DENSE GRADED ASPHALT

INTRODUCTION

VicRoads Standard Specification 407 describes Dense Graded Asphalt (DGA) types used by VicRoads. Asphalt types address low, medium and heavy duty mixes as outlined in the Provisional Guide for the Selection and Design of Asphalt Mixes APT-20/02 (Formerly Austroads APRG Report No.18). The Austroads mix design procedure is a performance based mix design procedure that is expected to eventually replace the current empirically based Marshall mix design procedure.

GUIDE TO SELECTION OF DENSE GRADED ASPHALT MIXES

The Annexure to this Technical Note provides recommendations on the most appropriate DGA mix for various traffic loadings and situations together with explanatory footnotes. Information on Open Graded, Stone Mastic and Ultra Thin Asphalt is provided in other Technical Notes and Guideline documents.

ASPHALT BINDERS

Table 1 provides the Class of binder that is to be used for each designated mix. The standard binder used in DGA is C320 bitumen. C170 and C600 can also be used in asphalt. Bitumen binders are produced to meet the technical requirements of AS 2008. Other binders that may be used in DGA mixes for enhanced performance, mainly heavy duty applications, include Multigrade (MG) binder and Class A10E Polymer Modified Binder (PMB) (AP-T41/06 and AP-T42/06).

MG binder is specified for enhanced properties over a wider range of pavement temperatures and is expected to provide improved deformation resistance.

In addition to high resistance to deformation, asphalt with a Class A10E PMB also results in a very flexible asphalt wearing course for medium duty pavements lacking in sufficient stiffness (i.e. pavements with high deflection bowl curvatures). Laboratory fatigue life testing has shown that PMB Class A10E has 10 to 20 times the fatigue life of asphalt produced from conventional bitumen binders.

Although a PMB (A10E) asphalt is about 20% - 30% more costly, this cost is offset by its considerably enhanced performance properties. PMB modified asphalt has 0.3% by mass of additional binder which lowers the mix air voids to increase durability, lower permeability, enhance fatigue performance and improve mix workability subject to appropriate placement procedures (refer below).

THIN ASPHALT SURFACING

For a variety of reasons, it is becoming more common to apply thin flexible asphalt wearing courses (<40 mm thick) in lieu of a sprayed seal on rural heavy duty unbound granular pavements. Compared to a sprayed seal surfacing an asphalt surfacing is more resistant to shear forces, does not generate the same degree of road/tyre noise and achieves some improvement to ride quality.

Whilst a deep strength asphalt pavement is usually the preferred pavement type for heavy duty urban pavements, sometimes economic considerations in rural areas suggest that thin asphalt surfaced granular pavements may have a lower whole of life cost. If conventional asphalt is used in such locations it may exhibit premature flexural cracking. The use of a PMB e.g. A10E can improve fatigue performance. As thin surfacings makes little contribution to the structural strength of the pavement, the performance of such pavements relies on the asphalt having sufficient fatigue resistance to withstand the higher deflections (deflection bowl curvatures) normally associated with unbound flexible pavements.

If a thin asphalt surfacing is applied to an existing medium to heavy duty granular pavement in lieu of a seal treatment, it is necessary to provide a prime or preferably a bitumen emulsion primerseal with possibly a Strain Alleviating Membrane Interlayer (SAMI) beneath the asphalt surfacing. This ensures that the asphalt surfacing is properly bonded to the underlying surface and helps to prevent ingress of water into the pavement through interconnected air voids or micro cracking in the asphalt layer. Treatments for pavements surfaced with a thin asphalt surfacing under various traffic loadings are given in VicRoads Code of Practice 500.22.

AUSTROADS ASPHALT MIX DESIGN PROCEDURE

Under the Austroads asphalt mix design procedure, the determination of the binder content and other volumetric requirements are undertaken using a gyratory compactor at 50, 80 or 120 Gyratory cycles depending whether the mix is a light, medium or heavy duty mix.

Medium and heavy duty mixes may be subject to one or more of the following performance tests to confirm that the mix meets certain requirements and provide assurance to the client that the mix will meet expectations.

Indirect Tensile Resilient Modulus Test - used to measure the modulus (stiffness) of medium and heavy duty mixes. The test subjects a 100mm diameter x 35-65mm thick cylindrical specimen of asphalt to a diametrically applied dynamic load pulse to determine the resilient indirect tensile modulus. High modulus mixes are usually required in structural applications whereas low modulus mixes are more suitable for surfacing over unbound flexible pavements where more flexibility is required.

Deformation (Wheel Tracking) Test - used to measure the deformation resistance of heavy duty wearing and intermediate courses using a laboratory based wheel track testing apparatus. The test requires a 300 mm long x 300 wide mm x 50 mm or 75mm thick slab specimen of asphalt to be repeatedly traversed by a loaded wheel. The final average tracking depth after 15,000 load passes is determined. A low value indicates a rut resistant mix suitable for intersections and roundabouts whereas a high value indicates a rut prone mix that may be unsuitable for heavy duty applications.

Fatigue Life Test - used to measure the resistance to cracking of asphalt under repeated flexural bending. The test requires a 63.5mm wide x 50mm thick x 400 mm long beam of asphalt to be tested under a dynamic 4 point loading at a prescribed strain level and test temperature. The fatigue life is defined as the number of loading cycles required to reduce the flexural modulus to 50% of its initial value. The greater the load cycles required to reach the test end point, the longer the time before flexural fatigue cracking should occur in practice given the same traffic conditions. The test is mainly applicable to mixes that are used as thin flexible surfacings for medium to heavy duty granular pavements and other types of pavements lacking in stiffness. The test can provide assurance that mix will have sufficient or improved flexibility compared to conventional mixes.

Moisture Sensitivity Test – used to measure the sensitivity of a mix to damage by stripping of binder from aggregates under saturated conditions. The test requires the indirect tensile strength of both dry and moisture conditioned 100mm by 65mm cylindrical test specimens to be determined. The moisture sensitivity is expressed as the wet to dry tensile strength ratio (TSR) as a percentage. The higher the TSR the less moisture sensitive the mix should be. The test is generally only applied to heavy duty wearing and intermediate course mixes where moisture effects may be an issue.

MIX DESIGN REGISTRATION

Asphalt mixes are designed by the asphalt suppliers to meet VicRoads requirements. All asphalt mixes for use on VicRoads works are required to be registered by VicRoads in accordance with VicRoads Code of Practice RC500.01. This Code of Practice describes the process to be undertaken when registering bituminous mix designs to comply with the appropriated sections of VicRoads Standard Specifications. A mix identification number is assigned to each registered mix and entered into an electronic data base for viewing by nominated VicRoads personnel. There are other categories of registration for mixes that do not comply with the specification or if a standard specification does not exist.

The VicRoads registration of mixes does not attest to the production, placement or compaction of the mix and does not guarantee the handling problems or performance of the mix.

PLACEMENT OF WEARING COURSE

Placement of wearing course should be avoided over the colder months from May to September (inclusive) because of difficulties in achieving compaction and a high standard of surface finish. This is more important with PMB asphalt mixes that tend to become very stiff and difficult to place and compact with rapid cooling. For best results, PMB modified asphalt should not be placed when the pavement surface temperature is less than 15°C.

REFERENCES

- VicRoads Standard Specification Section 407 – Hot Mix Asphalt and Guide Notes;
- VicRoads Code of Practice RC500.01 – Registration of Bituminous Mix Designs;
- VicRoads Code of Practice 500.22 – Selection and Design of Pavements and Surfacings;
- Austroads – AP-TO20/02 – Provisional Guide for Selection and Design of Asphalt Mixes;
- AP-T41/06: Specification Framework for Polymer Modified Binders and Mulitgrade Bitumens;
- AP-T42/06 – Guide to the Selection and Use of Polymer Modified Binders and Multigrade Bitumens.

FURTHER READING

- Austroads – AP-G63/03 – Guide to the Selection of Road Surfacings, 2nd Edition, 2003

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TABLE 1 GUIDE FOR SELECTION OF DENSE GRADED ASPHALT TYPES

Course		AADT / Lane [2]		Designation [1]		Binder Class	Minimum PSV	Standard Mix Sizes [3]	Remarks
		HV's	Total	Current	Former				
Wearing	Light Duty	< 25	< 500	L	L	C170 or C320	-	7 & 10	C170 binder must be used if mix contains more than 10% RAP
	Medium Duty	25 – 300	500 - 3000	N	N	C170 or C320	-	7, 10 & 14	C170 must be used if mix contains more than 10% RAP
	Heavy Duty	> 300	> 3000	H	H	C320	48	10 & 14	Standard heavy duty wearing course
	Heavy Duty	> 500	> 5000	V[4]	V	C320	54[6]	10 & 14	Restricted to signalised intersections and roundabouts
	Heavy Duty	> 1000	> 10000	HG[4],[5]	-	M (600/170)	48[6]	10 & 14	
	High Performance and/or Flexibility	> 200 #	> 2000 #	HP[4]	H_m	PMB (A10E)	48[6]	10 & 14	# For medium and heavy duty use. Specialist advice should be sought.
Structural	Intermediate	25 - 1000	500 - 10000	SI	T	C320	-	14 & 20	Standard Structural Mix. Generally Size 20
	Heavy Duty Intermediate	> 1000	> 10000	SS	T (600)	C600	-	20	
		> 1000	> 10000	SG[5]	-	M (600/170)	-	20	
		> 1000	>10000	SI	T	C320	-	20	Type SS preferred within 100 mm of finished surface level (excluding OGA) for freeways and large scale works
	High Performance Intermediate	> 1000	> 10000	SP	Tm	PMB (A10E)	-	20	Alternative PMB Class may be appropriate. Specialist advice should be sought prior to use
	Base	All	All	SI	T	C320	-	20	Standard Structural Mix
		All	All	SF	R	C320	-	20	Min. Layer thickness of 75mm and Min. Cover of 100 mm of DGA is required

(1) Standard Types of Dense Graded Asphalt (DGA)

L A light duty Size 7 or 10 wearing course with low air voids and higher binder wearing course for use in very lightly trafficked pavements.

N A light to medium duty Size 7, 10 or 14 wearing course for use in light to moderately trafficked pavements.

H A heavy duty Size 7, 10 or 14 asphalt wearing course for use in most heavily trafficked pavements.

V A heavy duty Size 10 or 14 asphalt wearing course for heavily trafficked intersections.

HG A multi purpose heavy duty to Size 10 or 14 wearing course asphalt incorporating Multigrade binder where a high resistance to deformation is required, particularly at heavily trafficked intersections.

HP A high performance Size 10 or 14 heavy to very heavy duty wearing course asphalt incorporating a Polymer Modified Binder (PMB) where a high resistance flexural cracking and/or deformation is required.

SI A multi purpose Size 14 or 20 structural asphalt for intermediate course in heavy duty pavements or base course in medium duty pavements.

SS A very stiff and rut resistant Size 20 structural intermediate course asphalt often used for large scale heavy duty asphalt pavements.

SG A multi purpose heavy duty Size 20 structural intermediate course asphalt incorporating a Multigrade binder for high resistance to deformation particularly at very heavily trafficked intersections.

SP A high performance heavy to very heavy duty Size 20 structural intermediate course asphalt incorporating a PMB for high resistance to deformation and flexural cracking.

SF A fatigue resistant Size 20 structural base course asphalt for heavy duty asphalt pavements with a total asphalt thickness in excess of 175 mm.

(2) Greater priority should be given to the volume of Heavy Vehicles (HVs) if known.

(3) The nominal size of asphalt should be compatible with the layer thickness as follows:

Size (mm)	Thickness Range (mm)	Recommended (mm)
7	15 - 25	20
10	25 - 35	30
14	35 - 50	40
20	50 - 100	75

(4) Where Type V, HG or HP is recommended for use at intersections, it should commence at the start of the turn lane taper (or a minimum of 80 m from the stop line) and extend through the intersection and the first 30 m of the departure lanes.

(5) The supply of Multigrade binder is limited in Victoria. Consider alternatives.

(6) PSV ≥ 54 must be used at high accident risk sites if available and economically feasible.