

# **NZTA M10: 2020**

## **SPECIFICATION FOR DENSE GRADED ASPHALTIC CONCRETE**

# 1 GENERAL

## 1.1 Scope

This specification covers dense graded asphaltic concrete (asphalt) for roads and related applications.

The areas covered by this specification include:

- a) Asphalt materials
- b) Asphalt mix design requirements
- c) Process control in manufacture and placement of asphalt
- d) Acceptance criteria for asphalt
- e) Quality systems, minimum process standards, plant requirements and sampling and testing frequencies.

This section is to be read in conjunction with the Appendix (Schedule of Job Details). Where there is conflict between the requirements of this section and the Appendix, the requirements of the Appendix shall apply.

## 1.2 References

### 1.2.1 New Zealand Transport Agency

- a) NZTA M01-A Specification for Performance-Graded Asphalt Binder
- b) NZTA T10 Specification for State Highway Skid Resistance Management
- c) NZTA T22 Quantitative Extraction of Binder from Asphalt Mixes
- d) Chipsealing in New Zealand <https://www.nzta.govt.nz/resources/chipsealing-new-zealand-manual/chipsealing-in-new-zealand/>

### 1.2.2 Austroads

- a) AGPT02 Austroads Guide to Pavement Technology Part 2: Pavement Structural Design
- b) AGPT04B Austroads Guide to Pavement Technology Part 4B: Asphalt
- c) AGPT-T220 Sample Preparation - Compaction of Asphalt Slabs
- d) AGPT-T231 Deformation Resistance of Asphalt Mixtures by the Wheel Tracking Test
- e) AGPT-T237 Binder Film Index
- f) AGPT-T274 Characterisation of Flexural Stiffness and Fatigue Performance of Bituminous Mixes

### 1.2.3 Standards New Zealand

- a) NZS ISO/IEC 17025 General Requirements for the Competence of Testing and Calibration Laboratories
- b) NZS 4407 Methods for Sampling and Testing Aggregates
- c) AS/NZS ISO 9001 Quality Systems – Requirements
- d) AS/NZS 2891.2.2 Compaction of Asphalt Test Specimens Using a Gyratory Compactor
- e) AS/NZS 2891.3.3 Bitumen Content and Grading – Pressure Filter Method
- f) AS/NZS 2891.14.2 Methods of Sampling and Testing Asphalt - Field Density Tests Backscatter Mode

### 1.2.4 Standards Australia

- a) AS 1141.5 Particle Density and Water Absorption of Fine Aggregate
- b) AS 1141.6 Particle Density and Water Absorption of Coarse Aggregate
- c) AS 1141.11 Particle Size Distribution – Sieving Method
- d) AS 2891.13.1 Determination of the resilient modulus of asphalt - Indirect tensile method

### 1.2.5 American Association of State Highway and Transportation Officials (AASHTO)

- a) AASHTO M 323 Standard Specification for Superpave Volumetric Mix design
- b) AASHTO R 35 Superpave Volumetric Mix design for Asphalt Mixtures

- c) AASHTO T 312 Standard Method of Test for Preparing and Determining the Density of Asphalt Mixture Specimens by Means of the Superpave Gyratory Compactor
- d) AASHTO T 329 Moisture Content of Asphalt Mixtures by Oven Method

#### 1.2.6 American Society for Testing and Materials (ASTM)

- a) ASTM C117 Materials Finer Than 75- $\mu$ m Sieve in Mineral Aggregates by Washing
- b) ASTM C127 Density, Relative Density (Specific Gravity) and Absorption of Coarse Aggregate
- c) ASTM C128 Density, Relative Density (Specific Gravity) and Absorption of Fine Aggregate
- d) ASTM C136 Sieve Analysis of Fine and Coarse Aggregates
- e) ASTM D242 Standard Specification for Mineral Filler for Bituminous Paving Mixtures
- f) ASTM D979 Sampling of Bituminous Paving Mixtures
- g) ASTM D1461 Moisture or Volatile Distillates in Asphalt Mixes
- h) ASTM D2041 Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
- i) ASTM D2172 Quantitative Extraction of Bitumen from Bituminous Paving Mixtures
- j) ASTM D2726 Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures
- k) ASTM D3203 Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures
- l) ASTM D2950 Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Methods
- m) ASTM D3549 Thickness or Height of Compacted Bituminous Paving Mixture Specimens
- n) ASTM D4867 Effect of Moisture on Asphaltic Concrete Paving Mixtures
- o) ASTM D5444 Mechanical Size Analysis of Extracted Aggregate
- p) ASTM D5361 Sampling Compacted Bituminous Mixtures for Laboratory Testing
- q) ASTM D6307 Asphalt Content of Hot-Mix Asphalt by Ignition Method
- r) ASTM D6925 Preparation and Determination of the Relative Density of Hot Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor
- s) ASTM D6926 Preparation of Bituminous Specimens Using Marshall Apparatus
- t) ASTM D6927 Marshall Stability and Flow of Bituminous Mixtures
- u) ASTM D7981 Standard Practice for Compaction of Prismatic Asphalt Specimens by Means of the Shear Box Compactor
- v) ASTM D8159 Standard Test Method for Automated Extraction of Asphalt Binder from Asphalt Mixtures

#### 1.2.7 Miscellaneous

- a) Civil Contractors New Zealand CCNZ BPG05 “Quality Assurance of Aggregates”
- b) Asphalt Institute “Mix Design Methods for Asphaltic Concrete (MS-2)” Manual Series 2 (7th edition)

### 1.3 Asphalt Mix Types

For the purposes of this specification dense graded asphalt mixes have been classified in terms of four traffic categories: Light, Medium, Heavy and Very Heavy. The particular mixes to be used shall be nominated in the schedule of job details.

Two types of dense-graded asphalt mixes are specified in this document: “AC” mixes in Table 3.1 and “DG” mixes in Table 3.2.

The AC mixes contain higher quantities of coarse aggregate particles and are best used where deformation resistance is a primary requirement.

The DG mixes are finer graded and tend to be more binder rich than the AC mixes. They are best used where resistance to fatigue cracking is a primary requirement.

## 1.4 Quality System

The Contractor shall establish, implement and maintain a Quality System in accordance with this Specification and the requirements of AS/NZS ISO 9001, or a recognised equivalent. The Quality System shall be certified and regularly audited by a JAS-ANZ registered agency

Where required in the Contract general clauses, the Contractor shall submit a Quality Plan prior to commencement of any works. The Quality Plan shall take into account the specific requirements for inspection and testing, acceptance/rejection criteria, details of proposed methods and other quality requirements that are contained in the Contract Documents. No part of the Quality System shall be used to pre-empt or otherwise negate the technical requirements of the Contract Documents or this specification.

## 1.5 Testing

All sampling and testing required by the Specification shall be undertaken by a laboratory accredited to NZS ISO/IEC 17025.

# 2 MATERIALS

## 2.1 Aggregate

### 2.1.1 General

Coarse aggregate shall consist of crushed stone, crushed gravel, recycled materials or a combination of these, produced from hard durable rock, river boulders or feedstock such as, but not limited to, slag or glass, or other materials approved by the Engineer.

Fine aggregate shall consist of particles of sand, crushed stone or crushed gravel or a mixture of these materials unless otherwise approved by the Engineer.

Testing frequency shall be in accordance with CCNZ BPG05 Quality Assurance of Aggregates.

Aggregates can also be comprised of, or contain synthetic or recycled materials subject to the Engineer's approval if they do not comply with the requirements of Table 2.1 or Table 2.2 below. Such approval may be conditional on additional testing relative to the proposed materials.

### 2.1.2 Coarse Aggregate

Coarse aggregate is comprised of particles that are retained on the 4.75 mm sieve. Coarse aggregate shall comply with Table 2.1 except that the Engineer can approve the use of non-complying materials from sources of proven performance.

The rock quality used for the production of the coarse aggregates for surfacing mixes shall comply with the site skid resistance requirements of NZTA T10 specification. If the Polished Stone Value method is used it does not apply to fractions associated with fine aggregate components when the contribution to the coarse aggregate is less than 15% by mass of the coarse aggregate fraction.

**Table 2.1 Coarse Aggregate Requirements for Dense Graded Asphalt**

Test Property	Test Method	Requirements
Crushing Resistance	NZS 4407 Test 3.10	< 10% Fines @ 200kN
Weathering Quality Index	NZS 4407 Test 3.11	AA or BA
Single Broken Faces	NZS 4407 Test 3.14	98% minimum
Two Broken Faces	NZS 4407 Test 3.14	60% minimum
Bulk Specific Gravity and Density	ASTM C127 or AS 1141.6	Report
Absorption	ASTM C127 or AS 1141.6	Report

**Note:** The Single Broken Faces and Two Broken Faces testing is not required for aggregate derived from a non-alluvial "hard rock" quarry or for Glenbrook Melter aggregate. In that instance the Broken Faces criterion is assumed to be 100%.

### 2.1.3 Fine Aggregate

Fine aggregate shall consist of crushed rock particles finer than the 4.75 mm sieve and manufactured from a source complying with the requirements of Table 2.2.

If natural (i.e. uncrushed) sands are used in significant proportion (i.e. greater than 10% of the aggregate blend) in mixes for medium, heavy or very heavy traffic categories then Wheel Tracking testing should be carried out to demonstrate that the mix is resistant to deformation (rutting).

The fine aggregate shall be clean, hard, durable and free from pumice and lumps of clay and other aggregations of fine materials, organic material and any other deleterious material.

**Table 2.2 Fine Aggregate Requirements**

Test Property	Test Method	Requirements
Crushing Resistance	NZS 4407 Test 3.10	< 10% Fines @ 200kN
Sand Equivalent, or	NZS 4407 Test 3.6	35 min, or
Clay Index (<0.075 mm)	NZS 4407 Test 3.5	3 maximum
Bulk SG and Density	ASTM C128 or AS 1141.5	Report
Absorption	ASTM C128 or AS 1141.5	Report

#### Notes:

- a) Crushing Resistance for fine aggregates is carried out on the parent rock used for the manufacture of the fine aggregates. This may not be possible for some natural fine aggregates, such as pit or beach sands as the appropriate size fractions for Crushing Resistance testing may not be available. In this case the Crushing Resistance requirement is waived.
- b) The fine aggregate is defined as the fraction of the blended aggregate passing the 4.75 mm sieve excluding added mineral filler (if any).

## 2.2 Mineral Filler

Mineral filler is that portion of mineral matter predominantly passing the 0.075 mm sieve and includes rock dust derived from coarse and fine aggregates used in the production of asphalt in accordance with this specification, and any other materials added to supplement the quantity and properties of filler in the mix.

Filler shall be consistent in mineral composition. It shall be dry, and free from lumps, clay, organic matter or other material deleterious to asphalt.

Added mineral filler (material not derived from the aggregate components) shall comply with ASTM D242.

## 2.3 Binder

### 2.3.1 Bitumen

The binder grade shall be a performance-graded binder complying with the requirements of NZTA M01-A specification.

The M01-A binder grade shall be selected using the following procedure:

- a) Identify the climate zone appropriate for the site location using the climate map in NZTA M01-A specification;
- b) Determine the expected traffic level for the asphalt pavement over its service life and select the appropriate binder grade category;
- c) Specify the required binder grade based on site temperature zone (cool, medium or warm) and traffic load (i.e. Standard, Heavy, Very Heavy or Extreme, S, H, V, E). Nominate the binder grade using the following format: PG [Climate Zone Temperature] [Binder Grade Category], for example:
  - i. For a binder required in a moderate climate zone, with a Very heavy grade category, specify PG 58V
  - ii. For a binder required in a Warm climate zone with a Heavy grade category, specify PG 64H.

Refer to NZTA M01-A specification for more information.

### 2.3.2 Binder Performance Grade

The specified performance grade of binder shall be used in the asphalt mix. Other grades (i.e. grades intended for heavier duty traffic categories) shall not be substituted unless specifically approved in writing by the Engineer.

### 2.3.3 Additives

The type and proportion of additives to be used in the mix, other than those specified elsewhere in this specification, shall be in accordance with an approved specification. An approved specification may be a manufacturer's recommendation, purchaser's specification or as agreed between the parties.

### 2.3.4 Rejuvenating Agent

Rejuvenating agent, if required in mixes incorporating recycled asphalt, shall be a low volatility oil capable of combining with bitumen to compensate for any hardened binder in the recycled asphalt. The net effect of the rejuvenating agent blended with the recycled asphalt binder shall approximate the binder grade used in the original mix design. Refer to clauses 3.5.3 and 3.5.4 of this document.

Rejuvenating agent shall comply with recognised standards for such materials.

## 2.4 Reclaimed Asphalt Pavement

Reclaimed asphalt pavement (RAP) shall be crushed and screened as necessary to ensure a maximum size no greater than the nominal size of asphalt being produced. Fine, "all-in" grades shall be well graded, free flowing and consistent. Coarser RAP fractions may be more uniformly graded.

## 3 MIX DESIGN

### 3.1 General

The Contractor shall provide the mix design. The Contractor's mix design shall be assessed by the Engineer for compliance with the requirements of this specification. The Engineer's approval of the mix design is a prerequisite for its use.

The method of ASTM D2726 and ASTM D3203 shall be used to determine the specimen air voids. The air voids result reported shall be the average of at least three specimens for each binder content trialled.

AC grade mixes for Medium, Heavy and Very Heavy traffic, as specified in 3.2, below shall be designed using the procedures contained in Austroads AGPT04B.

DG grade mixes for Light to Medium traffic may be designed using AGPT04B, or the procedures of *Mix Design Methods for Asphaltic Concrete (MS-2)* using the Marshall method of specimen compaction.

As an alternative the Engineer may accept mixes designed in accordance with AASHTO M 323 but with the following conditions and amendments:

- a) Acceptance of mixes designed using AASHTO M 323 shall be obtained in writing from the Engineer prior to commencement of any asphalt paving works;
- b) The requirements of AASHTO M 323 shall be amended as follows:
  - i. Section 5 is amended such that all binders shall be NZTA M01-A compliant;
  - ii. The aggregate blend particle size distribution may comply with M 323 table 4 provided the nominal maximum aggregate size is the same as that specified in the contract;
  - iii. Section 6 is amended such that coarse and fine aggregates comply with the requirements of this specification;
  - iv. The design ESALs of Table 7 shall be approximately converted to ESAs using the following formula:  $1 \text{ Austroads ESA} \approx 2.8 \text{ ESAs}$ .
  - v. Table 1 of AASHTO R 35 shall be used to establish the Superpave gyratory compaction effort, N, but converting site ESAs to ESALs using the formula above.
- c) Asphalt mixes designed to M 323 tend to be lower in binder for improved deformation resistance. This shall be carefully considered by mix designers to ensure that asphalt mixes have sufficient

binder for durability and good fatigue life for flexible New Zealand pavements. It is consequently recommended that fatigue testing to AGPT-T274 is done for all mixes designed using M 323 (i.e. not only those designed for Heavy or Very Heavy traffic levels).

When the method of AASHTO M 323 is used, the minimum “end of life” air voids shall be determined using the method of AASHTO T 312 at 160 gyratory compaction cycles.

## 3.2 Medium, Heavy and Very Heavy Traffic Mixes

### 3.2.1 Mix Design Requirements

Asphalt mixes shall be designed with a target combined aggregate particle size distribution (including filler) and binder content complying with the relevant limits given in Table 3.1 unless otherwise specified or if compliant volumetric test results can not be obtained (but see Note (a) below). Binder content shall be expressed as a percentage by mass of the total mix. Table 3.1 mixes shall be designed using the procedures of AGPT04B (i.e. gyratory compaction to AS/NZS 2891.2.2) apparatus or AASHTO M 323.

**Table 3.1 Dense Graded Asphalt (Medium, Heavy and Very Heavy Traffic)**

Sieve Size (mm)	Mix Designation			
	AC10	AC14	AC20	AC28
	Percentage Passing Sieve Size (By Mass)			
37.5	-	-	-	100
26.5	-	-	100	90 – 100
19.0	-	100	90 – 100	73 – 88
13.2	100	90 – 100	71 – 86	58 – 76
9.5	90 – 100	72 – 83	58 – 75	47 – 67
6.7	68 – 82	54 – 71	46 – 64	37 – 58
4.75	50 – 70	43 – 61	37 – 55	30 – 50
2.36	32 – 51	28 – 45	24 – 42	20 – 37
1.18	22 – 40	19 – 35	15 – 32	13 – 28
0.600	15 – 30	13 – 27	10 – 24	9 – 22
0.300	10 – 22	9 – 20	7 – 17	6 – 16
0.150	6 – 14	6 – 13	4 – 12	4 – 10
0.075	4 – 7	4 – 7	3 – 6	3 – 6
Minimum Layer Thickness (mm)	40	55	80	110
Binder Content (% by mass)	4.5 – 6.5	4.0 – 6.0	3.8 – 5.8	3.5 – 5.5

#### Notes:

- In some instances, the aggregate particle size distribution may need to fall outside of the limits above to achieve mixes with compliant volumetric and performance-related properties. Such departures shall be supported by evidence showing that the departures are justified and necessary.
- For high fatigue base mix types, the maximum binder content limit can be increased by 1 percentage point.
- Note that the binder content ranges specified in Table 3.1 may need to be adjusted for non-natural aggregates such as Glenbrook Melter Aggregate, where those materials have very high densities. Where the combined aggregate has a specific gravity greater than 2.70 then the binder content range can be adjusted by the following factor:

$$\frac{2.65}{\text{Aggregate Dry Bulk Specific Gravity}}$$

### 3.2.2 Volumetric Properties

Dense graded asphalt mixes shall comply with the volumetric design criteria listed in Table 3.2, Table 3.3 and the Voids in the Mineral Aggregate (VMA) requirements listed in Table 3.4. The method of AS 2891.2.2, or AASHTO T 312 with the agreement of the Engineer, may be used, but not both.

**Table 3.2 Volumetric Requirements for AC Grade Asphalt Mixes at Design Compaction Effort**

Mix Type		Laboratory Compaction Effort (Cycles)		Design Air Voids (%)
Traffic Category	Application	AS/NZS 2891.2.2	AASHTO T 312	
Medium	Wearing and base	80	75	4.0
Heavy and Very Heavy	Wearing and base	120	100	4.0
All	High fatigue base	80	75	3.0

**Note:** The compaction effort for AASHTO T 312 above is provided as a guide. Advice shall be sought from suitably experienced asphalt technologists to determine an appropriate compaction effort for the mix design.

**Table 3.3 Volumetric Requirements at “End of Life” Compaction Effort**

Mix Nominal Size (mm)	Gyratory Compaction Effort (cycles)		Minimum Air Voids (%)
	AS/NZS 2891.2.2	AASHTO T 312	
10	250	160	2.0
14			
20			
28			

**Table 3.4 Voids in the Mineral Aggregate (VMA) and Film Index Requirements for AC Grade Asphalt Mixes**

Mix Nominal Size (mm)	Minimum VMA (%)	Minimum Effective Binder Film Index ( $\mu\text{m}$ )
10	15.0	7.5
14	14.0	7.5
20	13.0	7.5
28	12.0	7.5

Binder Film Thickness shall be determined in accordance with AGPT-T237 Binder Film Index. Note that this is a design criterion and not intended to be used for quality control of plant-produced mixes.

### 3.3 Light to Medium Traffic Mixes

#### 3.3.1 Mix Design Requirements

DG asphalt mixes will normally be used in light to medium traffic loading applications. DG10 and DG14 asphalt may be used for heavy duty applications where:

- The asphalt mixes are designed using the procedures of AGPT04B or AASHTO M 323, and;
- Performance related testing demonstrates the deformation and fatigue resistance of the DG asphalt.

Asphalt mixes shall be designed with a target combined aggregate particle size distribution (including filler) and binder content complying with the relevant limits given in Table 3.5 unless otherwise specified or if compliant volumetric test results can not be obtained (but see Note (a) below). Binder content shall be expressed as a percentage by mass of the total mix. Table 3.5 mixes may be designed by using either:

- the procedures of AGPT04B (i.e. gyratory compaction to AS/NZS 2891.2.2), or;
- the procedures of AASHTO M 323 (but see 3.1 above), or;
- the procedures of the Asphalt Institute *Mix Design Methods for Asphaltic Concrete (MS-2)* using the Marshall method of specimen compaction.



**Table 3.5 Dense Graded Asphalt (Light to Medium Traffic Wearing Course Mix Types)**

Sieve Size (mm)	Mix Designation		
	DG7	DG10	DG14
	Percentage Passing Sieve Size (By Mass)		
19.0	-	-	100
13.2	-	100	83 – 100
9.5	100	79 – 100	68 – 90
6.7	80 – 100	63 – 90	54 – 79
4.75	66 – 90	50 – 79	43 – 70
2.36	44 – 75	32 – 61	28 – 55
1.18	29 – 60	22 – 48	19 – 43
0.600	19 – 47	15 – 36	13 – 32
0.300	12 – 33	10 – 26	9 – 23
0.150	8 – 22	6 – 17	6 – 16
0.075	5 – 12	4 – 11	4 – 10
Minimum Layer Thickness (mm)	25	35	50
Binder Content (% by mass)	5.0 – 7.0	4.5 – 6.5	4.3 – 6.3

**Notes:**

- In some instances, the aggregate particle size distribution may need to fall outside of the limits above to achieve mixes with compliant volumetric and performance-related properties. Such departures shall be supported by compliant volumetric and performance-related test results as appropriate
- Table 3.5 mixes will typically be used in light to medium-duty applications where rut resistance and surface texture are not primary requirements.
- Table 3.5 mixes will typically be more binder-rich than Table 3.1 mixes, for increased durability and fatigue life.
- Table 3.5 mixes will normally be designed using 80-cycle gyratory (Austroads) or 50 blow Marshall compaction. For heavier duty applications, 120-cycles or 75 blows can be used.
- Note that the binder content ranges specified in Table 3.5 may need to be adjusted for non-natural aggregates such as steel slag, where those materials have very high densities. Where the combined aggregate has a specific gravity greater than 2.70 then the binder content range can be adjusted by the following factor:

$$\frac{2.65}{\text{Aggregate Dry Bulk Specific Gravity}}$$

**3.3.2 Volumetric and Mechanical Properties**

Asphalt mixes shall comply with the volumetric and mechanical criteria in Table 3.6 or Table 3.7, and Table 3.8. The design criteria shall apply to only one method of compaction.

**Table 3.6 Design Air Voids Requirements for DG Grade Asphalt Mixes Prepared Using Gyratory Compaction**

Mix Type		Laboratory Compaction Level (cycles)		Design Air Voids (%)	Minimum "End of Life" Air Voids	
Traffic Category	Application	AS/NZS 2891.2.2	AASHTO T 312		AS/NZS 2891.2.2	AASHTO T 312
Light	Wearing and base	80	75	3.0	-	
Medium	Wearing and base	80	75	4.0	-	
Heavy	Wearing and base	120	100	4.0	2.0	
All	High fatigue base	80	75	3.0	-	

**Note:** “End of life” air voids shall be determined using the same compaction apparatus as used for determining the design air voids. Compaction effort shall be 250 gyratory cycles if AS/NZS 2891.2.2 is used or 160 gyratory cycles if AASHTO T 312 is used.

**Table 3.7 Design Air Voids Requirements for DG Grade Asphalt Mixes Prepared Using the Marshall Method**

Mix Type		Compaction Effort (Blows)	Design Air Voids (%)
Traffic Category	Application		
Light	Wearing and base	50	3.0
Medium	Wearing and base	50	4.0
Heavy	Wearing and base	75	4.0
All	High fatigue base	50	3.0

**Table 3.8 Voids in the Mineral Aggregate (VMA) Requirements for DG Grade Asphalt Mixes**

Mix Nominal Size (mm)	Design Air Voids		
	3.0%	4.0%	3.0%
	Wearing and Base Mixes		High Fatigue Base Mix
	Minimum VMA (%)		
7	15.0	16.0	16.0
10	14.0	15.0	15.0
14	13.0	14.0	14.0

## 3.4 Performance-Related Properties

### 3.4.1 General

All performance related testing shall be carried out at the design binder content, as follows:

- If the performance-related testing is carried out on asphalt prepared in the laboratory the testing shall be carried out at the design binder content established by the mix design process;
- If plant-produced asphalt is used for the performance related testing it shall be validated by a production trial as in clause 3.6.2 prior to testing. The performance-related testing shall be carried out at the binder content confirmed by the production trial which may differ from the laboratory mix design binder content.

### 3.4.2 Binder Adhesion

The adhesion of binder to the aggregate in the presence of water shall be determined by using the procedure of ASTM D4867 for all asphalt mixes designed for Medium, Heavy and Very Heavy traffic categories. Test specimens shall be compacted to an air voids level of  $7 \pm 1\%$  as measured using ASTM D2726 (water displacement). Refer to ASTM D4867 clause 6.6.2.

The Tensile Strength Ratio (TSR) shall be 75% minimum.

### 3.4.3 Asphalt Modulus

For pavement design purposes, the asphalt modulus shall be determined using one of the options below, listed in order of priority (but also see 3.4.4 below):

- Direct measurement of the flexural modulus obtained from four-point bending tests conducted at the Weighted Mean Annual Pavement Temperature (WMAPT) and for the rate of loading (frequency) experienced by the pavement, or;
- Interpolation of flexural modulus at the WMAPT and the rate of pavement loading from a range of four-point bending tests that span the WMAPT and rate of loading in the pavement, or;
- Estimation of flexural modulus from the resilient modulus measured using the standard indirect tensile strength adjusted to the WMAPT and for the rate of loading in the pavement, or;
- Estimation of the flexural modulus from bitumen properties and mix volumetrics using the Shell nomographs, the WMAPT and rate of loading in the pavement.

If all of the options above are precluded, then the design moduli may be estimated by selecting a representative value for the modulus from available published data. However, considerable care is needed in selecting a value that will fairly represent the proposed asphalt mix in its field situation. Refer to the *Guide to Pavement Technology Part 2: Pavement Structural Design* for more information and guidance.

**Note:** Where asphalt mixes are intended for very thin light duty surfacings (such as for pedestrian traffic, car parks etc.) the requirement to determine and report modulus as part of the mix design process should be waived. However, if these mixes are then used in pavements that are designed on an engineered basis then determination of modulus will be mandatory.

#### 3.4.4 Asphalt Fatigue and Flexural Modulus

If specified in the Schedule of Job Details the Flexural Modulus and the number of cycles to failure shall be determined using the procedure of AGPT-T274 for asphalt mixes designed for Heavy and Very Heavy traffic categories.

As this testing is complex and expensive it shall only be carried out for jobs involving large tonnages of asphalt used for a structural asphalt pavement. The flexural modulus and fatigue testing shall be scheduled and paid for as a separate item.

#### 3.4.5 Deformation resistance

The deformation resistance of all asphalt mixes designed for Heavy and Very Heavy traffic categories shall be determined using the procedure of AGPT-T231.

The mean tracking depth after 10000 passes shall not exceed 6.0mm.

### 3.5 Design of Asphalt Mixes Incorporating Reclaimed Asphalt Pavement (RAP)

#### 3.5.1 General

Mixes shall generally comply with the design and manufacture requirements specified elsewhere in this specification.

Asphalt producers shall have and maintain written procedures in their quality systems that describe how RAP consistency is measured and managed.

Asphalt mixes containing RAP shall only be manufactured in asphalt plants designed so that the RAP is not exposed to nor damaged by the aggregate drying and heating process (i.e. the burner).

RAP shall be stored in separate stockpiles. Stockpiles shall be homogeneous and sampled for mix design validation prior to use. Alterations greater than  $\pm 20\%$  of the proportion of RAP shall constitute a design change.

Binder in RAP shall be included as binder in the total mix.

#### 3.5.2 Asphalt Mixes Containing Not More Than 15% of RAP by Mass of Total Mix

Unless otherwise specified, RAP in proportions up to 15% by mass of the total mix shall be permitted in all dense graded asphalt mixes.

Addition of up to 15% RAP to current mix designs shall be validated at the original design Job-mix formula by volumetric testing. Validation may be either single-point volumetric testing of laboratory mixed samples or volumetric analysis of plant-produced asphalt mix.

#### 3.5.3 Asphalt Mixes Containing More Than 15% But Not More Than 30% of RAP by Mass of Total Mix

RAP in proportions greater than 15%, but not exceeding 30%, can be used in dense graded asphalt mixes.

In addition to the requirements specified in clause 3.5.1, allowance shall be made for increase in binder stiffness due to hardened binder in RAP by the use of a binder lower in viscosity than that otherwise specified and/or by the use of rejuvenating agents, supported by blending chart analysis using internationally accepted practices.

A new laboratory mix design shall be required where the RAP content exceeds 15%. The mix design process shall include evidence to show that the fatigue performance of the mix has not been degraded by the addition of RAP. Such evidence shall include mix testing to AGPT T274 and/or testing of the binder blend to demonstrate compliance with the specified performance grade.

### 3.5.4 Asphalt Mixes Containing More Than 30% of RAP

Asphalt mixes containing more than 30% of RAP shall only be accepted where the Contractor can demonstrate suitable manufacturing plant and quality control procedures to ensure consistent production of asphalt of a standard not less than that otherwise specified. Appropriate binder selection supported by blending chart analysis and performance-related mechanical testing on laboratory prepared specimens shall be used to demonstrate that the performance of these high RAP mixes is not degraded.

A new laboratory mix design shall be required where the RAP content exceeds 30%. The mix design process shall include testing to AGPT T274 to confirm that the fatigue performance of the asphalt mix has not been degraded by the addition of RAP.

The mix design process shall include testing of the binder blend to demonstrate compliance with the specified performance grade for the asphalt mix.

## 3.6 Approval of Laboratory Mix Design

### 3.6.1 Laboratory Mix design

The Contractor shall provide the information listed below for approval by the Engineer at least seven days prior to commencement of production:

- a) Properties of constituent materials required under this specification including aggregates, filler, binder, additives (if used) and source of materials;
- b) Test results of trial mixes made in the laboratory at varying binder contents to arrive at the design mix;
- c) Test results in accordance with the design requirements specified in section 3 of this document, either directly measured or interpolated, including:
  - i. The blend ratios of the individual aggregate components;
  - ii. The added filler content (if used);
  - iii. The type, source and quantity of additives (if used);
  - iv. The aggregate blend particle size distribution;
  - v. The bulk specific gravity and density of the aggregate components and combined aggregates;
  - vi. The design binder grade, density and content;
  - vii. The RAP content and properties including particle size distribution and binder content (if used);
  - viii. The specimen compaction temperature;
  - ix. The bulk specific gravity and density of the mix for each trial blend;
  - x. The maximum specific gravity and density of the mix for each trial blend;
  - xi. The air voids of the compacted mix for each trial blend;
  - xii. The VMA of the compacted mix for each trial blend;
  - xiii. The Effective design binder content by volume ( $V_{be}$ );
  - xiv. The Effective binder film index for each trial blend (for Table 3.1 mixes only);
  - xv. The air voids at 250 gyratory compaction cycles at design binder content (for Heavy and Very Heavy duty mixes only);
  - xvi. The tensile strength ratio at design binder content (for Medium, Heavy and Very Heavy duty mixes only);
  - xvii. The maximum rut depth determined by the Wheel Tracking test at the design binder content (for Heavy and Very Heavy duty mixes only);
  - xviii. Where required, the asphalt modulus at the design binder content;
  - xix. Where required, the flexural modulus and cycles to failure.

### 3.6.2 Production Trial

The following test results performed on a batch of each mix proposed to be used, and produced from the mixing plant for design verification from which the asphalt is to be supplied:

- a) The particle size distribution;
- b) The total binder content;

- c) The RAP content (if used);
- d) The maximum specific gravity of the mix;
- e) The bulk specific gravity and density of the compacted mix;
- f) The air voids at laboratory design compaction level.

The scale-up of manufacture from the laboratory to the plant affects mix volumetric properties. It is normal that asphalt mix blend adjustments are made following mix design validation trials to optimise the mix as produced by the plant. Such adjustments shall be documented in the mix design report.

Any adjustments to binder content shall not move the design binder content outside the limits of the specified range.

Changes to individual components of the asphalt mix shall not exceed 20% of the proportion of that component (i.e. a component representing 20% of the total asphalt mix shall not be adjusted to below 16% or 24% of the total asphalt mix). Refer to the Notes for guidance where significant proportion changes are found to be necessary.

### 3.6.3 Approval Criteria

Approval of the job mix formula will be granted if the following criteria are met:

- a) Constituent materials comply with the specified requirements;
- b) The blend particle size distribution complies with the specified requirements, unless a variation has been agreed;
- c) The volumetric properties of the mix obtained during the laboratory mix design process at the nominated design binder content, whether directly measured or interpolated, comply with the specified criteria;
- d) The mechanical and/or performance-related properties of the mix at the nominated design binder content, whether directly measured or interpolated, comply with specified criteria;
- e) The particle size distribution of the plant-produced mix complies with the envelope constructed by applying the tolerances of Table 5.3 to the mix design particle size distribution curve;
- f) The binder content of the plant-produced mix complies with the limits derived by applying the tolerances of Table 5.3 to the mix design binder content;
- g) The average air voids for three test specimens compacted from plant-produced mix, compared with the mix design air voids and following any adjustments, fall between  $\pm 1.0\%$  of the specified mix air voids. If the air voids for the plant-produced mix do not fall within these limits, then appropriate adjustments should be made to the mix design and/or the production process and the production trial repeated.

On request all test results must be supplied with the results showing the unrounded calculations followed by the rounded values to the accuracy required in the test specifications.

### 3.6.4 Asphalt Mix Design Validation

Asphalt mix designs shall be valid for six months from the date of the production trial. Validation shall be extended where testing no more than six months old confirms:

- a) The asphalt mix particle size distribution complies with the requirements of 5.3 below, and;
- b) The asphalt mix binder content complies with the requirements of 5.3 below, and;
- c) Volumetric testing confirms that the air voids of the asphalt mix complies with the requirements of 5.3 below, and;
- d) The type, quality, proportion and sources (i.e. the specific quarry) of all constituent materials remain substantially unchanged. Substantially is defined as 20% or less of the mass percentage of the constituent material (i.e. for a constituent with a design proportion of 20%, the proportion of that constituent shall not be less than 16% nor more than 24%);

Where there are no compliant test results within the last six months, or if the proportion of constituent materials require a change greater than 20% of that component, the following steps must be taken to revalidate the mix design:

- e) A sample of mix is prepared in the laboratory to confirm the compliance of the volumetric properties of the asphalt mix, and;

- f) The mix is validated by a production trial as in clause 3.6.2 above.

Where there are no compliant test results within two years of the production trial the mix design shall no longer be valid.

### 3.6.5 Approval to Use Previously Designed Mix

The Engineer shall accept a previously approved mix design used by the Contractor under other contracts for the supply of asphalt of the particular type and nominal size specified subject to the following conditions:

- (a) The conditions of clause 3.6.4 are met, and;
- (b) The in-service performance of the asphalt mix has been satisfactory.

## 4 MANUFACTURE AND STORAGE

### 4.1 General

Asphalt manufacturing plant shall be of sound design and construction and capable of consistently producing asphalt mixes with the properties specified and at a rate suitable for smooth, continuous asphalt placing.

### 4.2 Storage of Raw Materials

Raw materials shall be stored at the mixing site in sufficient quantities to ensure continuity of production and enable effective sampling and testing prior to use. The facilities for handling particular materials shall comply with the following:

- a) Aggregates shall be handled and stored in such a manner as to prevent contamination and avoid segregation.
- b) RAP shall be placed in separate stockpiles prior to use.
- c) Filler shall be handled and stored in such a manner as to keep it dry and free flowing at all times. Where more than one type of filler is to be used, each shall be handled and stored separately.
- d) Additives shall be protected from moisture or contamination. Materials that are contaminated or moisture-damaged shall not be used.
- e) Tanks for heating and storage of binder shall be thermostatically controlled and each shall be fitted with a thermometer that is located so that the temperature can be read conveniently. Bitumen binder shall not be heated to more than 170°C. Polymer modified binders shall not be heated or stored contrary to the temperature and time combinations specified by the manufacturer's written instructions.

### 4.3 Mixing Temperatures

Temperature of bitumen and aggregates at the mixing plant, and the temperature of asphalt as it is discharged from the asphalt mixer, shall be specified in the quality plan. Asphalt discharge temperatures shall not exceed 185°C unless specifically permitted by the Engineer in writing.

**Note:** Some highly modified or proprietary binders may require discharge temperatures exceeding 185°C. Such high discharge temperatures shall be substantiated by the binder supplier.

Continuous records of the mix temperature at discharge from the mixer shall be maintained. These records shall be made available for audit by the Engineer.

### 4.4 Moisture Content

After completion of mixing, the moisture content of the mix shall not exceed 0.5%.

### 4.5 Storage of Mixed Asphalt

Asphalt can be stored prior to delivery to the purchaser, subject to the following requirements being observed.

- a) The mix can be stored in an insulated storage bin.

- b) The Contractor shall nominate in the quality plan the maximum storage time appropriate to the contract, production plant and mix type.

## 4.6 Asphalt Mixes Incorporating Reclaimed Asphalt Pavement (RAP)

RAP shall only be used from stockpiles that have been tested for consistency in particle size distribution and binder content. Maximum Specific Gravity may also be advisable if the stockpile contains RAP from different sources.

RAP component(s) shall be metered into the plant in such a way that the RAP binder is not damaged or excessively hardened by exposure to the plant heating system (i.e. burner flame).

Batch mixing time shall be increased, if necessary, to ensure adequate heat transfer and dispersion of RAP.

# 5 SAMPLING AND TESTING OF ASPHALT PRODUCTION

## 5.1 General

The Contractor shall arrange for all relevant testing.

Samples from asphalt production shall be randomly selected using a recognised stratified random sampling technique from fresh production asphalt at the asphalt plant. Separate samples shall not be combined. All test results of samples associated with a specific contract shall be reported to the Engineer.

Production asphalt shall be tested for the following:

- a) Particle Size Distribution.
- b) Binder Content.
- c) Maximum Specific Gravity (for monitoring changes in aggregate properties and use in calculating laboratory test specimen and core air voids).
- d) Air voids as an average of three test specimens compacted from the plant-produced mix.

## 5.2 Frequency of Sampling and Testing

Unless otherwise specified, or agreed as per Section 5.4, frequency of sampling and testing shall be not less than that shown in Table 5.1 and Table 5.2 with a maximum of three samples per production lot. Acceptance of the mix will be based on lots. A production lot will normally consist of a day's or a shift production or as detailed in the Contractor's Quality Plan. When a day's output is less than 100 tonnes and the same asphalt mix is to be produced on subsequent days for the same pavement section, the lot considered for acceptance will include the next day's production.

Table 5.2 provides for two levels of minimum frequency. The reduced frequency can only be adopted where the process is demonstrated to be under statistical control as specified in clause 5.4. Where a non-conformance occurs in any test requirement, the frequency of sampling and testing for that particular property shall be increased to the normal level until conforming results have been obtained on five consecutive samples.

**Table 5.1 Minimum Frequency of Testing of Component Materials**

Test	Minimum Frequency
Particle Size Distribution	As per CCNZ BPG 05
Broken Faces (blend fraction coarser than 4.75 mm)	As per CCNZ BPG 05
Fine Aggregate quality (Sand Equivalent or Clay Index)	As per CCNZ BPG 05
Crushing Resistance	As per CCNZ BPG 05
Weathering Resistance	As per CCNZ BPG 05
Polished Stone Value (where applicable)	As per CCNZ BPG 05
Added Filler	Certification from the supplier
RAP Particle Size Distribution, Maximum SG and Binder Content	One test per 600 t of RAP

**Table 5.2 Minimum Frequency of Sampling and Testing of Production Asphalt**

Test	Normal Minimum Frequency	Reduced Minimum Frequency
Particle Size Distribution	One test per 200 t of asphalt plant production	One test per 300 t of asphalt plant production
Binder Content	One test per 200 t of asphalt plant production	One test per 300 t of asphalt plant production
Maximum Specific Gravity	One test per 600 t of asphalt plant production	One test per 900 t of asphalt plant production
Air Voids	One test per 600 t of asphalt plant production	One test per 900 t of asphalt plant production

### 5.3 Production Tolerances

Production tolerances for individual test results for particle size distribution, binder content and production air voids shall comply with Table 5.3. The tolerances are applied to the values obtained during the mix design process.

Where a project or a job requires three or more tests, a rolling average of the particle size distribution, binder content and air voids test results shall be calculated. The rolling averages shall fall within the limits formed by applying the “percentage mean of three” tolerances of Table 5.3 to the values obtained during the mix design process.

**Table 5.3 Production Tolerances for Dense Graded Asphalts (AC, DG grades)**

Description	Maximum Tolerance on Job-Mix Formula	
	Percentage for Individual Test Results	Percentage Mean of Three Test Results
Sieve size one size larger than nominal size	Nil	Nil
1.18 mm sieve and larger	± 8	± 5
0.600, 0.300 mm sieves	± 6	± 4
0.150, 0.075 mm sieves	± 3	± 2
Binder Content: Percent by Mass	± 0.5	± 0.3
Air voids	+2.0, -1.0	+1.2, -0.6

### 5.4 Process Control

The Contractor shall implement suitable measures for control of the asphalt manufacturing process. Process control measures can include the use of statistical process control charts for some, or all, of the tests required in Section 5.2, and suitable decision rules for determining that the process is under statistical control, and therefore subject to reduced minimum frequency of test, in agreement with the Engineer.

## 6 DELIVERY

Asphalt shall be transported to the point of delivery in vehicles complying with the following requirements:

- The inside of vehicle bodies shall be kept clean and coated with a thin film of an appropriate release agent to prevent asphalt sticking to the body of the vehicle. Care shall be taken to remove surplus release agent before loading asphalt into the vehicle.
- After loading with asphalt, suitable covers shall be used to prevent contamination and reduce the rate of cooling of the mix.
- Where the length of the haul or the weather is such that the temperature of the asphalt may drop below a suitable placing temperature, or where excessive local cooling of the mix may occur,



suitable means shall be implemented to ensure that the asphalt mix is delivered to the job site at or above the required compaction temperatures. These means shall be documented in the quality plan.

## 7 CONSTRUCTION TRIAL

### 7.1 General

Where a construction trial is specified in the contract, and not less than two days before the site work is due to commence, all the Contractor's plant and personnel proposed for use on the job shall carry out a construction trial in the presence of the Engineer. Asphalt manufactured in the production trial can also be used in the construction trial if it meets the requirements of the specification.

### 7.2 Manufacture

The mixing plant shall be operated at approximately the rate intended for full-scale production to produce the following quantities.

Sufficient asphalt shall be produced to give two paver runs at least 30 metres long, placed at specified thickness with at least one longitudinal joint.

The Contractor shall sample and test the asphalt in accordance with clause 5. Unless otherwise specified, constituent (binder content and particle size distribution) and air voids testing shall be carried out to confirm the properties of the produced asphalt mix.

If the tests on the samples indicate that the asphalt does not conform to the Specification, the Contractor shall make such alterations in the procedures or adjustments to the plant and equipment as necessary to produce asphalt in accordance with this Specification. The trial shall be repeated as necessary until asphalt of the quality specified is being consistently produced.

### 7.3 Placing, Compaction and Finishing

If specified in the contract the Contractor shall subject all of the placing, compaction and finishing equipment and operating personnel, proposed for use in the works, to a trial using the construction procedures proposed for the work. The trial shall consist of at least two adjacent lanes, 3 metres wide and at least 30 metres long, and shall be constructed in the designated area, in accordance with all the requirements of this Specification, or as directed.

### 7.4 Testing of Trial Section

The Contractor shall test the trial section for the finished pavement properties of this specification including Mean Profile Depth (MPD), for surfacing mixes. In the event that the tests indicate that the asphalt in the test section does not conform to the specification requirements, the Contractor shall make any necessary adjustments and, if necessary, repeat the production and construction trials, as specified above, until the Engineer is satisfied that asphalt of uniform quality is being consistently produced, placed, compacted and finished in accordance with the requirements of this specification. Testing shall include in-situ mat and joint air voids and mat thickness by drilling and testing core specimens.

A hold point shall be designated in the Contractor's Quality System at the conclusion of the trial (unless agreed with the Engineer) and the Contractor shall not commence full-scale production of any asphalt for the works until the hold point has been lifted.

## 8 CONTRACTOR QUALITY PLAN

The Contractor shall prepare a Quality Plan covering the following items. A separate quality plan should be prepared for larger jobs, but a separate quality plan is unnecessary for smaller jobs. In these instances, standard quality systems documentation may be used.

When a job-specific quality plan is prepared it shall be submitted to the Engineer not less than 7 days prior to construction of the asphalt pavement. Commencement of works is subject to formal acceptance of the quality plan by the Engineer.

## 8.1 Raw Materials

The quality plan shall outline the way in which raw materials being used in the produced asphalt are managed. This shall include such items as required tests and test frequency, handling and storage.

If it is proposed that RAP is included in the mix, then a specific detailed section on the management process for RAP may be required.

## 8.2 Mix Design and Production Trials

This quality plan shall outline the mix design procedure adopted and the process in which production trials, lay down trials (if required) will be completed including how compliance will be assessed.

## 8.3 Sampling and Testing

The quality plan shall describe the way in which sampling and testing is used to determine compliance of material. This will include detailing the time in which the random sample locations will be chosen. The section should include how non-conformances will be dealt with.

## 8.4 Manufacturing and Storage

The quality plan shall specify the following:

- a) Discharge temperature range from the plant, or the storage facility including rejection limits.
- b) Storage durations. Where an asphalt plant can store asphalt for extended periods of time then the quality plan must contain the details of this and evidence to support that this is not detrimental to the performance of the asphalt.

## 8.5 Placement

The quality plan shall specify:

- a) Asphalt delivery temperatures and associated rejection temperatures;
- b) Plant and equipment used to compact the asphalt mix;
- c) Compaction patterns and procedures;
- d) Methods used to manage the compaction process;
- e) Means by which compliance with the minimum thickness requirements is demonstrated;
- f) Location of joints, particularly in relation to vehicle wheel paths.

Where the layers to be paved are not required to be cored under clause 9.9 to confirm mat density then the quality plan shall outline the equipment and methodology to be used to demonstrate adequate compaction is achieved. This will be approved by the Engineer and become a compliance requirement. The quality plan should also contain the methods by which this will be recorded on site.

# 9 PLACING

## 9.1 General

The asphalt paving shall be constructed in conformity with the lines, grades and typical cross-sections shown on the plans. The mix types to be laid shall be as defined in the "Schedule of Job Details" or as outlined in the contract documents.

## 9.2 Preparation of Area to be Paved

Where the construction of the layer or existing surface on which the paving is to be laid is not part of the contract, the road will be handed over in a condition ready to be prepared for paving, unless specified otherwise in the job specification. The Engineer will define the date of handover after consideration of the Contractor's proposed timing and sequence of operations. From the date of handover, the work necessary to retain or reinstate the surface shall be at the Contractor's expense.

When a correction layer is not specified, depressions and other irregularities shall be patched or corrected in a manner as directed by the Engineer. All fatty and unsuitable patches, excess crack or joint filler, and all surplus bituminous material shall be removed from the area to be paved. Blotting of surplus bituminous material with sand or stone will not be permitted.

The surface on which the paving is to be laid shall be free from standing water, and any loose material, dust, clay or foreign matter shall be removed by sweeping.

## 9.3 Surface Pre-Treatment

### 9.3.1 Tack Coating

Tack coating shall be specified in the Schedule of Job Details.

Tack coat shall be applied to the cleaned surface prior to placing asphalt. Tack coats shall be applied using a distributor. The use of a hand lance shall be minimised to ensure an even application of the tack coat.

Tack coat shall consist of bituminous emulsion. The type and breaking rate shall be suitable to the climatic and surface conditions of use such that it is fully broken, free of surface water and intact before the commencement of asphalt spreading.

Unless otherwise directed, tack coat should be applied to provide a uniform application rate of residual binder of between 0.2 and 0.6 L/m<sup>2</sup>, depending on the texture and absorption of the substrate. Tack coat application rates shall be within  $\pm 0.1$  L/m<sup>2</sup> of the specified rate. The default application shall be 0.2 L/m<sup>2</sup> unless otherwise specified. Care must be taken to ensure application rates do not create excess binder on the substrate which could contribute to flushing of the finished asphalt.

Precautions shall be taken to protect kerbs, channels, adjoining structures, traffic and parked vehicles from tack coat spray.

### 9.3.2 Chip Seal

If required under the asphalt, a chip seal shall be specified in the Schedule of Job Details.

A chip seal can be applied to surfaces that require additional waterproofing and/or to provide a good friction bond between the asphalt and the layer below. Unless otherwise directed, the chip seal shall be designed as a chip seal using recognised design algorithms such as in *Chipsealing in New Zealand*. They should consist of at least 1.0 L/m<sup>2</sup> of residual binder and sparingly covered with a single layer of sealing chip, normally NZTA M6 Grade 4. Anti-stripping agents (adhesion agents) compatible with the sealing chip shall be included in the chip seal binder.

The use of volatile diluents in chip seal binders, such as kerosene, can cause thin layers of dense asphalt mixes to flush. Seal binders must be carefully chosen to minimise this risk.

### 9.3.3 Blinding

It is recommended to spread a blinding layer of fine chip or a very thin layer of lean asphalt mix over tack coat applied to new granular base course to prevent pickup of the binder by construction traffic. The blinding material shall be sparingly spread so that the asphalt bond to the tack coat is not compromised.

### 9.3.4 Levelling

Where a levelling course is required, a suitable asphalt mix shall be placed to correct surface irregularities. Suitable mixes include DG grades with suitable binder selected in accordance with NZTA M01-A.

## 9.4 Protection of Services

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

## 9.5 Spreading and Trimming

### 9.5.1 General

Paving shall be carried out with the prior agreement of the Engineer for the method of construction to be used. The Contractor shall set out true line markings to be closely followed by the paver in constructing longitudinal joints and edges. The Contractor shall supply the Engineer with a detailed paving plan to be followed by the paver in placing individual lanes. Unless otherwise specified, self-propelled mechanical pavers shall be employed to place asphalt, except for areas where the use of a paver is impracticable.

### 9.5.2 Ambient Conditions for Placing

Asphalt placed as in intermediate or a structural layer (i.e. not the surfacing layer) shall not be placed when the pavement surface temperature is less than 5°C. Wearing course asphalt shall not be placed when the pavement surface temperature is less than 10°C, except that placing at lower temperatures can be permitted subject to agreement with the Engineer on procedures used to compensate for rapid cooling of asphalt materials.

### 9.5.3 Level Control

The method of paver level control shall be as specified in the Schedule of Job Details. If no method is specified in the Schedule of Job Details, the Contractor shall apply suitable automatic or manual screed level controls to achieve the standards specified in section 10 of this document.

### 9.5.4 Operational Requirements

The asphalt mix shall be spread and struck off with a self-powered and propelled paving machine capable of spreading and finishing the mix true to line, grade and cross-section without the use of forms or side supports. The paving machine shall be capable of laying layers in thicknesses as specified, and it shall be equipped with a suitably controlled screed-heating device. The screed shall strike off the mix to the elevation and cross-section required and shall provide a smooth and uniform texture without segregation, tearing, shoving or gouging. Equipment which leaves tracks or indented areas which cannot be corrected in normal operation, or which produces flushing or other permanent blemishes or fails to produce a satisfactory surface, shall not be used. A fully trained and experienced operator shall be in direct charge of the paving machine.

If the delivery of material to the paving machine ceases for a time sufficient to allow the temperature of the unrolled portion of the freshly laid mix to drop below the minimum temperature in the quality plan then the paving machine shall be withdrawn and rolling of the mix completed. Paving shall be recommenced from a transverse joint, which is located in a fully compacted area. Where the paving is to be laid to conform to the level of an adjacent finished surface, the mix shall be spread sufficiently high so that when compacted, the finished surface will be true and uniform across the joint.

As soon as the first load of material has been spread, the texture of the unrolled surface shall be checked to determine its uniformity. The adjustment of the screed, tamping bars, feed screws, hopper feed, etc. shall be checked frequently to assure uniform spreading of the mix to proper line and grade and adequate initial compaction. Segregation of materials shall not be permitted. If segregation occurs, the spreading operation shall be immediately suspended until the cause is determined and corrected. Any area of segregation, which is not corrected prior to rolling, shall subsequently be removed and replaced with material supplied and compacted to specification requirements by the Contractor at their own expense.

Any irregularities in horizontal alignment left by the paver shall be corrected by trimming directly behind the machine. Immediately after trimming, the edges of the layer shall be thoroughly compacted by tamping. Distortion of the pavement during this operation shall be avoided.

Paving machines shall be operated so that material does not accumulate and remain along the sides of the receiving hopper. Material, which accumulates and cools along the sides of the receiving hopper of the paving machine shall be removed from the work site.

In small areas where the use of mechanical finishing equipment is not practical, the mix can be spread and finished by hand. Wood or steel forms, rigidly supported to assure correct grade and cross-section, can be used. In such instances, measuring blocks and intermediate strips shall be used to aid in obtaining the required cross-section.

## 9.6 Joints

### 9.6.1 General

Joints shall be provided as follows:

- a) Longitudinally, if the width of the pavement is such that more than one paving run is necessary.
- b) Transversely, after the completion of a day's paving operations, or where a delay in paving operation allows asphalt to cool and adversely affect placing.

The location of joints shall be planned before work commences.

The number of joints shall be minimised by adopting good asphalt paving practices.

All joints shall be well constructed and comply with the shape requirements specified in clause 10.

### 9.6.2 Longitudinal Joints

Longitudinal joints in the wearing course shall coincide with traffic lane lines unless otherwise specified or agreed. Longitudinal joints shall be offset from layer to layer by not less than 150 mm provided that no joint is placed directly below a trafficked wheel path.

The Contractor shall explicitly nominate and control joint compaction techniques and temperature in the quality plan.

### 9.6.3 Transverse Joints

Transverse joints shall be offset from layer to layer by not less than 2m in adjoining paver runs.

## 9.7 Thickness Requirements

The thickness of the various layers shall be determined by the Engineer on a lot by lot basis. A pavement lot shall be an essentially homogeneous section of work completed within a shift of production, unless otherwise specified in the contract specification.

Non-compliant or unsatisfactory work shall be repaired, replaced or corrected by the Contractor at their own expense.

The cutting of test holes to check the depth of paving, the refilling with acceptable material, and proper compaction of this material shall be done by and at the expense of the Contractor.

All mixes shall be laid to a thickness equal to or greater than the minimum thicknesses specified in Table 3.1 or Table 3.5 for the appropriate mix designation.

Where a minimum thickness is specified by the contract, the lower characteristic value for the set of core specimens for the lot shall not be less than the specified minimum thickness. Calculate the Lower Characteristic Value for the thickness, as follows:

- a) Calculate the mean thickness for the set of cores;
- b) Calculate the sample standard deviation (s) for the thickness for the set of cores;
- c) Determine the Acceptance Constant (k) using the number of core specimens from Table 9.1;
- d) Calculate the Lower Characteristic Value (LCV) for the core thicknesses:

$$\text{LCV} = \text{mean} - (k \times s)$$

Where a nominal or average thickness is specified by the contract the average total layer thickness for the set of cores shall be equal to or greater than the specified nominal or average thickness.

For a multi-layer asphalt pavement:

- a) where an individual layer thickness is less than or equal to 55mm, the thickness of any individual layer at any location shall not be less than the specified thickness minus 5mm;
- b) where the specified individual layer thickness exceeds 55mm, the thickness of any individual layer at any location shall not be less than 90% but no more than 10mm less than the specified thickness.

## 9.8 Surface Requirements

The final surface shall be of a uniform texture conforming to the line and grade shown on the plans. The surface texture for all wearing course asphalt mixes shall comply with the minimum macrotexture requirements

of Table 3 of NZTA T10 specification appropriate for the site and/or as specified by section 12 Schedule of Job Details.

Geometric design considerations excepted, the finished surface on surface courses shall comply with the maximum roughness level in the Schedule of Job Details. The finished surface at joints can be tested using a 3 m straight edge. Where the length of the site or the geometry is such that a road roughness-measuring vehicle cannot be used then the straight edge can be used for checking the surface shape. The straight edge shall be held in successive positions parallel to the road centreline in contact with the surface, and the entire area checked from one side to the other. Advance along the pavement shall be in successive stages of not more than half the length of the straight edge. The transverse truth of the surface shall be checked with a 3 m straight edge over the straight cross-fall portion of the cross-section. For surface layers, any irregularities, which vary more than 5 mm under this straight edge, longitudinally or transversely, shall be corrected by means approved by the Engineer.

**Note:** Where asphalt pavements are constructed using multiple asphalt layers, it is advisable to monitor pavement shape using the 3 m straight edge as each layer is completed. Corrections to irregularities can then be made prior to the placement of additional asphalt layers.

## 9.9 Compaction

Asphalt shall be uniformly compacted to the standards specified in clause 9.9.1 as soon as the asphalt has cooled sufficiently to support the compaction equipment without undue displacement.

Compliance testing of asphalt shall be undertaken on a lot-by-lot basis by testing of core specimens. A pavement lot shall be an essentially homogeneous section of work completed within a shift of production, unless otherwise specified in the contract specification.

Specific gravity (relative density) and air voids testing for core specimens need not be performed on:

- a) Lots of less than 30 tonnes;
- b) Layers with a thickness less than 35 mm;

All core holes shall be repaired by an appropriate method that is compatible with the pavement from which the cores have been taken. Sampling rates can be reduced with the agreement of the Engineer. Sampling and testing shall be performed by a laboratory accredited to NZS ISO/IEC 17025. Where the operators of the coring equipment are not accredited then they shall be supervised by a person accredited for the appropriate test.

For mixes with a nominal maximum aggregate size 14mm or less cores shall be 100 mm nominal diameter or greater. For mixes coarser than 14mm cores shall be nominally 150mm diameter.

For layer thicknesses 40mm or less the core diameter shall be nominally 100mm.

Core specimens may be trimmed when they have substrate materials adhering to their base. The depth of the asphalt layer shall be measured prior to trimming. It is recommended that all cores are photographed prior to trimming. The photograph should include a scale rule.

The air voids of the core shall be determined in accordance with the requirements of ASTM D3203 except that ASTM D2726 shall always be used to determine the specimen bulk specific gravity and density for dense bituminous paving mixtures. All core specimens sampled from a lot shall be used for the determination of compliance with this specification. Refer to M10 Notes for a discussion on the use of ASTM D2726.

For the determination of compliance, the maximum theoretical specific gravity (MTSG) used in the above calculation, in order of preference, can be taken as:

- (a) The average of all samples taken from the production of that lot of asphalt mix, or if there is insufficient asphalt produced to require an MTSG test;
- (b) The average of the last three MTSG test results provided each result is within acceptable limits (i.e. no outliers), or;
- (c) The MTSG as measured by testing the broken down core specimens.

As an alternative to taking cores, nuclear methods of density measurement may be accepted at the discretion of the Engineer provided that the Contractor can justify the method with statistically validated comparative test data on the mix being produced. If nuclear methods are to be used, a fully detailed testing plan must be submitted to the Engineer for agreement. The thickness used as an input to the density determination shall be the specified thickness for the layer.

**9.9.1 Mat Density**

Where the nominal thickness is sufficient, cores shall be cut from the pavement at a rate of one core for every 300 m<sup>2</sup> with a minimum of eight cores representing each lot. A pavement lot shall be an essentially homogeneous section of work completed within a shift of production, unless otherwise specified in the contract specification. The lot shall be divided into an appropriate number of approximately equal sub-lots and a core shall be taken randomly within each sub-lot. The number of sublots shall be calculated from the lot area in m<sup>2</sup>/300 with a minimum of 8. The Engineer or their delegate shall use a random method for locating each core position, such as ASTM D5361 or a similar process.

The lot shall be deemed acceptable in terms of density if the characteristic value for air voids for the mat are between the air voids value approved in the mix design plus the offset values in Table 9.2 (i.e. mix design air voids value +3, -2).

Note that mat core testing may not be appropriate for smaller jobs, or for exception cases noted in 9.9 above.

**9.9.2 Joint Density**

Where the nominal thickness is sufficient, cores shall be taken from randomly located distances along joints at the rate of one per 100 m of joint with a minimum of three representing each lot. The cores shall abut or span the joint line. The Engineer or their delegate shall use a random method for locating each core position, such as ASTM D5361 or a similar process..

The relevant sub-lot shall be deemed acceptable in terms of density if the characteristic value for air voids for the joint are between the air voids value approved in the mix design plus the offset values in Table 9.2 (i.e. mix design air voids value +5, -2).

Note that joint core testing may not be appropriate for smaller jobs, or for exception cases noted in 9.9 above.

**9.9.3 Density Requirements**

The upper and lower characteristic values for the core air voids are calculated as follows:

- a) Calculate the mean air voids for the set of cores;
- b) Calculate the sample standard deviation (s) for the air voids for the set of cores;
- c) Determine the Acceptance Constant (k) using the number of core specimens from Table 9.1;
- d) Calculate the Upper (UCV) and Lower Characteristic Value (LCV) for the core air voids:

$$UCV = \text{mean} + (k \times s)$$

$$LCV = \text{mean} - (k \times s)$$

**Table 9.1 Acceptance Constants**

Number of Tests or Measurements	Acceptance Constant (k)
2	0.403
3	0.535
4	0.617
5	0.675
6	0.719
7	0.755
8	0.783
9	0.808
10	0.828
11	0.847
12	0.863
13	0.877
14	0.890
15	0.901

Compliance limits for the maximum and minimum characteristic values for air voids shall be calculated by adding the offset values of Table 9.2 to the mix design air voids established during the mix design process. Maximum and minimum characteristic values for air voids shall fall within these limits.

Table 9.2 Limits for Characteristic Values of In-situ Air Voids

Core Locations	Maximum Characteristic Offset Value (%)	Minimum Characteristic Offset Value (%)
Mat Cores	3	-2
Joint Cores	5	-2

## 10 FINISHED PAVEMENT PROPERTIES

### 10.1 Level

The level at the top of each layer of asphalt shall not differ from the specified level by more than 10 mm, except that where asphalt is placed against kerb and channel, the surface at the edge of the wearing course shall be flush with, or not more than 5 mm above, the lip of the channel, unless otherwise specified or shown on the Drawings.

### 10.2 Alignment

The horizontal location of any point on the pavement shall not vary by more than  $\pm 50$  mm from the corresponding points shown on the documents, except where alignment with an existing pavement structure is necessary, when the new work shall be joined to the existing work or structure in a smooth manner.

### 10.3 Thickness

Where confirmation of asphalt thickness is required, it shall be determined by coring to a recognised random sampling plan.

The thickness of each layer of asphalt in the pavement shall comply with the thickness requirements of clause 9.7.

### 10.4 Ride Quality

The ride quality required shall be included in the contract specification.

The ride quality requirements at roundabouts and intersections shall take into account the design and pre-existing pavement shape and geometrics. Refer to <https://www.nzta.govt.nz/resources/roughness-requirements-finished-pavement/> for more information.

## 11 MEASUREMENT AND PAYMENT

The basis for payment shall be included in the contract specification.

### 11.1 Non-Complying Materials

In the event that the material supplied is not within the tolerances and standards defined for manufacture or placing of asphalt, the Engineer can direct:

- a) The removal of non-complying material; or,
- b) That the reduced service life arising from the non-complying material is offset by reducing payment for the non-complying material; or,
- c) With the consent of the Contractor, any other remedial treatment that is expected to provide the required level of service.

The basis for payment shall be included in the contract specification.



## 12 SCHEDULE OF JOB DETAILS

### 12.1 General

The following items shall be considered and scheduled in the contract specific job details:

- a) Location number (for more than one site).
- b) Length of contract.
- c) Width of paving.
- d) Layer depth.
- e) Layer depth nominal or minimum.
- f) Mix designation and traffic category.
- g) Nominal maximum aggregate size.
- h) Compaction effort for laboratory mix design: number of compaction cycles or blows.
- i) Mean Profile Depth (MPD) for a surfacing mix.
- j) If fatigue and flexural modulus testing is required and required method of test.
- k) Bitumen performance-grade for designated mix.
- l) NZTA T10 site category.
- m) Residual application rates for tack coat (0.2 L/m<sup>2</sup> if not otherwise specified).
- n) If required, material for any correction layer/blinding coat.
- o) Residual application rate for correction layer tack coat.
- p) Maximum finished pavement roughness.
- q) Construction trial if required.