositions of PMB Asphalt Grades

	Asphalt Grades in TfNSW 3252 Ed 10 Rev 0				
	A10E	**A15E**	**A30P**	**A35P***	**A40R**
Approximate composition of PMBs	5 to 5.5% SBS	4.5 to 5% SBS	~ 5% EVA or EMA	~ 5% EVA or EMA	20 - 25% scrap rubber

* Not in TfNSW 3252 Ed 10 Rev 0