SPECIFICATION 504

DENSE GRADED ASPHALT WEARING COURSE

REVISION REGISTER			
Clause Number	**Description of Revision**	**Authorised By**	**Issue Date**
504.02, 504.26.03.5, 504.32.3 & 504.35	Inclusion of Ignition Oven WA 730.2 Test Method for production testing and in requirements for mix design submission	BPC	17/09/2024
504.22 & 504.42.5	Paving Tape details replaced with reference to Specification 511		
Table 504.B1	50 blow clarification for 7 mm Principal Shared Path		
Various	Title updated to Dense Graded Asphalt Wearing Course	BPC	05/02/2024
504.05	Updated Sustainability considerations		
Various	Removal of Open Graded Asphalt – replaced with Specification 516		
Various	Removal of Main Roads Perth 10 mm and 14 mm recipe dense graded mix designs		
Table 504.B1	Inclusion of 7 mm Principal Shared Path volumetrics		
504.55.2	Updated Test Method Reference	BPC	06/04/2022
504.05	New Clause to align with other Specifications	MME	05/08/2021
504.32.7	Formatting change to new Table		
504.34 & 504.35.8	Updated as Workability Additive and requirements for use of Sasobit and Evotherm		
504.35.7 & 504.55.3	Rewording of Test Report distribution		
504.42.5	Added Flexiseal Tape HD 250mm wide		
504.48.1 & 504.49.2	Rewording to vertical face		
504.54.4	Updated wording on roller water		
504.55.3	Minimum time before coring added		
Guidance Note	Rewording to Manager Materials Engineering.		
Whole Document	Removal of Test Method T660		
Whole Document	Rewording Sasobit to Workability Additive		
Whole Document	Formatting Table numbering updated		
Whole document	Reformatted	SCO	22/05/2017

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SPECIFICATION 504

DENSE GRADED ASPHALT WEARING COURSE

GENERAL

504.01 SCOPE

1. The work under this specification consists of the supply and application of dense graded hot-mixed or warm-mixed asphalt for pavement wearing courses. Other wearing courses are addressed in:

   (a) Specification 502 STONE MASTIC ASPHALT

   (b) Specification 516 CRUMB RUBBER OPEN GRADED ASPHALT

   (c) Specification 517 CRUMB RUBBER GAP GRADED ASPHALT

   (d) Asphalt used in an asphalt pavement is addressed in Specification 510 ASPHALT INTERMEDIATE COURSE

2. Details of the location and extent of asphalt work are either summarised at Annexure 504A, or are indicated on the Drawings. ***Details***

3. The Works shall include surface preparation, supply of materials, production, hauling, placing and compaction of asphalt to the areas as shown in the Drawings, or as otherwise directed by the Superintendent, including correction of existing pavement surfaces.

504.02 REFERENCES

1. Australian Standards, Main Roads Western Australia Test Methods, Main Roads Western Australia Standards and Main Roads Western Australia Specifications are referred to in abbreviated form (e.g. AS 1234, MRS 67-08-43 or WA 123). For convenience, the full titles are given below:

Australian Standards

AS 1160	Bituminous emulsions for the construction and maintenance of pavements
AS 1672	Building limes
AS 1726	Geotechnical site investigations
AS 2150	Asphalt – A guide to good practice

Australian/New Zealand Standards

AS/NZS 2891.2.2	Sample preparation – compaction of asphalt test specimens using a gyratory compactor
AS/NZS 2891.10	Moisture content of asphalt
AS/NZS 2891.11	Degree of particle coating

AS/NZS 2891.13.1	Determination of the resilient modulus of asphalt – indirect tensile method

Austroads Test Methods

AG:PT/T234	Asphalt Binder Content (Ignition Oven Method)

MAIN ROADS Test Methods

WA 210.1	Particle Size Distribution of Aggregates
WA 212.1	Aggregate Moisture Content: Convection Oven Method
WA 212.2	Aggregate Moisture Content: Microwave Oven Method
WA 223.1	Crushing Test Value
WA 250.1	Colour of Aggregate
WA 313.2	Surface Profile: Three Metre Straightedge
WA 313.4	Surface Profile: ARRB Profiler
WA 341.1	Colour Saturation of Laterite Asphalt
WA 701.1	Sampling and Storage of Asphalt
WA 705.1	Preparation of Asphalt for Testing
WA 730.1	Bitumen Content & Particle Size Distribution of Asphalt and Stabilised Soil: Centrifuge Method
WA 730.2	Bitumen Content & Particle Size Distribution of Asphalt: Ignition Oven Method
WA 731.1	Stability and Flow of Asphalt: Marshall Method
WA 732.2	Maximum Density of Asphalt: Rice Method
WA 733.1	Bulk Density and Void Content of Asphalt

MAIN ROADS Specifications

Specification 201	QUALITY MANAGEMENT
Specification 511	MATERIALS FOR BITUMINOUS TREATMENTS

504.03 DEFINITIONS

Terminology

1. Unless otherwise detailed in the Contract, the meaning of terms and definitions in this Specification are as follows:

   (a) “asphalt course” comprises one or more layers of a single asphalt type.

   (b) “asphalt layer” comprises a single paving run of uniform asphalt.

   (c) “asphalt wearing course” is that part of the pavement upon which the traffic travels including any dense graded asphalt course immediately below a course of open graded asphalt.

(d) “asphalt pavement” is a pavement, the predominate structural strength of which is provided by asphalt layers.

(e) “reclaimed asphalt pavement (RAP)” is the material reclaimed from an asphalt wearing or intermediate course by cold planning and re-processed by crushing and/or screening for recycling into new asphalt.

504.04 NOT USED

504.05 SUSTAINABILITY CONSIDERATIONS

1. Materials for road pavements shall be managed under the sustainability hierarchy of REDUCE, REUSE and RECYCLE.

2. Unless defined otherwise, the materials described in this specification shall be sourced from quarries of natural materials and shall be crushed or processed as applicable to produce a homogenous material. These materials are a finite resource and waste shall be reduced to a minimum. ***Reduce***

3. Where practical, redundant pavement materials should be recovered and reused, or otherwise recycled to the highest level use practical. RAP and other reused or recycled materials are not permitted in wearing course asphalt, but should be recovered for use in relevant asphalt products, such as intermediate course asphalt. ***Reuse***

4. Recycled materials shall only be included in materials which are designated as recycled. ***Recycle***

PRODUCTS AND MATERIALS

504.06 BITUMINOUS BINDERS

1. Binder used in the production of dense graded asphalt shall be as shown on drawings. Where not shown the binder specified at Clause 504.26 for the relevant asphalt mix shall be used. ***Dense Graded Asphalt***

2. All binders shall conform to the requirements of Specification 511 MATERIALS FOR BITUMINOUS TREATMENTS.

3. **Prior to the use of bitumen or polymer modified bitumen the Contractor shall demonstrate compliance with the properties of the binder for each batch used on the Contract. Audit testing undertaken by the Principal shall not be used to demonstrate compliance.** ***HOLD POINT***

504.07 BITUMEN EMULSION

1. Bitumen emulsion to be used as the tack coat during the preparation of the surface prior to the laying or dense graded asphalt shall be Cationic Slow Setting emulsion grade CSS/170-60 or Cationic Rapid Setting emulsion grade CRS/170-60, both conforming to AS 1160, mixed 50:50 by volume with water.

504.08 AGGREGATE

1. Crushed aggregate, including its source rock, and screened or crushed laterite aggregate shall meet the requirements of Specification 511

MATERIALS FOR BITUMINOUS TREATMENTS. Coarse and fine aggregate used in the manufacture of asphalt shall only consist of crushed rock material.

504.09 – 504.10 NOT USED

504.11 MINERAL FILLER

1. Mineral filler shall meet the requirements of Specification 511 MATERIALS FOR BITUMINOUS TREATMENTS.

504.12 ADHESION AGENT

1. The adhesion agent shall meet the requirements of Specification 511 MATERIALS FOR BITUMINOUS TREATMENTS.

504.13 PIGMENT

1. Red iron oxide pigment shall be incorporated into dense graded laterite mixes. The Contractor shall use an appropriate type, quantity and process for the incorporation of red iron oxide pigment to meet the requirements of Clause 504.56 (6).

2. Red iron oxide pigment shall not be used in asphalt where laterite aggregate is not included.

504.14 – 504.21 NOT USED

504.22 PAVING TAPE

1. The Paving Tape shall meet the requirements of Specification 511 MATERIALS FOR BITUMINOUS TREATMENTS.

504.23 – 504.25 NOT USED

MIX DESIGN

504.26 DENSE GRADED ASPHALT MIX DESIGNS

504.26.01 DESIGN PARAMETERS

1. All dense graded asphalt under this Contract shall be assessed in accordance with the standard procedures laid down for the Marshall method of design as shown in Table 504.3, and in the case of job mixes, also in accordance with the gyratory air voids requirements specified in Clause 504.26.04.

TABLE 504.3 DESIGN PARAMETERS

Stability & Flow of Asphalt: Marshall Method	WA 731.1
Maximum Density of Asphalt: Rice Method	WA 732.2
Bulk Density & Void Content of Asphalt	WA 733.1

2. The design shall produce an asphalt which satisfies the limiting values of the various Marshall properties listed in Table 504.B1. These values shall be used as the basis of mix assessment. ***Limiting Values***

3. In addition to achieving all the specified property values, all asphalt shall have an adequate workability and shall be suitably resistant to segregation during handling and placing. ***Workability***

504.26.02 PRESCRIBED MIX DESIGN FOR DENSE GRADED ASPHALT

1. The prescribed mixes described in this clause are for mixes produced using granite and laterite aggregates from the Perth region. ***Application***

2. Laterite asphalt to be used for bus lanes or shoulders shall be 10 mm nominal size dense graded asphalt which satisfies the limiting values in Table 504.B1 and Table 504.B2 using A15E binder. ***10 mm Laterite Mix***

3. The 10 mm dense graded laterite mix shall be based on the use of crushed laterite aggregates. The mix shall include a maximum of 30% of granite aggregates by mass of the total aggregates in the mix. The mix shall include a minimum of 15% by mass of 10 mm sized granite aggregate.

4. Laterite asphalt to be used on shared paths shall be a 7 mm nominal sized dense graded laterite asphalt which satisfies the limiting values in Table 504.B1 using Class 170 binder. ***7 mm Laterite Mix***

5. The 7 mm dense graded laterite mix shall be based on the use of crushed laterite aggregates. The mixes shall include a maximum of 20% of granite aggregate by mass of the mix.

6. All laterite mixes shall include a minimum of 1.0% by mass of the total aggregate of hydrated lime. Sand shall not be used in the mixes. ***Lime***

7. All laterite mixes shall include a red iron oxide pigment as specified in Clause 504.13 to meet the requirements of Clause 504.56 (6). ***Oxide***

504.26.03 JOB MIX DESIGN FOR DENSE GRADED ASPHALT

1. The job mix design used in the Works must have been approved by the Principal prior to the closing date for tenders. ***Approved Job Mix Design***

2. The job mix design shall be based on the use of crushed rock as the coarse and fine aggregates and the inclusion of 1.0% by mass of the total aggregate of hydrated lime. Job mixes for the Perth Metropolitan area shall be produced using granite rock. Job mixes for areas outside of Perth where it may be impractical to use hydrated lime shall use an adhesion agent additive with the binder as specified in Clause 504.12. ***Design Parameters***

3. To obtain the Principal's approval for a job mix design the following details shall be submitted to the Materials Engineering Branch of Main Roads:

   (a) A detailed description of all the materials to be used in the manufacture of the dense graded asphalt. These descriptions shall include a geological description of all the aggregates to be used. Test reports showing the conformance of the aggregates to be used in the job mix ***Materials Description***

design listed for all properties in Specification 511 MATERIALS FOR BITUMINOUS TREATMENTS.

(b) The binder content expressed as in Table 504.B2. The bitumen content shall be based on a design mid point with a maximum and minimum value within a tolerance of ± 0.3% from the mid point. ***Binder***

(c) A particle size distribution in a format as shown in Table 504.B2. The particle size distribution shall be based on a design mid point with the coarse and fine limits within the production tolerances shown in Table 504.4. ***Particle Size***

TABLE 504.4 PRODUCTION TOLERANCES

Particle Size Distribution AS Sieve Size (mm)	Tolerances on Percentage by Mass Passing
13.20	-3 + 7
9.50	± 7 (Note)
4.75 and 6.70	± 7
2.36 and 1.18	± 5
0.6 and 0.3	± 4
0.150	± 2.5
0.075	± 1.5

Note – for 10 mm sized mix the tolerance can be -3 + 7.

(d) Test results for the proposed job mix which confirm Marshall properties conforming with Table 504.B1 over the range of particle sizes and binder contents in the proposed job mix. Five mixes shall be prepared and tested with the mix proportions as listed below: ***Test Results***

- Fine PSD high binder – the fine PSD shall be prepared by adding the positive production tolerance values shown in Table 504.4 on to the design mid point PSD. The binder content shall be the design mid point binder content plus 0.3% binder.
- Fine PSD low binder – the fine PSD shall be prepared by adding the positive production tolerance values shown in Table 504.4 on to the design mid-point PSD. The binder content shall be the design mid-point binder content minus 0.3% binder.
- Coarse PSD low binder – the coarse PSD shall be prepared by adding the negative production tolerance values shown in Table 504.4 on to the design mid point PSD. The binder content shall be the design mid point binder content minus 0.3% binder.
- Coarse PSD high binder – the coarse PSD shall be prepared by adding the negative production tolerance values shown in Table 504.4 on to the design mid point PSD. The binder content shall be the design mid point binder content plus 0.3% binder.

- Mid point PSD – three mid point conditions shall be tested with binder contents at the design mid point and the design mid point binder content plus and minus 0.3% binder.

  Laboratory mixes produced to replicate the five mixes shall not vary from the PSD or bitumen content at the mid point, coarse and fine boundaries by more than the limits shown below.

  (i) ± 2% for ≥ 2.36 mm sieve

  (ii) ± 1% for < 2.36 mm sieve

  (iii) ± 0.1% for bitumen content

(e) Test results for gyratory compaction air voids and resilient modulus conforming with Clause 504.26.04.

4. All tests shall be performed in laboratories accredited with the National Association of Testing Authorities of Australia (NATA) to perform these tests, except for AS/NZS 2891.13.1 and the results shall be presented on NATA endorsed reports.

5. Where an ignition oven is proposed to be used to determine the binder content during production, the submission shall include: ***Ignition Oven Offset***

   (a) Offset determination in accordance with WA 730.2 and AG:PT/T234 Appendix A.

   (b) Samples to satisfy AG:PT/T234 Appendix A to be provided to Materials Engineering Branch.

504.26.04 APPROVAL OF A JOB MIX DESIGN

1. The Principal will only approve job mix designs that conform to the following requirements: ***Mix Requirements***

   (a) The results of testing the five mixes, defined in Clause 504.26.03.4(d) indicate that any permissible combination of the various mix proportions will result in a dense graded asphalt having Marshall Properties satisfying the limits specified in Table 504.B1.

   (b) The mix shall produce a satisfactory workable material in the Works.

   (c) The mid point grading and bitumen content of the mix shall be defined as the design mix. When specimens are prepared in accordance with AS/NZS 2891.2.2 the air voids after 350 cycles of compaction shall be no less than 2.5% when determined in accordance with WA 733.1. ***Gyratory Compaction***

   (d) The mix shall be tested in accordance with AS/NZS 2891.13.1 to determine the resilient modulus. The resilient modulus shall be determined at an air void content of 5 ± 1.0%. ***Modulus***

2. Use of the job mix shall be for only those ranges in the mix proportions and the types and sources of materials nominated with the job mix design. The Contractor shall not undertake any changes to either the mix proportions or the character or source of material without repetition of the full series of test mixes described above. ***Use of Job Mix***

504.26.05 USE OF JOB MIX DESIGN

1. **The Contractor shall provide proof to the Superintendent that the asphalt job mix design has been approved by the Principal before any asphalt manufactured in accordance with that job mix design is placed in the Works.** ***HOLD POINT***

504.27 – 504.30 NOT USED

MANUFACTURE AND TRANSPORT

504.31 MIXING PLANT

1. Asphalt shall be manufactured in a central mixing plant by either, batch mixing, continuous mixing or drum mixing. All mixing plant and equipment and associated facilities shall conform to the requirements of AS 2150 and shall be such as to prevent segregation of the asphalt at all stages. ***Plant***

2. A sampling cock shall be installed in the inlet pipe between the road tanker and binder storage tanks. An additional sampling cock shall be installed for sampling at the time of asphalt production between the binder tank and the mixing chamber to facilitate the sampling of any binder being used for asphalt production. ***Binder Sampling Cocks***

3. For the verification of weights or proportions and character of materials and determination of temperatures used in the preparation of the asphalt, the Superintendent shall have access at any time to all parts of the plant subject to safety considerations.

504.32 MANUFACTURE OF ASPHALT

1. The quantities of coarse and fine aggregates, mineral filler, pigment, adhesion agent and binder shall be accurately and positively controlled so as to produce the asphalt specified for use in the Works. RAP shall not be included in the production of any dense graded asphalt wearing course. ***Control***

2. The mixing process shall be such as to produce a uniform distribution of aggregate sizes and a uniform coating of binder on a minimum of 95% of aggregate particles when tested in accordance with AS/NZS 2891.11. ***Mixing***

3. The particle size distribution and the percentage of bitumen shall be in accordance with the asphalt mix design when tested in accordance with WA 730.1 or WA 730.2. ***Particle Size Distribution***

4. The air voids, VMA, stability and flow shall be in accordance with Table 504.B1 for dense graded asphalt when tested in accordance with WA 731.1 and 733.1. ***Marshall Properties***

5. The moisture content of the asphalt at the completion of the mixing process shall not be greater than 0.15% by mass when measured in accordance with AS/NZS 2891.10. ***Moisture Content***

6. In a batch mixer the volume of material shall be limited to an amount allowing the paddle tips to be seen when passing through the top vertical position during mixing. ***Volume of Material***

7. The production temperature of the mixed asphalt shall be measured and recorded at the discharge point of the pugmill or mixing drum. The temperature of the asphalt shall meet the requirements of Table 504.6. ***Temperature at Discharge Point***

TABLE 504.6 TEMPERATURE AT DISCHARGE POINT

	Hot Asphalt (Max)	Asphalt Mixture with Workability Additive (Max)	Warm Mix Asphalt (Min) (Note 1)
DGA Class 170	170°C	170°C	140°C
DGA Class 320	170°C	170°C	140°C
DGA Polymer Modified Binder	185°C	185°C	155°C

Note 1 – the maximum temperature shall be less than Hot Asphalt.

504.33 STORAGE AND HANDLING

1. Binders shall be heated and stored to meet the requirements of Specification 511 MATERIALS FOR BITUMINOUS TREATMENTS and the AAPA Advisory Note 7. At no time shall binder be heated to a temperature greater than 180°C. ***Storage Temperature***

504.34 WORKABILITY ADDITIVE

1. Approved workability additives may be used in the production of dense graded asphalt and dense graded laterite asphalt in the applications shown in Table 504.7.

TABLE 504.7 USE OF WORKABILITY ADDITIVES

	Long Distance Transport	Reduced Pavement Temperature	Warm Mix Asphalt
Distance to be Transported (Note 1) Dense Graded Asphalt with Bitumen	Maximum 400 km	Maximum 150 km	Maximum 150 km
Dense Graded Asphalt with Polymer Modified Bitumen	Maximum 300 km	Maximum 150 km	Maximum 150 km
Asphalt Transport Equipment (Note 2)	Multiple trailers can be used when using bitumen. Single truck or trailer units shall be used when using PMB	Single truck or trailer units shall be used	Single truck or trailer units shall be used
Additive (Note 3)	Sasobit Evotherm	Sasobit Evotherm	Sasobit Evotherm

Note 1 – the Contractor must consider the driving time, delays on site and road temperatures amongst other factors to ensure the asphalt has adequate workability on site to meet specified requirements.

Note 2 – the asphalt must be tipped direct into the paver from the cartage vehicle unless an MTV is being used.

Note 3 – the dosage rate of additive shall be determined in accordance with this specification.

2. The asphalt supplier shall determine the dosage rate and method of dosing of the additive to ensure that the manufactured asphalt has adequate workability to achieve all specified requirements including surface shape and compaction. ***Dosage and Mixing***

504.35 TESTING

1. The asphalt producer shall provide and maintain at a suitable location at the site of the mixing plant for the duration of the Contract a suitably equipped air conditioned testing laboratory accredited by NATA to perform the following tests: ***Testing Laboratory***

   WA 210.1, 212.1 or 212.2, 701.1, 705.1, 730.1, 731.1, 732.2, 733.1, AS/NZS 2891.10, AS/NZS 2891.11, WA 730.2 and 733.2 where applicable

2. The laboratory shall be equipped with all testing equipment necessary to perform these tests. The asphalt producer shall operate and maintain the equipment in good condition in accordance with NATA requirements. ***Testing Equipment***

3. Asphalt shall be tested for the properties and at the testing frequency shown in Specification 201 QUALITY MANAGEMENT. Tests to be undertaken include: ***Testing Requirements***

   Routine Testing – Full Test

   - PSD and Bitumen Content (WA 730.1 or WA 730.2)
   - Maximum Density of Asphalt Rice Method (WA 732.2)
   - Bulk Density and Void Content of Asphalt (WA 733.1)
   - Stability and Flow of Asphalt Marshall Method (WA 731.1)

   Routine Testing – Partial Test

   - PSD and Bitumen Content (WA 730.1 or WA 730.2)
   - Maximum Density of Asphalt Rice Method (WA 732.2)

   Periodic Testing

   - Moisture Content (AS/NZS 2891.10)
   - Degree of Particle Coating (AS/NZS 2891.11)

4. Asphalt shall be sampled in accordance with WA 701.1 with samples tested immediately they are taken. The number of tests undertaken shall be evenly spread across the entire period of production for each asphalt mix being tested within a shift. ***Sample Testing Frequency***

5. The first sample of asphalt in a shift shall be taken from the first 50 tonnes of asphalt manufactured in the shift for each type of mix being manufactured. ***First Sample***

6. If the result of a test sample does not conform to any specified requirements another sample of asphalt shall be taken immediately and tested immediately for a full test.

7. Results of testing shall be reported on a NATA endorsed test report within 24 hours of a sample being taken. The testing laboratory shall send all results directly to, amongst others, the Contractor, the Superintendent and Materials Engineering Branch (mailbox MEB Asphalt reports MEBAsphaltreports@mainroads.wa.gov.au), nominated representative at Main Roads Materials Engineering Branch. ***Reporting***

8. When a workability additive is used in the asphalt the temperature for the compaction of Marshall and Gyratory test specimens needs to be determined for each additive used and for each dose rate of the additive. Refer to Section 6.1 of test method WA 731.1 or in test method AS/NZS 2891.2.2 for details on determining the compaction temperature. ***Workability Additive***

504.36 NON-CONFORMANCE

1. **A hold point will apply when any mix test result indicating a non conformance occurs. This hold point shall also apply to a mix produced prior to the non-conforming test result, but which has not been placed.** ***HOLD POINT***

504.37 TRANSPORT

1. The asphalt shall be transported from the asphalt plant to the Works in metal bodied trucks or trailers previously cleaned of all foreign materials. In long distance haul situations, the asphalt should be transported in insulated vehicles sufficient to ensure arrival of the asphalt on site in a conforming condition. ***Vehicle Type***

2. The temperature of the asphalt in each truck load and each trailer load shall be measured using a calibrated digital probe thermometer before the truck leaves the site of the asphalt manufacturing plant. The thermometer shall have a digital display readable to 1°C and have a measurement of uncertainty of not more than 3°C. Infrared thermometers shall not be used to measure temperature. The temperature shall comply with the requirements of Clause 504.32.7. ***Temperature in Truck***

3. The temperature of the asphalt shall be recorded on a printout showing date, time and asphalt temperature for each truck load and each trailer load of mix dispatched. The printout shall be provided with the load delivery docket. ***Temperature Record***

4. Each load shall be covered with suitable material of sufficient size to prevent loss of heat from the mixture. ***Heat Loss***

5. The asphalt shall be delivered at a uniform rate within the capacity of the placing and compacting plant. ***Delivery Rate***

504.38 – 504.40 NOT USED

PLACING OF ASPHALT

504.41 GENERAL

1. **Prior to commencing asphalting, the Contractor shall submit to the Superintendent the proposed number and widths of asphalt runs, and the proposed joint layout.** ***HOLD POINT***

2. Asphalt shall not be placed if the truck delivery docket does not include a printout of the date, time and temperature of asphalt when the truck was dispatched.

3. Asphalt shall be delivered to the work site at temperatures as follows: ***Delivery Temperatures***

   - Hot mixed dense graded asphalt with bitumen 140°C to 170°C.
   - Hot mixed dense graded asphalt with polymer modified binder 160°C to 185°C.
   - Warm mixed dense graded asphalt 135°C to 155°C.

4. If a delay occurs of more than 30 minutes between successive truck deliveries to the paver, the paver shall be moved clear of the laid asphalt and a proper transverse joint formed. ***Delays***

5. Prior to commencing each day's operations, and also after any delay exceeding half an hour during the day, the screed shall be preheated for at least 15 minutes in order to eliminate drag marks and imperfections in the finished mat. ***Screed to be Preheated***

6. All kerbs, gullies, grates and other structures shall be protected at all times from damage or defacement by asphalt placement works and the site shall be left in a clean and tidy condition. ***Damage***

504.42 SURFACE PREPARATION

1. Prior to the placement of asphalt, the Contractor following shall carry out preparation work as detailed in the following clauses.

2. The Contractor shall sweep all road surfaces on which asphalt is to be placed under this Contract to a clean condition with no appreciable amounts of loose materials or any other foreign matter remaining. Loose surface material against kerbing shall be removed by handwork if necessary. The surface to be paved shall be dry. ***Sweeping***

3. Where the surface to be covered is asphalt, all depressions more than 20 mm deep shall be filled with a nominal 10 mm or 14 mm dense graded asphalt and shall be screeded or raked and then compacted to similar density as the remainder of the surface to be paved. ***Surface Correction***

4. The surface of a shared path shall have a uniform texture with a tightly bonded surface and be primed. The texture of this surface should key the asphalt to the surface and resist any tendency for "slippage" failures.

5. Where paving tape is shown in asphalt drawings the tape shall be applied to a surface that is clean, dry and all loose material has been removed beyond the width of the tape to be applied. Joins of the tape shall be overlapped and any air bubbles or creases in the tape shall be cut and flattened. ***Paving Tape***

504.43 EQUIPMENT

1. The asphalt must be placed by a self-propelled paver equipped with the ability to be operated with automatic thickness control and automatic joint matching facility. The paver must be equipped with a ski or laser control system and crossfall controller to maintain levels, and also suitable sensing equipment to provide longitudinal joint matching. It shall further be equipped with a vibrating or tamping screed capable of achieving 85% of final compaction. ***Requirements***

2. Where the use of a material transfer vehicle (MTV) is specified at Annexure 504C the MTV shall be a self-propelled machine capable of receiving asphalt from delivery trucks, storing the asphalt, heating asphalt in storage and transferring the asphalt to the paver without any contact with the paver. The MTV must have a minimum storage capacity of 15 tonnes and the paver must be fitted with a bin in its hopper to transfer asphalt directly to the feed conveyor of the paver. ***Material Transfer Vehicle***

504.44 TACK COAT

1. A tack coat shall be applied to the prepared surface at the rate of 0.6 L/m² of the dilute emulsion or as directed by the Superintendent. The tack coat shall be sprayed in a uniform film over the entire road surface. ***Composition***

2. No asphalt shall be placed on the tack coat until the emulsion has broken and the water has substantially evaporated.

3. The Superintendent may direct the pavement area ahead of the paver to be resprayed and may specify the time to be allowed between the spraying of tack coat and the placing of asphalt. However, this area shall not exceed the requirements for half a day's placing of asphalt. ***Respraying***

4. The tack coat shall be applied with care to reduce the possibility of concrete kerbs, driveways and footpaths being sprayed with bitumen. Any such contamination shall be removed by the Contractor at no cost to the Principal. ***Contamination***

504.45 NOT USED

504.46 WEATHER CONDITIONS

1. Asphalt placement shall not commence or continue upon a surface which is not clean and dry, and only when the pavement temperature meets the requirements shown in Table 504.8 and rain is not imminent. ***Pavement Temperature***

TABLE 504.8 PAVEMENT TEMPERATURES FOR PLACEMENT

Mix Type	Binder in Mix	Minimum pavement temperature when wind speed < 20 km/hr	Minimum pavement temperature when wind speed ≥ 20 km/hr
DGA	C320 bitumen	15°C	20°C
DGA	C320 bitumen with Workability Additive	10°C	15°C
DGA	Polymer Modified Binder	20°C	25°C
DGA	Polymer Modified Binder with Workability Additive	10°C	15°C

2. The Superintendent may, if the weather or surface conditions are considered to be unsuitable, instruct the Contractor to cease laying operations. Any materials laid after this instruction is given will not be paid for and are to be removed at no cost to the Principal.

504.47 JOINTS

1. The number and extent of joints in asphalt layers shall be kept to a minimum and the paving pattern shall be designed accordingly in advance of the work. ***Paving Pattern***

2. The main paving runs shall be laid first and any smaller or irregular adjacent areas later so that they can be matched to the main run.

3. Each joint shall be neat, thoroughly compacted, and have a surface finish equal in quality to that of the surrounding asphalt layer. ***Surface Finish***

4. Where the edge of the previously laid work has become distorted it shall be cut back a sufficient distance to provide the true cross section. ***Edges***

504.48 LONGITUDINAL JOINTS

1. Longitudinal joints shall be continuous and parallel to the pavement centreline. Joints in successive layers shall be offset by at least 150 mm. Joints shall be located away from traffic wheel tracks. Where possible, joints in wearing courses shall be located beneath traffic line marking. The vertical face of the previous run shall be lightly tack coated before the paving of the adjacent run proceeds. ***Position***

2. Temporary longitudinal ramps shall be provided for any asphalt course that has not been completed to the full carriageway width and is subjected to traffic. These ramps shall be cut back before the adjacent lane is laid. ***Temporary Ramps***

504.49 TRANSVERSE JOINTS

1. Transverse joints shall be at right angles to the direction of paving. They should be staggered by at least one (1) metre between successive layers and between adjacent runs.

2. The vertical face of the previous run shall be lightly tack coated before the paving of the next run proceeds. ***Tack Coat***

3. Temporary transverse ramps shall be provided where traffic is to use the newly laid work prior to a run being completed. These ramps shall be cut back before the next run is laid. ***Temporary Ramps***

504.50 TERMINAL JOINTS

1. Terminal joints between the new and existing surfaces shall be formed by ramping with a nominal 5mm dense graded asphalt mix. The ramp shall extend over a sufficient distance to provide a slope of at least 1:100.

504.51 ASPHALT CONSTRUCTION DRAWINGS

1. Unless otherwise specified details for transverse joints, longitudinal joints and profiles shall be in accordance with the asphalt construction drawings available on the Main Roads website as listed in Table 504.9.

TABLE 504.9 LIST OF ASPHALT CONSTRUCTION DRAWINGS

Drawing Number	Title
201331-0031	Pavement Series – Typical details full depth asphalt transverse joints
201331-0032	Pavement Series – Typical details Granular transverse joints
201331-0033	Pavement Series – Typical details full depth asphalt longitudinal joints and profile
201331-0035	Wearing Course Series – Typical details OGA/DGA transverse joints
201331-0036	Wearing Course Series – Typical details DGA transverse joints
201331-0037	Wearing Course Series – Typical details SMA transverse joints
201331-0038	Wearing Course Series – Typical details longitudinal joints

504.52 – 504.53 NOT USED

504.54 COMPACTION

1. Self-propelled steel wheel rollers and pneumatic tyred rollers meeting the requirements of AS 2150 shall be used. Vibratory pneumatic tyred rollers may be used. All rollers shall be fitted with reticulation to water wheels or tyres to prevent pick up of asphalt and be fitted with scrapers to clean the wheels or tyres. ***Equipment***

2. Unless otherwise directed by the Superintendent rolling shall commence immediately after placing and compacting with the vibrating or tamping screed. The rolling shall start longitudinally at the sides and proceed towards the centre of the pavement, overlapping on successive passes by at least 150 mm. Successive passes of the roller shall be of slightly different lengths.

3. Roller speed shall be uniform. Stops and starts shall be controlled so that displacement (shoving) of the asphalt mix does not occur when changing direction. Any shoving occurring as a result of changing direction, or from any other cause, shall be corrected at once by the use of rakes and of fresh asphalt when required. ***Roller Stop/Starts***

4. To prevent adhesion of asphalt to the roller, all wheels shall be kept properly moistened but excess of water shall be avoided. The use of potable water or potable water with water softener shall be used to moisten tyres and/or drums. Products that cut or clean bitumen shall not be used, including but not limited to any petroleum based, diesel based or solvent products. Minimal water softener products can be utilised within the parameters of this clause. ***Moistened Wheels***

5. Vibratory compaction shall be discontinued in areas where it is considered such vibrations could cause damage to adjacent buildings or structures. Under these conditions, initial compaction of the asphalt shall be achieved using the self-propelled static steel wheeled rollers of appropriate mass to meet the compaction requirements in Clause 504.55. ***Vibratory Compaction***

6. The Contractor shall ensure the protection of services and property from deterioration or damage due to the Works. ***Protection***

7. Rollers shall be kept in continuous operation as much as practicable and in such a manner that all parts of the pavement receive substantially equal compaction. In the event of a delay in the laying operation, rolling is to be carried out as close as practicable to the paving machine. Rollers shall not be parked on work carried out the same day. ***Continuous Operations***

8. A sufficient number of rollers shall be available on site commensurate with the rate of supply of asphalt and the output of the paving machine. ***Number of Rollers***

9. All joints must be filled and edges adjacent to kerbing and such other hand work as may be necessary must be rolled with a suitable pedestrian-type roller. ***Joints***

10. Finish rolling shall be carried out while the material is still warm enough for the removal of tyre marks. Steel wheeled rollers shall be used. ***Finish Rolling***

11. At places not accessible to the roller, thorough compaction must be ensured by means of hot tampers and at all joints with structures the surface mixture must be effectively sealed. ***Hot Tampers***

504.55 DENSITY REQUIREMENTS

1. The Characteristic Percent Marshall Density (Compaction) for any lot shall be deemed to be conforming if it attains a value of 93% or greater, except for shared path dense graded asphalt that shall attain a value of 91% or greater. Payment for conforming work shall be at the scheduled rate. ***Marshall Density***

2. Density shall be calculated on the basis of the results of tests of core samples of asphalt sampled from an asphalt layer, after laying and compaction, in accordance with WA 701.1. The density of the samples shall be determined in accordance with WA 733.1 Section 5.1.2 and expressed as a percentage of the mean Marshall Density of all asphalt results from the same production shift in accordance with WA 731.1 and WA 733.1.

Testing and Reporting of Results

3. Core samples shall be taken three (3) hours post completion of the lot and within 24 hours of placement of a lot of asphalt. Results of testing shall be reported on a NATA endorsed test report within 48 hours of the core samples being taken. The testing laboratory shall send all density results directly to, amongst others, the Contractor, the Superintendent and Materials Engineering Branch mailbox (MEBAsphaltreports@mainroads.wa.gov.au).

Pay Factors

4. Where the Characteristic Percent Marshall Density is less than the specified density the Quality Level shall be deemed to be either Non-conformance or Conditional Conformance depending on the difference between the Characteristic Percent Marshall Density and the specified density. The tolerances applicable to Conditional Conformance are given in Table 504.10. A Pay Factor, as shown in Table 504.10, shall be applied for work at the appropriate conformance level in accordance with these tolerances. The Pay Factor shall reflect the lower level of serviceability of conditionally conforming asphalt.

5. Conditional acceptance is NOT applicable if:

Shared Path Mix

(a) Shared path dense graded asphalt will be considered to either conform, where the Characteristic Percent Marshall Density Rc is greater than or equal to 91.0%, or be Non-conforming where the Rc is less than 91.0%.

Scheduled Rates Not Included

(b) Where the Contract does not include a separate scheduled rate for the placement of asphalt the asphalt will be considered to either conform, where the Characteristic Percent Marshall Density Rc is greater than or equal to 93.0%, or be Non-conforming where the Rc is less than 93.0%.

TABLE 504.10 PAY FACTORS

Characteristic Percent Marshall Density Rc (%)	Quality Level	Pay Factor
93.0 or greater	Conformance	1.0
Less than 93.0 and greater than or equal to 91.0	Conditional Conformance	0.15 Rc – 12.95
Less than 91.0	Non-conformance	N/A

6. Where any lot of asphalt work is deemed non-conforming the Contractor shall apply remedial action in accordance with the procedures contained in Specification 201 QUALITY MANAGEMENT, and the lot shall be removed and replaced with fresh asphalt and retested. Removal shall be carried out so as not to damage the underlying layers or any road furniture such as gully gratings. Any such damage shall be repaired at no cost to the Principal.

Non-conformance

504.56 SURFACE REQUIREMENTS

1. The surface of the compacted asphalt shall be smooth and true to the specified crown and grades, be of uniform appearance, free of dragged areas, cracks, open textured patches and roller or paver marks. Any section of asphalt that is loose or broken, mixed with dirt or other impurities, or is in any way defective, shall be removed and replaced.

2. When using the 3 metre straight edge, in accordance with WA 313.2, the shape of the compacted asphalt shall be deemed to be conforming when the maximum deviation from a 3 m straight edge, placed in any position on the surface of a layer does not exceed the limits specified in Table 504.11. A 3 m straight edge shall be provided with each paver.

Shape: 3 m Straight Edge

3. When using the ARRB TR Walking Profiler, in accordance with WA 313.4, the shape of the compacted asphalt shall be deemed to be conforming when the maximum deviation, measured in any direction and within any 3 m long section of the surface does not exceed the limits specified in Table 504.11.

Shape: ARRB Profiler

TABLE 504.11 SURFACE SHAPE

Direction of Measurement	Maximum Deviation	Maximum rate of Change of Deviation
Longitudinal	3 mm	1.0 mm per 240 mm
Transverse	5 mm	1.0 mm per 240 mm

4. For construction works, the upper surface of the compacted asphalt shall be within 5 mm of the final design levels. For construction work the thickness of the compacted asphalt layers shall be within 5 mm of the specified thickness. On resurfacing works where the underlying levels vary, the minimum thickness of compacted asphalt shall be within 5 mm of the specified thickness. The thickness of a Lot of asphalt shall be determined from the mean thickness of core samples taken for compaction testing. Thickness shall be measured in accordance with WA 705.1.

Level and Thickness

5. The plan location of the outer edge of the asphalt shall be within +25 mm of its true location and the rate of change of the edge from its true plan position shall not exceed 1 in 40.

Position

6. Laterite asphalt mixes, including shared path mix, when placed and compacted shall have a colour saturation meeting the requirements of this clause. When tested in accordance with WA 341.1 a lot of dense graded laterite mix, or portion of a lot nominated by the Superintendent, shall have a value for Chroma (C*) not less than 6.5. Testing of a lot or portion thereof may be initiated by the Superintendent at any time after placement of the asphalt. Where the colour of a lot does not comply the Contractor shall pay for the cost of testing the lot. In response to a non-conformance the Contractor shall review its selection and use of a red iron oxide pigment to colour the asphalt before further asphalt is placed. Non-conforming asphalt shall be removed and replaced with conforming mix at no cost to the Principal. ***Colour***

7. The Contractor shall test for compliance with the specified lines, levels, thickness and surface finish immediately after initial compaction. Any variations shall be corrected by removing or adding materials as may be necessary. Rolling shall then be continued as specified. After final rolling out, the smoothness of the course shall be checked again. ***Compliance***

8. Where work is deemed non-conforming the Contractor shall apply remedial action in accordance with the procedures contained in Specification 201 QUALITY MANAGEMENT, and the lot shall be removed and replaced with fresh asphalt and retested. ***Non-conformance***

504.57 OPENING FINISHED WORKS TO TRAFFIC

1. **Prior to opening the finished asphalt surface to traffic, the Contractor shall certify to the Superintendent that the final road surface is completed in accordance with the specification, and that the Works are properly delineated and safe for public use.** ***HOLD POINT***

504.58 – 504.80 NOT USED

AS-BUILT AND HANDOVER REQUIREMENTS

504.81 – 504.90 NOT USED

CONTRACT SPECIFIC REQUIREMENTS

504.91 – 504.99 NOT USED

ANNEXURE 504A

SCHEDULE OF WORKS

Section		Length (m)	Width (m)	Area (m^2)	Depth (mm)	Asphalt Type (Dense/Open/ Intersection Mix)	Nom Agg. Size (mm)
From	To						

(Insert appropriate details of all asphalt treatments: for Main Roads Policy, refer Guidance Note 1. Supplement with drawings, Diagrams, etc. where necessary.)

ANNEXURE 504B

SPECIAL DETAILS

TABLE 504.B1 MARSHALL PROPERTIES – DENSE GRADED ASPHALT (75 BLOW COMPACTION)

Values Used as the Basis of Mix Assessment

Parameter	Min	Max
Marshall Stability		
All mixes except 7 mm Laterite Principal Shared Path	8.0 kN	-
7 mm Laterite Principal Shared Path	5.0 kN	-
Marshall Flow	2.00 mm	4.00 mm
Air Voids (WA 733.1):		
nominal 10 mm Laterite	3.0%	6.0%
nominal 10 mm	4.0%	6.0%
nominal 5 mm	3.0%	5.0%
nominal 14 mm (Intersection Mix)	4.0%	7.0%
nominal 7 mm Laterite Principal Shared Path (50 Blow)	3.0%	6.0%
Voids in Mineral Aggregate:		
nominal 10 mm Laterite	15.0%	-
nominal 10 mm	15.0%	-
nominal 5 mm	16.0%	-
nominal 14 mm (Intersection Mix)	14.0%	-

TABLE 504.B2 PARTICLE SIZE DISTRIBUTION AND BITUMEN CONTENT – PRESCRIBED DENSE GRADED ASPHALT MIX DESIGNS

Australian Standard (AS 1152) Sieve mm	Percent Passing
	Nominal 10 mm Laterite (Bus Lanes)
13.20	100
9.50	90 – 100
6.70	73 – 87
4.75	60 – 74
2.36	41 – 53
1.18	29 – 39
0.600	19 – 27
0.300	12 – 20
0.150	7 – 12
0.075	3 – 7
Binder Content (by percentage mass of whole mixture)	Minimum 5.0% (Note 1)

Note 1 – the bitumen content shall be adjusted to produce air voids and VMA complying with the limits shown in Table 504.B1 but shall not be lower than the minimum bitumen content.

ANNEXURE 504C

SPECIFIC CONTRACT REQUIREMENTS

1. MATERIAL TRANSFER VEHICLE

A material transfer vehicle is required to be used for the following layers:

Location	Yes	No

2. ECHELON PAVING

Echelon paving is required to be used for the following areas:

Location	Yes	No

GUIDANCE NOTES

FOR REFERENCE ONLY – DELETE GUIDANCE NOTES FROM FINAL DOCUMENT

1. All edits to this specification are to be made using track changes, to clearly show added/ deleted text.

2. If **all** information relating to a clause is deleted, the clause number should be retained and the words **"NOT USED"** should be inserted.

3. The proposed document with tracked changes must be submitted to the Project Manager for review, prior to finalising the document.

4. Once the Project Manager's review is complete, accept all changes in the document, turn off track changes and refresh the Table of Contents.

5. The Custodian of this specification is Manager Materials Engineering.

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1. GUIDANCE ON THE USE OF DENSE GRADED WEARING COURSE ASPHALT

1.1 Main Roads document number 6706-04-154 Guide for Surfacing Type Selection provides guidance on the use of various types of asphalt surfacings in different scenarios and speed zones.

2. 10 mm DENSE GRADED LATERITE ASPHALT (refer Clause 504.26)

2.1 Laterite asphalt shall be used for bus lanes, principal shared paths, medians or road shoulders where delineation is required.

2.2 Laterite asphalt shall not be used for general traffic lanes.

3. USE OF A MATERIAL TRANSFER VEHICLE

3.1 The requirement to use an MTV has to be specified at Annexure 504C. MTVs facilitate continuous paving by having a truck come in contact with the MTV to empty its load whilst asphalt is transferred into the paver by conveyor. Removing contact between a truck and paver overcomes bumps from the stop/start of the paver and reduces the likelihood of mix segregation near the end of a truckload. The outcome is more uniform temperature of the asphalt which will result in improved and more uniform compaction, improved ride and less incidence of segregated areas of asphalt.

MTVs are not suited to all asphalting applications as shown below. Where an MTV must be used includes:

- On a project where there will be high daily production outputs of asphalt, e.g. widening of Tonkin and Leach Highways near Perth Airport (Gateway WA Project).
- Where there are long paving runs, e.g. Kwinana Fwy widening Roe to Armadale and Armadale to Russell.
- Where improved ride quality is required, e.g. Great Eastern Hwy from Graham Farmer Fwy to Tonkin Hwy (City East Alliance).

- Where asphalt is to be placed in adverse weather conditions such as low temperatures or strong winds, e.g. winter paving.

- When paving thin layers of asphalt containing a polymer modified binder.

MTVs may not be suited for the following scenarios:

- On a project where there will be small daily production outputs of asphalt, e.g. small minor improvement works.

- Where there are confined spaces.

- Small areas of widening such as intersection channelisation including short turn pockets.

4. MINOR WORKS CONTRACTS

4.1 Where this document is used in a Minor Works Contract with dense graded wearing course asphalt as the sole or primary work required, Authors should ensure that the following specifications are also included in the tender documentation:

(a) Specification 100 GENERAL REQUIREMENTS

(b) Specification 604 PAVEMENT MARKINGS (if required)

4.2 Contract Specific Requirements – include any details provided or required by the Principal, such as:

(a) Setting Out information

(b) Working Hours and Days (if not already included in the tender document)

(c) Surface Preparation – e.g. normally sweeping only, but may include localised surface correction requirements

(d) Record Forms – to include any required details of proof and origin of asphalt supply, etc.

Insert appropriate Annexures and reference to Annexures to suit in conjunction with these additional provisions.

CONTRACT SPECIFIC REQUIREMENTS

The following clauses are to be placed under the CONTRACT SPECIFIC REQUIREMENTS, as required. After inserting the clause, change the clause number and heading to style “H2 SP” so it appears in the Table of Contents.

XXX.XX SUB-HEADING (H2 SP)

1. Insert text (Main Table SP) ***XXXX***

2. Insert text (Main Table SP)

XXX.XX SUB-HEADING (H2 SP)

1. Insert text (Main Table SP)

2. Insert text (Main Table SP)

AMENDMENT CHECKLIST

Specification No. **504** Title: **DENSE GRADED ASPHALT WEARING COURSE** Revision No: _____

Project Manager: _____ Signature: _____ Date: _____

Checked by: _____ Signature: _____ Date: _____

Contract No: _____ Contract Name: _____

ITEM	DESCRIPTION	SIGN OFF
Note: All changes/amendments must be shown in tracked changes until approved.		
1.	Project Manager has reviewed the Specification and identified additions and amendments.	
2.	Standard clauses amended? **MUST SEEK** approval from the Specification Custodian.	
3.	Any unlisted materials/products proposed and approved by the Project Manager? If "Yes" provide details at 16.	
4.	Deleted clauses shown as **"NOT USED"**.	
5.	Ensure appropriate **INSPECTION AND TESTING** parameters are included in Specification 201 (test methods, minimum testing frequencies verified).	
6.	**AS-BUILT AND HANDOVER** requirements addressed.	
7.	**CONTRACT SPECIFIC REQUIREMENTS** addressed? Contract specific materials, products, clauses added? (refer Specification Guidance Notes).	
8.	**ANNEXURES** completed (refer Specification Guidance Notes).	
9.	Estimates Manager has approved changes to **SMM**.	
10.	Project Manager certifies completed Specification reflects intent of the design.	
11.	Independent verification of completed Specification arranged by Project Manager.	
12.	Project Manager's review completed.	
13.	**SPECIFICATION GUIDANCE NOTES** deleted.	
14.	**TABLE OF CONTENTS** updated.	
15.	**FOOTER** updated with Document No., Contract No. and Contract Name.	
16.	Supporting information prepared and submitted to Project Manager.	
Additional information or further action:		

Signed: _____ *(Project Manager)* Date: _____