WAKA KOTAHI
NZ TRANSPORT AGENCY

NZTA M27: 2020

SPECIFICATION FOR STONE MASTIC ASPHALT

New Zealand Government

1 GENERAL

1.1 Scope

This specification covers stone mastic asphalt (SMA) for roads and related applications.

The areas covered by this specification include:

(a) SMA materials
(b) SMA mix design requirements
(c) Process control in manufacture and placement of SMA
(d) Acceptance criteria for SMA
(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-T235 Asphalt Binder Drain-Off
(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

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

(a) AASHTO M 325 Standard Specification for Stone Matrix Asphalt
(b) AASHTO R 46 Designing Stone Matrix Asphalt

(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-μm 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 D3549 Thickness or Height of Compacted Bituminous Paving Mixture Specimens

(m) ASTM D4867 Effect of Moisture on Asphaltic Concrete Paving Mixtures

(n) ASTM D5444 Mechanical Size Analysis of Extracted Aggregate

(o) ASTM D5361 Sampling Compacted Bituminous Mixtures for Laboratory Testing

(p) ASTM D6307 Asphalt Content of Hot-Mix Asphalt by Ignition Method

(q) ASTM D6925 Preparation and Determination of the Relative Density of Hot Mix asphalt (HMA) by Means of the Superpave Gyratory Compactor

(r) 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”

1.3 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.

1.4 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 or a combination of these, produced from hard durable rock, river boulders or feedstock such as, but not limited to, slag or other materials approved by the Engineer.

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

Aggregates can also be comprised of, or contain synthetic 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.

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

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

Test Property	Test Method	Aggregate Source	Requirements
Crushing Resistance	NZS 4407 Test 3.10	Natural Rock	< 10% Fines @ 230 kN
		Glenbrook Melter	< 13% Fines @ 230 kN
Weathering Quality Index	NZS 4407 Test 3.11	All	AA or BA
Particle Shape (ratio ALD/AGD)	NZS 4407 Test 3.13	All	2.25 maximum
Two Broken Faces	NZS 4407 Test 3.14	All	98% minimum
Bulk SG and Density	ASTM C127 or AS 1141.6	All	Report
Absorption	ASTM C127 or AS 1141.6	All	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. Uncrushed aggregate, such as natural sands, shall not be used in the fine aggregate.

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

2.3 Additives

The SMA mix shall contain additives, such as cellulose or other fibres or other materials, added in sufficient quantities to prevent binder drain-off.

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.

2.4 Binder

2.4.1 Bitumen

The binder grade shall be a Grade V or Grade E performance-graded binder complying with the requirements of NZTA M01-A specification. Refer to M01-A specification to identify the job site climate zone and traffic category. Select the binder grade appropriate to the traffic category using Table 2.3 below. Refer to M27 Notes for advice in selecting an appropriate binder grade.

Table 2.3 SMA Binder Grades

Climate Zone	Traffic Category	Binder Grade
Cool	All	PG 52E
Moderate	Light, Medium and Heavy	PG 58V
	Heavy and Very Heavy	PG 58E
Warm	Light, Medium and Heavy	PG 64V
	Heavy and Very Heavy	PG 64E

2.4.2 Binder Performance Grade

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

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.

Existing mix designs based on earlier versions of this specification (i.e. M10: 2014) shall be considered valid for one year following the issue of this specification.

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.

The principles of AASHTO R 46 sections 6, 7, 8, 9 and 10 shall be used for the laboratory mix design process for stone mastic asphalt.

SMA mixes shall be manufactured in the laboratory and specimens prepared using the method of AS/NZS 2891.2.2 using the Servopac™ apparatus or equivalent. As an alternative the Engineer may accept SMA mixes designed in accordance with AASHTO M 325 using the Superpave gyratory compactor but with the following amendments:

(a) The binder shall be a performance grade selected from Table 2.3 above;
(b) The aggregates shall conform to the requirements of Table 2.1 or Table 2.2 as appropriate;
(c) The SMA particle size distribution shall comply with either the requirements of clause 3.2.1 of this document or AASHTO M 325 Table 3.

3.2 Design Process

3.2.1 Aggregate Blends

Aggregate blends shall be calculated from the individual aggregate components such that the blends comply with the particle size distribution envelopes in Table 3.1 or the specification bands of AASHTO M 325 (but see 3.5.1 below). It is expected that several aggregate blends will be tested so that the optimum aggregate structure for the SMA mix can be determined.

Table 3.1 Stone Mastic Asphalt Particle Size Distribution Design Envelopes

Sieve Size (mm)	Mix Designation		
	SMA 7	SMA 10	SMA 14
	Percentage Passing Sieve (By Mass)		
19.0	-	-	100
13.2	-	100	90 – 100
9.5	100	90 – 100	30 – 55
6.7	85 – 100	30 – 55	20 – 35
4.75	30 – 62	20 – 40	18 – 30
2.36	20 – 35	15 – 28	15 – 28
1.18	16 – 28	13 – 24	13 – 24
0.600	14 – 24	12 – 21	12 – 21
0.300	12 – 20	10 – 18	10 – 18
0.150	10 – 16	9 – 14	9 – 14
0.075	8 – 12	8 – 12	8 – 12
Minimum Layer Thickness (mm)	30	40	55
Binder Content (% by mass)	6.3 – 7.3	6.0 – 7.0	5.8 – 6.8

Note: 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. Refer to clause 3.5.1.

3.2.2 Voids in the Coarse Aggregate Fraction

The coarse aggregate fraction shall form a stone-on-stone aggregate skeleton so that the SMA mix is deformation resistant and does not undergo post-construction compaction under trafficking. For the sole purpose of determining the voids in the coarse aggregate, the coarse aggregate fraction is that portion of the total aggregate blend retained on the sieves as in Table 3.2 below:

Table 3.2 Coarse Aggregate Fractions for SMA Mixes

Mix Designation	Coarse Aggregate Fraction
SMA 7	> 1.18 mm
SMA 10	> 2.36 mm
SMA 14	> 4.75mm

Determine the voids in the coarse aggregate fraction VCA_{drc} for the various trial aggregate blends using the dry rodding process of AASHTO R 46 section 9.

3.2.3 Trial Mixes

Prepare trial mixes in the laboratory for the aggregate blends. Select the midpoint of the binder content range in Table 3.1 for each trial mix. Compact at least three specimens for each aggregate blend using 120 compaction cycles in the gyratory asphalt compactor using the method of AS/NZS 2891.2.2. Calculate the volumetric properties for each blend using the average of the three (or more) specimens using the procedure of AASHTO R 46 section 8.

Note: If SMA is designed to AASHTO M 325 then 100 gyratory cycles of the Superpave gyratory compactor configured to comply with AASHTO T 312 shall be used to prepare laboratory specimens. See AASHTO R 46 section 5.

Select an optimum aggregate blend that has volumetric properties compliant with Table 3.3. See AASHTO R 46 section 9 for guidance in selecting the optimum aggregate blend. Prepare at least two additional mixes, one with a binder content 0.5% less, and the other with a binder content 0.5% more than the selected trial optimum blend. Compact specimens in the gyratory compactor and determine the volumetric properties.

Determine the design binder content by direct measurement or interpolation that returns volumetric properties compliant with Table 3.3. The design binder content shall fall within the limits of Table 3.1.

3.3 Volumetric Properties

3.3.1 Volumetric Requirements

Stone mastic asphalt mixes shall comply with the volumetric design criteria listed in Table 3.3 and Table 3.4. Laboratory specimens shall be prepared using the method of AS 2891.2.2 or AASHTO T 312 (but not both).

Table 3.3 Volumetric Requirements at Design Compaction Effort

Mix Nominal Size (mm)	Gyratory Compaction Effort (cycles)		Design Air Voids (%)	VMA (%)	VCAmix (%)
	AS 2891.2.2	AASHTO T 312			
7	120	100	4.0	≥ 18.0	< VCAdrc
10				≥ 17.0	
14				≥ 16.0	

Table 3.4 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	
7 10 14	250	160	2.0

Notes:

(a) All mixes shall be designed to an air voids content of 4.0%;
(b) To ensure that stone-on-stone contact is achieved for the coarse aggregate fraction, the Voids in the Coarse Aggregate for the trial mix (VCAmix) shall be less than the Voids in the Coarse Aggregate determined by dry rodding (VCAdrc). Refer to AASHTO R 46 for the procedure and calculations to determine these criteria.

3.3.2 Binder Drain-Off

The binder drain-off shall be determined for the SMA mix, at the design binder content, at a test temperature 10°C above the manufacturing temperature. The binder drain-off shall not exceed 0.30% by mass.

3.4 Performance-Related Properties

3.4.1 General

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

(a) 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;

(b) If plant-produced asphalt is used for the performance related testing it shall be validated by a production trial as in 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. Test specimens shall be compacted to an air voids level of 7 ± 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. when tested in accordance with ASTM D4867.

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:

(a) 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;
(b) 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;
(c) 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;
(d) 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.

3.4.4 Deformation resistance

The deformation resistance of all SMA 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 6.0 mm.

3.5 Design Variations

3.5.1 Particle Size Distribution

In some circumstances where a specific aggregate is specified, for example Glenbrook Melter Aggregate (GMA), or where the availability of suitable natural rock aggregates prevent it, or if stone-on-stone contact can not be achieved, the blend particle size distribution may need to fall outside of the limits of Table 3.1. This is acceptable provided the following criteria are met:

(a) All aggregate components and added filler comply with the requirements of section 2 of this document;
(b) The non-compliance is declared to, and accepted by, the Engineer prior to commencement of production;
(c) The volumetric and performance-related properties of the SMA mix comply with the requirements of section 3 of this document;
(d) Suitable adjustments to the specified binder content range and minimum layer thickness are made on a pro-rata basis.

3.5.2 Aggregate Density

Where aggregates are used that have a specific gravity (relative density) significantly higher or lower than 2.70 (for example non-natural aggregates such as Glenbrook Melter Aggregate) the binder content ranges specified in Table 3.1 may need to be adjusted. Where the aggregate has a specific gravity greater than 2.70 if necessary, the binder content range can be adjusted by the following factor:

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

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 type, source and content;
    iii. The type, source and quantity of additives;
    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 specimen compaction temperature;
    viii. The voids in the coarse aggregate, by dry rodding (VCA_{drc}) and in the compacted SMA specimens (VCA_{mix}) for each trial blend;
    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 (Vbe);
    xiv. The air voids at 250 gyratory compaction cycles at the design binder content;
    xv. The tensile strength ratio at design binder content;
    xvi. The asphalt modulus at the design binder content;
    xvii. If required, the maximum rut depth determined by the Wheel Tracking test at the design binder content.

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 SMA is to be supplied:

(a) The particle size distribution;
(b) The total binder content;
(c) The maximum specific gravity of the mix;
(d) The bulk specific gravity and density of the compacted mix;
(e) 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 changes 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 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, fall between ±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 SMA Mix Design Validation

SMA 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 SMA 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 SMA mix complies with the requirements of 5.3 below, and;
(d) The type, quality, proportion and sources of all constituent materials remain substantially unchanged. Substantially is defined as 20% or less of the mass percentage of the constituent (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 may be taken to revalidate the mix design:

(a) A sample of mix is prepared in the laboratory to confirm the compliance of the volumetric properties of the SMA mix, or;
(b) The mix is validated by a production trial as in 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 SMA of the particular type and nominal size specified subject to the following conditions:

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

4 MANUFACTURE AND STORAGE

4.1 General

Asphalt manufacturing plant shall be of sound design and construction and specifically equipped to produce SMA mixes. Specifically equipped includes but is not limited to:

(a) A silo, metering and conveying equipment for the storage and supply of filler into the mixing zone of the asphalt plant;
(b) A suitable hopper for the supply, metering and conveying of additives such as cellulose or other fibres into the mixing zone of the asphalt plant.

The plant shall capable of consistently producing SMA mixes with the properties specified and at a rate suitable for smooth, continuous placement.

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) 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.
(c) Additives, including cellulose or mineral fibre, shall be protected from moisture or contamination. Materials that have become wet shall not be used.
(d) 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 SMA as it is discharged from the 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

SMA 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.

5 SAMPLING AND TESTING OF SMA PRODUCTION

5.1 General

The Contractor shall arrange for all relevant testing.

Samples from SMA production shall be randomly selected using a recognised stratified random sampling technique from fresh production mix 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 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, frequency of sampling and testing shall be not less than that shown in Table 5.2 and Table 5.1 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 SMA 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
Added Filler	Certification from the supplier

Table 5.2 Minimum Frequency of Sampling and Testing of Produced SMA

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

Table 5.3 Production Tolerances for SMA Mixes

Description	Maximum Tolerance on Job-Mix Formula	
	Percentage for Individual Test Results	Percentage Mean of Three Test Results Per Lot
Sieve size one size larger than nominal size	Nil	Nil
1.18 mm sieve and larger	± 5	± 3
0.600, 0.300 mm sieves	± 3	± 2
0.150, 0.075 mm sieves	± 2	± 1
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 SMA 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

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

(a) The inside of vehicle bodies shall be kept clean and coated with a thin film of an appropriate release agent to prevent SMA sticking to the body of the vehicle. Care shall be taken to remove surplus release agent before loading asphalt into the vehicle.

(b) After loading with SMA, suitable covers shall be used to prevent contamination and reduce the rate of cooling of the mix.

(c) 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 SMA is delivered to the job site at or above the required compaction temperatures. These means shall be documented in the quality plan.

Where transport distances are lengthy the quality plan shall describe the means by which binder drain-off is prevented.

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. SMA manufactured in the production trial can also be used in the construction trial provided that 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 SMA shall be produced to give two paver runs at least 30 metres long, placed at specified thickness with one longitudinal joint.

The Contractor shall sample and test the SMA in accordance with section 5 of this document. 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 SMA mix.

If the tests on the samples indicate that the SMA does not conform to the requirements of this specification, the Contractor shall make such alterations in the procedures or adjustments to the plant and equipment as necessary to produce compliant SMA. The trial shall be repeated as necessary until SMA 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). In the event that the tests indicate that the SMA 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 SMA 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 SMA 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 SMA 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 SMA are managed. This shall include such items as required tests and test frequency, handling and storage.

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 SMA 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 material.

8.5 Placement

The quality plan shall specify:

(a) SMA delivery temperatures and associated rejection temperatures;
(b) Plant and equipment used to compact the SMA 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 SMA 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 the SMA. 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/m², depending on the texture and absorption of the substrate. Tack coat application rates shall be within ±0.1 L/m² of the specified rate. The default application shall be 0.2 L/m² 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 SMA.

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

Where SMA is to be spread over clean, freshly placed asphalt, the Engineer can direct the Contractor to omit the tack coat.

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/m² 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 SMA 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 SMA 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 NZTA M10 compliant 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 materials or other material used on the work from entering, adhering 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 SMA, except for areas where the use of a paver is impracticable.

9.5.2 Ambient Conditions for Placing

The surface on which the SMA is to be placed shall be dry. SMA 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 SMA 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 and compacted, the texture of the surface shall be visually checked to determine its uniformity and macrotexture. 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.

Continuous visual monitoring of the SMA macrotexture shall be maintained throughout the paving operation. If low textured “fatty” areas or very open textured “bony” areas are observed paving shall cease and remedial actions taken to remove the cause of the fatty or bony areas.

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 SMA 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 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 shall coincide with traffic lane lines unless otherwise specified or agreed. Longitudinal joints shall be offset from those of lower asphalt layers 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 SMA mixes shall be laid to a thickness equal to or greater than the minimum thicknesses specified in Table 3.1 for the specified SMA mix.

The SMA minimum layer thickness shall be specified by the contract. The lower characteristic value (LCV) 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:

LCV = mean – (k x s)

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 stone mastic 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 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 the final SMA surfacing layer.

9.9 Compaction

The SMA shall be uniformly compacted to the standards specified in clause 9.9.1. Suitable compaction plant shall be used to ensure that the surface texture is not lost by the binder mastic being drawn to the surface. For this reason, pneumatic tyred rollers are not recommended for use.

Compliance testing of the SMA 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) testing for core specimens need not be performed on:

(a) Lots of less than 30 tonnes;
(b) Layers with a specified minimum thickness less than 40 mm;

All core holes shall be repaired using a suitable material that fills and renders the core hole waterproof. 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.

Core specimens may be trimmed when they have substrate materials adhering to their base. The depth of the SMA layer shall be measured prior to trimming.

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. Refer to M27 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 SMA mix, or if there is insufficient SMA 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.

The testing of cores shall be commenced within 24 hours of their being cut from the pavement.

9.9.1 Mat Density

Cores shall be cut from the pavement at a rate of one core for every 300 m² 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^2/300 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

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:

$$UCV = mean + (k \times s)$$

$$LCV = mean - (k \times s)$$

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

9.9.4 Opening to Traffic

The finished SMA surfacing should not be opened to traffic until the mat has cooled. This is to prevent the drawing of the mastic binder to the surface with the consequent loss of texture.

10 FINISHED PAVEMENT PROPERTIES

10.1 Texture

The texture of the SMA surfacing shall comply with the requirements of NZTA T10 specification.

10.2 Level

The level at the top of the SMA surfacing shall not differ from the specified level by more than -0, +5 mm, except that where the SMA 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.

10.3 Alignment

The horizontal location of any point on the pavement shall not vary by more than ±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.

10.4 Thickness

Where confirmation of the SMA 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.

10.5 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 SMA, 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 minimum thickness.
(e) Mix designation and traffic category.
(f) Nominal maximum aggregate size.
(g) If fatigue and flexural modulus testing is required.
(h) Bitumen performance-grade for designated mix and required method of test.
(i) NZTA T10 site category.
(j) Minimum Mean Profile Depth (MPD).
(k) Residual application rates for tack coat (0.2 L/m² if not otherwise specified).
(l) If required, material for any correction layer/blinding coat.
(m) Maximum finished pavement roughness.
(n) Construction trial if required.