Research and Development

Fine AC10 Asphalt Trial in SA

IPWEA – SA Division

August 2019

Ref No. 20150248FR3C

Rod Ellis and Rodney Uebergang (Tonkin Consulting)

Hugo Van Loon (DPTI)

Government of South Australia
Department of Planning, Transport and Infrastructure

South Australia
IPWEA
INSTITUTE OF PUBLIC WORKS ENGINEERING AUSTRALASIA

Tonkin CONSULTING

Document History and Status

Rev	Description	Author	Reviewed	Approved	Date
A	Draft report for comment – to Reference Group	RU	RKE	RKE	23 April 2018
B	Updated draft based on AAPA and DPTI feedback	RKE	RU	RKE	13 September 2018
C	Update to acknowledgements	RKE	RKE	RKE	22 August 2019

Contents

1 Acknowledgements 1

2 Introduction 2

3 Background 3

4 Objectives 4

5 Mix Descriptions 5

5.1 Mix Philosophy 5

5.2 Descriptions of Mixes 5

5.3 Installation of the Mixes 6

5.4 Aggregate Grading 8

5.5 Binder Content 8

6 Construction 10

6.1 Asphalt Mix Spreading Temperature 10

6.2 Average Asphalt Core Depth 10

6.3 Compaction and Air Voids 11

6.4 Compaction and Auger Temperature 19

6.5 Completed Asphalt Thickness 21

6.6 Overview of Conformance of Mixes 21

7 Analysis and Discussion 23

7.1 Maximum Characteristic Air Voids Vs Binder Content 23

7.2 Air Voids Vs Stiffness of Underlying Pavement 24

7.3 Field Air Void Binder Film Thickness 25

7.4 Lab Air Voids vs Binder Film Thickness 26

7.5 Binder Film Thickness Vs Production Binder Content 27

7.6 Field Air Void Vs Lab Air Voids 28

7.7 Wheel Track Testing 29

8 Discussion 30

9 Technical Recommendations 32

10 References 34

Tables

Table 5.1	Installation of Mixes	6
Table 5.2	Mix Grading Envelopes of Fine AC10 Mix Asphalt	8
Table 5.3	Production binder content of mixes	8
Table 6.1	Typical Spreading temperatures for dense-graded asphalt	10
Table 6.2	Average Asphalt Core Depth	10
Table 6.3	Phase 1: April 2015 – June 2015 Air Voids Test Results of Cores Taken from the Trial Sites	13
Table 6.4	Phase 2: February 2016 – April 2016 Air Voids Test Results of Cores Taken from the Trial Sites	14
Table 6.5	Phase 3: August 2016 – November 2016 Air Voids Test Results of Cores Taken from the Trial Sites	15
Table 6.6	Phase 3: January 2017 – March 2017 Air Voids Test Results of Cores Taken from the Trial Sites	16
Table 6.7	Average for Mix A, Mix B, Mix C and Mix D: Characteristic Air Void Test Results of Cores Taken from the Trial Sites	17
Table 6.8	DPTI Specification Compliance	19
Table 6.9	Phase 3: Ambient and Auger Temperature Protocol Requirements	21
Table 6.10	Comparison of Average Air Void – 2012 – 2013 Trials and 2015 – 2017	22
Table 7.1	Wheel Track Testing Results	29

Figures

Figure 6.1	Maximum Characteristic Air Voids for the Various Asphalt Mixes Installed	18
Figure 6.2	Auger Temperature Vs Maximum Characteristic Air Voids	19
Figure 6.3	Ambient Temperature Vs Maximum Characteristic Air Voids	20
Figure 6.4	Average Core Depth Vs Maximum Characteristic Air Voids	21
Figure 7.1	Production Binder Content % Vs Maximum Characteristic Air Voids %	23
Figure 7.2	Mean FWD Deflection Vs Maximum Characteristic Air Voids %	24
Figure 7.3	Binder Film Thickness Vs Maximum Characteristic Air Voids %	25
Figure 7.4	Binder Film Thickness Vs Lab Air Voids %	26
Figure 7.5	Binder Film Thickness Vs Production Binder Content %	27
Figure 7.6	Lab Voids Vs Maximum Characteristic Voids	28

Appendices

Appendix A	Trials Protocol Document
Appendix B	DPTI Specification Part R27 and R28

1 Acknowledgements

The delivery and oversight of this project was managed by the Institute of Public Works Engineering Australia – SA Division (IPWEA-SA) on behalf of the following co-funding organisations:

- City of Salisbury
- West Torrens City Council
- City of Playford
- City of Port Adelaide Enfield
- Corporation of the City of Marion
- Corporation of the City of Adelaide
- Adelaide Hills Council
- City of Unley
- Light Regional Council
- City of Mitcham
- City of Prospect.

This project was supported by the Australian Asphalt Pavement Association (AAPA) and its members with in kind support for trials, input into the protocol and providing feedback during reference group sessions.

The Department of Planning, Transport & Infrastructure (DPTI) has provided valuable input to reviews and advising at reference group meetings at no cost.

Tonkin Consulting (Tonkin) have provided in-kind support over and above available funding in order to complete this report.

2 Introduction

In March 2015, funding was secured from the contributing Councils to assess the performance of Fine AC10 asphalt through the installation of 15 trial sites across metropolitan Adelaide. The Fine AC10 specification is now part of DPTI's Master Specification as a result of previous work undertaken through the LGA Research and Development Fund in 2012 and 2013.

This project was conducted in collaboration between ten municipalities and four asphalt contractors with the coordinating support of IPWEA-SA to undertake trials of different asphalt mixes.

A trial protocol was developed by Tonkin Consulting for each phase (refer Appendix A), with some oversight from the Australian Road Research Board (ARRB) and DPTI. The protocol provided a standardised approach across the trials for:

- The selection criteria for appropriate trial sites
- Mix design requirements
- The recording requirements for construction sites
- The monitoring requirements
- Forms for reporting conditions and test results.

This report outlines the findings of the trials and provides recommendations for further work based on the learnings of this project.

3 Background

In 2012, as part of the LGA Research and Development Scheme, the City of Salisbury (on behalf of a collection of Councils), secured funding to undertake trials in asphalt surfacing for low volume roads.

This project involved trialling new asphalt mixes with the results to inform the development of a specification for long life asphalt for low trafficked roads.

Most asphalt specifications up to 2012 were designed for heavy traffic loads and to withstand traffic damage. However, the majority of local government sealed roads have low traffic volumes and deteriorate more by the environmental effects of oxidation and soil movement rather than by traffic damage.

In total, 11 sites were installed across 7 municipalities with 4 different asphalt mixes installed at each site. The main objectives of these asphalt trials were:

- Creating asphalt mixes that are:
  - Easy to compact
  - Accommodating for the stiffness and irregular shape of underlying pavement
- Achieve low insitu voids (equals longer life)
- Achieve high flexibility of mixes to accommodate high deflections in residential roads.

Following analysis of these results, key outcomes included:

- Adopt 4% lab air voids (50 cycles Gyproc – AS 2891.2.2) – to improve workability
- Incorporate minimum binder film thickness (60% absorption) of 8.0 micron
- A minimum binder content of 5.7% should be specified
- Field density results should be included in acceptance criteria for local government roads
- Warm asphalt tends to improve potential to achieve lower voids
- Local Government should consider amending asphalt contracts to include:
  - Incentives for field voids achieving 4% – 6%
  - Penalties for field voids being greater than 7%
- Review construction practices – with focus on improving field compactions
- Updates to DPTI specifications R27-supply of asphalt and R28 construction of asphalt pavement to incorporate ‘Fine Dense Mix Asphalt’.

The report was finalised in March 2014 and DPTI issued the Fine AC10 mix as part of its Master Specification set.

The industry needed to better understand the impacts of the specification in practice.

4 Objectives

The aim of this Fine AC10 road trial project was to evaluate asphalt mixes that are specifically intended for use on residential streets carrying limited numbers of heavy vehicles. This is defined as an urban street carrying traffic that falls within the lowest category of Table A 2 of the Austroads 'Guide to Pavement Technology Part 4B: Asphalt', i.e.:

- A street that carries less than 100 commercial vehicles per lane per day
- The structural design level for the street should be less than 5×10^5 ESAs
- Light free flowing traffic.

These mixes are designed to yield a longer life, to be more environmentally sustainable and to minimise whole-of-life cost. The mixes would also be suitable for use in pedestrian areas and for maintenance patching.

The technical characteristics of the asphalt designs include: a fine, dense graded aggregate distribution in combination with a high binder content. The aim was to create mixes that are easy to compact, this is to remedy the rapid cooling that takes place when mixes are constructed in thin layers and the influence of other compaction challenges such as insufficient stiffness of underlying pavement, irregular shape of underlying pavement, access for full size paving and compaction equipment. By constructing low insitu air voids, it reduces the permeability of the mixes, which helps to protect the underlying granular layers and limits oxidation aging of the binder. The high flexibility of the mixes accommodates the relatively high deflections in residential street pavements.

Some of the trial mix designs included Reclaimed Asphalt Pavement (RAP) to increase environmental sustainability and reduce cost.

Some of the trial mix designs included warm mix asphalt (WMA) additives to further improve compactability of the mixes and increase environmental sustainability.

A majority of the trial mix designs consisted of C170 binder, to improve compactability, durability and flexibility of the material.

Conducting this trial was expected to scientifically support increased scrutiny of asphalt supply and placement by local governments and to identify activities for particular focus and improvement

The outcomes of the trials will guide specification development in collaboration with DPTI.

5 Mix Descriptions

5.1 Mix Philosophy

The technical characteristics of the asphalt mix designs include: a fine, dense graded aggregate distribution in combination with high binder content.

The aim is to create mixes that are easy to compact, that is to remedy the rapid cooling that takes place when mixes are constructed in thin layers and the influence of other compaction challenges such as:

- lack of stiffness of underlying pavement
- irregular shape of underlying pavement
- access for full size paving
- compaction equipment.

The aim is to construct mixes with low in-situ air voids. This will reduce the permeability of the mixes, which helps to protect the underlying granular pavement layers and limits oxidation ageing of the binder.

This is consistent with the desirable aims outlined in APRG Technical Note 4 – Light Duty Non-Structural asphalt surfacing and overlays (July 1997), where residential mix aims were:

- Low air voids (density)
- High bitumen content (impermeability).

Oliver (1992) in a long term performance study of asphalt mixes on lightly trafficked Australian streets showed that aging of the binder is greatly reduced for mixes that are compacted to 6% air void content and below. The study showed these mixes to be more durable in terms of cracking resistance. As the air void content increases beyond 7% it becomes increasingly easier for water and oxygen to penetrate the asphalt, which leads to an increased rate of oxidation aging and a risk of stripping. Linden et al (1989) found that an asphalt pavement's life is reduced by 10 percent for each percent increase in voids above 7 percent. This finding may be expected to be exacerbated for thin surfacing layers. McLeod (1967) concluded that "compacting a well-designed paving mixture to low air voids retards the rate of hardening of the asphalt binder, and results in longer pavement life, lower pavement maintenance, and better all-around pavement performance."

5.2 Descriptions of Mixes

A total of 29 trials sites were selected across residential streets in the Adelaide metropolitan area. While the original scope was for 15 sites, as the project developed, the reference group saw the merit in increasing the number of field trials. The main variation between the mixes are generally the binder type used, incorporation of any warm mix asphalt (WMA) additive and/or reclaimed asphalt pavement (RAP) as follows:

- Mix A: class 320 bitumen
- Mix B: class 320 bitumen with WMA additive
- Mix C: class 170 bitumen with RAP
- Mix D: class 170 bitumen with RAP and WMA additive.

Table 5.1 presents more descriptions on the mixes and the trial sites. The DPTI classification of the mixes is 10 mm fine dense mix asphalt (Fine AC10) (DPTI specification: Part R27), refer Appendix B.

5.3 Installation of the Mixes

The evolution of these asphalt trials progressed in three phases with a review conducted by the reference group at the conclusion of each phase.

- Phase 1: April 2015-June 2015 (refer Appendix A – 20150248DR1B)
- Phase 2: February 2016-April 2016 (refer Appendix A – 20150248DR1D)
- Phase 3: August 2016 March 2016 (refer Appendix A – 20150248DR1E)

Table 5.1 presents the various asphalt mixes installed at each site for each project phase. The classification of the four different asphalt mixes has remained consistent with the 2012 asphalt trials to allow some comparison between these two research projects.

Table 5.1 Installation of Mixes

Site name	Mix A	Mix B	Mix C	Mix D	Comment
Phase 1: April 2015-June 2015					
Koonga Avenue	Binder C320; No RAP				
Conrad Street			Binder C170; RAP 20%		
Phillip Highway				Binder C170; RAP 10%; WMA Sasobit	
Hawson Avenue				Binder C170; RAP 15%; WMA Sasobit	
Bransby Street				Binder C170; RAP 10%; WMA Sasobit	
Alpha Road			Binder C170; RAP 10%		
Eden Avenue			Binder C170; RAP 10%		
Ramsay Street (wearing course for road reconstruction)				Binder C170; RAP 20%; WMA Sasobit	
Phase 2: February 2016 – April 2016					
Chartwell Crescent (Vincent Road – 40m north of Kentwood Drive)			Binder C170; RAP 20%		Fine AC10 Mix
Chartwell Crescent (40m North of Kentwood Drive – Venturi Avenue)			Binder C170; RAP 20%		Contractor LG Mix
International Avenue (Geoffrey Street – McCormack Road near Winters Road)			Binder C170; RAP 20%		Fine AC10 Mix
International Avenue (McCormack Road near Waterloo Corner Road – Geoffrey Street)			Binder C170; RAP 20%		Contractor LG Mix
Harnham Road (Waterloo corner Road – Harcourt Terrace)			Binder C170; RAP 20%		Fine AC10 Mix

Site name	Mix A	Mix B	Mix C	Mix D	Comment
Ashley Street (Half Road width – west side)			Binder C170; RAP 10%		Fine AC10 Mix
Ashley Street (Half Road width – east side)			Binder C170; RAP 10%		Contractor Mix
Hooper Road (Half road width south side)			Binder C170; RAP 10%		Fine AC10 Mix
Hooper Road (half road width north side)			Binder C170; RAP 10%		Contractor Mix
Phase 3: August 2016 – March 2017 – Winter Trials August 2016 – November 2016					
Nellie Street				Binder C170; RAP 20%; WMA Foamed	
Devlin Court				Binder C170; RAP 20%; WMA Foamed	
Falcon Drive				Binder C170; RAP 20%; WMA Foamed	
Aylwin Street and Dulkara Avenue		Binder C320 WMA not reported			
Treves Street		Binder C320, RAP 0%, WMA Sasobit			
Acorn Avenue		Binder C320, RAP 20%, WMA Sasobit			
Phase 3: August 2016 – March 2017 – Summer Trials January 2017 – March 2017					
Douglas Road			Binder C170; RAP 20%		
Paraware Road			Binder C170; RAP 20%		
Danielle Drive			Binder C170; RAP 20%		
Dimboola Court		Binder C320; WMA Sasobit			
Hutt Street and Osler Street		Binder C320; WMA not reported			
Hayward Avenue				Binder C170; RAP 20%; WMA Foamed	

5.4 Aggregate Grading

The grading envelope for the Fine AC10 class mix is defined with reference to DPTI specification Part R27. The grading envelopes are summarised in Table 5.2 below.

Table 5.2 Mix Grading Envelopes of Fine AC10 Mix Asphalt

Sieve	DPTI Specification Fine Dense Grade mix Part R27 May 2014 (% passing)	
(mm)	Max.	Min.
19	100	100
13.2	100	100
9.5	100	90
6.7	90	75
4.75	77	63
2.36	56	43
1.18	41	30
0.6	29	20
0.3	20	13
0.15	13	8
0.075	8	5

The design gradings for the trial mixes were generally conforming to trial protocol criteria

5.5 Binder Content

A requirement of the trial was that the binder content be a minimum of 5.7%. The target and production binder contents of individual mixes are presented in Table 5.3 below. The target binder content for each Fine AC10 asphalt mix conformed to the minimum value of 5.7%.

Table 5.3 Production binder content of mixes

Site name	Target binder content (%)	Production binder content (%)				
		Mix A	Mix B	Mix C	Mix D	Comments
Phase 1: April 2015 – June 2015						
Koonga Avenue	5.8	5.8				
Conrad Street	5.5-6.1			5.8		
Phillip Highway	Not reported				6.0	
Hawson Avenue	Not reported				6.2	
Bronsby Street	Not reported				6.0	
Alpha Road	5.8			5.7		
Eden Avenue	5.8			6.1		
Ramsay Street	5.8				6.1	

Site name	Target binder content (%)	Production binder content (%)				
		Mix A	Mix B	Mix C	Mix D	Comments
Phase 2: February 2016 – April 2016						
Chartwell Crescent	5.8			5.8		Fine AC10 Mix
Chartwell Crescent	5.7			5.9		Contractor LG Mix
International Avenue	5.8			5.7		Fine AC10 Mix
International Avenue	5.7			6.1		Contractor LG Mix
Harnham Road	5.8			5.7		Fine AC10 Mix
Ashley Street	5.9			6.0		Fine AC10 Mix
Ashley Street	5.6			5.3		Contractor LG Mix
Hooper Road	5.9			5.7		Fine AC10 Mix
Hooper Road	5.6			5.1		Contractor LG Mix
Phase 3: August 2016 – March 2017 – Winter Trials August 2016 – November 2016						
Nellie Street	5.8				6.0	
Devlin Court	5.8				5.9	
Falcon Drive	5.8				5.8	
Aylwin Street and Dalkara Avenue	5.7		5.8			
Treves Street	5.7		5.8			
Acorn Avenue	5.8		6.1			
Phase 3: August 2016 – March 2017 – Summer Trials January 2017 – March 2017						
Douglas Road	5.8			5.8		
Parawal Road	5.8			5.9		
Danielle Drive	5.8			5.7		
Dimboola Court	5.7		6.0			
Hutt and Osler Street	5.7		Not reported			
Hayward Avenue	5.9				5.8	

The trial project demonstrates the prescribed minimum binder content of 5.7% is being achieved for Fine AC10 asphalt. In contrast; 50% of the Contractor LG Mix possessed a binder content less than 5.7%.

6 Construction

6.1 Asphalt Mix Spreading Temperature

DPTI specification for asphalt pavement construction (Part R28 – refer to Appendix B) states that, during the construction, mixes shall be placed at temperatures recommended in the Australian Standard for Hotmix Asphalt. A Good Guide to Practice (AS 2150: 2005). The recommended spreading temperatures are presented in Table 6.1.

Table 6.1 Typical Spreading temperatures for dense-graded asphalt

Road surface temperature (°C)	Thickness of layer (mm)		
	< 30	30 - 40	41 – 100
	Minimum (°C)		
5 – 10	-	-	145
10 – 15	150	145	140
15 – 25	150	145	135
> 25	150	145	130

Source: based on AS 2150: 2005 (Table 12).

The nominal layer thickness of the Fine AC10 surfacings used for this trial was not reported.

A spreading temperature of 145 °C was consequently chosen from Table 6.1 for Phase 1 and 2 of this project, to assess the conformity of the mix spreading temperatures for hotmix. As a noted exception, and based on the DPTI specification Part R28, the minimum spreading temperature of 120°C was adopted for the WMA (Warm Mix Additive) mixes.

The temperatures of mixes at the auger were recorded during construction and these records were used as the spreading temperatures.

The spreading temperature records of individual mixes show that most of the sites conformed with the requirements of AS 2150:2005. However, during the third phase, three sites did not report this information so it is unknown if the spreading temperature requirements of the protocol and AS 2150 were followed to at these locations.

6.2 Average Asphalt Core Depth

To provide an appreciation of the average asphalt depth installed at each site, this data from the post construction laboratory testing is compiled within Table 6.2.

Table 6.2 Average Asphalt Core Depth

Site name	Average Asphalt Core Depth (mm)				
	Mix A	Mix B	Mix C	Mix D	Comments
Phase 1: April 2015 – June 2015					
Koonga Avenue	44.2				
Conrad Street			30.8		
Phillip Highway				45.8	
Hawson Avenue				32.3	
Bronsby Street				47.0	
Alpha Road			43.0		
Eden Avenue			34.0		

Site name	Average Asphalt Core Depth (mm)				
	Mix A	Mix B	Mix C	Mix D	Comments
Ramsay Street				34.0	
Phase 2: February 2016 – April 2016					
Chartwell Crescent			43.5		Fine AC10 Mix
Chartwell Crescent			45.8		Contractor LG Mix
International Avenue			34.3		Fine AC10 Mix
International Avenue			32.5		Contractor LG Mix
Harnham Road			43.8		Fine AC10 Mix
Ashley Street			45.5		Fine AC10 Mix
Ashley Street			43.8		Contractor LG Mix
Hooper Road			46.0		Fine AC10 Mix
Hooper Road			33.3		Contractor LG Mix
Phase 3: August 2016 – March 2017 – Winter Trials August 2016 – November 2016					
Nellie Street				32.8	
Devlin Court				38.8	
Falcon Drive				31.8	
Aylwin Street and Dalkara Avenue		41.5			
Treves Street		43.0			
Acorn Avenue		44.5			
Phase 3: August 2016 – March 2017 – Summer Trials January 2017 – March 2017					
Douglas Road			35.1		
Parawal Road			23.5		
Danielle Drive			22.5		
Dimboola Court		40.0			
Hutt and Osler Street		44.3			
Hayward Avenue				41.5	
Average	44.2	42.7	37.2	38.0	

This indicates that all sites in the trials were installed with an average depth of asphalt greater than 35mm.

6.3 Compaction and Air Voids

The trial protocol document states that achieving satisfactory field compaction (i.e. achieving in-situ air voids less than the DPTI 7.0% benchmark for high characteristic voids) is the most important goal of this trial. The trial participants were requested to use a minimum binder content of 5.7% derived from the mix design procedure. The laboratory air voids at 50 gyratory cycles and binder film thickness were reporting requirements.

For the field compaction assessment, a number of cores were taken from each site after the construction. Air voids of the cores were then measured in the laboratory and compared to the specified target air voids range of 2.5% to 7%.

Table 6.3 – 6.5 present the air voids test results and calculated min/max characteristic air voids of mixes for each of the three project phases. Table 6.6 summarises the average for each asphalt mix type for the entire data set (i.e. over the 3 phases).

- While the size of the data set covers 29 sites; the variance for the range of maximum characteristic voids in 5.8% (minimum 4.5%, maximum 10.3%)
- It is noted from the tables that approximately 30% of these mixes met the required maximum characteristic air voids range of being less than 7% (i.e. mixes were adequately compacted)
- No site provided results indicating that 'over-compaction' (over-working of the asphalt) had occurred, achieving a maximum characteristic air void less than 4%

Table 6.3 Phase 1: April 2015 – June 2015 Air Voids Test Results of Cores Taken from the Trial Sites

Street	MIX A (C320 Binder)					MIX B (C320 Binder with Warm Mix Additive)					MIX C (C170 Binder with RAP)					MIX D (C170 Binder with RAP and Warm Mix Additive)				
	Air Voids (%)		K Value	Characteristic Air Voids (%)		Air Voids (%)		K Value	Characteristic Air Voids (%)		Air Voids (%)		K Value	Characteristic Air Voids (%)		Air Voids (%)		K Value	Characteristic Air Voids (%)	
				Minimum	Maximum				Minimum	Maximum				Minimum	Maximum				Minimum	Maximum
Koonga Avenue	Average	7.2	0.72	5.8	8.5	Average					Average					Average				
	Standard Deviation	1.93				Standard Deviation					Standard Deviation					Standard Deviation				
Conrad Street	Average					Average					Average	6.1	0.62	5.3	6.9	Average				
	Standard Deviation					Standard Deviation					Standard Deviation	1.27				Standard Deviation				
Phillip Highway	Average					Average					Average					Average	6.61	0.62	5.5	7.7
	Standard Deviation					Standard Deviation					Standard Deviation					Standard Deviation	0.88			
Hawson Avenue	Average					Average					Average					Average	7.10	0.62	6.9	7.3
	Standard Deviation					Standard Deviation					Standard Deviation					Standard Deviation	0.33			
Bransby Street	Average					Average					Average					Average	5.66	0.62	5.1	6.2
	Standard Deviation					Standard Deviation					Standard Deviation					Standard Deviation	0.86			
Alpha Road	Average					Average					Average	7.40	0.62	6.2	8.6	Average				
	Standard Deviation					Standard Deviation					Standard Deviation	2.00				Standard Deviation				
Eden Avenue	Average					Average					Average	6.60	0.62	6.4	6.8	Average				
	Standard Deviation					Standard Deviation					Standard Deviation	0.40				Standard Deviation				
Ramsay Street	Average					Average					Average					Average	7.30	0.62	6	8.7
	Standard Deviation					Standard Deviation					Standard Deviation					Standard Deviation	2.20			
	Average	7.2		5.8	8.5	Average	-		-	-	Average	6.70		5.97	7.43	Average	6.7		5.9	7.5
	Standard Deviation	1.93				Standard Deviation	-				Standard Deviation	1.22				Standard Deviation	1.1			

Table 6.4 Phase 2: February 2016 – April 2016 Air Voids Test Results of Cores Taken from the Trial Sites

Street	MIX A (C320 Binder)					MIX B (C320 Binder with Warm Mix Additive)					MIX C (C170 Binder with RAP)					MIX D (C170 Binder with RAP and Warm Mix Additive)				
	Air Voids (%)		K Value	Charactertistic Air Voids (%)		Air Voids (%)		K Value	Charactertistic Air Voids (%)		Air Voids (%)		K Value	Charactertistic Air Voids (%)		Air Voids (%)		K Value	Charactertistic Air Voids (%)	
				Minimum	Maximum				Minimum	Maximum				Minimum	Maximum				Minimum	Maximum
Chartwell Crescent Finace AC10 Mix	Average					Average					Average	5.80	0.72	4.7	6.9	Average				
	Standard Deviation					Standard Deviation					Standard Deviation	1.53				Standard Deviation				
Chartwell Crescent Contractor LG Mix	Average					Average					Average	6.20	0.72	4.7	7.7	Average				
	Standard Deviation					Standard Deviation					Standard Deviation	2.02				Standard Deviation				
International Avenue Fine AC10 Mix	Average					Average					Average	6.22	0.62	5.4	7	Average				
	Standard Deviation					Standard Deviation					Standard Deviation	1.26				Standard Deviation				
International Avenue Contractor LG Mix	Average					Average					Average	5.16	0.62	4.2	6.1	Average				
	Standard Deviation					Standard Deviation					Standard Deviation	1.49				Standard Deviation				
Harnham Road Fine AC 10 Mix	Average					Average					Average	5.50	0.62	4.7	6.2	Average				
	Standard Deviation					Standard Deviation					Standard Deviation	1.22				Standard Deviation				
Ashley Street Fine AC10 Mix	Average					Average					Average	6.33	0.62	5.6	7	Average				
	Standard Deviation					Standard Deviation					Standard Deviation	1.11				Standard Deviation				
Ashley Street Contractor LG Mix	Average					Average					Average	9.60	0.62	8.8	10.3	Average				
	Standard Deviation					Standard Deviation					Standard Deviation	1.16				Standard Deviation				
Hooper Road Fine AC10 Mix	Average					Average					Average	6.77	0.62	6.1	7.4	Average				
	Standard Deviation					Standard Deviation					Standard Deviation	1.01				Standard Deviation				
Hooper Road Contractor LG Mix	Average					Average					Average	8.51	0.62	8.1	8.9	Average				
	Standard Deviation					Standard Deviation					Standard Deviation	0.59				Standard Deviation				
Fine AC10 Mix	Average					Average					Average	6.12		5.30	6.90	Average				
	Standard Deviation					Standard Deviation					Standard Deviation	1.23				Standard Deviation				
Contractor LG Mix	Average					Average					Average	7.37		6.45	8.25	Average				
	Standard Deviation					Standard Deviation					Standard Deviation	1.32				Standard Deviation				

Table 6.5 Phase 3: August 2016 – November 2016 Air Voids Test Results of Cores Taken from the Trial Sites

Street	MIX A (C320 Binder)					MIX B (C320 Binder with Warm Mix Additive)					MIX C (C170 Binder with RAP)					MIX D (C170 Binder with RAP and Warm Mix Additive)				
	Air Voids (%)		K Value	Charactertistic Air Voids (%)		Air Voids (%)		K Value	Charactertistic Air Voids (%)		Air Voids (%)		K Value	Charactertistic Air Voids (%)		Air Voids (%)		K Value	Charactertistic Air Voids (%)	
				Minimum	Maximum				Minimum	Maximum				Minimum	Maximum				Minimum	Maximum
Nellie Street	Average					Average					Average					Average	7.70	0.62	6.7	8.8
	Standard Deviation					Standard Deviation					Standard Deviation					Standard Deviation	1.71			
Devlin Court	Average					Average					Average					Average	6.38	0.62	4.6	8.1
	Standard Deviation					Standard Deviation					Standard Deviation					Standard Deviation	2.77			
Falcon Drive	Average					Average					Average					Average	7.53	0.62	6.3	8.8
	Standard Deviation					Standard Deviation					Standard Deviation					Standard Deviation	2.02			
Aylwin Street (combined with Dulkara Crescent)	Average					Average	8.99	0.62	8.1	9.9	Average					Average				
	Standard Deviation					Standard Deviation	1.40				Standard Deviation					Standard Deviation				
Treves Street	Average					Average	8.80	0.62	7.8	9.9	Average					Average				
	Standard Deviation					Standard Deviation	1.70				Standard Deviation					Standard Deviation				
Acorn Avenue	Average					Average	6.15	0.72	4.4	7.9	Average					Average				
	Standard Deviation					Standard Deviation	2.50				Standard Deviation					Standard Deviation				
	Average					Average	7.98		6.77	9.23	Average					Average	7.20		5.87	8.57
	Standard Deviation					Standard Deviation	1.87				Standard Deviation					Standard Deviation	2.17			

Table 6.6 Phase 3: January 2017 – March 2017 Air Voids Test Results of Cores Taken from the Trial Sites

Street	MIX A (C320 Binder)					MIX B (C320 Binder with Warm Mix Additive)					MIX C (C170 Binder with RAP)					MIX D (C170 Binder with RAP and Warm Mix Additive)				
	Air Voids (%)		K Value	Characteristic Air Voids (%)		Air Voids (%)		K Value	Characteristic Air Voids (%)		Air Voids (%)		K Value	Characteristic Air Voids (%)		Air Voids (%)		K Value	Characteristic Air Voids (%)	
				Minimum	Maximum				Minimum	Maximum				Minimum	Maximum				Minimum	Maximum
Douglas Road	Average					Average					Average	7.20	0.76	5.2	9.2	Average				
	Standard Deviation					Standard Deviation					Standard Deviation	2.60				Standard Deviation				
Parawae Road	Average					Average					Average	7.90	0.62	6.6	9.1	Average				
	Standard Deviation					Standard Deviation					Standard Deviation	2.10				Standard Deviation				
Danielle Drive	Average					Average					Average	5.90	0.62	4.1	7.6	Average				
	Standard Deviation					Standard Deviation					Standard Deviation	2.46				Standard Deviation				
Dimboola Court - Eucla Court (Craigmore)	Average					Average	4.40	0.62	3.4	5	Average					Average				
	Standard Deviation					Standard Deviation	0.85				Standard Deviation					Standard Deviation				
Hull Street (Elizabeth East) combined with Osler Street (Elizabeth Vale)	Average					Average	6.27	0.62	5.7	6.9	Average					Average				
	Standard Deviation					Standard Deviation	0.97				Standard Deviation					Standard Deviation				
Hayward Avneue (Torrensville)	Average					Average					Average					Average	4.20	0.62	3.8	4.5
	Standard Deviation					Standard Deviation					Standard Deviation					Standard Deviation	0.60			
	Average					Average	5.34		4.55	5.95	Average	7.00		5.30	8.63	Average	4.20		3.78	4.52
	Standard Deviation					Standard Deviation	0.91				Standard Deviation	2.39				Standard Deviation	0.60			

Table 6.7 Average for Mix A, Mix B, Mix C and Mix D: Characteristic Air Void Test Results of Cores Taken from the Trial Sites

Street	MIX A (C320 Binder)				MIX B (C320 Binder with Warm Mix Additive)				MIX C (C170 Binder with RAP)				MIX D (C170 Binder with RAP and Warm Mix Additive)			
	Air Voids (%)	K Value	Characteristic Air Voids (%)		Air Voids (%)	K Value	Characteristic Air Voids (%)		Air Voids (%)	K Value	Characteristic Air Voids (%)		Air Voids (%)	K Value	Characteristic Air Voids (%)	
			Minimum	Maximum			Minimum	Maximum			Minimum	Maximum			Minimum	Maximum
Average	7.2		5.8	8.5	6.66		5.66	7.59	6.61		5.52	7.66	6.02		5.17	6.85
Standard Deviation	1.93				1.39				1.61				1.28			
Sample Size			1		Sample Size		5		Sample Size		11		Sample Size		8	

** Different K values are used according to the number of cores tested (draft DPTI specification Part R28). In most cases, four cores were taken for the testing (i.e. K = 0.62). If five or six cores were used for the lot, the K values are 0.68 and 0.72, respectively.*

One observation from Phase 1 of the trials questioned if the cost of the higher binder content required for the Fine AC10 mix is providing a tangible benefit over and above the current asphalt mixes available for Local Government within the market. This comparison was conducted during Phase 2 of the project and it indicated that, for two sites, the binder contained within the Local Government mix was lower than 5.7% and the average of the maximum characteristic air voids for the two different asphalt mixes pointed to the Fine AC10 having the ability to satisfy the requirements of the DPTI Master Specification while the Local Government mix was unable to. Due to this finding, the data associated with the four sites consisting of the Local Government asphalt mix were excluded from the data analysis and subsequent discussion covered by this report.

The Maximum Characteristic Insitu Air Voids results were plotted in Figure 6.1 to graphically represent where the tabulated results from Tables 6.2, 6.3, 6.4 and 6.5 correspond to the specified target range of 2.5% to 7% insitu air voids. Eleven of the twenty-nine trials (38%) resulted in a maximum characteristic insitu air voids result within the target range. This appraisal of the data also indicates that 62% of the sites yielded maximum characteristic insitu air voids greater than 7%.

The average Maximum Characteristic Insitu Air Voids for each of the four mix types has also been incorporated (colour crosses) which indicates that the use of C170 binder enhances the potential to achieve the desired maximum characteristic air voids than C320 binder.

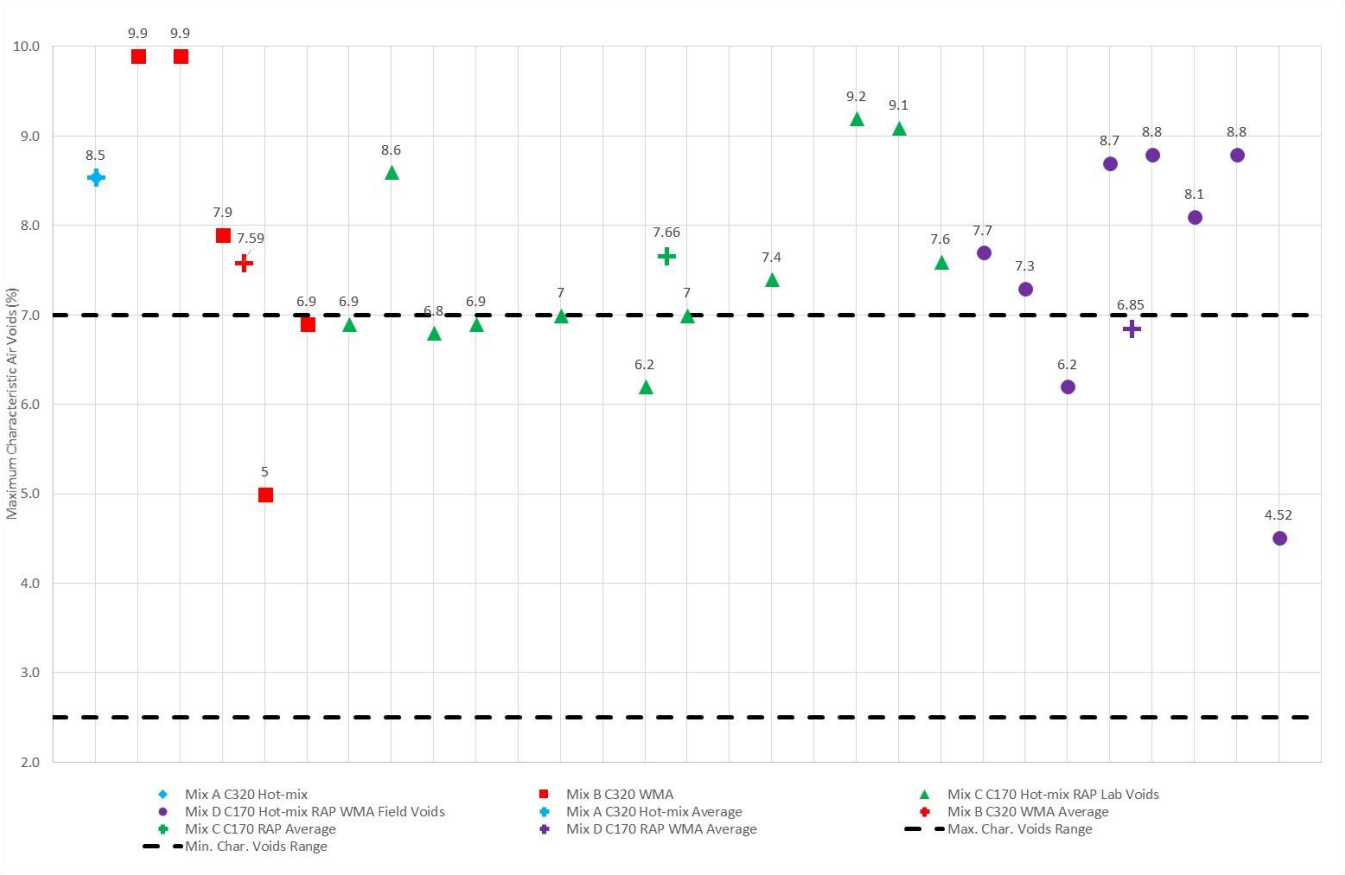

Figure 6.1 Maximum Characteristic Air Voids for the Various Asphalt Mixes Installed

The following table 6.8 was compiled to demonstrate the varying degrees of success for the various Fine AC10 mixes in satisfying the maximum characteristic air voids requirements of the DPTI specification.

Table 6.8 DPTI Specification Compliance

Mix Type	No. of sites	Percentage of sites achieving the required Max. Characteristic Air Voids
C320 Hot-mix	1	0%
C320 WMA	5	40%
C170 with RAP	11	55%
C170 with RAP and WMA	8	25%

6.4 Compaction and Auger Temperature

The temperature in the auger was plotted against the insitu air voids and the results are presented below in Figure 6.2

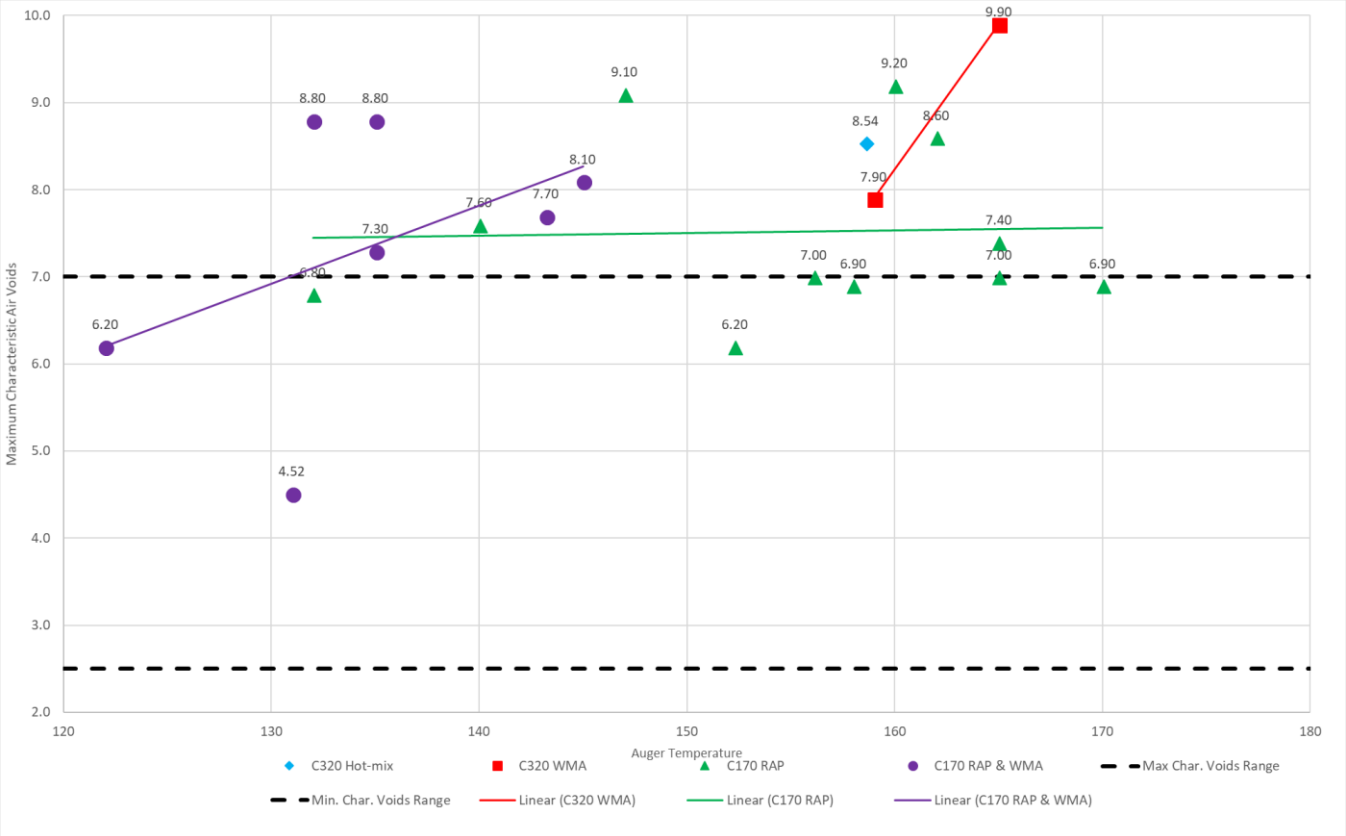

Figure 6.2 Auger Temperature Vs Maximum Characteristic Air Voids

From this data there is no discernible trend indicating that in-situ voids improve with the increase in temperature of the in asphalt mix at the auger.

6.5 Compaction and Ambient Temperature

The ambient temperature was plotted against the insitu air voids and the results are presented below in Figure 6.3.

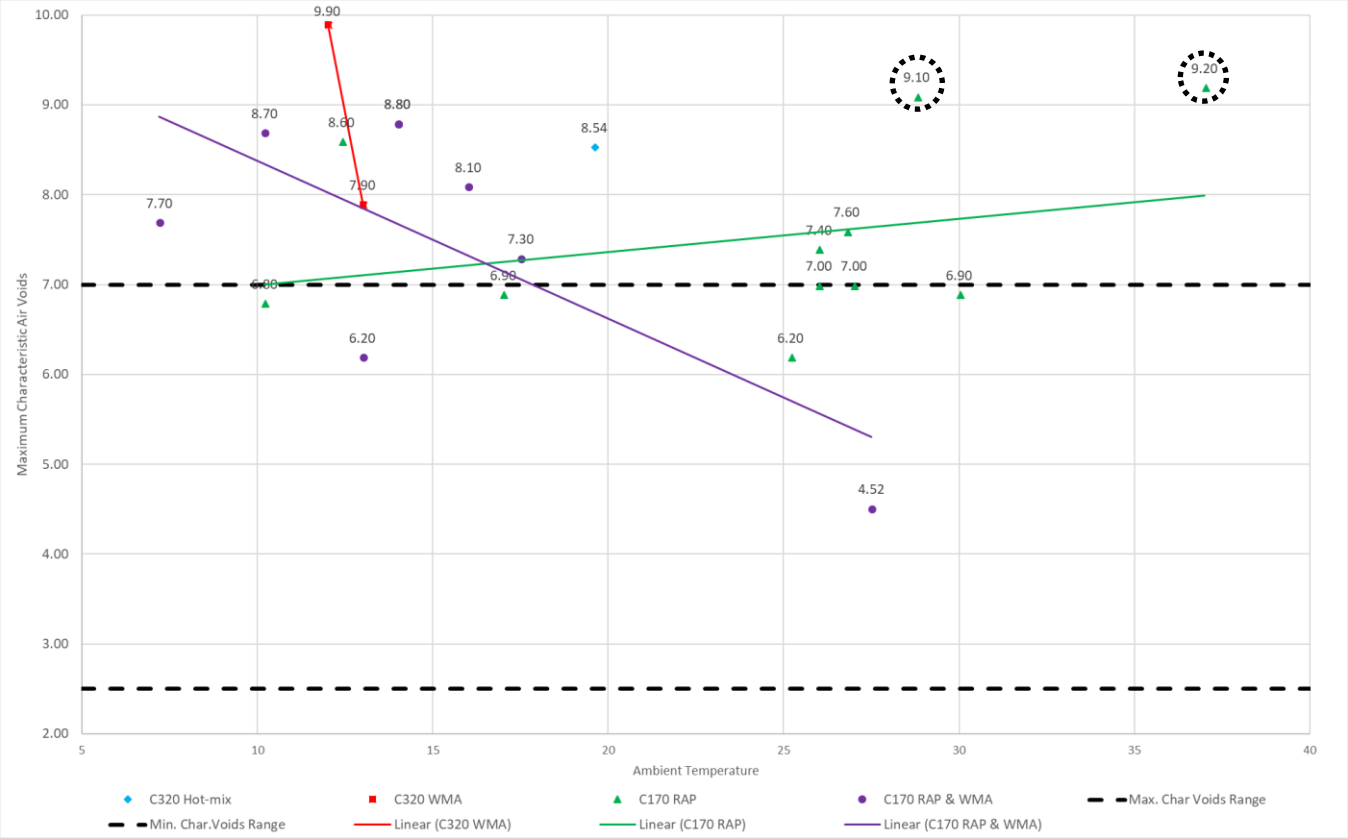

Figure 6.3 Ambient Temperature Vs Maximum Characteristic Air Voids

With reference to Figure 6.3, two data points associated with the C170 RAP mixture appear to influence the linear "line of best fit" for this data set. These two points have been circled and it was noted that these two sites did not achieve the compaction level required by the specification. Upon further interrogation of these two data samples, it became apparent that these two sites (installed during Stage 3: Summer Trials) had been installed with an ambient temperature above 25 degrees and also possessed a poor surface condition and high curvatures prior to undertaking the work. However, when isolating these two sites Douglas Road (9.2%) and Parawae Road (9.1%); there is a trend that the higher the ambient temperature the lower the field air voids for all mix types.

From this set of data ambient temperature alone is not the sole contributor to achieving low in-situ air voids as high in-situ air voids can occur at high ambient temperatures.

6.6 Compacted Asphalt Thickness

The average core depth for each site was plotted against the in-situ air voids and compiled in Figure 6.4 below.

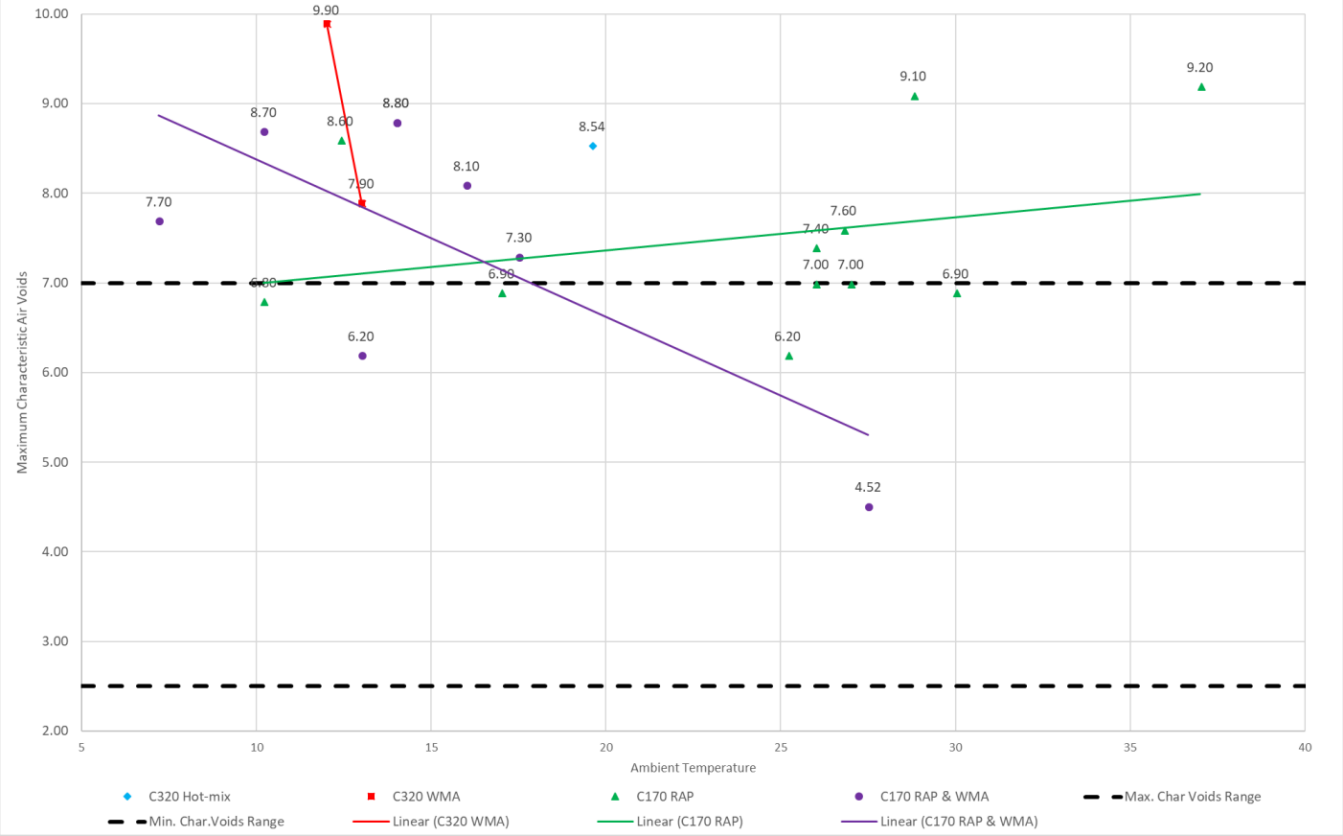

Figure 6.4 Average Core Depth Vs Maximum Characteristic Air Voids

From this data and sample size there is a slight relationship between depth and max characteristic air voids.

6.7 Overview of Conformance of Mixes

The data was assessed in relation to the DPTI Master Specification Part R27 and R28. As mentioned previously, 62% of the sites failed to satisfy the required maximum characteristic voids criteria.

During the third phase of the site trials, the protocol document requested the following requirements:

Table 6.9 Phase 3: Ambient and Auger Temperature Protocol Requirements

Winter Round of trials (August 2016 – November 2016)	Ambient Temperature Max. 25°C	Temperature of mix at Auger min 150°C
Summer round of trials (January 2017 – March 2017)	Min 25°C	Max 135°C

At least half of the asphalt mixes for the winter period of Phase 3 were installed with an auger temperature below 150°C. Also, the auger temperature for one site was not recorded. The summer phase of these asphalt trials only recorded one site achieving the required temperature at the auger being less than 135°C. In addition to this, the auger temperature for two sites was not recorded.

This shows that even with the best intentions of scheduling, the asphalt contractors found it difficult to comply with these specific protocol controls during Phase 3 of the trials.

Based on these circumstances, it is difficult to determine if ambient temperature and auger temperature act in combination to enhance or restrict the workability of the Fine AC10 mix.

6.8 Comparison between asphalt trials 2012 – 2013 to 2015 - 2017

To gain an appreciation of where the asphalt construction industry's confidence lies with respect to installing Fine AC10 asphalt, a simple comparison of the average air voids across the four pre-defined mix types have been compiled within Table 6.10.

Table 6.10 Comparison of Average Air Void – 2012 – 2013 Trials and 2015 – 2017

	Asphalt Trials 2012 – 2013		Asphalt Trials 2015 - 2017	
	Sample Size	Average Air Voids	Sample Size	Average Air Voids
Mix A C320 (Hot-mix)	11	6.64%	1	7.2%
Mix B C320 - WMA Additive	11	7.19%	5	6.66%
Mix C C170 – RAP (Hot-mix)	11	6.81%	11	6.61%
Mix D C170 - RAP and WMA Additive	11	7.43%	8	6.02%

Due to the large difference in sample size for Mix A and Mix B; it is not possible to confidently perceive if these two mixes have improved within the asphalt industry. However, with the sample sizes for Mix C and Mix D being relatively similar, the results in Table 6.10 indicate that the use of warm mix additives does lead to improved compaction on site when used with C170 binder.. This appears to show that since 2012 (the time of the previous asphalt trials), contractors have improved their understanding of how warm mix technology can be implemented both during production at the batching plant and installation on site.

7 Analysis and Discussion

The central aim of these low volume road asphalt trials was to compare a number of technical properties within the asphalt mixes to air voids and gain an understanding of the industry's current capability to place Fine AC10 to the specification – especially field voids.

However, the results from the trial sections indicate that the objective to compact the mixes to 2.5 - 7% characteristic air void was not achieved for a majority of the sections.

What follows is a discussion on some of the results from the Fine AC10 trials.

7.1 Air Voids vs Binder Content

One of the key interest areas in this study was to determine whether a higher binder content for the Fine AC10 asphalt mixes assists in achieving higher compaction (low air voids).

Figure 7.1 shows the binder content recorded during production plotted against the maximum characteristic air voids determined for cores taken from the sections. The results indicate a slight trend of decreasing air void content with increasing binder content for the Fine AC10 mix.

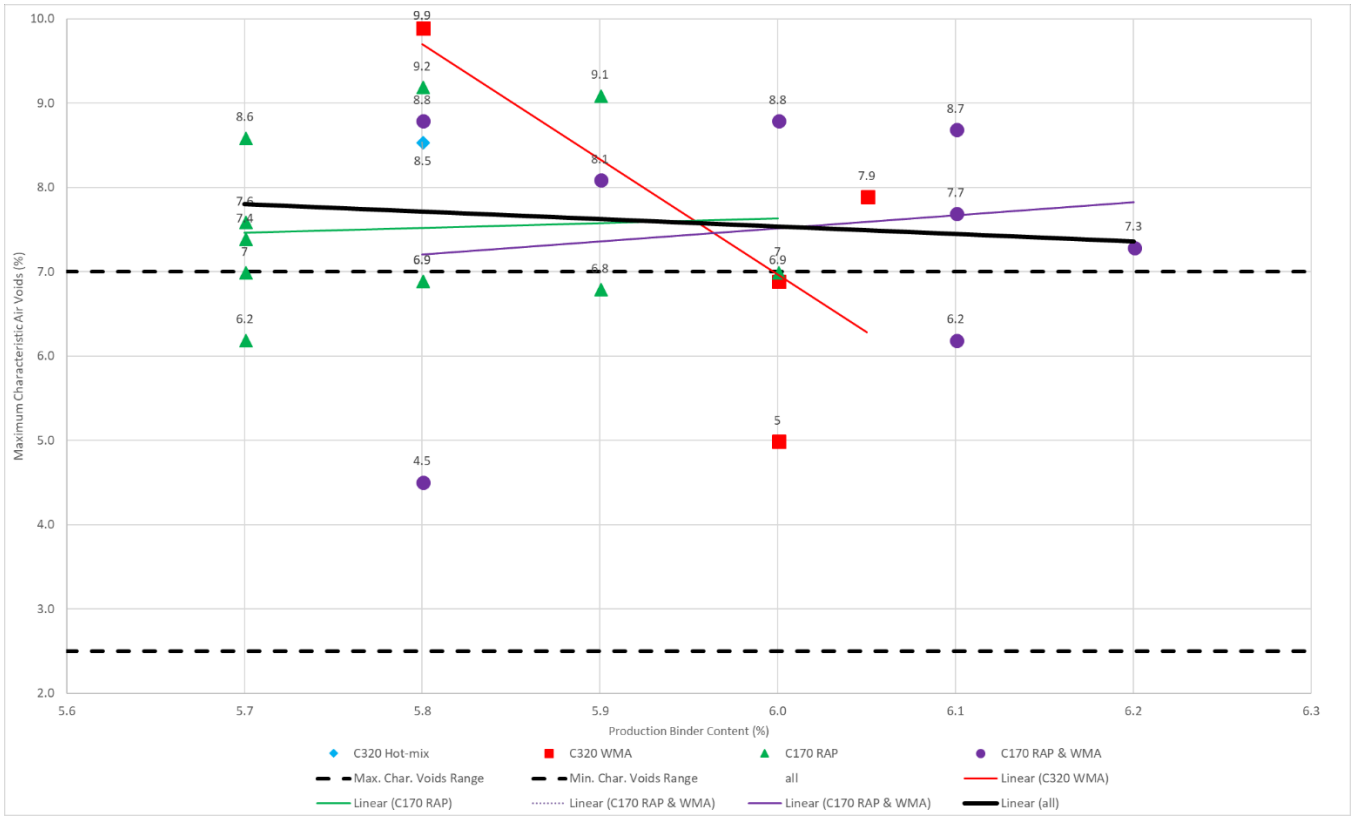

Figure 7.1 Production Binder Content % Vs Maximum Characteristic Air Voids %

These results indicate that increasing the binder content does assist in improved compaction; albeit not sufficiently on its own to merit to the field compaction requirements of the DPTI specification.

7.2 Air Voids vs Stiffness of Underlying Pavement

As a means to investigate whether the compaction of the surfacing mix could be affected by the stiffness of the underlying base, eleven Falling Weight Deflectometer (FWD) tests were conducted during phase 3 and prior to resurfacing. Understanding this aspect in further detail provided insight into the typical existing site conditions that industry contends with.

The mean of maximum deflection values (at the centre of the delfection bowl – D_0) were referenced as the parameter indicating stiffness of the pavement (e.g. a softer pavement will deflect more under the same load). The relationship between the aid voids and FWD deflection is illustrated in Figure 7.2 below.

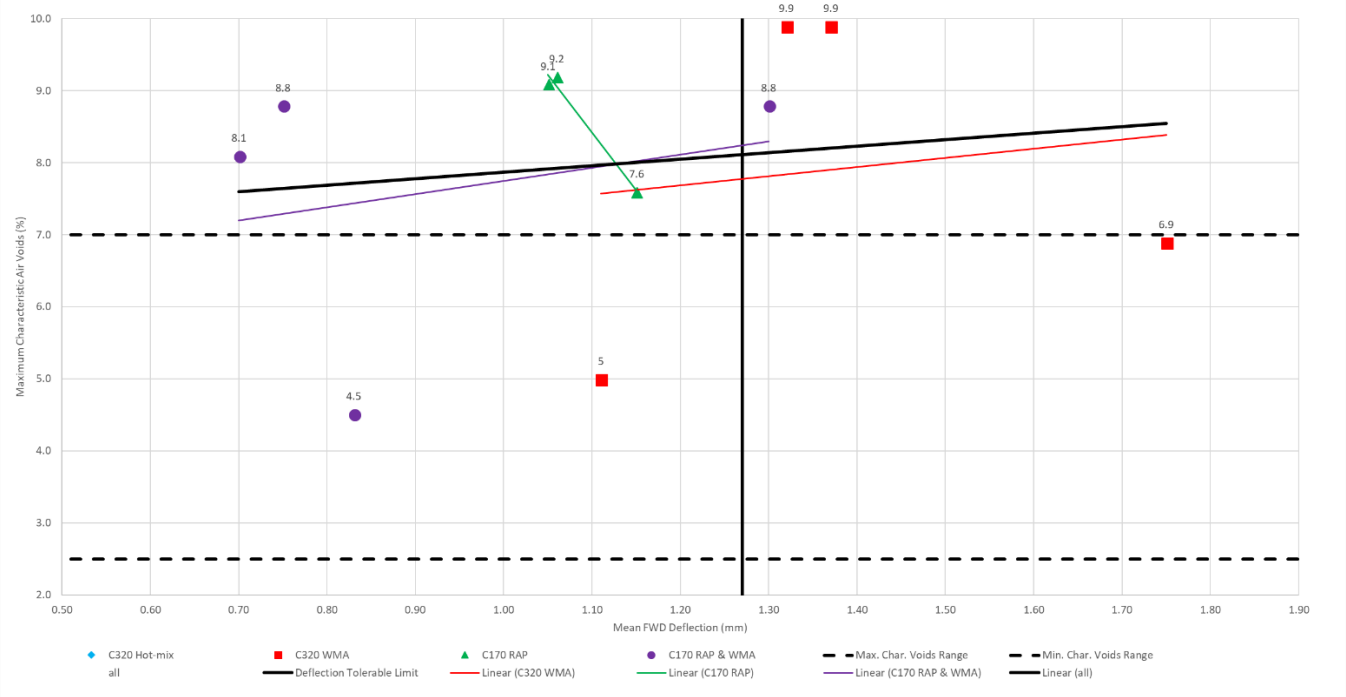

Figure 7.2 Mean FWD Deflection Vs Maximum Characteristic Air Voids %

Four sites exhibited a mean deflection beyond the tolerable limit of 1.27mm – based on a design traffic loading of 5 x 10^5 ESAs and three of these also possessed a characteristic curvature beyond the tolerable limit of 0.38mm – based on a 40mm asphalt overlay. However, the corresponding high characteristic voids for these sites were not significantly different from the other sites that presented acceptable deflection and characteristic curvature. While the sample size is small there is a slight trend, as you would expect, that the stiffer the pavement the easier it should be to achieve compaction, however the trend is not as strong as expected.

7.3 Field Air Void vs Binder Film Thickness

The binder film thickness for 27 of the 29 asphalt mixes produced and was measured in the laboratory and reported. The results are plotted against the laboratory air voids. The two sites not reporting the binder film thickness of the asphalt mix did achieve maximum characteristic air voids less than or equal to 7%.

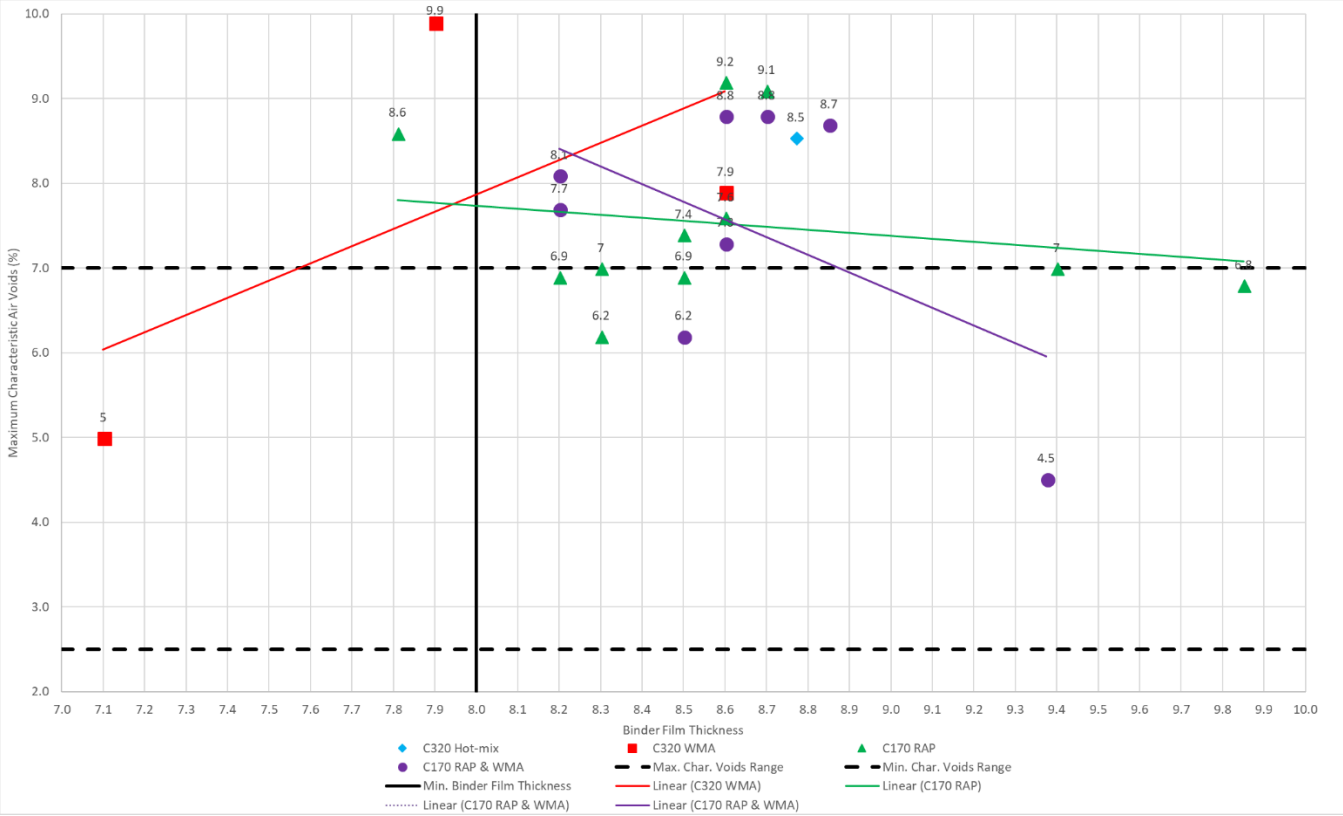

Figure 7.3 Binder Film Thickness Vs Maximum Characteristic Air Voids %

Part R27 of the DPTI specification requires a minimum thickness of 8µm; and from the data, it appears that a binder film thickness between 7.9 and 8.5 has more success with achieving the required maximum characteristic air voids than asphalt mixes possessing a binder film thickness beyond this range.

With the aid of plotting the linear trends for the three different sample sets of asphalt mixes, there does appear to be an inconsistency between the visual gradient of each line. It is generally accepted that increasing the binder film content would normally directly translate into achieving lower air voids. This indicates that other (or a combination of) factors are influencing the ability to achieve the maximum characteristic air voids below 7%.

7.4 Lab Air Voids vs Binder Film Thickness

Part R27 specified a target lab air void of 4% (± 1.5%)

The data labels highlighted with white text within black boxes correlate with nine Fine AC10 sites that satisfied the criteria for Maximum Characteristic Air Voids.

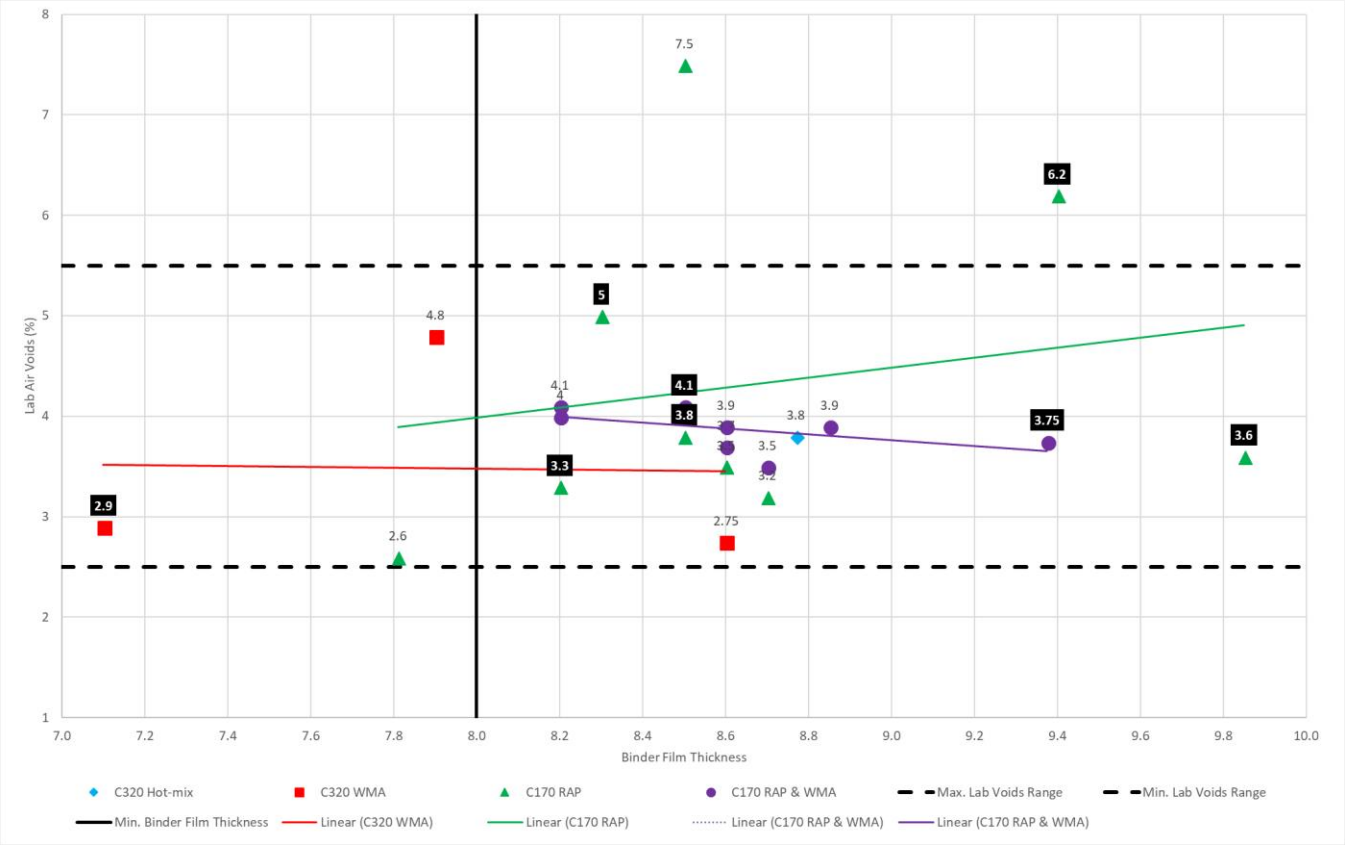

Figure 7.4 Binder Film Thickness Vs Lab Air Voids %

These data labels appear to be dispersed across the area of the graph with no obvious trends or clusters to draw conclusions with reasonable confidence.

Therefore, based on this data set, it is difficult to determine if there is a relationship between binder film thickness and lab air voids for finely graded asphalt.

7.5 Binder Film Thickness Vs Production Binder Content

The data labels highlighted with white text and black text boxes correlate with the nine sites that satisfied the criteria for Maximum Characteristic Air Voids.

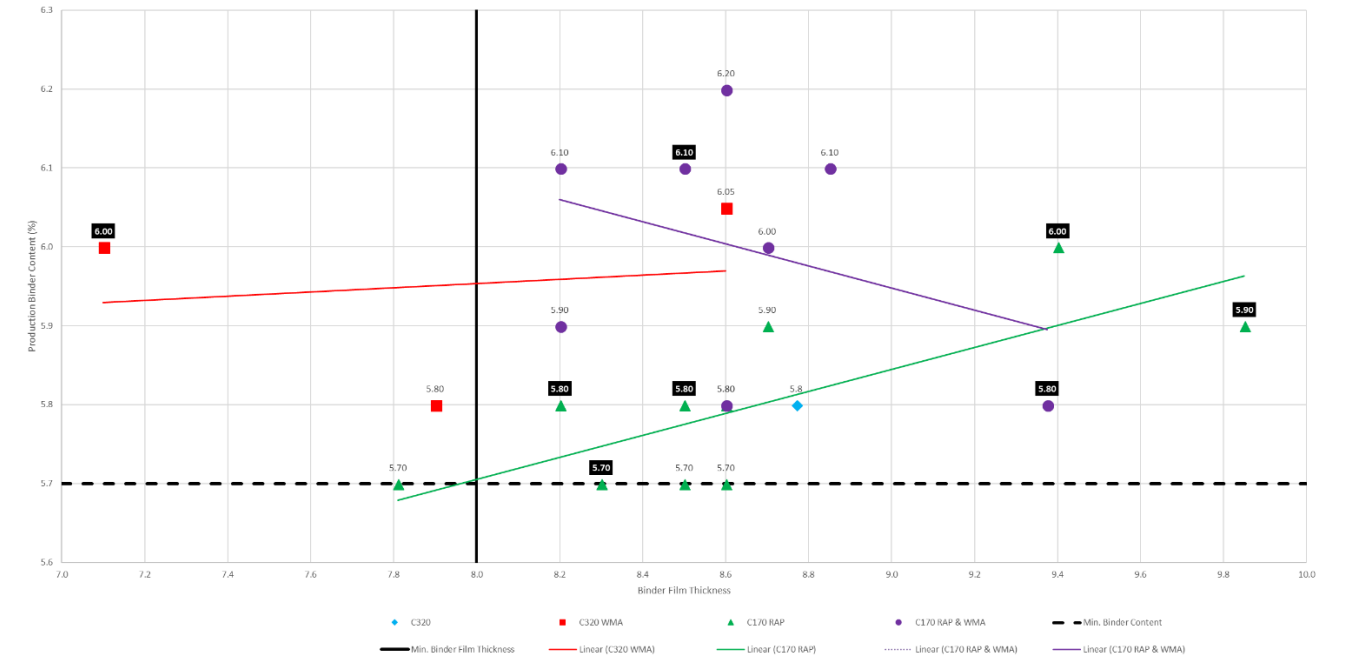

Figure 7.5 Binder Film Thickness Vs Production Binder Content %

Again, these data labels appear to be dispersed across the plot area with no obvious trends or clusters to draw conclusions with reasonable confidence.

From this data it is difficult to determine if there is a relationship between binder film thickness and lab air voids for finely graded asphalt.

7.6 Field Air Void Vs Lab Air Voids

Figure 7.16 shows the lab air voids recorded during production plotted against the maximum characteristic air voids determined for cores taken from the corresponding sites.

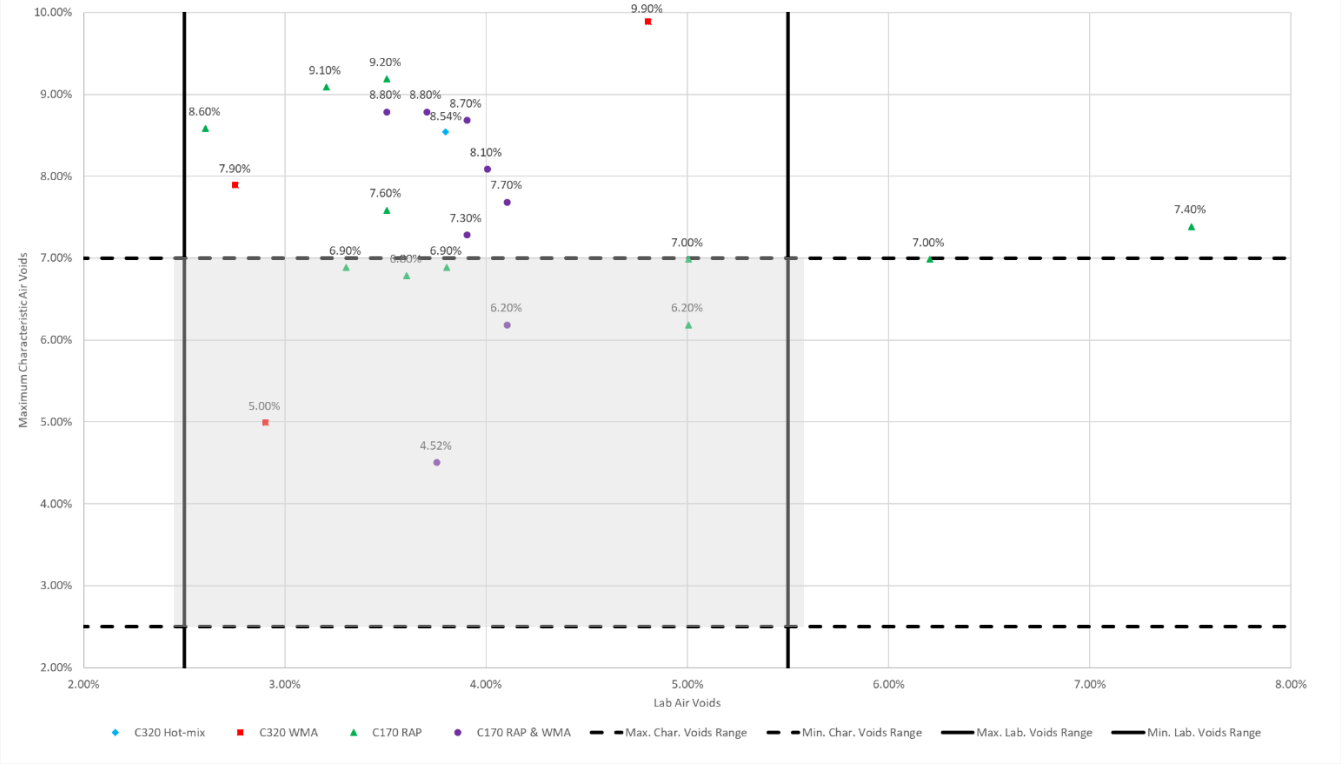

Figure 7.6 Lab Voids Vs Maximum Characteristic Voids

The majority of mixes are satisfying the laboratory air voids criteria set down by Part R27 of the DPTI Master Specification. However, this is not being directly reflected when it comes to the installation of the same mix on site, because all of the data points should be located within the grey shaded area of Figure 7.6 to comply with Part R27 of the DPTI Master Specification.

7.7 Wheel Track Testing

Results for Wheel Track Testing were limited due to three out of the four participating contractors required to utilise specialist laboratory equipment interstate.

However, two construction samples were tested and the results are compiled in the table below.

Table 7.1 Wheel Track Testing Results

	Average Rut Depth (mm)	Central Rut Depth (mm)
C320 Hot Mix	-	-
C320 WMA	3.7	-
C170 RAP	3.86	3.62
C 170 RAP & WMA		--

Samples were subject to an applied load of 700N and terminated at 10,000 passes in accordance with the DPTI testing regime.

These two results comply with the wheel tracking test requirements of the DPTI specification (Table R27(b) – Nominated Mixes) for an asphalt mix consisting of AC10M 320 (which includes RAP and WMA) where the acceptable range in 3mm to 6mm.

While only 3 results were provided through these trials, it demonstrates that the wheel track test results are well within the specification limits for medium duty asphalt mixes.

8 Discussion

The results from these trials provide a good indication of the asphalt products being delivered for metropolitan municipalities in South Australia.

While the sample data is relatively small, it is sufficient to help provide direction to Local Government and industry to work together with DPTI to find ways to improve the manufacturing and placement of asphalt for low volume roads.

The application of the recommendations of this report apply to light free flowing traffic with streets carrying less than 100 commercial vehicles per day with less than 5×10^5 ESA.

The key findings can be summarised as follows.

Deflection

While deflection did not appear to be a dominant factor for the roads in this trial, it remains something for consideration, particularly if more roads above 1.3 mm deflection are included in future trials.

Air Voids

The trial was established with the intent to achieve characteristic air voids within the specified range of 2.5% - 7%. The results of this trial indicates that the mixes produced and work practices have improved since the last asphalt trials conducted in 2012/2013. However, some refinement is required across the areas of asphalt mix design, production and construction in order to reduce field air voids to the specified target range. The results show the specification is not being met in 15 of the 25 sites (comprising of 4 sites over 9%, 6 over 8% and 5 over 7%).

Binder

The trial provides some confidence that the specification requirement of a 5.7% minimum binder content is generally being met.

Binder Type

While the selection of the C170 binder was the more obvious choice of Local Government during these trials; the potential benefits or limitations of C320 binder remains something for consideration.

Laboratory Air Voids

The trial used a range of laboratory air void to maximise compaction in the field. This report recommends investigating the potential for lowering laboratory air voids to 2-3% (50 cycles Gyproc AS 2891.2).

Grading

The potential to extend the bandwidth of grading for fine particles contained with fine asphalt mixes should be considered. While this may contradict the requirements of AS 2150 it would provide an avenue for asphalt Contractors to “showcase” their expertise in asphalt mix design.

Wheel Tracking

The small data sample of wheel track testing results compiled as part of these trials show results within the DPTI Master Specification requirements for medium duty asphalt mixes.

Warm Asphalt

Results for Fine AC10 mixes containing a Warm Mix Additive indicate that recent developments to this area of the specification is delivering improvements in field compaction compared to the previous asphalt trials undertaken from 2012 – 2013.

General

The protocol established by this project has the potential to be used for future trials.

The trial has also left open the opportunity for Local Government and Industry to continue with a coordinated approach to improve the level of testing and reporting and potentially share information.

It is anticipated further funding will be needed for further specification developments and the analysis of results for further trials.

The data set for these trials is small compared to the total number of roads resealed on an annual basis. If Council's were able to pool their testing results for finely graded asphalts it may introduce another avenue for the Local Government Sector to drive improvement within the industry. These results could then be compared with typical void values for conventional mixes in SA, which is not readily available at this stage.

There is also an opportunity for DPTI to review any data being collated from any other local research projects that may be made available.

The results of the trial indicate that Fine AC10 specification will need modification, however this trial does not provide sufficient definitive results to suggest where the specification needs to change. Therefore, consideration is needed for IPWEA-SA to approach contributing councils with a proposal to extend trials into the future to include mixes outside the bounds of this DPTI specification.

9 Technical Recommendations

1. For future trials the potential exists for 2-3% Laboratory air voids (50 cycles Gyropac – AS 2891.2.2) including a review of design properties with respect to gradings of mix designs to improve workability for low volume road asphalt. Guidance from DPTI should be provided to confirm a suitable tolerance for this parameter together with mandating the requirements for wheel track testing.
2. Local Government should conduct in-situ field air void testing as part of contracts to better understand the achievement of improved asset life and reduce instances on high in-situ air voids above 8%
3. A minimum binder content of 5.7% should be maintained.
4. Future trials should consider the benefit of incorporating wheel track testing within the protocol requirements of future asphalt trials to establish a sample set that can provide the potential to draw sound conclusions on the long term durability of the Fine AC10 mix.
5. DPTI is encouraged to provide commentary on the acceptance criteria (refer below suggestion) within the current specification for the maximum characteristic air voids of the Fine AC10 asphalt mix.
6. Local Government needs to consider how to manage non-conformances associated with the maximum characteristic voids criteria of the current DPTI Specification.
7. The implementation of future asphalt trials should investigate the incorporation of greater flexibility in the current specification/governing protocol and aim to achieve a sample set for varying mix types that is more uniform.
8. Sponsors of future trials should consider scope for continuation of a coordinated approach to funding this research.

10 Suggested commentary for DPTI R28 specification

"The report "FineAC10 trials in SA" dated September 2018 by DPTI/IPWEA and Tonkin Consulting (Reference 20150248FR3B) presents research findings of the insitu air voids of fine dense asphalt mixes suitable for light duty traffic.

The report presents the trials carried out by industry on insitu voids over three years.

The first year demonstrated the need for a minimum binder content of 5.7% and the need to increase the specification upper limit for insitu characteristic air voids from 6% to 7%. It was apparent that placing in winter conditions, the warm mix technology using C170 and Sasobit with 10-15% RAP and the higher binder content provided lower field air voids than fine hot bitumen mix with either C170 or 320. The average of the high characteristic field voids for both mix types remained over the specified limit of 7.

In subsequent summer condition's fine hotmix with C170 binder placed in all situations delivered the average of the high characteristic field voids below 7. No warm mix technology was placed in this period.

The next year it was demonstrated that warm mix technology placed on average temperatures above 147° C, with average ambient temperatures of 13° C, delivered poor results with the average of the high characteristic field voids approaching 9. These mixes were either C320 with Sasobit or C170 Foamed all with 20% RAP

The last year placed over summer included sites with depths less then 25mm and some poor pavement conditions using C170 Hot Bitumen 20% RAP and one site with C170 Warm mix Foamed with 20% RAP resulting in the average of the high characteristic field voids just over 7.5.

It is noted that the 7% upper characteristic air voids can be achieved however not in all situations. Specifiers and asset owners need to consider the following when enforcing the high characteristic field void requirement on existing roads resurfacings, which may inhibit achieving specified high characteristic field voids:

- Weak pavements
- Variable pavement conditions
- Variable thicknesses of mixes placed
- Ambient temperatures below 25 degree
- Hand work
- Binder type, C170 may be more compactable
- Lack of preparation work prior to surfacing which does not address or remove weak pavement sections
- Selection of Warm mix additive and placing temperature may need to be higher when placed below ambient temperatures of 25-degree C

The 7% upper characteristic limit is still where industry should remain below if at all possible.

11 References

Ellis, R., Denneman, E, Van Loon, H, 2014. Low Volume Road Asphalt Trial in SA, Tonkin Consulting Report 20120799DR2F

DPTI Specification Part R27: Supply of Asphalt

DPTI Specification Part R28: Construction of Asphalt Pavements

AS 2150: 2005, Hot mix asphalt – a guide to good practice, Standards Australia, Sydney, NSW.

APRG Technical Note 4, Austroads Pavement Research Group, ARRB Transport Research.

Linden, R.N.; Mahoney, J.P. and Jackson, N.C, 1989. Effect of compaction on asphalt concrete performance. Transportation Research Record 1217, Transportation Research Board, Washington, D.C.

McLeod, N.W. 1967. Influence of Viscosity of Asphalt-Cements on Compaction of Paving Mixtures in the Field." Highway Research Record No. 158: Highway Research Board, National Research Council, Washington, D.C.

Oliver, J.W.H., 1992. A long life asphalt mix for lightly trafficked streets: results after 10 years. ARR 228, Australian Road Research Board, Vermont South, VIC.

Appendix A

Trials Protocol Document

FineAC10 -Trials

Protocol for the Establishment of Road Trial Sections

IPWEA (SA)

March 2015

Ref No. 20150248DR1B

Rod Ellis (Tonkin Consulting)

Erik Denneman (ARRB)

South Australia
IPWEA
INSTITUTE OF PUBLIC WORKS ENGINEERING AUSTRALASIA

arrb GROUP

Tonkin CONSULTING
a better approach

Document History and Status

Rev	Description	Author	Reviewed	Approved	Date
A	Draft for reference group review	RKE	RKE	RKE	16 March 2015
B	Revised draft after reference group review	RKE	RKE	RKE	31 March 2015

Acknowledgements

This project is co-funded by the following organisations:

- City of Salisbury
- West Torrens City Council
- City of Mitcham
- City of Playford
- City of Port Adelaide Enfield
- Corporation of the City of Marion
- Corporation of the City of Adelaide
- City of Unley
- Light Regional Council
- City of Prospect

Contents

Acknowledgements

1 Background 1

2 Selecting an Appropriate Trial Site 2

3 Mix Designs 3

4 Production 5

5 Construction 6

6 Monitoring 7

Tables

Table 3.1 Fine Graded Mixes Grading Envelope 3

Appendices

Appendix A Trial Site Condition Form
Appendix B Mix Design Report Form
Appendix C Asphalt Production Report
Appendix D Construction Record Form

1 Background

In 2013 asphalt trials were undertaken as part of the LGA Research and Development project. As a result of this project the following documents were key outcome of the trials:

- Final Report - LGA Research and Development – Low Volume Road Asphalt Trial in SA -27 March 2014 (Ref -20120799DR2F)
- Part 227 Supply of Asphalt – May 2014
- Part 228 Construction of Asphalt Pavement - May 2014

Within Part 227 and 228 there exists a new specification suitable for low volume roads, namely "Fine Dense Mix Asphalt". For trials the 10mm (Fine AC10) is proposed.

Further funding has been secured from the contributing Councils to place Fine AC10 and to determine if the target air voids in Part 228 are practically achievable.

The aim of the low volume road trial project is to evaluate asphalt mixes that are specifically intended for use on residential streets carrying limited numbers of heavy vehicles. These mixes are designed to yield a longer life, to be more environmentally sustainable and to minimise whole-of-life cost. The mixes would also be suitable for use in pedestrian areas and for maintenance patching.

The technical characteristics of the asphalt designs include: a fine, dense graded aggregate distribution in combination with a high binder content. The aim is to create mixes that are easy to compact, this is to remedy the rapid cooling that takes place when mixes are constructed in thin layers and the influence of other compaction challenges such as stiffness of underlying pavement, irregular shape of underlying pavement, access for full size paving and compaction equipment. Mixes will be constructed to a low insitu air voids content. This will reduce the permeability of the mixes, which helps to protect the underlying granular layers and limits oxidation aging of the binder. The high flexibility of the mixes will accommodate the relatively high deflections in residential street pavements.

Some of the trial mix designs may include Reclaimed Asphalt Pavement (RAP) to increase environmental sustainability and reduce cost.

Some of the trial mix designs may include warm mix asphalt additives to further improve compactability of the mixes and increase environmental sustainability.

Some of the trial mix designs may include a softer grade bitumen (Class 170), to improve compactability durability and flexibility of the material.

This document is intended for use by local governments as guidance in selecting the mix designs for trials and for establishing trial sites.

The outcomes of the trials will guide specification development in collaboration with DPTI.

2 Selecting an Appropriate Trial Site

The trial site should be an urban street carrying traffic that falls within the lowest category of Table A 2 of the Austroads 'Guide to Pavement Technology Part 4B: Asphalt', i.e.:

- A street that carries less than 100 commercial vehicles per lane per day.
- The structural design level for the street should be less than 5 x 10^5 ESAs.
- Light free flowing traffic.

For the purpose of the trial a street should be selected that does not include steep inclines or busy intersections.

The intention is to trial a typical street in a Council's works program. There will be no need the place multiple mix combinations of C320 or C170 and RAP and/or warm asphalt rather simply note the mix used for the entire street. It is encouraged that Council use any combination of these mix options rather than settling for traditional C320 hot asphalt.

The following information on the condition of the trial site and the nature of the proposed works should be gathered:

- The reason why the road or street is being resurfaced.
- A visual condition survey of the road, including photo register should be developed.
- A record of a visual inspection of the site describing any defects and the location (chainage) of the defects.
- The extent of the preparation works carried out before the trial is installed (e.g. patches and crack sealing).
- Describe the proposed profiling treatment and any potential for bond breakage between existing layers.
- A recent traffic count, differentiating commercial vehicles, should be available for the trial section.
- Ideally, a Falling Weight Deflectometer (FWD) survey of the section would be performed before the trial mix is installed. A testing pattern of one FWD measurement every 20m of trial section length is recommended.

The Council is required to complete Form 1 – Trial Site Condition form in Appendix A and as part of the trial Tonkin Consulting will complete the site condition assessment and photo records.

3 Mix Designs

The intention is that a mix design record is kept for aggregate grading and binder content. The mixes will be either C320 or C170 binder with or without RAP/Warm Asphalt. The industry is keen to continue to explore WMA and RAP so we encourage Councils to trial these options with the Fine AC10 mix specification.

As part of the preparation for the low volume road asphalt trials, adjusted versions of DPTI specifications Part 227: Supply of Asphalt May 2014 and Part 228: Construction of Asphalt Pavements May 2014 are to be used and are available on DPTI website below:

http://www.dpti.sa.gov.au/contractor_documents/specifications_-_division_2_roadworks

The asphalt materials for the trial sections should comply with these specifications. A summary of the mix design method for fine dense graded mixes for low volume roads in the specifications is provided below. This summary is intended as a guideline only, the mix designs and material should comply with all relevant requirements in Part 227 and Part 228, with the following exceptions:

- For the purpose of the trial, the inclusion of hydrated lime as a filler is allowed, but is not a requirement.
- For the purpose of the trial, the inclusion of 20% RAP is allowed.

The fine graded mixes for the trial shall have a nominal maximum particle size of 10mm, the grading envelope is provided in Table 3.1 (which is based on Part 227).

Table 3.1 Fine Graded Mixes Grading Envelope

SIEVE (mm)	MIX GRADING ENVELOPES OF FINE DENSE MIX ASPHALT [1] FineAC10	
19		
13.2		100
9.5	100	90
6.7	90	75
4.75	77	63
2.36	56	43
1.18	41	30
0.6	29	20
0.3	20	13
0.15	13	8
0.075	8	5

[1] Aggregate gradings with percentage passing sieve size (mm), in accordance with AS 1152.

The recommended mix design procedure consists of determining optimum binder content based on a 50 gyratory cycles compactive effort, targeting 4.0% air voids in the laboratory, within the tolerance of 3.0-5.5%.

The objective of the design is to produce a mix that can be more readily compacted to 3.0 to 7% air voids in the field, preferably below 5%. The minimum binder content is 5.7% and the laboratory air voids and binder film thickness are reporting requirements rather than specified to allow the Contractor to showcase their mix designs to meet field requirements. This may include going higher with the binder content than the minimum for the trial to help inform the wider industry on what binder content provides the optimum results in the field and take on board the learning's from the previous trial where the filler content appeared to be an important factor best measured through Filler/Binder ratio.

For the mix design selected for the trial, the following is to be reported on Form 2:

- Binder type.
- WMA type.
- Combined aggregate grading.
- Target Binder content.
- Hydrated lime content (if used).
- Laboratory air voids at 150°C.
- Laboratory air void at proposed laying temperature for warm asphalt.
- RAP %.
- When RAP is used the following additional information is to be provided:
  - Combined grading after inclusion of RAP.
  - RAP grading.
  - RAP Binder content.
  - Source of RAP.

The contractor is requested to complete Form 2 - Mix Design Report (Refer Appendix B).

4 Production

The contractor is required to provide asphalt production records for the actual mix placed at the trial site, which include the following:

- Binder type.
- Warm mix additive.
- Bulk density and air voids content 50 gyrations, and optionally at 10,20,30,40 gyrations if equipment allows for this
- Maximum density (t/m^3).
- Air voids content after 50 gyrations.
- Temperature record for lab air void.
- Binder filler thickness (um).
- Filler Binder ratio.
- Indirect Tensile strength (MPa).
- RAP content %.
- Production Binder content.

In addition the contractor shall provide:

- Combined Grading (including RAP if used).
- RAP Grading (if RAP is used).
- RAP Binder content %.
- RAP Rejuvenator content %.
- RAP source.

The Contractor is required to complete Form 3 – Mix Production Report Form (Refer Appendix C).

5 Construction

The target for compaction of the trial mixes in the field should be to achieve an air void content of 3.0% to 7.0%.

For each batch of mix produced for the trial retain 40kg of plant produced sample in tins for future performance testing.

The following should be recorded during the trial:

- Ambient air temperature.
- Temperature of existing surface prior to AC placement.
- Temperature of the mix at the auger for each truck load of material.
- Temperature of the asphalt mat prior to compaction.
- Type of compaction equipment, weight, number of rollers, whether vibratory or static rolling was used, rolling pattern (incl. number of passes).
- Perception whether the mix is easy to compact.
- Any delays during paving.
- Any signs of segregation, excess fines or excess binder.
- Any deficiencies, e.g. open construction joints.
- Visual condition, photos of the finished surface.

The Contractors are required to complete Form 4a and 4b – Construction Record form in Appendix D.

6 Monitoring

One day after construction, a minimum of four cores should be taken from each road section in accordance with Table 8(b) in Part 228.

The cores should also be tested for permeability. The testing for field compaction is randomly selected in accordance with requirements of Part 228 and production binder content for the mix placed needs to be recorded.

A visual assessment of the final product with be undertaken by representatives of the reference group for the Project.

Appendix A

Trial Site Condition Form

Low volume road asphalt trial
Form 1 - Trial site condition form

Site description

Name:			Date:	
Location of the site:				
Traffic	Light vehicles per lane per day:		Percentage commercial vehicles:	
Reason(s) for road being resurfaced:				
Age of existing surfacing				
Extent of preparation works carried out (e.g. patches, crack sealing)				
Describe profiling treatment and potential for debonding				
FWD survey conducted?	yes	no		
Provide situation sketch of site and proposed location of different mixes (refer Figure 1 of protocol)				

Low volume road asphalt trial
Form 1 - Trial site condition form

Visual assessment

Rate the condition of the existing surfacing at the trial site. Develop a photo register of the observed distresses and the overall condition of the section Rank the degree and extent of different distress types on a scale of 0 to 5, using the following guideline:

Degree = 1: slight distress, hardly visible Degree = 5: severe distress

Extent = 1: isolated occurrence Extent = 5: extensive occurrence over a most of the section

Use degree = 0 and extent = 0 in case the distress type does not occur at the section

Distress type	Degree	Extent
Longitudinal cracks		
Transverse cracks		
Crocodile cracks		
Surfacing defects (potholes)		
Bleeding/Flushing		
Pumping of fines		
Rutting		
Undulation (differential settlement)		
Patching		
Services trenching		
Drainage problems		
Location sketch of distresses, if relatively isolated:		

Presence of trees at site (please tick)

	exclusive		average		isolated		No trees

Appendix B

Mix Design Report Form

Low volume road asphalt trial
Form 2 - Mix design report form

Mix design for trial at:		Date:	

Combined grading

Sieve size [mm]	Percent passing
19	
13.2	
9.5	
6.7	
4.75	
2.36	
1.18	
0.6	
0.3	
0.15	
0.075	

Target Binder content	[%]

Hydrated lime content (not a requirement)	[%]

Low volume road asphalt trial
Form 2 - Mix design report form

Properties of the mix design

Binder type (C170,C320)	
Warm mix additive (type)	
Bulk density (50 gyrations) [t/m^3] (AS2891.9.2)	
Maximum density [t/m^3] (AS2891.7.1)	
Air void content after 50 gyrations [%] (AS2891.8) *	
Temperature record for lab air voids (°C)	
Binder film thickness [µm]	
Filler/Binder ratio	
Indirect tensile strength [MPa] TP 460	
RAP content [%]	
Bulk density (40 gyrations) (optional) [t/m^3] (AS2891.9.2)	
Bulk density (30 gyrations) (optional) [t/m^3] (AS2891.9.2)	
Bulk density (20 gyrations) (optional) [t/m^3] (AS2891.9.2)	
Bulk density (10 gyrations) (optional) [t/m^3] (AS2891.9.2)	

* Note: Laboratory air voids at 150°C for a standard mix and at proposed laying temperature for warm asphalt.

Low volume road asphalt trial
Form 2 - Mix design report form

Combined grading after inclusion of RAP

Sieve size [mm]	Percent passing
19	
13.2	
9.5	
6.7	
4.75	
2.36	
1.18	
0.6	
0.3	
0.15	
0.075	

Low volume road asphalt trial
Form 2 - Mix design report form

RAP grading

Sieve size [mm]	Percent passing
19	
13.2	
9.5	
6.7	
4.75	
2.36	
1.18	
0.6	
0.3	
0.15	
0.075	

RAP Binder content	[%]

Source of RAP (please tick)

	Plant waste (1)		Reclaimed from road (2)		Combined (1+2)		Unknown

Appendix C

Asphalt Production Report

Low volume road asphalt trial
Form 3 - Asphalt Production Form

Mix design for trial at:		Date:	

Properties of the mix production

Binder type (C170,C320)	
Warm mix additive (type)	
Bulk density (50 gyrations) [t/m^3] (AS2891.9.2)	
Maximum density [t/m^3] (AS2891.7.1)	
Air void content after 50 gyrations [%] (AS2891.8) *	
Production Binder Content [%]	
Temperature record for lab air voids (°C)	
Binder film thickness [µm]	
Filler/Binder ratio	
Indirect tensile strength [MPa] TP 460	
RAP content [%]	
Bulk density (40 gyrations) (optional) [t/m^3] (AS2891.9.2)	
Bulk density (30 gyrations) (optional) [t/m^3] (AS2891.9.2)	
Bulk density (20 gyrations) (optional) [t/m^3] (AS2891.9.2)	
Bulk density (10 gyrations) (optional) [t/m^3] (AS2891.9.2)	

* Note: Laboratory air voids at 150°C for a standard mix and at proposed laying temperature for warm asphalt.

Low volume road asphalt trial
Form 3 - Asphalt Production Form

Combined grading

Sieve size [mm]	Percent passing
19	
13.2	
9.5	
6.7	
4.75	
2.36	
1.18	
0.6	
0.3	
0.15	
0.075	

Low volume road asphalt trial
Form 3 - Asphalt Production Form

IF RAP used complete these pages.

Combined grading after inclusion of RAP

Sieve size [mm]	Percent passing
19	
13.2	
9.5	
6.7	
4.75	
2.36	
1.18	
0.6	
0.3	
0.15	
0.075	

Low volume road asphalt trial
Form 3 - Asphalt Production Form

RAP grading

Sieve size [mm]	Percent passing
19	
13.2	
9.5	
6.7	
4.75	
2.36	
1.18	
0.6	
0.3	
0.15	
0.075	

RAP Binder content	[%]

Source of RAP (please tick)

	Plant waste (1)		Reclaimed from road (2)		Combined (1+2)		Unknown

Appendix D

Construction Record Form

Low volume road asphalt trial
Form 4a - Construction record

Construction record for trial at:		Date:	

Target level of compaction: 3.0 – 7.0 % air voids

Was 40 kg of plant produced sample retained in tins for every mix type?	Yes	No

Constructed Asphalt Thickness (mm)	
Ambient air temperature [°C]	
Surface temperature prior to AC placement [°C]	
Temperature of mix at auger [°C]	
Temperature of mat prior to compaction [°C]	

Type of compaction equipment	
Weight	
Number of rollers	
Vibration / static	
Rolling pattern (incl. number of passes and vibration setting)	
Was the mix easy to compact? (Easy, Average, Difficult)	
Detail delays during paving	

Low volume road asphalt trial
Form 4a - Construction record

Details and location of any segregation, excess fines, excess binder	
Describe any deficiencies (e.g. open joints)	
Describe visual condition of finished pavement, develop photo record	
Comments	

Low volume road asphalt trial
Form 4b - Field Compaction

Construction record for trial at:		Date:	

Monitoring

A minimum of four cores per mix are to be taken for density determination. For each mix cores should be taken from the middle third of the paved section shall be the arithmetic mean of the five most recent test results for that mix as per DPTI specification Part 228. :

Maximum density

Mean maximum density [t/m^3] (AS2891.7.1)	

Production Binder Content

Actual Binder content of mix placed (%) [t/m^3] (AS2891.7.1)	

Bulk density

	Core 1	Core 2	Core 3	Core 4	
Bulk density [t/m^3] (AS2891.9.2)					
Air void content (AS2891.8) [%]					
Core Height (mm)					

Mean air void content [%]	
Standard deviation [%]	
K (DPTI Part 228, Table 9.20)	
Low characteristic value of air voids content (Lvc) [%]	
High characteristic value of air voids content (Hvc) [%]	

FineAC10 -Trials

Protocol for the Establishment of Road Trial Sections Summer 2015/2016

IPWEA (SA)

January 2016

Ref No. 20150248DR1D

Rod Ellis (Tonkin Consulting)

Erik Denneman (ARRB)

South Australia
IPWEA
INSTITUTE OF PUBLIC WORKS ENGINEERING AUSTRALASIA

arrb GROUP

Tonkin CONSULTING

a better approach

Document History and Status

Rev	Description	Author	Reviewed	Approved	Date
A	Draft for reference group review	RKE	RKE	RKE	16 March 2015
B	Revised draft after reference group review	RKE	RKE	RKE	31 March 2015
C	Revised protocol for summer 2015/2016 trial	RKE	RKE	RKE	19 November 2015
D	Updated with Reference group feedback	RKE	ED/KD/ HVL	RKE	12 January 2016

Acknowledgements

This project is co-funded by the following organisations:

- City of Salisbury
- West Torrens City Council
- City of Mitcham
- City of Playford
- City of Port Adelaide Enfield
- Corporation of the City of Marion
- Corporation of the City of Adelaide
- City of Unley
- Light Regional Council
- City of Prospect

Contents

Acknowledgements

1 Background 1

2 Selecting an Appropriate Trial Site 3

3 Mix Designs 4

4 Production 6

5 Construction 7

6 Monitoring 8

Tables

Table 3.1 Fine Graded Mixes Grading Envelope 4

Appendices

Appendix A Trial Site Condition Form
Appendix B Mix Design Report Form
Appendix C Asphalt Production Report
Appendix D Construction Record Form

1 Background

In 2013 asphalt trials were undertaken as part of the LGA Research and Development project. As a result of this project the following documents were key outcome of the trials:

- Final Report - LGA Research and Development – Low Volume Road Asphalt Trial in SA -27 March 2014 (Ref -20120799DR2F)
- Part R27 Supply of Asphalt – July 2015
- Part R28 Construction of Asphalt Pavement - July 2015

Within Part R27 and R28 there exists a new specification suitable for low volume roads, namely "Fine Dense Mix Asphalt". For trials the 10mm (Fine AC10) is proposed.

Further funding has been secured from the contributing Councils to place Fine AC10 and to determine if the target air voids in Part R28 are practically achievable.

The aim of the low volume road trial project is to evaluate asphalt mixes that are specifically intended for use on residential streets carrying limited numbers of heavy vehicles. These mixes are designed to yield a longer life, to be more environmentally sustainable and to minimise whole-of-life cost. The mixes would also be suitable for use in pedestrian areas and for maintenance patching.

The technical characteristics of the asphalt designs include: a fine, dense graded aggregate distribution in combination with a high binder content. The aim is to create mixes that are easy to compact, this is to remedy the rapid cooling that takes place when mixes are constructed in thin layers and the influence of other compaction challenges such as stiffness of underlying pavement, irregular shape of underlying pavement, access for full size paving and compaction equipment. Mixes will be constructed to a low insitu air voids content. This will reduce the permeability of the mixes, which helps to protect the underlying granular layers and limits oxidation aging of the binder. The high flexibility of the mixes will accommodate the relatively high deflections in residential street pavements.

Some of the trial mix designs may include Reclaimed Asphalt Pavement (RAP) to increase environmental sustainability and reduce cost.

Some of the trial mix designs may include warm mix asphalt additives to further improve compactability of the mixes and increase environmental sustainability.

Some of the trial mix designs may include a softer grade bitumen (Class 170), to improve compactability durability and flexibility of the material.

This document is intended for use by local governments as guidance in selecting the mix designs for trials and for establishing trial sites.

The outcomes of the trials will guide specification development in collaboration with DPTI.

In April-June 2015 8 trial sites were placed in accordance with Protocol reference 20150248DR1B. Upon review of results it was evident the field void upper limit of 6% specified in R28 was not met. Accordingly a review of the protocol was required in order to direct the remaining 7 trial sites.

The findings so far put into question the following:

a) Will results improve in summer conditions i.e. ambient temp over 25°C

b) Is the cost of the higher binder of FineAC10 mix providing a tangible benefit over and above local government mixes on the market with lower binder content

c) In order to provide mixes consistently below 6% air voids in the field does the grading envelope need to be amended.

d) Does the inclusion of warm mix asphalt additives result in measurable benefits in terms of reduced mix production temperature and/or improved density achieved in the field?

2 Selecting an Appropriate Trial Site

The trial site should be an urban street carrying traffic that falls within the lowest category of Table A 2 of the Austroads 'Guide to Pavement Technology Part 4B: Asphalt', i.e.:

- A street that carries less than 100 commercial vehicles per lane per day.
- The structural design level for the street should be less than 5 x 10^5 ESAs.
- Light free flowing traffic.

For the purpose of the trial a street should be selected that does not include steep inclines or busy intersections.

The intention is to trial a typical street in a Council's works program. It is encouraged that Council use any combination of these mix options rather than settling for traditional C320 hot asphalt.

Two trial sections are to be placed on the same street either half each end or half LHS and RHS and a minimum 100m length.

a) Fine AC10 mix

b) Local government mix (contractor choice).

Both mixes are to be identical in terms of binder type, RAP and WMA additives if any.

The following information on the condition of the trial site and the nature of the proposed works should be gathered:

- The reason why the road or street is being resurfaced.
- A visual condition survey of the road, including photo register should be developed.
- A record of a visual inspection of the site describing any defects and the location (chainage) of the defects.
- The extent of the preparation works carried out before the trial is installed (e.g. patches and crack sealing).
- Describe the proposed profiling treatment and any potential for bond breakage between existing layers.
- A recent traffic count, differentiating commercial vehicles, should be available for the trial section.
- Ideally, a Falling Weight Deflectometer (FWD) survey of the section would be performed before the trial mix is installed. A testing pattern of one FWD measurement every 20m of trial section length is recommended.

The Council is required to complete Form 1 – Trial Site Condition form in Appendix A and as part of the trial Tonkin Consulting will complete the site condition assessment and photo records.

3 Mix Designs

3.1 Fine AC10

The intention is that a mix design record is kept for aggregate grading and binder content. The mixes will be either C320 or C170 binder with or without RAP/Warm Asphalt. The industry is keen to continue to explore WMA and RAP so we encourage Councils to trial these options with the Fine AC10 mix specification.

As part of the preparation for the low volume road asphalt trials, adjusted versions of DPTI specifications Part R27: Supply of Asphalt July 2015 and Part R28: Construction of Asphalt Pavements July 2015 are to be used and are available on DPTI website below:

http://www.dpti.sa.gov.au/contractor_documents/specifications_-_division_2_roadworks

The asphalt materials for the trial sections should comply with these specifications. A summary of the mix design method for fine dense graded mixes for low volume roads in the specifications is provided below. This summary is intended as a guideline only, the mix designs and material should comply with all relevant requirements in Part R27 and Part R28, with the following exceptions:

- For the purpose of the trial, the inclusion of hydrated lime as a filler is allowed, but is not a requirement.
- For the purpose of the trial, the inclusion of 20% RAP is allowed.

The fine graded mixes for the trial shall have a nominal maximum particle size of 10mm, the grading envelope is provided in Table 3.1 (which is based on Part R27).

Table 3.1 Fine Graded Mixes Grading Envelope

SIEVE (mm)	MIX GRADING ENVELOPES OF FINE DENSE MIX ASPHALT (1) FineAC10	
19		
13.2		100
9.5	100	90
6.7	90	75
4.75	77	63
2.36	56	43
1.18	41	30
0.6	29	20
0.3	20	13
0.15	13	8
0.075	8	5

(1) Aggregate gradings with percentage passing sieve size (mm), in accordance with AS 1152.

The recommended mix design procedure consists of determining optimum binder content based on a 50 gyratory cycles compactive effort, targeting 4.0% air voids in the laboratory, within the tolerance of 3.0-5.5%.

The objective of the design is to produce a mix that can be more readily compacted to 3.0 to 7% air voids in the field, preferably below 5%. The minimum binder content is 5.7% and the laboratory air voids and binder film thickness are reporting requirements rather than specified to allow the Contractor to showcase their mix designs to meet field requirements. This may include going higher with the binder content than the minimum for the trial to help inform the wider industry on what binder content provides the optimum results in the field and take on board the learning's from the previous trial where the filler content appeared to be an important factor best measured through Filler/Binder ratio.

3.2 Contractor Local Government Mix

The contractor is to complete a mix design record of the alternate mix it generally produces as a local government mix.

3.3 Reporting

A mix design report is required for each mix.

For the mix design selected for the trial, the following is to be reported on Form 2:

- Binder type.
- WMA type.
- Combined aggregate grading.
- Target Binder content.
- Hydrated lime content (if used).
- Laboratory air voids at 150°C.
- Laboratory air void at proposed laying temperature for warm asphalt.
- RAP %.
- When RAP is used the following additional information is to be provided:
  - Combined grading after inclusion of RAP.
  - RAP grading.
  - RAP Binder content.
  - Source of RAP.

The contractor is requested to complete Form 2 - Mix Design Report (Refer Appendix B) for both mixes.

4 Production

The contractor is required to provide asphalt production records for the actual mix placed at the trial site, which include the following:

- Binder type.
- Warm mix additive.
- Bulk density and air voids content 50 gyrations, and optionally at 10,20,30,40 gyrations if equipment allows for this
- Maximum density (t/m^3).
- Air voids content after 50 gyrations.
- Temperature record for lab air void.
- Binder filler thickness (um).
- Filler Binder ratio.
- Indirect Tensile strength (MPa).
- RAP content %.
- Production Binder content.

In addition the contractor shall provide:

- Combined Grading (including RAP if used).
- RAP Grading (if RAP is used).
- RAP Binder content %.
- RAP Rejuvenator content %.
- RAP source.

A separate requirement is to provide wheel tracking results in accordance with AGTP/T231 on the production mix. This is a reporting requirement only to understand the potential rutting risk of the various mixes. This is to be tested for both mixes placed. Testing to be performed in duplicate.

The Contractor is required to complete Form 3 – Mix Production Report Form (Refer Appendix C) for both the Fine AC10 and contractors' Council mix.

5 Construction

Both mixes to be placed with ambient temperature over 25°C and are to have the same compaction effort.

The target for compaction of the trial mixes in the field should be to achieve an air void content of 3.0% to 7.0%.

For each batch of mix produced for the trial retain 40kg of plant produced sample in tins for future performance testing.

The following should be recorded during the trial:

- Ambient air temperature.
- Temperature of existing surface prior to AC placement.
- Temperature of the mix at the auger for each truck load of material.
- Temperature of the asphalt mat prior to compaction.
- Type of compaction equipment, weight, number of rollers, whether vibratory or static rolling was used, rolling pattern (incl. number of passes).
- Perception whether the mix is easy to compact.
- Any delays during paving.
- Any signs of segregation, excess fines or excess binder.
- Any deficiencies, e.g. open construction joints.
- Visual condition, photos of the finished surface.

The Contractors are required to complete Form 4a and 4b – Construction Record form in Appendix D (one for each mix placed). It would be desirable for Council staff to witness and confirm details included in these forms.

6 Monitoring

One day after construction, a minimum of four cores should be taken from each road section in accordance with Table 8(b) in Part R28.

The testing for field compaction is randomly selected in accordance with requirements of Part R28 and production binder content for the mix placed needs to be recorded.

A visual assessment of the final product with be undertaken by representatives of the reference group for the Project.

Appendix A

Trial Site Condition Form

Low volume road asphalt trial
Form 1 - Trial site condition form

Site description

Name:			Date:	
Location of the site:				
Traffic	Light vehicles per lane per day:		Percentage commercial vehicles:	
Reason(s) for road being resurfaced:				
Age of existing surfacing				
Extent of preparation works carried out (e.g. patches, crack sealing)				
Describe profiling treatment and potential for debonding				
FWD survey conducted?	yes	no		
Provide situation sketch of site and proposed location of different mixes (refer Figure 1 of protocol)				

Low volume road asphalt trial
Form 1 - Trial site condition form

Visual assessment

Rate the condition of the existing surfacing at the trial site. Develop a photo register of the observed distresses and the overall condition of the section Rank the degree and extent of different distress types on a scale of 0 to 5, using the following guideline:

Degree = 1: slight distress, hardly visible Degree = 5: severe distress

Extent = 1: isolated occurrence Extent = 5: extensive occurrence over a most of the section

Use degree = 0 and extent = 0 in case the distress type does not occur at the section

Distress type	Degree	Extent
Longitudinal cracks		
Transverse cracks		
Crocodile cracks		
Surfacing defects (potholes)		
Bleeding/Flushing		
Pumping of fines		
Rutting		
Undulation (differential settlement)		
Patching		
Services trenching		
Drainage problems		
Location sketch of distresses, if relatively isolated:		

Presence of trees at site (please tick)

	exclusive		average		isolated		No trees

Appendix B

Mix Design Report Form

Low volume road asphalt trial
Form 2 - Mix design report form

Mix design for trial at:		Date:	
Binder Type:		WMA Type:	

Mix type (FineAC10 or other please describe)	

Combined grading

Sieve size [mm]	Percent passing
19	
13.2	
9.5	
6.7	
4.75	
2.36	
1.18	
0.6	
0.3	
0.15	
0.075	

Target Binder content	%

Hydrated lime content (not a requirement)	%

Target Air Voids at 150°C	%

Target Air Void WMA at laying temperature	%

RAP	%

RAP Rejuvenator	%

Low volume road asphalt trial
Form 2 - Mix design report form

Combined grading after inclusion of RAP

Sieve size [mm]	Percent passing
19	
13.2	
9.5	
6.7	
4.75	
2.36	
1.18	
0.6	
0.3	
0.15	
0.075	

Low volume road asphalt trial
Form 2 - Mix design report form

RAP grading

Sieve size [mm]	Percent passing
19	
13.2	
9.5	
6.7	
4.75	
2.36	
1.18	
0.6	
0.3	
0.15	
0.075	

RAP Binder content	[%]

Source of RAP (please tick)

	Plant waste (1)		Reclaimed from road (2)		Combined (1+2)		Unknown

A separate form is needed for each mix placed in each street

Appendix C

Asphalt Production Report

Low volume road asphalt trial
Form 3 - Asphalt Production Form

Mix design for trial at:		Date:	

Properties of the mix production

Mix Type	
Binder type (C170,C320)	
Warm mix additive (type)	
Bulk density (50 gyrations) [t/m^3] (AS2891.9.2)	
Maximum density [t/m^3] (AS2891.7.1)	
Air void content after 50 gyrations [%] (AS2891.8) *	
Production Binder Content [%]	
Temperature record for lab air voids (C)	
Binder film thickness [µm]	
Filler/Binder ratio	
Indirect tensile strength [MPa] TP 460	
RAP content [%]	
Bulk density (40 gyrations) (optional) [t/m^3] (AS2891.9.2)	
Bulk density (30 gyrations) (optional) [t/m^3] (AS2891.9.2)	
Bulk density (20 gyrations) (optional) [t/m^3] (AS2891.9.2)	
Bulk density (10 gyrations) (optional) [t/m^3] (AS2891.9.2)	
Wheel Tracking Test Result mm (Sample 1)	
Wheel Tracking Test Result mm (Sample 2)	

* Note: Laboratory air voids at 150C for a standard mix and at proposed laying temperature for warm asphalt.

Low volume road asphalt trial
Form 3 - Asphalt Production Form

Combined grading

Sieve size [mm]	Percent passing
19	
13.2	
9.5	
6.7	
4.75	
2.36	
1.18	
0.6	
0.3	
0.15	
0.075	

Low volume road asphalt trial
Form 3 - Asphalt Production Form

IF RAP used complete these pages.

Combined grading after inclusion of RAP

Sieve size [mm]	Percent passing
19	
13.2	
9.5	
6.7	
4.75	
2.36	
1.18	
0.6	
0.3	
0.15	
0.075	

Low volume road asphalt trial
Form 3 - Asphalt Production Form

RAP grading

Sieve size [mm]	Percent passing
19	
13.2	
9.5	
6.7	
4.75	
2.36	
1.18	
0.6	
0.3	
0.15	
0.075	

RAP Binder content	[%]

Source of RAP (please tick)

	Plant waste (1)		Reclaimed from road (2)		Combined (1+2)		Unknown

Note – A separate form is needed for each mix type on each street

Appendix D

Construction Record Form

Low volume road asphalt trial
Form 4a - Construction record

Construction record for trial at:		Date:	

Target level of compaction: 3.0 – 7.0 % air voids

Was 40 kg of plant produced sample retained in tins for every mix type?	Yes	No

Constructed Asphalt Thickness (mm)	
Ambient air temperature [°C] (Min 25 °C)	
Surface temperature prior to AC placement [°C]	
Temperature of mix at auger [°C]	
Temperature of mat prior to compaction [°C]	

Type of compaction equipment	
Weight	
Number of rollers	
Vibration / static	
Rolling pattern (incl. number of passes and vibration setting)	
Was the mix easy to compact? (Easy, Average, Difficult)	
Detail delays during paving	

Low volume road asphalt trial
Form 4a - Construction record

Details and location of any segregation, excess fines, excess binder	
Describe any deficiencies (e.g. open joints)	
Describe visual condition of finished pavement, develop photo record	
Comments	

Low volume road asphalt trial
Form 4b - Field Compaction

Construction record for trial at:		Date:	

Monitoring

A minimum of four cores per mix are to be taken for density determination. For each mix cores should be taken from the middle third of the paved section shall be the arithmetic mean of the five most recent test results for that mix as per DPTI specification Part R28. :

Maximum density

Mean maximum density [t/m^3] (AS2891.7.1)	

Production Binder Content

Actual Binder content of mix placed (%) [t/m^3] (AS2891.7.1)	

Bulk density

Description of mix type for density results	

	Core 1	Core 2	Core 3	Core 4	
Bulk density [t/m^3] (AS2891.9.2)					
Air void content (AS2891.8) [%]					
Core Height (mm)					

Mean air void content [%]	
Standard deviation [%]	
K (DPTI Part 228, Table 9.20)	
Low characteristic value of air voids content (Lvc) [%]	
High characteristic value of air voids content (Hvc) [%]	

Note – A separate form is needed for each mix type on each street

FineAC10 -Trials

Protocol for the Establishment of Road Trial Sections Winter 2016 and Summer 2017

IPWEA (SA)

July 2016

Ref No. 20150248DR1E

Rod Ellis (Tonkin Consulting)

Erik Denneman (ARRB)

South Australia
IPWEA
INSTITUTE OF PUBLIC WORKS ENGINEERING AUSTRALASIA

arrb GROUP

Tonkin CONSULTING
a better approach

Document History and Status

Rev	Description	Author	Reviewed	Approved	Date
A	Draft for reference group review	RKE	RKE	RKE	16 March 2015
B	Revised draft after reference group review	RKE	RKE	RKE	31 March 2015
C	Revised protocol for summer 2015/2016 trial	RKE	RKE	RKE	19 November 2015
D	Updated with Reference group feedback	RKE	ED/KD/ HVL	RKE	12 January 2016
E	Revised protocol for Winter 2017 and Summer 2017 trial	RU	RKE	RKE	1 July 2016

Acknowledgements

This project is co-funded by the following organisations:

- City of Salisbury
- West Torrens City Council
- City of Mitcham
- City of Playford
- City of Port Adelaide Enfield
- Corporation of the City of Marion
- Corporation of the City of Adelaide
- City of Unley
- Light Regional Council
- City of Prospect

Contents

Acknowledgements

1 Background 1

2 Selecting an Appropriate Trial Site 3

3 Mix Designs 4

3.1 Fine AC10 4

3.2 Reporting 5

4 Production 6

5 Construction 7

5.1 Winter 2016 7

5.2 Summer 2017 7

6 Monitoring 8

Tables

Table 3.1 Fine Graded Mixes Grading Envelope 4

Appendices

Appendix A Trial Site Condition Form
Appendix B Mix Design Report Form
Appendix C Asphalt Production Report
Appendix D Construction Record Form

1 Background

In 2013 asphalt trials were undertaken as part of the LGA Research and Development project. As a result of this project the following documents were key outcome of the trials:

- Final Report - LGA Research and Development – Low Volume Road Asphalt Trial in SA -27 March 2014 (Ref -20120799DR2F)
- Part R27 Supply of Asphalt – July 2015
- Part R28 Construction of Asphalt Pavement - July 2015

Within Part R27 and R28 there exists a new specification suitable for low volume roads, namely "Fine Dense Mix Asphalt". For trials the 10mm (Fine AC10) is proposed.

Further funding has been secured from the contributing Councils to place Fine AC10 and to determine if the target air voids in Part R28 are practically achievable.

The aim of the low volume road trial project is to evaluate asphalt mixes that are specifically intended for use on residential streets carrying limited numbers of heavy vehicles. These mixes are designed to yield a longer life, to be more environmentally sustainable and to minimise whole-of-life cost. The mixes would also be suitable for use in pedestrian areas and for maintenance patching.

The technical characteristics of the asphalt designs include: a fine, dense graded aggregate distribution in combination with a high binder content. The aim is to create mixes that are easy to compact, this is to remedy the rapid cooling that takes place when mixes are constructed in thin layers and the influence of other compaction challenges such as stiffness of underlying pavement, irregular shape of underlying pavement, access for full size paving and compaction equipment. Mixes will be constructed to a low insitu air voids content. This will reduce the permeability of the mixes, which helps to protect the underlying granular layers and limits oxidation aging of the binder. The high flexibility of the mixes will accommodate the relatively high deflections in residential street pavements.

Some of the trial mix designs may include Reclaimed Asphalt Pavement (RAP) to increase environmental sustainability and reduce cost.

Some of the trial mix designs may include warm mix asphalt additives to further improve compactability of the mixes and increase environmental sustainability.

Some of the trial mix designs may include a softer grade bitumen (Class 170), to improve compactability durability and flexibility of the material.

This document is intended for use by local governments as guidance in selecting the mix designs for trials and for establishing trial sites.

The outcomes of the trials will guide specification development in collaboration with DPTI.

In April-June 2015 8 trial sites were placed in accordance with Protocol reference 20150248DR1B. Upon review of results it was evident the field void upper limit of 6% specified in R28 was not met. Accordingly a review of the protocol was required in order to direct the remaining 7 trial sites.

The findings so far put into question the following:

a) Will results improve in summer conditions i.e. ambient temp over 25°C

b) Is the cost of the higher binder of FineAC10 mix providing a tangible benefit over and above local government mixes on the market with lower binder content

c) In order to provide mixes consistently below 6% air voids in the field does the grading envelope need to be amended.

d) Does the inclusion of warm mix asphalt additives result in measurable benefits in terms of reduced mix production temperature and/or improved density achieved in the field?

In February 2016 – April 2016; 5 trial sites were conducted in accordance with protocol reference 20150248DR1D. When these results were reviewed by the reference group it was pleasing that in summer conditions the Fine AC10 field voids improved from previous trials conducted in cooler conditions.

The reference group now wants to focus the trials on the following:

- Summer trials with warm asphalt placed at 135°C
- Winter trials with warm asphalt placed at 150°C

The intention for this round of the Asphalt Trials is to install the same Fine AC10 mix in both Winter 2016 and Summer 2017 – with the only differentiator being the placement temperature.

The key purpose is to determine if the properties of the warm mix additive helps the workability of asphalt in both summer and winter conditions.

2 Selecting an Appropriate Trial Site

The trial site should be an urban street carrying traffic that falls within the lowest category of Table A 2 of the Austroads 'Guide to Pavement Technology Part 4B: Asphalt', i.e.:

- A street that carries less than 100 commercial vehicles per lane per day.
- The structural design level for the street should be less than 5 x 10^5 ESAs.
- Light free flowing traffic.
- Minimum length of 100m.

For the purpose of the trial a street should be selected that does not include steep inclines or busy intersections.

The intention is to trial a typical street in a Council's works program. It is required that Council use C170 binder and a Warm Mix Additive (e.g. Foaming Agent, Sasobit, etc.).

Council is also encouraged to incorporate RAP into the asphalt mix.

The following information on the condition of the trial site and the nature of the proposed works should be gathered:

- The reason why the road or street is being resurfaced.
- A visual condition survey of the road, including photo register should be developed.
- A record of a visual inspection of the site describing any defects and the location (chainage) of the defects.
- The extent of the preparation works carried out before the trial is installed (e.g. patches and crack sealing).
- Describe the proposed profiling treatment and any potential for bond breakage between existing layers.
- A recent traffic count, differentiating commercial vehicles, should be available for the trial section.
- Ideally, a Falling Weight Deflectometer (FWD) survey of the section would be performed before the trial mix is installed. A testing pattern of one FWD measurement every 20m of trial section length is recommended.

The Council is required to complete Form 1 – Trial Site Condition form in Appendix A and as part of the trial Tonkin Consulting will complete the site condition assessment and photo records.

3 Mix Designs

3.1 Fine AC10

The intention is that a mix design record is kept for aggregate grading and binder content. The mixes will be C170 binder with a Warm Mix Asphalt Additive with or without RAP. The purpose of this round of trials is to explore WMA and RAP so we need Councils to trial these options with the Fine AC10 mix specification.

As part of the preparation for the low volume road asphalt trials, adjusted versions of DPTI specifications Part R27: Supply of Asphalt July 2015 and Part R28: Construction of Asphalt Pavements July 2015 are to be used and are available on DPTI website below:

http://www.dpti.sa.gov.au/contractor_documents/specifications_-_division_2_roadworks

The asphalt materials for the trial sections should comply with these specifications. A summary of the mix design method for fine dense graded mixes for low volume roads in the specifications is provided below. This summary is intended as a guideline only, the mix designs and material should comply with all relevant requirements in Part R27 and Part R28, with the following exceptions:

- For the purpose of the trial, the inclusion of hydrated lime as a filler is allowed, but is not a requirement.
- For the purpose of the trial, the inclusion of 20% RAP is allowed.

The fine graded mixes for the trial shall have a nominal maximum particle size of 10mm, the grading envelope is provided in Table 3.1 (which is based on Part R27).

Table 3.1 Fine Graded Mixes Grading Envelope

SIEVE (mm)	MIX GRADING ENVELOPES OF FINE DENSE MIX ASPHALT (1) FineAC10	
19		
13.2		100
9.5	100	90
6.7	90	75
4.75	77	63
2.36	56	43
1.18	41	30
0.6	29	20
0.3	20	13
0.15	13	8
0.075	8	5

(1) Aggregate gradings with percentage passing sieve size (mm), in accordance with AS 1152.

The recommended mix design procedure consists of determining optimum binder content based on a 50 gyratory cycles compactive effort, targeting 4.0% air voids in the laboratory, within the tolerance of 3.0-5.5%.

The objective of the design is to produce a mix that can be more readily compacted to 3.0 to 7% air voids in the field, preferably below 5%. The minimum binder content is 5.7% and the laboratory air voids and binder film thickness are reporting requirements rather than specified to allow the Contractor to showcase their mix designs to meet field requirements. This may include going higher with the binder content than the minimum for the trial to help inform the wider industry on what binder content provides the optimum results in the field and take on board the learning's from the previous trial where the filler content appeared to be an important factor best measured through Filler/Binder ratio.

3.2 Reporting

A mix design report is required for each mix.

For the mix design selected for the trial, the following is to be reported on Form 2:

- Binder type.
- WMA type.
- Combined aggregate grading.
- Target Binder content.
- Hydrated lime content (if used).
- Laboratory air voids at 150°C.
- Laboratory air void at proposed laying temperature for warm asphalt.
- RAP %.
- When RAP is used the following additional information is to be provided:
  - Combined grading after inclusion of RAP.
  - RAP grading.
  - RAP Binder content.
  - Source of RAP.

The contractor is requested to complete Form 2 - Mix Design Report (Refer Appendix B).

4 Production

The contractor is required to provide asphalt production records for the actual mix placed at the trial site, which include the following:

- Binder type.
- Warm mix additive.
- Bulk density and air voids content 50 gyrations, and optionally at 10,20,30,40 gyrations if equipment allows for this
- Maximum density (t/m^3).
- Air voids content after 50 gyrations.
- Temperature record for lab air void.
- Binder filler thickness (um).
- Filler Binder ratio.
- Indirect Tensile strength (MPa).
- RAP content %.
- Production Binder content.

In addition the contractor shall provide:

- Combined Grading (including RAP if used).
- RAP Grading (if RAP is used).
- RAP Binder content %.
- RAP Rejuvenator content %.
- RAP source.

A separate requirement is to provide wheel tracking results in accordance with AGTP/T231 on the production mix. This is a reporting requirement to understand the durability (i.e. the potential rutting risk) of the various mixes. This is to be tested for the Fine AC mixes only.

Because wheel track testing cannot be completed by any asphalt testing laboratories located in South Australia; samples for each Fine AC mix will need to be sent interstate. To cover the cost of this exercise, the participating municipalities and the associated asphalt contractors are encouraged to consider a cost share arrangement with IPWEA. This approach has the potential to ensure multiple wheel track tests can be completed with the results analysed by the project team and the reference group.

Another separate requirement is to provide tensile strength ratio results in accordance with AG:PT/T232 on the production mix. This is another reporting requirement to evaluate the durability of the Fine Asphalt when compared to existing asphalt mixes provided by industry.

The Contractor is required to complete Form 3 – Mix Production Report Form (Refer Appendix C) for the Fine AC10 mix.

5 Construction

The target for compaction of the trial mixes in the field should be to achieve an air void content of 3.0% to 7.0%.

For each batch of mix produced for the trial retain 40kg of plant produced sample in tins for future performance testing.

The following should be recorded during the trial:

- Ambient air temperature.
- Temperature of existing surface prior to AC placement.
- Temperature of the mix at the auger for each truck load of material.
- Temperature of the asphalt mat prior to compaction.
- Type of compaction equipment, weight, number of rollers, whether vibratory or static rolling was used, rolling pattern (incl. number of passes).
- Perception whether the mix is easy to compact.
- Any delays during paving.
- Any signs of segregation, excess fines or excess binder.
- Any deficiencies, e.g. open construction joints.
- Visual condition, photos of the finished surface.

The Contractors are required to complete Form 4a and 4b – Construction Record form in Appendix D. It would be desirable for Council staff to witness and confirm details included in these forms.

5.1 Winter 2016

For the Winter 2016 component of this trial, the asphalt mix shall be laid with the ambient temperature below 15°C.

The warm asphalt mix needs to be alid on site with a minimum temperature of 150°C at the auger.

5.2 Summer 2017

For the Summer 2017 component of this trial, the asphalt mix sahll be laid with the ambient temperature above 25°C.

The warm asphalt mix needs to be alid on site with a maximum temperature of 135°C at the auger.

6 Monitoring

One day after construction, a minimum of four cores should be taken from each road section in accordance with Table 8(b) in Part R28.

The testing for field compaction is randomly selected in accordance with requirements of Part R28 and production binder content for the mix placed needs to be recorded.

A visual assessment of the final product with be undertaken by representatives of the reference group for the Project.

Appendix A

Trial Site Condition Form

Low volume road asphalt trial
Form 1 - Trial site condition form

Site description

Name:			**Date:**	
Location of the site:				
Traffic	Light vehicles per lane per day:		Percentage commercial vehicles:	
Reason(s) for road being resurfaced:				
Age of existing surfacing				
Extent of preparation works carried out (e.g. patches, crack sealing)				
Describe profiling treatment and potential for debonding				
FWD survey conducted?	yes	no		
Provide situation sketch of site and proposed location of different mixes (refer Figure 1 of protocol)				

Low volume road asphalt trial
Form 1 - Trial site condition form

Visual assessment

Rate the condition of the existing surfacing at the trial site. Develop a photo register of the observed distresses and the overall condition of the section Rank the degree and extent of different distress types on a scale of 0 to 5, using the following guideline:

Degree = 1: slight distress, hardly visible Degree = 5: severe distress

Extent = 1: isolated occurrence Extent = 5: extensive occurrence over a most of the section

Use degree = 0 and extent = 0 in case the distress type does not occur at the section

Distress type	Degree	Extent
Longitudinal cracks		
Transverse cracks		
Crocodile cracks		
Surfacing defects (potholes)		
Bleeding/Flushing		
Pumping of fines		
Rutting		
Undulation (differential settlement)		
Patching		
Services trenching		
Drainage problems		
Location sketch of distresses, if relatively isolated:		

Presence of trees at site (please tick)

	exclusive		average		isolated		No trees

Appendix B

Mix Design Report Form

Low volume road asphalt trial
Form 2 - Mix design report form

Mix design for trial at:		Date:	
Binder Type:		WMA Type:	

Mix type (FineAC10 or other please describe)	

Combined grading

Sieve size [mm]	Percent passing
19	
13.2	
9.5	
6.7	
4.75	
2.36	
1.18	
0.6	
0.3	
0.15	
0.075	

Target Binder content	%

Hydrated lime content (not a requirement)	%

Target Air Voids at 150°C	%

Target Air Void WMA at laying temperature	%

RAP	%

RAP Rejuvenator	%

Low volume road asphalt trial
Form 2 - Mix design report form

Combined grading after inclusion of RAP

Sieve size [mm]	Percent passing
19	
13.2	
9.5	
6.7	
4.75	
2.36	
1.18	
0.6	
0.3	
0.15	
0.075	

Low volume road asphalt trial
Form 2 - Mix design report form

RAP grading

Sieve size [mm]	Percent passing
19	
13.2	
9.5	
6.7	
4.75	
2.36	
1.18	
0.6	
0.3	
0.15	
0.075	

RAP Binder content	[%]

Source of RAP (please tick)

	Plant waste (1)		Reclaimed from road (2)		Combined (1+2)		Unknown

A separate form is needed for each mix placed in each street

Appendix C

Asphalt Production Report

Low volume road asphalt trial
Form 3 - Asphalt Production Form

Mix design for trial at:		Date:	

Properties of the mix production

Mix Type			
Binder type (C170,C320)			
Warm mix additive (type)			
Bulk density (50 gyrations) [t/m^3] (AS2891.9.2)			
Maximum density [t/m^3] (AS2891.7.1)			
Air void content after 50 gyrations [%] (AS2891.8) *			
Production Binder Content [%]			
Temperature record for lab air voids (°C)			
Binder film thickness [µm]			
Filler/Binder ratio			
Indirect tensile strength [MPa] TP 460			
RAP content [%]			
Bulk density (40 gyrations) (optional) [t/m^3] (AS2891.9.2)			
Bulk density (30 gyrations) (optional) [t/m^3] (AS2891.9.2)			
Bulk density (20 gyrations) (optional) [t/m^3] (AS2891.9.2)			
Bulk density (10 gyrations) (optional) [t/m^3] (AS2891.9.2)			
Wheel Tracking Test Result mm (Only 1 Sample))			
Tensile Strength (dry)			
Tensile Strength (wet)			
Tensile Strength Ratio			

* Note: Laboratory air voids at 150°C for a standard mix and at proposed laying temperature for warm asphalt.

Low volume road asphalt trial
Form 3 - Asphalt Production Form

Combined grading

Sieve size [mm]	Percent passing
19	
13.2	
9.5	
6.7	
4.75	
2.36	
1.18	
0.6	
0.3	
0.15	
0.075	

Low volume road asphalt trial
Form 3 - Asphalt Production Form

IF RAP used complete these pages.

Combined grading after inclusion of RAP

Sieve size [mm]	Percent passing
19	
13.2	
9.5	
6.7	
4.75	
2.36	
1.18	
0.6	
0.3	
0.15	
0.075	

Low volume road asphalt trial
Form 3 - Asphalt Production Form

RAP grading

Sieve size [mm]	Percent passing
19	
13.2	
9.5	
6.7	
4.75	
2.36	
1.18	
0.6	
0.3	
0.15	
0.075	

RAP Binder content	[%]

Source of RAP (please tick)

	Plant waste (1)		Reclaimed from road (2)		Combined (1+2)		Unknown

Note – A separate form is needed for each mix type on each street

Appendix D

Construction Record Form

Low volume road asphalt trial
Form 4a - Construction record

Construction record for trial at:		**Date:**	

Target level of compaction: 3.0 – 7.0 % air voids

Was 40 kg of plant produced sample retained in tins for every mix type?	Yes	No

Constructed Asphalt Thickness (mm)	
Ambient air temperature [°C] (Winter 2016: max. 25 °C) (Summer 2017: min. 25 °C)	
Surface temperature prior to AC placement [°C]	
Temperature of mix at auger [°C] (Winter 2016:150 °C min.) (Summer 2017: 135 °C max)	
Temperature of mat prior to compaction [°C]	

Type of compaction equipment	
Weight	
Number of rollers	
Vibration / static	
Rolling pattern (incl. number of passes and vibration setting)	
Was the mix easy to compact? (Easy, Average, Difficult)	
Detail delays during paving	

Low volume road asphalt trial
Form 4a - Construction record

Details and location of any segregation, excess fines, excess binder	
Describe any deficiencies (e.g. open joints)	
Describe visual condition of finished pavement, develop photo record	
Comments	

Low volume road asphalt trial
Form 4b - Field Compaction

Construction record for trial at:		**Date:**	

Monitoring

A minimum of four cores per mix are to be taken for density determination. For each mix cores should be taken from the middle third of the paved section shall be the arithmetic mean of the five most recent test results for that mix as per DPTI specification Part R28. :

Maximum density

Mean maximum density [t/m^3] (AS2891.7.1)	

Production Binder Content

Actual Binder content of mix placed (%) [t/m^3] (AS2891.7.1)	

Bulk density

Description of mix type for density results	

	Core 1	Core 2	Core 3	Core 4	
Bulk density [t/m^3] (AS2891.9.2)					
Air void content (AS2891.8) [%]					
Core Height (mm)					

Mean air void content [%]	
Standard deviation [%]	
K (DPTI Part 228, Table 9.20)	
Low characteristic value of air voids content (Lvc) [%]	
High characteristic value of air voids content (Hvc) [%]	

Note – A separate form is needed for each mix type on each street

Appendix B

DPTI Specification Part R27 and R28

PART R27

SUPPLY OF ASPHALT

CONTENTS

1. GENERAL
2. QUALITY REQUIREMENTS
3. MATERIALS
4. MIX REQUIREMENTS
5. MANUFACTURE OF MIXES
6. PRODUCTION SAMPLING AND TESTING
7. PROPERTY VARIATIONS OF PRODUCTION ASPHALT
8. STORAGE OF ASPHALT
9. DELIVERY OF MIX
10. TEST PROCEDURES
11. HOLD POINTS
12. VERIFICATION REQUIREMENTS AND RECORDS

1. GENERAL

.1 This Part specifies the requirements for the supply of Hot Mix Asphalt (HMA), with and without an Additive, and Warm Mix Asphalt (WMA) including the design and manufacture of the following:

(a) Coarse Dense Mix Asphalt (AC10, AC14 & AC20);

(b) Fine Dense Mix Asphalt (FineAC7, FineAC10 & FineAC14);

(c) Open Graded Asphalt (OG10 & OG14); and

(d) Stone Mastic Asphalt (SMA7 & SMA10).

.2 In the event of any inconsistency, ambiguity or discrepancy between any of the Contract Documents, the following order of precedence will apply:

1. This Part
2. Austroads Guide to Pavement Technology Part 4B “Asphalt”
3. AS2150 “Hot Mix Asphalt - A Guide to Good Practice”
4. Industry documentation.

.3 The following definitions apply to this Contract:

"AAPA" means Australian Asphalt Pavement Association.

“Additive” means an organic, chemical, or emulsion product used to assist in the compaction of asphalt.

“AS 2150” Australian Standard: Hot Mix Asphalt-A Guide to Good Practice

“Austroads 4B” Guide to Pavement Technology Part 4B Asphalt.

"Asphalt Mix Design Assessment" is a documented assessment of a submitted asphalt mix design with an Asphalt Mix Register Number provided by DPTI.

"Asphalt Mix Register Number" is a mix approval number provided by DPTI to an accepted nominated mix. All mixes are placed on DPTI’s Asphalt Mix Register and monitored by DPTI.

"Coarse Asphalt Mix" (AC) means asphalt of a coarse nature suitable for Medium, Heavy and Very Heavy Duty applications unless used in Fine Asphalt Mix applications or expressly noted otherwise.

"Fine Asphalt Mix" (FineAC) means asphalt of a fine nature suitable for Light to Medium Duty applications and suitable for DPTI patch maintenance, bikeways, footpaths, car parks and Local Government residential streets.

“Hot Mix Asphalt” (HMA) means an Asphalt Mix manufactured and compacted at standard temperatures. It may also mean Hot Mix Asphalt manufactured at standard temperatures but with the addition of an “Additive” to assist in meeting compaction requirements.

"Nominated Mix" means an asphalt mix design proposed by the Contractor.

"Nominated Combined Aggregate Grading" means the Contractor's target design gradings for the Nominated Mix.

"Nominated Binder Content" means the Contractor's target design binder content for the Nominated Mix.

"Process Control" means a controlled documented system of practices and procedures used to monitor and control the product inputs, equipment and manufacturing processes to ensure the product replicates the product design.

"**Production Mix**" means manufactured product at an asphalt plant.

"RAP" means Reclaimed Asphalt Pavement.

"SDS" means Safety Data Sheets.

"Special Process" means the Contractor's documented and demonstrated techniques to achieve the requirements of this Part.

"Warm Mix Asphalt" (WMA) means Hot Mix Asphalt manufactured and compacted at lower temperatures with the addition of an "Additive" or by using the foaming technique.

2. QUALITY REQUIREMENTS

Process Control

.1 The Contractor must develop and implement a Process Control System. The following requirements must be submitted to DPTI for the asphalt plant to obtain approved process control:

(a) Monthly RAP & Asphalt Production test results in electronic spreadsheet format;

(b) Audit Samples;

(c) Monthly process control charts and invitation to process control meeting; and

(d) Monthly asphalt plant computing data outputs to match with samples being taken.

Quality Plan, Procedures and Documentation

.2 Further to the requirements of Part G20 "Quality System Requirements", the Contractor must prepare and implement a Quality Plan that at a minimum, includes detailed procedures and documentation for:

(a) Mix Design

(b) Manufacture of Mixes

(i) The asphalt production plant, including company brand, mixing type, capacity, year of manufacturing, functionalities, special abilities, silos, computer control system and production history.

(ii) The laboratory NATA Accreditation certificate, approved tests, and calibration schedule.

(iii) Process control requirements, which include a description of the flow of materials and the processes carried out on them from input materials to the plant through to delivery of asphalt to the customer. It must incorporate a flow diagram and identification of the key elements of the manufacturing process requiring monitoring, measurement or verification.

(iv) Control of aggregates transferred from quarry stockpiles and delivered to an asphalt plant.

(v) Control of Reclaimed Asphalt Pavement (RAP) transferred from stockpiles and delivered to an asphalt plant.

(vi) Requirements for labelling of storage bays and silos and bituminous tanks.

(vii) Requirements for heating, temperature control and insulation of tanks.

(viii) Requirements for controlling delivery of binders into the correct tanks.

(ix) Control requirements for binders, foam, additives, admixtures, fillers and reclaimed asphalt.

(x) Plant calibration and maintenance.

(xi) Description of the characteristics of any hot storage system and define its mode of operation.

(xii) Handling, storage and delivery of asphalt mixture to ensure the minimum of segregation, degradation or binder drain down and that the asphalt remains within the specified temperature range.

(c) Inspection and Test Requirements

(i) An Inspection and Test Plan, vide Clause G20.7 "Inspection and Testing", which includes a schedule for monitoring and measuring the performance of the process (as identified in the key process element identification) and products. At a minimum, it must meet the requirements of Clauses R27.6 and R27.7 and Attachment R27A.

(ii) Constant monitoring and statistical analysis of records to verify process capability and product characteristics.

(iii) A Calibration Schedule, which includes daily visual inspection of all equipment and calibration of weighting equipment, admixture dispensers, flow meters, batching or proportioning systems and temperature monitoring equipment (vide Clause G20.7.4 "Inspection, Measuring and Test Equipment"). At a minimum, it must meet the requirements of Attachment R27A.

.3 If not provided previously the procedures and documentation must be submitted at least 10 days prior to the commencement of supply.

.4 Provision of the procedures and documentation listed in this Clause shall constitute a **HOLD POINT**.

.5 The Contractor must use test procedures in accordance with Table 10 “Test Procedures” (refer http://www.dpti.sa.gov.au/materials_technology_documents/test_procedures2) to verify conformance with this Part.

3. MATERIALS

Quality of Materials

.1 Materials must comply with the following:

Binder, Flux and Cutter	Part R25 "Supply of Bituminous Materials"
Aggregate, Sand a Mineral Filler	Part R15 "Supply of Pavement Materials”
Tack Coat	AS 1160 "Bitumen Emulsions for Construction and Maintenance of Pavements"
	AS 2157 "Cutback Bitumen"
Hydrated Lime Fil	AS 1672.1 "Limes for Building".
Rejuvenating Age	Rejuvenating agent must comply with recognised standards for such materials. Diesel is not considered a suitable rejuvenating agent. Rejuvenation agent must be fully disclosed for mix assessment includ submission of Safety Data Sheets.

Reclaimed Asphalt Pavement Material

.2 Reclaimed asphalt pavement material (RAP) must be obtained from milling or excavation of existing asphalt pavements or asphalt plant waste.

.3 For the use of RAP within asphalt mixes the Contractor’s Quality Plan must include a Reclaimed Asphalt Pavement Management Plan and Industry Code of Practice meeting the following minimum requirements:

(a) RAP must be crushed and screened as necessary to ensure a maximum size no greater than the maximum size of asphalt being produced and to achieve a reasonably well graded, free flowing, and consistent product.

(b) The processed RAP of each size must be placed in separate stockpiles not exceeding 1000 tonne and represent a Lot. Each Lot must be tested for binder content, gradings, viscosity and moisture content at a minimum of one per lot. Test results must be traceable to the asphalt mix containing the RAP.

(c) RAP that has been stockpiled for some time and has bound together in some way must be reprocessed, to ensure that it is in a free flowing state at the time of use.

.4 A minimum of one kilogram sample per lot must be provided to the DPTI for auditing.

4. MIX REQUIREMENTS

.1 Mix requirements must comply with the requirements of the latest edition of AUSTROADS 4B, except as varied below.

Nominated Mixes

.2 All submissions of nominated mixes must be in accordance with Attachment R27B “Assessment and Registration of Asphalt Mix Designs”.

.3 The Contractor must submit to DPTI details of each asphalt mix proposed, together with a Certificate from a laboratory with appropriate NATA registration, stating that each asphalt mix and its constituents meet the requirements of this Part at least:

(a) 10 working days for new mix designs; or

(b) 5 working days for revised mixes before commencing production of asphalt.

.4 Submission of the details of nominated mixes and Certificate(s) shall constitute a **HOLD POINT**.

Compliance with Nominated Mixes

.5 If the Contractor has previously submitted the nominated mix to DPTI, and has a current Asphalt Mix Register Number and the mix has not been varied in accordance with Clause 4.1.3 "Variations to Nominated Mixes", the following must be submitted:

(a) Description of the Job Mix Formula (JMF); and

(b) A copy of the latest Asphalt Mix Design Assessment.

.6 Submission of the above information shall constitute a **HOLD POINT**.

.7 The Contractor must monitor the production results of all its registered mixes, and must submit a summary of previous mix production data for the submitted mix and to include:

(a) Plot of voids verses binder content, max density verses binder content;

(b) Summary sheet of JMF data in an electronic spreadsheet format;

(c) Process control plots of binder content, max density, production voids & in-situ voids; and

(d) Summary of associated non-conformances and dispositions.

.8 Where the analysis of the production test data shows that the Design Air Voids Target requires a different binder content to the nominated binder content, an alternative mix design must be submitted.

Variations to Nominated Mixes

.9 The Contractor must submit a new nominated mix in compliance with Clause 4.1.1 “General" if:

(a) The Contractor proposes to vary the proportions of the constituents in a nominated mix; or

(b) The Contractor proposes to change the source of supply of any constituent; or

(c) The Asphalt Mix Register Number is withdrawn by DPTI.

Mobile Plants

.10 The Contractor must submit the asphalt mix history (including mix production data) and details of the nominated mobile plant in accordance Clause 2 “Quality Requirements”.

.11 Plant settings and mix design parameters must be met before proceeding with the permanent works and shall constitute a **HOLD POINT**.

.12 A proposal to use plant fuel other than liquefied petroleum gas (LPG), liquefied natural gas (LNG), petrol or diesel shall constitute a **HOLD POINT**.

Wearing Course

.13 Asphalt Binder and Mix types for wearing course must comply with the following:

(a) Coarse Dense Mixes must be modified binders using A15E, A35P, A40P or A5E.

(b) Open Graded Mix (OG) must be modified binders using A15E.

(c) Stone Mastic Asphalt (SMA) must be modified binders using A15E or A5E.

(d) Fine Dense Mixes must be Class C170 binder for light duty. Class C320 may also be used for light duty pavements subject to approval.

.14 All wearing course layers must contain at least 1% added hydrated lime. A levelling course that is trafficked more than 30 days is deemed to be a wearing course.

.15 Design of asphalt mixes must also meet the requirements of Part R35 “Surface Characteristics”.

Coarse Dense Mix Asphalt

.16 Mix properties for the design and production control of coarse dense mix asphalt excluding RAP must meet the requirements of Table 4.3(a) "Mix Properties of Coarse Dense Mix Asphalt" & Table 4.3(b) "Mix Properties of High Flexural-Modulus Coarse Dense Mix Asphalt". The grading envelopes must meet the requirements of Table 4.3(c) "Mix Grading Envelopes" and production tolerances on grading and binder content must comply with Table 11 in AS 2150.

TABLE 4.3(a) - MIX PROPERTIES OF COARSE DENSE MIX ASPHALT

CHARACTERISTIC		GYRATORY CYCLE No.	AC10	AC14	AC20	AC14HB
Nominal Mix Sieve Size (mm)			9.5	13.2	19	13.2
Design & Production Air Voids Target (%)	Medium Duty (MD)	80	4.0	4.0	4.0	2.5
	Heavy Duty (HD)	120	4.0	4.0	-	-
Production Air Voids Tolerance (%)			Target ± 1.5	Target ± 1.5	Target ± 1.5	Target ± 1.5
Binder Film Index (BFI) (µm) - Minimum	Medium Duty	80	8.5	8.5	8.5	10.0
	Heavy Duty	120	8.0	8.0	-	-
Indirect Tensile Strength (ITS) (kPa)			Report Only	Report Only	Report Only	Report Only

TABLE 4.3(b) - MIX PROPERTIES OF HIGH FLEXURAL-MODULUS COARSE DENSE ASPHALT

CHARACTERISTIC		GYRATORY CYCLE No.	AC10 A5E
Nominal Mix Sieve Size (mm)			9.5
Design & Production Air Voids Target (%)	Light Duty (LD)	50	4.0
	Medium Duty (MD)	80	4.0
Production Air Voids Tolerance (%)			Target ± 1.5
Binder Film Index (BFI) (µm) - Minimum	Light Duty	50	9.5
	Medium Duty	80	8.5
Indirect Tensile Strength (ITS) (kPa)			Report Only

TABLE 4.3(c) - COARSE DENSE MIX GRADING ENVELOPES[(1)]

SIEVE	AC10		AC14 and AC14HB		AC20	
26.5					100	100
19			100	100	92	80
13.2	100	100	92	80	82	66
9.5	92	80	83	67	70	53
6.7	82	66	70	54	60	43
4.75	70	52	60	43	51	34
2.36	48	34	42	28	36	23
1.18	34	21	30	19	27	14

0.6	24	14	21	12	19	10
0.3	17	8	16	7	14	6
0.15	11	5	10	6	9	5
0.075	7	4	6	3	6	3

(1) Aggregate gradings with percentage passing sieve size (mm), in accordance with AS 1152.

Fine Dense Mix Asphalt

.17 Mix properties for design and production control of fine dense mix asphalt excluding RAP must meet the requirements of Table 4.4(a) "Mix Properties of Fine Dense Mix Asphalt". The grading envelopes must meet the requirements of Table 4.4(b) "Mix Grading Envelopes of Fine Dense Mix Asphalt" and production tolerances on grading and binder content must comply with Table 11 in AS 2150.

TABLE 4.4(a) - MIX PROPERTIES OF FINE DENSE MIX ASPHALT		
CHARACTERISTIC	**FineAC7**	**FineAC10**
Light Duty Design (Gyratory Cycles)	50 cycles	50 cycles
Nominal Mix Sieve Size (mm)	6.7	9.5
Minimum Binder Content (%)	6.0	5.7
Design & Production Air Voids Target (%)	4.0	4.0
Production Air Voids Tolerance (%)	Target ± 1.5	Target ± 1.5
Target In-situ Voids (%) (refer to Spec R28)	2.0 – 5.0	2.5 – 6.0
Binder Film Index (µm) Minimum	8.0	8.0

TABLE 4.4(b) - MIX GRADING ENVELOPES OF FINE DENSE MIX ASPHALT(1)				
SIEVE (mm)	**FineAC7**		**FineAC10**	
13.2				100
9.5		100	100	90
6.7	100	90	90	75
4.75	90	75	77	63
2.36	65	51	56	43
1.18	47	35	41	30
0.6	33	23	29	20
0.3	22	15	20	13
0.15	14	9	13	8
0.075	8	5	8	5

(1) Aggregate gradings with percentage passing sieve size (mm), in accordance with AS 1152.

Coarse / Fine Dense Mix Asphalt Including RAP

.18 In addition to the requirements of this clause, Dense Mix Asphalt incorporating Reclaimed Asphalt Pavement must meet the design requirements of Clause 4.3 "Coarse Dense Mix Asphalt" or Clause 4.4 "Fine Dense Mix Asphalt" and the following:

(a) For wearing course mixes, the proportion of RAP in the total mix must not exceed 10% for “Coarse Dense Mix Asphalt” and 20% for “Fine Dense Mix Asphalt”;

(b) For asphalt mixes with 10% RAP or less added, no added binder or rejuvenation is required;

(c) For levelling, intermediate and base course mixes, the proportion of RAP in the total mix must not exceed 50%; excepted for asphalt mixes using polymer modified binders (PMB) must not exceed 20%;

(d) For asphalt mixes with 10% or greater (5% increments) RAP content in the total mix, the actual percentage added must be approved by DPTI; and

(e) For asphalt mixes with higher than 10% RAP incorporation must use the following additional design components of binder rejuvenation:

(i) Extract RAP Binder to determine binder content and viscosity.

(ii) The Resilient Modulus of RAP Mixes to be the same as equivalent Virgin Mixes in accordance with Table 27B(b). Testing frequency is one test (a pair of production pat per sample) per 10 production samples per mix.

(iii) Regular Indirect Tensile Strength (ITS) testing (on a daily production basis) to confirm strength equivalence to mix without addition of RAP as noted on Asphalt Mix Design Assessment.

(iv) Rejuvenating Agent must be a softer grade bitumen and low volatility oil (if required) capable of combining with bitumen to counteract hardening and produce a lower viscosity grade of binder.

Open Graded Asphalt

.19 The following applies to Open Graded Asphalt (OG):

(a) mix properties for the design and production control must comply with Table 4.6(a) "Mix Properties of Open Graded Asphalt";

(b) the grading envelopes must comply with Table 4.6(b) "Mix Grading Envelopes";

(c) production tolerances on grading and binder content must comply with Table 11 in AS 2150;

(d) the design and production must be to Medium Duty category (80 gyratory cycles);

(e) cellulose fibres may be added to reduce binder drain down; and

(f) RAP content is not permitted.

TABLE 4.6(a) - MIX PROPERTIES OF OPEN GRADED ASPHALT

CHARACTERISTIC	OG10	OG14
Nominal Mix Sieve Size (mm)	9.5	13.2
Hydrated Lime (%) - Minimum	1.0	1.0
Design Air Voids Target (%)	20	20
Production Air Voids Tolerance (%)	18 – 23	18 – 23
Binder Content Target (% by mass)	5.6	5.3

TABLE 4.6(b) - MIX GRADING ENVELOPES (1) ~~(2)~~

SIEVE (mm)	OG10		OG14	
19			100	100
13.2	100	100	100	85
9.5	100	85	70	45
6.7	65	35	45	25
4.75	45	20	25	10
2.36	20	10	15	7
1.18	14	6	12	6
0.6	10	5	10	5
0.3	8	4	8	4
0.15	7	3	7	3
0.075	5	2	5	2

(1) Aggregate gradings with percentage passing sieve size (mm), in accordance with AS 1152.

Stone Mastic Asphalt

.20 The following applies to Stone Mastic Asphalt (SMA):

(a) mix properties for the design and production control must meet the requirements of Table 4.7(a) "Mix Properties of Stone Mastic Asphalt";

(b) the grading envelopes must meet the requirements of Table 4.7(b) "Mix Grading Envelopes";

(c) production tolerances on grading and binder content must comply with Table 11 in AS 2150;

(d) the design and production must be to Medium Duty category (80 gyratory cycles);

(e) minimum of 0.3% (by mass) cellulose fibre to reduce binder drain down must be added and the nominated mix submission must include details of the filler, fibre type and source; and

(f) RAP content is not permitted.

TABLE 4.7(a) - MIX PROPERTIES OF STONE MASTIC ASPHALT		
CHARACTERISTIC	**SMA7**	**SMA10**
Nominal Mix Sieve Size (mm)	6.7	9.5
Hydrated Lime (%) - Minimum	1.0	1.0
Design Air Voids Target (%)	3.5	3.5
Production Air Voids Tolerance (%)	3.0 – 5.0	3.0 – 5.0
Binder Content Target (% by mass)	7.0	6.5
Binder Film Index (BFI) (µm) - Minimum	-	9.5
Indirect Tensile Strength (ITS) (kPa)	Report Only	Report Only

TABLE 4.7(b) - MIX GRADING ENVELOPES [(1)]				
SIEVE (mm)	**SMA7**		**SMA10**	
13.2				100
9.5		100	100	90
6.7	100	85	55	30
4.75	62	30	40	20
2.36	35	20	28	15
1.18	28	16	24	13
0.6	24	14	21	12
0.3	20	12	18	10
0.15	16	10	14	9
0.075	12	8	12	8

(1) Aggregate gradings with percentage passing sieve size (mm), in accordance with AS 1152.

Job Mix Formula

.21 The nominated mix will be assessed by DPTI for compliance with the requirements of this Part. An Asphalt Mix Design Assessment will be supplied to the Contractor and will incorporate:

(a) Mix Register Number.

(b) Production grading tolerances.

(c) A "Job Mix Formula" (JMF) comprising of Combined Grading, Binder Content, Max Density, Bulk Density, Design Target Air Voids, Binder Film Thickness, RAP Percentage, Indirect Tensile Strength & Resilient Modulus.

5. MANUFACTURE OF MIXES

General

.1 Mixes must be manufactured to replicate the JMF in accordance with AS 2150, Clause 7 "Manufacturing and Storage of Mix".

.2 Mixes must not exhibit drainage of the binder and/or contain less than 95% of aggregate particles that are not fully coated with binder as determined by AS 2891.11.

.3 Asphalt must be manufactured so that its properties comply with the requirements specified in Clause 12 "Verification Requirements and Records".

Manufacturing Controls

.4 Plant temperatures and mixing times must be maintained in a range sufficient to ensure a homogenous mix without causing deleterious effects to the binder through overheating and within the manufacturer's specifications as detailed in AAPA Advisory Note 7. The binder temperature used for storage/transport must not exceed the values shown against the binder class indicated in Table 5.2.

TABLE 5.2 - MAXIMUM BINDER TEMPERATURE	
BINDER CLASS	**MAX. TEMPERATURE(ºC)**
170	180
320	185
600	195

.5 The above maxima may be increased by up to 10ºC when additives such as polymers or scrap rubber are incorporated in the binder.

.6 Spray temperature of the binder into a pugmill type environment must be such as to minimise oxidation or drainage of the binder.

.7 The temperature of the mix delivered into each truck must be recorded on the weighnote.

Manufacture of Mixes Including RAP

.8 In batch mixing plants, the RAP must be either:

(a) metered into the asphalt plant after heating and drying of aggregates;

(b) added directly to the weigh hopper with other aggregate materials, for each batch; or

(c) weighed separately and added direct to the pugmill.

.9 If necessary, batch mixing time must be increased to ensure adequate heat transfer and dispersion of RAP. In drum mixing plants, RAP must be protected from excessive temperatures by a combination of entry point to drum and shielding from direct flame contact.

Manufacture of Asphalt with Additive or Foaming Technique

.10 Subject to prior approval, the Contractor may use an additive or foaming technique:

(a) to manufacture at standard temperatures but air and pavement placement temperatures are reduced in Clause R28.(HMA),

(b) to manufacture at standard temperatures but time until placement is extended and mix placement temperature reduced (HMA), or

(c) to manufacture asphalt at lower temperatures (WMA).

.11 Where placement temperature is reduced, compaction requirements must still be in accordance with Part R28 “Construction of Asphalt Pavements”.

.12 The Contractor must provide the testing temperature of gyratory compaction when additives or foaming technique are used in accordance AS2891.2.2:2014.

.13 The propriety product of the additive used must be fully disclosed in accordance with Clause 4.1 “Nominated Mixes”.

6. PRODUCTION SAMPLING AND TESTING

General

.1 The Contractor must conduct sampling and testing of asphalt and binder for control and verification purposes during manufacture. Minimum sampling and testing frequency for each mix type in a 24 hour period must be as shown in Table 6.1.

TABLE 6.1 - ASPHALT SAMPLING AND TESTING FREQUENCY			
Sampling & Testing Frequency	**Fixed Asphalt Plant and approved(1) Process Control (tonne)**	**Fixed Asphalt Plant without approved(1) Process Control (tonne)**	**Mobile Asphalt Plant (tonne)**
1	30 - 150	30 - 100	0 - 30
2	151 - 400	101 - 250	31 - 100
3	Additional sample/test each 300 tonne > 400	251 - 400	101 - 250
4		Additional sample/test each 300 tonne > 400	251 - 400
5			Additional sample/test each 300 tonne > 400

(1) As documented in Asphalt Mix Design Assessment

.2 For Fine Dense Mixes meeting the requirements in this Part, sample rate is one per lot (a lot defined as a day's production).

.3 For Coarse Dense Mixes, Stone Mastic Asphalt & Open Graded Asphalt meeting the requirements of this Part, sample rate is in accordance Table 6.1 "Asphalt Sampling and Testing Frequency".

.4 The following tests & calculations must be performed and reported on each production sample:

(a) Combined Grading;

(b) Binder Content;

(c) Maximum Density;

(d) Bulk Density;

(e) Air Voids;

(f) Indirect Tensile Strength (ITS) (one test per mix per day only); and

(g) Binder Film Index (BFI).

.5 Test results and calculations of production mix must be supplied to the Principal within 24 hours.

Audit Samples

.6 The Contractor must provide audit samples using DPTI's random selection template for product auditing purposes in accordance MAT-PC063 "Random Sample Template" for the following:

Asphalt

From each production mix sample, the Contractor must provide a single sample (6L tin) of a minimum 11kg asphalt for retention by DPTI. These samples may be used for product auditing purposes.

The Contractor must submit asphalt audit samples using Random Sample Template (selection rate of 1 in 1).

Residual Bitumen

The Contractor must provide one sample per type per delivery (minimum of 1 litre) for product auditing purposes. Audit samples are not required where a DPTI arrangement exists.

Polymer Modified Binder

The Contractor must provide one sample per type per delivery (minimum of 1 litre) for product auditing purposes.

.7 All samples must be delivered to DPTI's Materials Laboratory at 19 Bridge Road, Walkley Heights at a minimum monthly intervals or as requested by the Principal. The Contractor may dispose remaining random asphalt samples after a minimum of 30 days.

.8 All samples must be a minimum of 11 kg and clearly labeled on the side of the container in clear indelible ink or paper sticker and must include: materials, mix type, sample number, date of sampling and asphalt mix design register number and project.

.9 The samples will be stored at DPTI's expense. The Contractor must provide documentation to confirm that the samples have been received at DPTI's Laboratory, and submit this as part of the Lot package. All samples must be clearly marked and traceable to the relevant Lot in accordance with Part G20 "Quality System Requirements".

7. PROPERTY VARIATIONS OF PRODUCTION ASPHALT

.1 In replicating the JMF properties, production mix variations must not exceed the limits shown in Table 11 of AS 2150.

.2 Variations of the Production Air Voids from the Design Air Voids Targets must not exceed the Limits of Production Air Voids Tolerance in:

(a) Table 4.3(a) "Mix Properties of Dense Mix Asphalt";

(b) Table 4.4(a) "Mix Properties of Fine Dense Mix Asphalt";

(c) Table 4.6(a) "Mix Properties of Open Graded Asphalt; and

(d) Table 4.7(a) "Mix Properties of Stone Mastic Asphalt".

.3 The Contractor must ensure that the moisture content of production asphalt is less than 0.2%.

8. STORAGE OF ASPHALT

.1 Asphalt must be stored in accordance with AS 2150, Section 7.5 "Storage of Mix".

9. DELIVERY OF MIX

.1 Mix must be transported to site in a manner which does not result in a deterioration of the properties of the mix or contamination of the mix. The Contractor must ensure that transport operations are arranged in a manner which ensures continuous placing of asphalt. If haulage distance is measured for the purpose of payment, the haulage distance must be calculated from the Nominated Asphalt Plant which is closest to the work site, regardless of whether it is sourced from any other plant for any reason (including breakdown). The haulage distance includes the loaded trip only and excludes the return trip.

10. TEST PROCEDURES

.1 The Contractor must use the following test procedures (refer http://www.dpti.sa.gov.au/contractor_documents) to verify conformance with the Specification:

TEST	TEST PROCEDURE
Sampling of Raw Materials: • Aggregates & Processed RAP • Bitumen & Polymer Modified Binder • Mineral Filler	 TP 226 AS 2008 TP 226
Sampling of Asphalt	TP 425
Compaction of Asphalt Test Specimens using a Gyratory Compactor	TP 428
Determination of the Maximum Density of Asphalt - Water Displacement Method (Duplicate sample testing not required)	AS 2891.7.1
Bulk Density of Compacted Asphalt Specimens: • Presaturation Method for Dense Graded and SMA • Mensuration Method for Open Graded	 AS 2891.9.2 AS 2891.9.3
Measurement of Thickness or Height of Compacted Asphalt	ASTM D3549
Voids - Calculation	AS 2891.8
Binder Film Index - Calculation	AS 2891.8

TEST	TEST PROCEDURE
Binder Content: - Pressure Filtration Method - Ignition Oven Method	AS 2891.3.3 TP 473
Stripping Potential of Asphalt – Tensile Strength Ratio (TSR)	AGPT/T232
Static Indirect Tensile Test (ITS)	TP 460
Extractions of Bituminous Binder from Asphalt	AGPT/T191
Design of Bituminous Binder Blends to a Specified Viscosity Value	AGPT/T193
Characterisation of the Viscosity of RAP Binder using the Shear Rheometer (DSR) Asphalt Binder Viscosity	AGPT/T192 TP 664
Asphalt Particle Loss	AGPT/T236
Asphalt Binder Drain-Off	AGPT/T235
Particle Size Distribution by Dry Sieving	AS 1141.11
Voids in Dry Compacted Fillers	AS 1141.17
Moisture Content	AS 2891.10
Specific Surface	AS 2350.8
Loss on Ignition	AS 3583.3
Water Soluble Fraction of Filler	AS 1141.8
Deformation Resistance of Asphalt Mixtures by the Wheel Tracking test	AGPT/T231
Fatigue Fife of Compacted Bituminous Mixes Subject to Repeated Flexural Bending	TP477
Determination of the Resilient Modulus of Asphalt – Indirect Tensile Method	AS2891.13.1

11. HOLD POINTS

.1 The following is a summary of Hold Points referenced in this Part:

CLAUSE REF.	HOLD POINT	RESPONSE TIME
2.0	Submission of Quality Plan (if not provided previously)	20 working days
4.4	Submission of the details of Nominated Mixes and Certificate(s)	20 working days
4.16	Submission of Job Mix Formula	15 working days
4.11	Submission of Trial mix data from a mobile plant	As required

12. VERIFICATION REQUIREMENTS AND RECORDS

Test Records & Verification for Asphalt Mix Design Initial Assessment

.1 The Contractor must undertake the testing specified in this Part & Table R27B(d) and must supply written evidence of compliance.

Test Records & Verification for Plant Production

.2 The Contractor must undertake the testing specified in this Part and Table 12.2 this Clause and must supply written evidence of compliance within the Lot Package.

.3

TABLE 12.2 - PLANT PRODUCTION TESTING					
CLAUSE REF.	**SUBJECT**	**PROPERTY**	**TEST PROCEDURE**	**TEST FREQUENCY**	**ACCEPTANCE LIMITS**
5.2	Manufacturing Controls	Temperature at manufacture	Thermometer reading or infrared gun	Each truckload	Refer Clause 5.2 "Manufacturing Controls"
6.0	Production Sampling & Testing	Binder Content & Combined Grading	AS 2891.3.3	Refer Clause 6.1	Refer Clause 4.3, 4.4, 4.6 & 4.7 and Asphalt Mix Design Assessment
		Bulk Density	AS 2891.9.2 AS 2891.9.3	Refer Clause 6.1	Report Only
		Absorption of Compacted Specimens	AS 2891.9.2	Refer Clause 6.1	≤ 2.0% for AC20 ≤ 1.0% for SMA
		Maximum Density	AS 2891.7.1	Refer Clause 6.1	Report Only
		Voids on Compacted Specimens	AS 2891.8	Refer Clause 6.1	Refer Clause 4.3, 4.4, 4.6 & 4.7 and Asphalt Mix Design Assessment
		Binder Film Index (BFI) (1)	AS 2891.8	Refer Clause 6.1	Refer Clause 4.3, 4.4 & 4.7
		Indirect Tensile Strength (ITS)	TP 460	Refer Clause 6.1	Refer Clause 4.3

(1) Absorption for RAP component assumed to be zero.

ATTACHMENT R27A

ASPHALT INSPECTION TEST AND VERIFICATION

TABLE R27A(a) - PLANT INSPECTION SCHEDULE			
CONTROL AREA	**INSPECTION/TEST**	**PURPOSE**	**FREQUENCY**
Cold feed bins	As set out in quality plan	To ensure correct feeding of plant	a) On installation. b) As set out in quality plan.
Dryer Drum	As set out in quality plan	To ensure correct heating and drying of aggregates	As set out in quality plan
Hot feed bins	As set out in quality plan	To ensure correct batching	As set out in quality plan
Binder	Tank temperature Penetration or softening point	To check storage temperature To check for binder hardening(1)	a) Daily b) In case of doubt
Additive Silos	As set out in quality plan	To ensure correct feed rates for additives	As set out in quality plan
Mixed asphalt	Temperature	To ensure temperature conforms	a) Every batch or continuously

(1) Binder can harden during storage, particularly when circulated. The quality plan should state the 'safe' storage period for binder in its tank configuration and require testing if that period is exceeded without fresh deliveries. In the absence of other information, a period of two weeks should be adopted

TABLE R27A(b) - INSPECTION AND TEST FREQUENCIES FOR ADDITIVES(2)		
INSPECTION/TEST	**PURPOSE**	**FREQUENCY**
Appropriate tests to determine intrinsic properties	To confirm characteristics of product or check compliance with specification	a) Source approval prior to initial use b) As stated in the quality plan
Inspection of delivery ticket	To check that consignment is as ordered and from the correct source	Each delivery
Organoleptic check of consignment	For comparison with normal appearance	Each delivery, if practicable; otherwise in accordance with quality plan

(2) This table may include the results of tests and inspections by the additive supplier as part of the Process Control System

TABLE R27A(c) - INSPECTION/TEST FREQUENCIES FOR ASPHALT TO BE DELIVERED		
PRODUCT INSPECTION/TEST	**PURPOSE**	**FREQUENCY**
Organoleptic check on mixed asphalt	For comparison with normal appearance with respect to grading, evenness of mixing and adequacy of coating	Every load
Temperature	To ensure material conforms with Clause 5 or other requirements	a) As required under Process Control b) Whenever samples are taken
Grading, Binder Content, Voids, Maximum Density and Binder Film Index	To ensure material conforms to Clause 4	

TABLE R27A(c) - INSPECTION/TEST FREQUENCIES FOR ASPHALT TO BE DELIVERED		
PRODUCT INSPECTION/TEST	**PURPOSE**	**FREQUENCY**
Other design characteristics	To assess conformity	As detailed in quality plan
Suitability of delivery vehicles by visual assessment	To check adequacy of insulation	Prior to first use and in case of doubt
Cleanliness of delivery vehicles by visual assessment	To avoid contamination	Every load prior to loading1

TABLE R27A(d) - PLANT CALIBRATION REQUIREMENTS			
ITEM OF PLANT	**INSPECTION/TEST**	**PURPOSE**	**MINIMUM FREQUENCY**
Weighing equipment	Visual inspection	To ascertain that weighing equipment is functioning correctly	Daily
	Testing of weighing accuracy	To ensure accuracy within quality plan requirements	a) On installation (3) b) Annually c) In case of doubt
Admixture dispensers	Organoleptic inspection	To ascertain that the dispenser is functioning correctly	First batch of the day containing admixture
	Test for accuracy	To ensure accuracy within quality plan requirements	a) On installation (3) b) Annually c) In case of doubt
Flow meters	Comparison of the actual amount with the metered amount by reconciliation	To ensure accuracy within quality plan requirements	a) On installation (3) b) Annually c) In case of doubt
Batching system (on batch plants)	Comparison of actual mass of constituents in the batch with the intended mass using the method prescribed in the quality plan	To ascertain the batching accuracy in accordance with the quality plan	a) On installation (3) b) Annually c) In case of doubt
Proportioning system (on continuous plants)	Comparison of actual mass in a measured period of time with the intended mass using the method prescribed in the quality plan	To ascertain the accuracy in accordance with the quality plan	a) On installation (3) b) Annually c) In case of doubt
Temperature Monitoring equipment	Visual	To ascertain the equipment is functioning correctly	Daily
	Test of accuracy	To ensure correct temperatures are recorded	a) On installation(3) b) Annually c) In case of doubt

(3) or after comprehensive repair.

ATTACHMENT R27B

ASSESSMENT AND REGISTRATION OF ASPHALT MIX DESIGNS

1. SUBMISSION

The Contractor must submit the mix design together with supporting documentary evidence and laboratory and plant test results for mix and material properties to DPTI.

The following details of Nominated Mix (NM) must be submitted:

(a) Constituent materials:

(i) Aggregates - source, geological type,

(ii) Added Mineral Filler - type, source

(iii) Binder - source, class or grade,

(iv) Bitumen Adhesion Agent - name, type, source, SDS,

(v) Relevant test results verifying material properties for the above mentioned materials.

(b) Mix Design:

(i) Design mix maximum density.

(ii) Nominated combined aggregate grading and binder content.

(iii) Test results of the properties in tables of Clause 4 – "Mix Requirements" of each nominated mix.

(iv) Details of mixing plant location, description capacity, history and any relevant information in accordance Clause 2 "Quality Requirements".

(c) Test Results of representative material of each nominated mix produced by the mixing plant from which the asphalt is to be supplied.

(d) Manufacturer's instructions of any additive including submission of SDS.

TABLE R27B(a) - NOMINATED MIXES - TESTING REQUIREMENTS

CHARACTERISTIC (1)	FineAC7	FineAC10	AC10	SMA7	SMA10	AC14	OG10	OG14	AC20
Gyropac Gyratory Compaction									
Raw Aggregate Grading –Individual Sizes (%)	YES	YES	YES	YES	YES	YES	YES	YES	YES
Total Aggregates, Sand & Fillers Absorption (%)	YES	YES	YES	YES	YES	YES	YES	YES	YES
Mix Design Proportions	YES	YES	YES	YES	YES	YES	YES	YES	YES
Combined Gradings (%)	YES	YES	YES	YES	YES	YES	YES	YES	YES
Maximum Density (t/m3)	YES	YES	YES	YES	YES	YES	YES	YES	YES
Voids (%)	YES	YES	YES	YES	YES	YES	YES	YES	YES
Binder Content (%)	YES	YES	YES	YES	YES	YES	YES	YES	YES
Binder Film Thickness (BFT) (µm)	YES	YES	YES	YES	YES	YES	NO	NO	YES
Indirect Tensile Strength (ITS) (kPa)	YES	YES	YES	YES	YES	YES	YES	YES	YES
Tensile Strength Ratio (TSR) (3) (%)	YES	YES	YES	NO	NO	YES	NO	NO	YES
RAP (%) and Viscosity Treatments	YES	YES	YES	NO	NO	YES	NO	NO	YES
Viscosity (pa.s) (2)	YES	YES	YES	NO	NO	YES	NO	NO	YES

(1) Including asphalt dense mixes containing RAP and WMA.

(2) For asphalt dense mixes containing RAP in accordance Clause 4.5.

(3) Tensile Strength Ratio testing must be added to laboratory mix design for mobile plants and must exceed 75%.

Testing must be carried out on representative material of each NM progressively of:

(a) Laboratory prepared mix; and

(b) Plant prepared mix from which the asphalt is to be applied.

When requested, the Contractor must submit a sample of 100 kg of loose asphalt of the nominated mix for verification of performance testing undertaken by DPTI.

2. NOMINATED MIX PERFORMANCE TEST REQUIREMENTS

The Contractor must conduct testing on plant produced mix upon receipt of Asphalt Mix Design Assessment in accordance with Tables R27B(b) & R27B(c).

TABLE R27B(b) - NOMINATED MIXES - MIX PERFORMANCE TEST PROPERTIES (1)

ASPHALT MIX CHARACTERISTIC		WHEEL TRACKING	FLEXURAL FATIGUE DPTI: TP477	RESILIENT MODULUS (1)
No.	Mix Type (including RAP & WMA)	AG:PT/T231 (mm)	Minimum MICRO-STRAIN @ 1 Million Cycles	AS2891.13.1 (MPa) ± 1,000 MPa
1	AC10M320	3.0 ≤ WT ≤ 6.0	180 με	4,800 MPa
2	AC14M320	3.0 ≤ WT ≤ 6.0	170 με	4,600 MPa
3	AC20M320	3.0 ≤ WT ≤ 6.0	150 με	4,300 MPa
4	AC14H320	≤ 3.0	160 με	4,300 MPa
5	AC14M320H	≥ 6.0	200 με	5,200 MPa
6	AC10H35P	≤ 2.0	160 με	6,000 MPa
7	AC14H35P	≤ 2.0	150 με	5,800 MPa
8	AC10H15E	≤ 3.0	300 με	2,700 MPa
9	AC14H15E	≤ 3.0	290 με	2,700 MPa
10	AC10M35P	≤ 3.0	170 με	5,500 MPa
11	AC14M35P	≤ 3.0	160 με	5,300 MPa
12	AC10M15E	≤ 4.0	330 με	2,400 MPa
13	AC14M15E	≤ 4.0	310 με	2,500 MPa
14	AC10M5EP	≤ 2.0	225 με	6,500 MPa
15	AC14M5EP	≤ 2.0	200 με	6,600 MPa
16	SMA7M15E	-	-	-
17	SMA10M15E	≤ 3.0	350 με	2,000 MPa
18	SMA10M5EP	≤ 3.0	250 με	5,000 MPa

(1) Minimum Testing Frequency (per Calendar Year). The Contractor must carry out performance testing if the total asphalt amount is greater than 5,000t per mix per calendar year and for special asphalt mixes including SMA10 or as requested by DPTI Asphalt Engineer. The Contractor must also carry out additional performance testing for every 20,000t per mix per calendar year.

The Nominated Mixes must be tested as required by Table R27B(c) and to meet the requirements of R27B(b).

TABLE R27B(c) - NOMINATED MIXES - TESTING REQUIREMENTS									
CHARACTERISTIC[(1)]	**FineAC7**	**FineAC10**	**AC10**	**AC14**	**AC20**	**SMA7**	**SMA10**	**OG10**	**OG14**
Gyratory Compaction									
Tensile Strength Ratio (TSR) (%)	NO	NO	YES	YES	YES	NO	NO	NO	NO
Slab Compaction									
Resilient Modulus	NO	NO	YES	YES	YES	YES	YES	NO	NO
Flexural Fatigue	NO	NO	YES	YES	YES	YES	YES	NO	NO
Wheel Tracking	NO	NO	YES	YES	YES	YES	YES	NO	NO

(1) Including asphalt dense mixes containing RAP and WMA.

3. ASPHALT MIX DESIGN ASSESSMENT PROGRESSION

The following general stages apply to an asphalt mix design:

(a) Laboratory assessment,

(b) Plant production assessment,

(c) Performance testing assessment,

(d) Field Inspection (for surface course mixes).

On an ongoing basis, the following applies to an asphalt mix design:

(e) Plant production assessment including process control monitoring,

(f) Performance testing on a minimum yearly basis.

If at any stage DPTI deems a mix to be unsatisfactory, the registration may be withdrawn as indicated in Clause R27.4.1.3 “Variations to Nominated Mixes”.

4. LABORATORY ASSESSMENT

The laboratory mix design must incorporate the requirements of Clause R27.4 including following minimum requirements:

(a) Design grading curve based on raw aggregate gradings,

(b) Five point binder content verses voids laboratory analysis (washout binder content not required) using standard bitumen,

(c) Determination of design binder content at required target air voids,

(d) Provision of all R27.4.8 requirements

(e) Plant trial of mix to verify aggregate gradings and design binder content,

The Contractor must undertake the testing specified in this Part & Table R27B(d) and submit the mix design together with supporting documentary evidence and laboratory and plant test results for mix and material properties to DPTI.

TABLE R27B(d) – INITIAL MIX DESIGN TESTING					
CLAUSE REF.	**SUBJECT**	**PROPERTY**	**TEST PROCEDURE**	**TEST FREQUENCY**	**ACCEPTANCE LIMITS**
3.1	Materials for Asphalt	Binder, Flux and Cutter	Refer Clause 3.1	Refer Clause 3.1	Refer Clause 3.1
		Aggregate, Sands & Mineral Filler	Refer Clause 3.1	Refer Clause 3.1	Refer Clause 3.1
		Hydrated Lime	Refer Clause 3.1	Refer Clause 3.1	Refer Clause 3.1
3.2	Reclaimed Asphalt Pavement Material (RAP)	Binder Content (wash out) & Grading	AS 2891.3.3	Refer Clause 3.2	Report Only
		Asphalt Binder Viscosity	TP 664	Refer Clause 3.2	Report Only
		Moisture Content	AS 1289.B1.3	Refer Clause 3.2	Report Only
4.0	Mix Requirements	Total Absorption by Combined Agg.	AS 2891.9.2	Attachment R27B	Report Only
		Mix Design Proportions	Refer PC044	Attachment R27B	Report Only
		Binder Content & Combined Grading	AS 2891.3.3	Attachment R27B	Refer Clause 4.3, 4.4, 4.6 & 4.7 and Asphalt Mix Design Assessment
		Bulk Density	AS 2891.9.2 AS 2891.9.3	Attachment R27B	Report Only
		Absorption of Compacted Specimens	AS 2891.9.2	Refer Table 6.1	≤ 2.0% for AC20 ≤ 1.0% for SMA
		Maximum Density	AS 2891.7.1	Attachment R27B	Report Only
		Voids on Compacted Specimens	AS 2891.8	Attachment R27B	Refer Clause 4.3, 4.4, 4.6 & 4.7 and Asphalt Mix Design Assessment
		Void in Mineral Aggregate (VMA)	AS 2891.8	Attachment R27B	Refer Clause 4.3 & 4.4
		Tensile Strength Ratio (TSR)	AGPT/T232	Attachment R27B	Refer Clause 4.3 & 4.4
		Binder Film Index (BFI)	AS 2891.8	Attachment R27B	Refer Clause 4.3 & 4.4
		Indirect Tensile Strength (ITS)	TP 460	Attachment R27B	Refer Clause 4.3
		Viscosity of the Binder of the Combined Mix Containing RAP	AGPT/T192	Attachment R27B	Refer Clause 4.5

DPTI will compare the mix design and test results submitted with the requirements contained in:

(a) Parts R15 & R27.

(b) AS 2150, Sections 4, 5 and 6.

(c) AGPT04B-14 Guide to Pavement Technology – Part 4B: Asphalt.

5. PLANT PRODUCTION ASSESSMENT

The Contractor must submit all production test data to DPTI and the following analysis:

(a) Sieve data is within the design grading curve envelope;

(b) Binder content and air voids meet the nominated binder content; and

(c) Constructed pavement air voids confirm mix design suitability.

When satisfied that the mix meets the specified requirements, DPTI will note the summary of test results and give notice for performance testing via the Asphalt Mix Design Assessment.

6. INITIAL PERFORMANCE TESTING ASSESSMENT

The Contractor must undertake performance testing on the NM and submit performance test results to DPTI.

7. REGULAR MIX DESIGN ASSESSMENT

The Contractor must submit asphalt plant production test data and material test data to DPTI to support the NM.

The Contractor must demonstrate to DPTI the following:

(a) The average air voids determined from production tests per mix are within ± 0.2% from target for 25 consecutive discrete samples.

(b) The average binder content determined from production tests per mix must not be lower than 0.05% from the nominated binder content for 25 consecutive discrete samples.

8. REGULAR PERFORMANCE TESTING ASSESSMENT

Performance testing must be undertaken in accordance with Tables R27B(a) and R27B(b) and submit them to DPTI.

9. Registration

DPTI will maintain a register of assessed asphalt mixes. DPTI will not issue additional mix register numbers if asphalt mixes are equal or less than 10% RAP incorporation, Warm Mix Asphalt Additives or Foaming Technique are used. The “Mix Design Assessment” will consist of 5 pages, with a summary page that can be issued to the client. The “Registered Mix” number will be of the form:

AASSDBBBZ-CCC-XXXX

where: AA = Mix Type

SS = Nominal Mix Size (mm)

D = Duty Type

B = Binder Type

Z = additional suffix, e.g., L for Hydrated Lime, R for Regular, H for High Binder, and for inclusion of RAP, each 5% is given a number (1 to 9 for 5% through 45%).

CCC = Contractor’s name and plant

TXXX = sequential number for each mix combination, beginning at T001

PART R28

CONSTRUCTION OF ASPHALT PAVEMENTS

CONTENTS

1. GENERAL
2. QUALITY REQUIREMENTS
3. MATERIALS
4. CONSTRAINTS TO THE PLACEMENT OF ASPHALT
5. CRACK SEALING
6. PAVEMENT SURFACE PREPARATION
7. PLACEMENT OF ASPHALT
8. SAMPLING AND TESTING
9. PROPERTIES OF FINISHED ASPHALT PAVEMENT
10. DISCARDED ASPHALT
11. TEST PROCEDURES
12. HOLD POINTS

1. GENERAL

.1 This Part specifies the requirements for the construction of asphalt pavements.

.2 In the event of any inconsistency, ambiguity or discrepancy between any of the Contract Documents, the order of precedence must be as follows:

1. this Part R28;
2. AS 2150 "Hot Mix Asphalt-A Guide to Good Practice"; and
3. Austroads Guide to Pavement Technology Part 4B “Asphalt”

.3 The following definitions apply to this Contract:

“Additive” means an organic, chemical, or emulsion product used to assist in the compaction of asphalt.

"Coarse Asphalt Mix" (AC) means asphalt of a coarse nature suitable for Medium, Heavy and Very Heavy Duty applications unless used in Fine Asphalt Mix applications or expressly noted otherwise.

"Fine Asphalt Mix" (FineAC) means asphalt of a fine nature suitable for Light to Medium Duty applications and suitable for DPTI patch maintenance, bikeways, footpaths, car parks and Local Government residential streets.

“Hot Mix Asphalt” (HMA) means an Asphalt Mix manufactured and compacted at standard temperatures. It may also mean Hot Mix Asphalt manufactured at standard temperatures but with the addition of an “Additive” to assist in meeting compaction requirements and required to be registered as a different mix.

“Special Process” means the Contractor’s documented and demonstrated techniques to achieve the requirements of this Part.

“Warm Mix Asphalt” (WMA) means Hot Mix Asphalt manufactured and compacted at lower temperatures with the addition of an “Additive” or by using the foaming technique.

.4 The asphalt must be placed in the configuration specified in **Contract Specific Requirements** “Pavement Work” or on the Drawings.

2. QUALITY REQUIREMENTS

.1 The Contractor must prepare and implement a Quality Plan that includes detailed procedures for:

(a) Provision for traffic (if not covered in the Traffic Management Plan)

(b) Preparation of the surface

(c) Setting out

(d) Tack Coating

(e) Placing the mix

(f) Placement of any mix less than 30 mm thick (vide Clause 4.1)

(g) Placement of any mix between 10 – 15oC or below 10oC (vide Clause 4.2)

(h) Protection of Wearing Course not open to traffic (vide Clause 4.3)

(i) Placement of crack sealing (including details of nominated product)

(j) Placement of Open Graded & Stone Mastic Asphalt mixes (vide Clause 4.1)

(k) Level control and Compaction

(l) Finished Asphalt pavement properties

(m) Sampling and Testing.

.2 If not provided previously the procedures must be submitted at least 28 days prior to the commencement of site work.

.3 Provision of the procedures listed in this Clause shall constitute a **HOLD POINT**.

3. MATERIALS

.1 Asphalt must comply with Part R27 "Supply of Asphalt".

.2 Sprayed bituminous surfacing must comply with Part R26 "Application of Sprayed Bituminous Surfacing".

4. CONSTRAINTS TO THE PLACEMENT OF ASPHALT

General

.1 Where a layer of asphalt is laid less than 30 mm in thickness for any reason except Fine Dense Mixes as defined in Clause R27.4.4 “Fine Dense Mix Asphalt” is deemed to be a "special process".

.2 Open Graded Asphalt (OG) and Stone Mastic Asphalt (SMA) must meet the requirements of Part R35 “Surface Characteristics”.

.3 Unless specified otherwise in the **Contract Specific Requirements** or on the Drawings, waterproofing membranes must be applied prior to placement of OG and SMA.

.4 Modified binder mixes must not be used when the time between batching and delivery into the paver hopper exceeds 3 hours, unless the Contractor can demonstrate that such a mix can be adequately compacted.

Temperature Restrictions

.5 Asphalt mix must only be placed at temperatures which conform with AS 2150-Clause 12.4 "Asphalt Temperatures". The minimum mix temperature referred to in AS 2150-Table 12 must be the temperature of the mix at the time that it is first placed on the surface.

.6 Minimum spreading temperatures for dense graded and stone mastic asphalt mixes containing C320 and C600 binder must be 100 C higher than in AS 2150-Table 12, whereas for mixes incorporating modified binders the temperatures must be 200 C higher. The range of mix temperatures must be highlighted accordingly.

.7 Spreading temperatures for OG, including those with modified binders must be as indicated in AS 2150 Clause 12.4 “Asphalt Temperature”.

.8 Asphalt conforming to the requirements of Clause R27.5.4 “Manufacture of Asphalt with Additive or Foaming Technique” may be compacted at lower temperatures to those required in this clause. The minimum compaction temperature at time of placement must not be below 120oC.

.9 Applicability of mix types for a range of pavement layer thickness and temperatures (measured in the shade) must be as indicated in Table 4.8.

TABLE 4.8 - MIX TYPES FOR DENSE GRADED ASPHALT		
Pavement Surface Temperature (ºC)	**Nominal Layer Thickness (mm)**	
	≤ 40mm	**41 to 100mm**
0ºC to <10ºC	Special Process	HMA with Additive
10ºC to 20ºC	HMA with Additive (if <15ºC) HMA or HMA with Additive (if ≥ 15ºC)	HMA or HMA with Additive
> 20ºC	HMA with Additive or HMA or WMA	HMA or HMA with Additive or WMA

Wearing Course Restrictions

.10 The wearing course must not be placed on a bituminous seals including a SAMI seal earlier than one day and no later than seven days of the seal being commenced.

.11 The wearing course must not be laid earlier than 2 weeks prior to the opening to traffic, unless the Contractor prepares and implements a procedure to protect the wearing course from any deleterious environmental effects.

.12 Traffic must not be permitted on any wearing course until it has cooled to a temperature below 65oC except for Stone Mastic Asphalt (SMA), Heavy Duty Dense Graded Asphalt (HD) and Very Heavy Duty Dense Graded Asphalt (VHD), which must be not be trafficked until it has cooled to a temperature below 30ºC. Water sprays must not be used to cool the road surface until the surface temperature is below 70oC.

.13 Placement of asphalt wearing course must meet the requirements of Part R35 “Surface Characteristics”.

.14 Refer to **Contract Specific Requirements** or Part CH20 "Provision for Traffic" for any additional constraints relating to traffic management.

5. CRACK SEALING

General

.1 Prior to the placement of asphalt for all pavement types, spray seals or wearing course any remaining cracks greater than 3 mm in width must be sealed with an approved crack sealant.

.2 Crack sealing treatment must be undertaken in accordance with the requirements of Part R37 “Supply of Pavement Crack Sealant” & Part R38 “Application of Pavement Crack Sealant” and additional clauses below.

.3 At least 14 days prior to the use of the product, the Contractor must submit the manufacturer’s instructions and product performance data.

.4 Submission of the information shall constitute a **HOLD POINT**.

Material

.5 The crack sealing compound must be Class 170 bitumen to AS 2008 "Residual Bitumen for Pavements", modified with an appropriate polymer, designed to penetrate the crack, adhere to the crack surface and resist further crack activity.

.6 The material must remain stable on the pavement surface during periods of extreme temperature.

.7 Gritting off of sealant or plugging excessively deep cracks prior to sealing must be undertaken with SA 5-2, 5-2 mm Sealing Aggregate.

Crack Sealing Treatment

.8 Prior to placement of sealant, all cracks must be thoroughly cleaned of foreign material, without damage to the adjoining sound pavement, to provide a clean, dry surrounding. If the pavement is damp, warm/hot compressed air may be used in the drying of the surface of the crack.

.9 Crack sealing must not be undertaken unless the surfaces of the cracks are dry. Cracks must be cleaned to a depth of between 10 - 15 mm. In excessively deep cracks, the crack may be plugged with

SA 5-2, 5-2 mm Sealing Aggregate to within 10 - 15 mm of the pavement surface. All cracks must be filled with sealant material to a level of not less than 10 mm below the pavement surface.

.10 The level of sealant after gritting must be flush with the adjoining road pavement. The width of the visible bond on the pavement surface must be as narrow as is practical. Run out of the sealant over the asphalt surface beyond the crack length will not be permitted.

Gritting

.11 The Contractor must place 5-2 mm Grit on the surface of all sealed material while it is hot and prior to vehicular traffic. Grit must be placed at the minimum application necessary to prevent pick-up of the sealant by traffic.

.12 Following completion of the crack sealing treatment A **HOLD POINT** must apply.

6. PAVEMENT SURFACE PREPARATION

General

.1 Pavement surface preparation must be carried out in accordance AS2150 Clause 10 “Preparation of Surface to be paved” and additional clauses below.

.2 A **HOLD POINT** shall apply prior to the placement of asphalt.

Overlay Placed to Specified Design Levels

.3 This Sub-clause only applies where an asphalt overlay is to be placed to specified design levels on an existing pavement.

.4 The existing pavement must be surveyed. For each layer, the required thickness of asphalt must be written on the existing surface at each point where there is a specified level.

.5 Crack sealing must be applied to an existing pavement in accordance R28 Clause 5.0 “Crack Sealing”.

.6 Where multiple layers are to be placed, the Contractor must prepare a plan and cross sections showing the layer configurations and areas to be planed.

.7 Submission of the survey data and overlay plan shall constitute a **HOLD POINT**.

Planing

.8 Where the minimum layer thickness cannot be achieved within the specified tolerances, the existing surface must be planed to achieve the required layer thickness.

.9 Where an overlay has multiple layers, edge planing must be undertaken for each layer so as to ensure that the minimum layer thickness is achieved and is keyed into the existing pavement.

.10 All planing must be carried out in accordance with Part R30 "Cold Planing".

.11 Following completion of the preparation of the surface and prior to the application of the tack coat a **HOLD POINT** shall apply.

Tack Coating

.12 A tack coat must consist of CRS grade emulsion to AS 1160 "Bitumen Emulsions for Construction and Maintenance of Pavements", uniformly sprayed at ambient temperature (for 60% residual bitumen emulsions or in accordance with the manufacturer's specification for higher percentages of bitumen).

.13 Tack coat must be applied at the following locations:

(a) at vertical edges between old and new asphalt pavements;

(b) on top of existing asphalt layers; and

(c) on top of new asphalt not placed on the same day.

.14 The tack coat for (a) above must be applied at a rate sufficient to ensure bond at the joint between the old and new asphalt pavements.

.15 The tack coat for (b) and (c) must be applied at a rate between 0.2 l/m^2 and 0.4 l/m^2 of residual binder to ensure adequate bond between pavement layers and must be uniformly applied to the surface prior to placement of asphalt.

.16 Tack coat must be applied with a tolerance of ± 0.05 litre/square metre of the specified application rate. The Contractor must supply the actual spread rates, including litres used and area covered for each lot.

.17 Asphalt must not be placed until the tack coat is broken. Any construction traffic is to be minimised. The Contractor must coordinate work so that no tack coated surface is opened to traffic.

7. PLACEMENT OF ASPHALT

General

.1 The Contractor must spread asphalt so as to:

(a) minimise segregation and loss of materials;

(b) produce a homogeneous product;

(c) achieve the specified in-situ air voids relative compaction for Dense Graded Asphalt, Stone Mastic Asphalt or Open Graded Asphalt before the asphalt has cooled; and

(d) provide the specified thickness of asphalt.

.2 Spreading methods must follow the guide to good practice set out in AS 2150-Section 12 "Spreading". The paver must be a self-propelled paving machine with automatic level control.

.3 Hand placement of asphalt must be used only for minor correction of the existing surface and in areas where placement with a paver is impracticable. Laying of mix must be in the direction of traffic.

.4 Other than in an emergency situation, if the Contractor proposes to source asphalt from another plant during a day's production, the Contractor must provide 48 hours prior notice. A procedure to ensure traceability of the product during placement must be provided prior to production of mix from an alternative plant.

.5 If it becomes necessary to use more than one plant because of a plant breakdown, the Contractor must provide immediate notification and details of the alternative mix.

.6 Each course must be compacted uniformly to the full depth and over the full width. Compaction methods must be in accordance with AS 2150-Section 13 "Compaction". The Contractor must ensure that compaction does not commence before any deficiencies in the spreading of the mix are corrected.

.7 At the time of placing asphalt, the existing surface must be dry.

.8 A **HOLD POINT** applies between individual layers of asphalt.

Protection of Road Fixtures

.9 The Contractor must prevent tack coat, binder, aggregate, asphalt or other material used on the work from entering, adhering or obstructing gratings, hydrants, valve boxes, inspection pit covers, kerbs and other road fixtures.

Joints

.10 Joints must be constructed in accordance with AS 2150-Clause 12.6 "Joints" and the following additional requirements:

(a) The mix must be spread in a manner which ensures continuity of placing and the number and extent of joints is kept to a minimum.

(b) Must ensure that the density and surface finish at joints satisfies the requirements of this Specification, and the joints are well sealed.

(c) Joints between old and new pavements, and between sections of work which have not been placed on the same day must have tack coat applied in accordance with Clause 6.4 "Tack Coating".

(d) Longitudinal joints in successive layers must be staggered at least 150 mm. Transverse joints in successive layers must be staggered at least 1.0m. Permanent transverse joints at the starts and ends of runs must be ramped at the maximum rate of 1 in 20 down to a final edge which must not exceed 10 mm in height.

(e) All temporary joints which are to be opened to traffic must be ramped at the maximum rate of 1 in 10 down to a final edge which must not exceed 10 mm in height.

(f) Prior to subsequent laying of mix adjacent to a temporary joint, the temporary ramp must be cut back and removed to expose a near vertical face of fresh dense asphalt prior to the subsequent laying of the adjacent run.

(g) In making the joint along any adjoining edge such as kerb, gutter or an adjoining pavement, and after the mix is placed by the finishing machine, sufficient hot material must be carried back to fill any space left open. This joint must be properly "set-up" with the back of a rake or lute at proper height and level to receive the maximum compression under rolling.

(h) The wearing course for all pavement types and pavement overlay must be laid in such a manner that the longitudinal joints correspond as far as practicable with the lane lines and, in particular, avoid the wheel paths.

(i) Longitudinal surface joints must not be in the wheel path.

8. SAMPLING AND TESTING

.1 Sampling locations for density compliance assessment must be undertaken on a stratified random basis in accordance with AS 1289.1.4.2 “Selection of Sampling or Test Sites - Stratified Random Number Method”.

.2 The sampling frequency must be in accordance with:

TABLE 8(a) - SAMPLING AND TESTING FREQUENCY FOR COARSE DG, OG & SMA	
LOT PRODUCTION QUANTITY (tonnes)	**MINIMUM NUMBER OF CORE COMPACTION SAMPLES AND TESTS**
30 - 150	4
151 - 300	6
> 300	6 plus 1 for each additional 100 tonne of delivered mix or part thereof.

TABLE 8(b) - SAMPLING AND TESTING FREQUENCY FOR FINE DENSE MIXES	
LOT PRODUCTION QUANTITY (road length (m))	**MINIMUM NUMBER OF CORE COMPACTION SAMPLES AND TESTS**
0 - 50	0
51 - 400	4
> 400	4 plus 1 for each additional 150 m of road length or part thereof.

.3 All cores taken for a pavement must be reported for voids and thickness. No core must be taken within 150 mm of a free edge, and no more than one core per lot must be taken within 150 mm of a joint.

.4 The Contractor must provide results of all cores taken from the pavement, notwithstanding whether these cores are for the Contractor’s own internal processes or otherwise. Tests for density, air voids and layer thickness must be carried out on each core.

.5 Coring is not required when asphalt is placed on concrete bridge decks.

9. PROPERTIES OF FINISHED ASPHALT PAVEMENT

General

.1 Finished asphalt must comply with the requirements specified in Clause 13 "Verification Requirements and Records".

Compaction Acceptance Criteria – Quality Standards

.2 Statistical analysis using an unknown variability scheme must be used to determine acceptance of the compaction of asphalt layers.

.3 Compliance will be based on the analysis of a random set of tests taken from each lot of the works. Compliance must be determined indirectly in terms of percentage defective compared to the desired quality of the lot (10% defective) at either the low or high limit value.

.4 A 90% probability assurance is required that accepted lots comply with the desired quality at either the low or high limit value. The acceptability characteristic k, quantified in Table 9.2 "k Value" is used to provide this statistical assurance. A lot must not exceed a day’s work. Compliance will apply to the whole of the lot of the works from which the set of tests is taken.

Relative Compaction

.5 The relative compaction of a core must be the bulk density expressed as a percentage of mean maximum density and reported in in-situ air voids terms using AS 2891.8. The mean maximum density value must be the arithmetic mean of the test results for that mix within a Lot, provided that they meet all of the following criteria:

(a) The binder content of the samples tested are within ± 0.3% of the job mix binder content; and

(b) There has been no change in mix components or proportions.

.6 A low and high characteristic value of air voids content (Lvc and Hvc) of a lot must be calculated from the formula, x - ks in the case of the low value and x + ks in the case of the high value. x and s are the mean and standard deviations respectively of the individual air voids test values of the lot and k is a constant depending on the number of test values in the lot as shown in Table 9.6.

TABLE 9.6 - k VALUE

Number of Tests	k	Number of Tests	k
4	0.62	13	0.877
5	0.68	14	0.890
6	0.72	15	0.901
7	0.76	16	0.910
8	0.78	17	0.919
9	0.81	18	0.928
10	0.83	19	0.937
11	0.85	20	0.946
12	0.86	21	0.952

.7 Compaction air voids data must be calculated and reported to two decimal places and rounded to one for the first decimal point as described in AS 2706-Clause 3.2 “Rounding to One Unit in The Last Place Retained”.

Compaction Criteria

.8 Compaction must comply with Table 9.8.

TABLE 9.8 - COMPACTION CRITERIA

Asphalt Mixes	Pavement Layer	Characteristic Air Voids (%) - Min	Characteristic Air Voids (%) - Max
AC10	Wearing & Levelling Layers	4.0 %	8.0 %
AC14	Levelling, Intermediate & Base Layers	2.5 %	7.0 %
AC20	Intermediate & Base Layers	2.5 %	7.0 %
AC14 High Binder	High Binder Base Layer	1.0 %	5.0 %
Stone Mastic Asphalt	Wearing Course	2.5 %	7.0 %
Open Graded Asphalt	Wearing Course	18.0 %	25.0 %
FineAC7	Wearing Course	2.0 %	6.0 %
FineAC10	Wearing Course	2.5 %	7.0 %

Tolerances on Asphalt Layers

.9 If the asphalt is to be placed to specified design levels, the finished level of asphalt layers must be as specified in Contract Specific Requirements “Pavement Work” or on the Drawings.

.10 Where asphalt is to be placed adjacent to kerb and gutter, the wearing course must be constructed within a tolerance of +5 mm, -0 mm. At joints between the surface of new and existing pavements, the levels must be flush. If tolerances of base courses and intermediate courses are not specified in Contract Specific Requirements “Pavement Work” or on the Drawings, the tolerance must be 10 mm.

.11 Tolerances on the specified lateral position of asphalt treatments must be +/- 50 mm.

.12 The thickness of Dense Graded Mix, Stone Mastic and Open Graded Asphalt Wearing Course laid on asphalt base must be determined from the specified spread rate using an assumed density of 2 400 kg/cubic metre, 2 400 kg/cubic metre and 1 900 kg/cubic metre respectively.

Surface Irregularity and Finish

.13 The surface irregularities of asphalt courses, as measured by deviation from a 3 m straight edge, must not exceed:

Wearing Course	5 mm
Correction (Levelling) and Intermediate Courses	10 mm
Base Courses	15 mm
Base Courses (where no Correction and Intermediate Courses)	10 mm

.14 The surface irregularities of asphalt courses at longitudinal and transverse joints, as measured by deviation from a 1.2 m straight edge placed centrally and at right angles over the joint, must not exceed:

Wearing Course	3 mm
Correction and Intermediate Courses	5 mm

.15 The surface of finished asphalt courses must be free of segregated or "bony" areas, soft and "fatty" areas, ravelling and loose material, surface cracking, shoving and ruts.

Major Project Requirements

.16 Where a project is estimated to contain more 50,000 ton of asphalt (“Major Project”), the Contractor must:

(a) use a material transfer device to place asphalt for all layers of asphalt pavement except localised areas within the acceptance of the Principal to increase the quality and consistence of asphalt placement and properties;

(b) shall supply and place wearing course mixes to meet surfacing characteristics in accordance with Part R35 “Surfacing Characteristics”; and

(c) Use asphalt complying with Table 9.16 on any bridge decks.

TABLE 9.16 The Pavement Structure of Asphalt Mixes and Waterproof Membranes for Concrete Bridge Deck	
Wearing Course [(1)]	AC10M15EL, OG14M15EL or SMA10M15EL
Waterproofing Membrane	SAMI - 10mm S25E (1.8l/m^2) or Sprayed Seal - 7mm S20E (1.4l/m^2)
Correction Course [(2)]	AC10M15E or AC14M15E
Waterproofing Membrane	SAMI - 10mm S25E (1.8l/m^2)
Primer Binder	AMCO (0.5l/m^2)
Concrete Deck	Concrete Deck

[(1)] Waterproof membrane only required beneath the “OG” Wearing Course mix.

[(2)] More than one layer may be required and also plane out in some areas to achieve the required surface profile to improve the rideability.

.17 The Contractor must use a hand-held gas flaming torch or equivalent technique to improve the asphalt joints if a parallel asphalt mat is not placed on the same day.

.18 Asphalt compaction ranges shall use Table 9.5(b) “Asphalt Compaction Criteria” and replaces Table 9.18. Target values are a guide and are not binding.

TABLE 9.18 - COMPACTION CRITERIA				
Pavement Layers	**Asphalt Mixes**	**In-situ Voids Target (%)**	**Characteristic Air Voids (%) - Min**	**Characteristic Air Voids (%) - Max**
Wearing Course	Dense Graded Mix	6.5 %	4.0 %	8.0 %
Levelling Course	Dense Graded Mix	6.0 %	4.0 %	8.0 %
Intermediate Courses	Dense Graded Mix	5.0%	2.5 %	7.0%
Base Course	Dense Graded Mix	4.0%	2.5 %	7.0 %
High Binder Base Course	Dense Graded Mix	2.5 %	1.0 %	5.0 %
Wearing Course	Stone Mastic Asphalt	5.0 %	2.5 %	7.0 %
Wearing Course	Open Graded Asphalt	22 %	18.0 %	25.0 %
Wearing Course	FineAC7	4.0 %	2.0 %	5.0 %
Wearing Course	FineAC10	4.5 %	2.5 %	6.0 %

A **HOLD POINT** shall apply between individual layers of asphalt and also waterproof membrane.

10. DISCARDED ASPHALT

.1 All excess or discarded asphalt remains the property of the Contractor and must be disposed of by the Contractor.

11. TEST PROCEDURES

.1 The Contractor must use the following test procedures (refer http://www.dpti.sa.gov.au/contractor_documents) to verify conformance with the Specification:

TEST	TEST PROCEDURE
Site Selection by Stratified Random Technique	AS 1289.1.4.2
Sampling of Asphalt	TP 425
Determination of the Maximum Density of Asphalt - Water Displacement Method	AS 2891.7.1
Bulk Density of Compacted Asphalt Specimens • Presaturation Method for Dense Graded • Mensuration Method for Open Graded	 AS 2891.9.2 AS 2891.9.3
Measurement of Thickness or Height of Compacted Asphalt	ASTM D3549
Voids - Calculation	AS 2891.8

12. HOLD POINTS

.1 The following is a summary of Hold Points referenced in this Part:

CLAUSE REF.	HOLD POINT	RESPONSE TIME
2.	Submission of Procedures (if not in Post Tender Submission)	7 days
5.3	Submission of crack sealing product	7 days
6.2	Prior to the placement of asphalt.	2 hours
6.7	On submission of survey data and overlay plan prior to overlay work	2 days
6.11	Following completion of the preparation of the surface and prior to the application of the tack coat	1 hour
7.8	Between individual layers of asphalt	6 hours

1. VERIFICATION REQUIREMENTS AND RECORDS

The Contractor must supply written verification that the following requirements have been complied with and supply the verification with the lot package.

CLAUSE REF.	SUBJECT	PROPERTY	TEST PROCEDURE	TEST FREQUENCY	ACCEPTANCE LIMITS
4.5	Temperature Restriction	The Placement of Asphalt	-	-	Refer Clause 9. and Report
4.13	Wearing Course	Surface Characteristics	Refer Part R35	Refer Part R35	Refer Part R35 or **Contract Specific Requirements**
5.2	Crack Sealing	Pavement Crack Treatment	Refer Part R37	Calculated for total volume of sealant	Refer Clause 5. and Report
6.15	Tack Coat	Application Rate	Calculated by dividing volume by area covered (calculations to be submitted)	Calculated for each application of tack coat	± 0.05 l/m^2 of the specified application rate
8.	Coring	Sampling & Testing	AS 1289.1.4.2	Refer Clause 8.0	Refer Clause 9. and Report
9.	Compaction	In-situ Air Voids	AS 2891.8	Refer Clause 8.0	Refer Clause 9.
9.(1)	Asphalt Laid to Design Levels or	Level of course	As specified in Part CH30	As specified in Part CH30	Unless detailed otherwise in Part R20 or the **Contract Specific Requirements** the following must apply: Wearing Course: ± 5 mm of nominal thickness Other layers: ± 10% nominal thickness
	Asphalt Laid to Nominal Thickness or	Average Layer Thickness	ASTM D3549	Refer Clause 8	Wearing Course: ± 5 mm of nominal thickness Other layers: ± 10% nominal thickness
		Minimum Layer Thickness	ASTM D3549	Refer Clause 8	Nominal thickness minus 5 mm

(1) Asphalt placement method to be clarified with the Principal prior to placement, and verification to be provided by contractor in accordance with the method specified for determining layer thickness.