NZTA P11: 2023

Specification for Open-Graded Porous Asphalt

WAKA KOTAHI
NZ TRANSPORT AGENCY

Te Kāwanatanga o Aotearoa
New Zealand Government

1 General

1.1 Scope

This specification describes the required properties of open graded porous asphalt for use as a surfacing course for road pavements.

Component physical characteristics, mix properties and construction methods for this material are specified.

Two binder classes are specified for the open-graded porous asphalt:

(a) A bituminous binder compliant with NZTA M01-A specification for porous asphalt mixes used for conventional applications, and
(b) An epoxy-modified bituminous binder for porous asphalt mixes used for very long-life applications. This material was previously specified by drafts of NZTA P11E.

The epoxy modified binders must be on the current Waka Kotahi NZ Transport Agency (NZTA) list of approved epoxy binders. The list of approved epoxy binders is available from Waka Kotahi at https://www.nzta.govt.nz/resources/open-graded-porous-asphalt/. The minimum eligibility requirements for a binder to be considered for addition to the approved list are given in clause 5.3.2 of this document.

2 Related Documents

2.1 Waka Kotahi NZ Transport Agency

(a)	NZTA M01	Specification for Bitumen
(b)	NZTA M01-A	Specification for Performance-Graded Asphalt Binder
(c)	NZTA M10	Specification for Dense Graded Asphaltic Concrete
(d)	NZTA Q05	Specification for the Minimum Standard for Managing Bitumen Quality
(e)	NZTA T10	Specification for State Highway Skid Resistance Management
(f)	NZTA T14	Test Method for the Durability of Open-Graded Porous Asphalt
(g)	NZTA T21	Test Methods for Epoxy-Modified Open-Graded Porous Asphalt
(h)	NZTA T22	Quantitative Extraction of Binder from Asphalt Mixes
(i)	NZTA Z01	Minimum Standard for Quality Management Plans
(j)	NZTA Z08	Minimum Requirements for Inspection, Sampling and Testing
(k)	NZTA	Chipsealing in New Zealand

2.2 Austroads

(a)	AGPT T212	Gyratory Compactor Test Method
(b)	AGPT T235	Asphalt Binder Drain-Off
(c)	AGPT T236	Asphalt Particle Loss

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 2891.3.3	Bitumen Content and Grading – Pressure Filter Method

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 1141.22	Wet/dry Strength Variation

2.5 American Association of State Highway and Transportation Officials (AASHTO)

(a) AASHTO R 30 Mixture Conditioning of Hot Mix Asphalt
(b) AASHTO T 312 Standard Method of Test for Preparing and Determining the Density of Asphalt Mixture Specimens by Means of the Superpave Gyratory Compactor

2.6 American Society for Testing and Materials (ASTM)

(a) ASTM C127 Density, Relative Density (Specific Gravity) and Absorption of Coarse Aggregate
(b) ASTM C128 Density, Relative Density (Specific Gravity) and Absorption of Fine Aggregate
(c) ASTM C136 Sieve Analysis of Fine and Coarse Aggregates
(d) ASTM D242 Standard Specification for Mineral Filler for Bituminous Paving Mixtures
(e) ASTM D979 Sampling of Bituminous Paving Mixtures
(f) ASTM D2041 Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
(g) ASTM D2172 Quantitative Extraction of Bitumen from Bituminous Paving Mixtures
(h) ASTM D3203 Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures
(i) ASTM D3549 Thickness or Height of Compacted Bituminous Paving Mixture Specimens
(j) ASTM D4867 Effect of Moisture on Asphaltic Concrete Paving Mixtures
(k) ASTM D5444 Mechanical Size Analysis of Extracted Aggregate
(l) ASTM D6307 Asphalt Content of Hot-Mix Asphalt by Ignition Method
(m) ASTM D6925 Preparation and Determination of the Relative Density of Hot Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor
(n) ASTM D8159 Standard Test Method for Automated Extraction of Asphalt Binder from Asphalt Mixtures
(o) ASTM E3209 Standard Test Method for Pavement Thickness by Magnetic Pulse Induction

2.7 Miscellaneous

(a) CCNZ BPG05 Civil Contractors New Zealand “Quality Assurance of Aggregates for Roads”

3 Quality

The asphalt supplier shall implement a quality management system that complies with the requirements of NZTA Z01 and Z08 specifications. The quality system shall be registered to AS/NZS 9001 and be regularly audited by a JAS-ANZ accredited agency.

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

4 Materials

4.1 Aggregate

4.1.1 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 Principal.

Fine aggregate shall consist of particles of sand, crushed stone or crushed gravel or a mixture of these materials.

Testing frequency shall be in accordance with CCNZ BPG05 Quality Assurance of Aggregates for Chipseals and Bituminous Mixes

Aggregates can also be comprised of, or contain, synthetic or recycled materials subject to the Principal's written approval if they do not comply with the requirements of Table 1 below. Such approval may be conditional on additional testing relative to the proposed materials.

4.1.2 Coarse Aggregate

Coarse aggregate is comprised of particles that are retained on the 4.75mm sieve. The source rock used to prepare the coarse aggregate shall comply with Table 1.

The rock quality used for the production of the coarse aggregates for surfacing mixes must 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 1: Requirements for Coarse Aggregate Source Materials

Test Property	Test Method	Requirements
Crushing Resistance	NZS 4407 Test 3.10	< 10% Fines @ 230kN
Weathering Quality Index	NZS 4407 Test 3.11	AA or BA
Wet/Dry Strength Variation	AS 1141.22	35% maximum

A blended composite sample of aggregate the same as that to be used in the final mix design (coarse aggregate, fine aggregate and filler) shall be prepared and tested to meet the requirements of Table 2. The composite sample shall be sieved over the 4.75mm sieve and all testing carried out on subsamples taken from the combined aggregate retained on the 4.75mm sieve (as required by the test methods in Table 2 below).

Table 2: Requirements for Blended Coarse Aggregate

Test Property	Test Method	Requirements
Particle Shape	NZS 4407 Test 3.13	2.25 maximum
Single Broken Faces	NZS 4407 Test 3.14	98% minimum
Two Broken Faces	NZS 4407 Test 3.14	60% minimum
Relative Density (SG) and 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%.

4.1.3 Fine Aggregate

Fine aggregate shall consist of crushed rock particles finer than the 4.75mm sieve and manufactured from a source complying with the requirements of Table 3.

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 3: Fine Aggregate Requirements

Test Property	Test Method	Requirements
Crushing Resistance	NZS 4407 Test 3.10	< 10% Fines @ 130kN
Sand Equivalent, or	NZS 4407 Test 3.6	35 minimum, or
Clay Index (<0.075 mm)	NZS 4407 Test 3.5	3 maximum
Relative Density (SG) and Absorption	ASTM C128 or AS 1141.5	Report

Note: The fine aggregate is defined as the fraction of the blended aggregate passing the 4.75mm sieve excluding added mineral filler (if any).

4.1.4 Mineral Filler

Mineral filler is that portion of mineral matter predominantly passing a 0.075mm 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.

5 Binder

5.1 General

The binder type shall be specified by the contract and shall either be a binder complying with NZTA M01-A as required by clause 5.2, or an epoxy-modified binder complying with NZTA T21 as in clause 5.3 below.

5.2 Bitumen

The binder grade shall be a performance-graded binder complying with the requirements of NZTA M01-A specification. The binder shall be the least stiff, (i.e. highest J_{nr}) grade appropriate to the climate zone that complies with Grade category H, V or E while providing for compliance with the asphalt particle loss ("Cantabro" abrasion) requirements of Table 8.

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 Principal.

5.3 Epoxy Modified Bitumen

5.3.1 General

The binder used in Epoxy Modified Open-Graded Porous Asphalt (EMOGPA) shall be an approved epoxy modified bitumen or diluted epoxy modified bitumen as detailed in the specific contract requirements.

Diluted epoxy modified bitumen is epoxy modified bitumen to which bitumen has been added in some proportion. The bitumen used to prepare a diluted epoxy modified binder shall comply with either NZTA M01 or NZTA M01-A specifications and contain no additives, such as but not limited to, diluting oils or volatile diluents, rheology modifiers such as elastomeric polymers or polyphosphoric acid. The epoxy-modified bitumen must be free from solvents and amine type accelerators.

The concentration of epoxy bitumen in the binder shall by 25 ± 5.0% by mass unless otherwise approved in writing by the Principal.

No changes to an approved formulation are allowed without obtaining reapproval from Waka Kotahi. This includes changes in the source of diluting bitumen, addition of solvents, accelerators or other additives, or combination in any manner of two or more approved formulations or formulation components.

5.3.2 Binder Approval

The binder used for epoxy-modified porous asphalt shall be a binder approved by Waka Kotahi and be recorded on the list of approved binders. The list of approved binders is published on the Waka Kotahi web site and is available at https://www.nzta.govt.nz/resources/open-graded-porous-asphalt/.

Approval may be obtained by application to the Principal by email at pavements@nzta.govt.nz. Approval may be granted at the absolute discretion of the Principal if:

(a) When tested in accordance with NZTA T21 the Durability complies with clause 5.3.3 below,
(b) Demonstration calibration and curing correction curves are provided and plotted as required by NZTA T21, and,

(c) The epoxy materials are supplied by a reputable supplier.

A mix design meeting the requirements of the PA 10 mix envelope (Table 5) must be used for approval testing purposes.

Approvals are granted for a specific formulation of epoxy resin (Part A), hardener (Part B) and diluting bitumen grade. Approvals will be valid for seven years and may be renewed by carrying out the Durability testing of NZTA T21 and demonstrating compliance with Table 4 below. Application can then be made to Waka Kotahi for extension of renewal for a further five years.

5.3.3 Durability

Following the test method given in NZTA T21, the mean percentage mass loss of the control specimens must not exceed 60% and the reported t value must be greater than or equal to the critical value given in Table 4 for the reported degrees of freedom.

Table 4: Critical values for assessment of durability

Degrees of freedom	6	7	8	9	10
Critical value	1.94	1.89	1.86	1.83	1.81

5.4 Additives

Additives used in the mix, other than those specified elsewhere in this specification, shall be in accordance with a specification. Such a specification may be a manufacturer's recommendation, purchaser's specification or as agreed between the parties.

6 Mix Design

6.1 General

The Contractor shall provide the mix design which shall be submitted to the Principal for approval.

6.2 Mix Designations

Open-graded porous asphalt mixes manufactured using binders compliant with NZTA M01-A specification shall be designated "PA"; for example, PA 10, or PA 10 HS.

Open-graded porous asphalt mixes manufactured using epoxy-modified binders shall be designated "EPA"; for example, EPA 10 or EPA 10 HS.

6.3 Particle Size Distribution

Aggregate components for the open-graded porous asphalt mix shall be blended such that the particle size distribution of the blend complies with the Specified Mix Envelopes requirements of Table 5.

Table 5: Porous Asphalt Specified Mix Envelopes

Sieve Size (mm)	Specified Mix Envelopes Percentage Passing Sieve (%)				
	PA 7	PA 7 HS	PA 10	PA 10 HS	PA 14
19.0	-	-	-	-	100
13.2	-	-	100	100	85 - 100
9.5	100	100	85 - 100	85 - 100	35 - 50
6.7	85 – 100		-	-	-
4.75	10 – 40	25 – 55	20 - 40	30 - 40	12 - 22
2.36	5 – 15	20 - 30	5 - 15	19 - 25	5 - 15
0.075	2 - 5	2 - 5	2 - 5	2 - 5	2 - 5
Minimum Effective binder content (%)	5.0	5.0	4.5	4.5	4.0
Minimum layer thickness (mm)	20	20	25	25	30

Notes: Refer to clause 6.2 for specified mix envelope designations relating to the binder used.

The specified mix envelope for the PA 7 HS should be regarded as preliminary. Design particle size distributions may need to fall outside to achieve the specified volumetric properties. This is acceptable.

6.4 Mixing and Compaction Temperatures

For binders compliant with NZTA M01-A specification, mixing and compaction temperatures for asphalt mixes prepared in the laboratory shall be the temperature at which the binder viscosity is 1 ± 0.1 Pa.s and 2 ± 0.2 Pa.s respectively. Note that this requirement may differ from mixing and compaction requirements of the test methods referenced below.

For epoxy-modified binders, mixing and compaction temperatures shall be as recommended by the epoxy bitumen manufacturer.

6.5 Volumetric Requirements

Open-graded porous asphalt mixes shall be prepared in the laboratory and test specimens compacted to determine compliance with the volumetric and mechanical requirements of Table 7. At least three trial mixes shall be prepared, with binder contents 0.5% w/w apart. At least one trial mix shall have a binder content below, and at least one trial mix shall have a binder content above the final design binder content.

After completing the mixing process, condition the loose mix at the compaction temperature using the method of AASHTO R 30 but use a conditioning period of 60 ± 5 minutes. Stir the mixture after conditioning and prepare the test specimens in the gyratory compactor.

Three test specimens for each trial binder content shall be prepared and compacted using AASHTO T312 (or equivalent method as noted below). Compaction level shall be as in Table 6 below.

Table 6: Compaction level for Laboratory Prepared test Specimens

Test Method	Laboratory Compaction Level (cycles)
AASHTO T312	50

Note: The specimen compaction method is AASHTO T312 but AGPT T212 or ASTM D6925 may be used if preferred. These methods are effectively the same.

Allow specimens to cool to ambient temperature before undertaking further testing. If required specimens shall be stored at ambient temperature and not heated prior to testing.

Specimens shall be tested for compliance with Table 7 below within 48 hours of manufacture. Specimen volume shall be determined by mensuration using ASTM D3549 and air voids shall be calculated in accordance with ASTM D3203. Determine the binder drain off by using the method of AGPT/T235.

Table 7: Laboratory Mixture Design Volumetric and Physical Requirements

Criterion		Test Method	PA	PA HS
Air Voids	(%)	ASTM D3203	20 - 25	12 - 16
Binder drain off	(%)	AGPT/T235	0.1 - 0.3	0.1 - 0.3

Plot the air voids versus the binder content. Select the design binder content as the maximum binder content that complies with the air voids and drain off criteria of Table 7.

Note: The object of the mix design process is to maximise the binder content, while maintaining compliance with the drain off and volumetric criteria. This is to maximise the durability of the open-graded asphalt mix. It may be necessary, and desirable in some instances, to control the drain off by the use of additives such as cellulose or recycled textile fibres.

6.6 Mechanical and Performance-Related Requirements

6.6.1 Determination of the Tensile Strength Ratio

Prepare a sample of open-graded porous asphalt mix in the laboratory at the design binder content selected in 6.5 above. Compact test specimens using the same procedure and level of compaction as used to determine the design binder content. Testing shall be completed within 48 hours of specimen manufacture.

Determine the Tensile Strength Ratio in accordance with ASTM D4867, except that the air void limits (D4867 clause 6.6.2) and the saturation step (D4867 clause 8.6) are waived. Test the specimens at the design binder content. The test specimens may need to be transferred into a suitable perforated sleeve to prevent sample slumping in the 60°C bath while allowing water to access the whole specimen

Moisture condition the compacted specimens in distilled or deionised water at 60° ± 1°C for 24 hours. After the moisture conditioning time, the specimens shall be cooled, removed from the sleeve and placed in the 25° ± 1°C water bath for one hour before testing for retained strength. The Tensile Strength Ratio shall comply with the requirement of Table 8 at the design binder content.

6.6.2 Determination of the Particle Loss

Determine the Asphalt Particle Loss (the “Cantabro” test) using AGPT/T236 except use AASHTO T312 (using 50 compaction cycles) to prepare the test specimens. Omit the moisture conditioning step of AGPT T236 clause 3.2. The Asphalt Particle Loss shall comply with the requirements of Table 8 at the design binder content.

Table 8: Laboratory Mixture Design Mechanical and Performance-Related Requirements

Criterion		Test Method	PA	PA HS
Tensile Strength Ratio	(%)	ASTM D4867	75 minimum	
Asphalt Particle Loss	(%)	AGPT/T236	15 maximum	

7 Approval of Laboratory Mix Design

7.1 Laboratory Mix Design

The Contractor shall provide the information listed below for approval by the Principal at least seven days prior to commencement of production. This shall constitute a hold point and work may not proceed until the laboratory mix design has been approved.

(a) Properties of constituent materials required under this specification including aggregates, filler (if used), 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 clause 6 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 specimen compaction temperature

(viii) The bulk specific gravity and density of the mix for each trial blend

(ix) The maximum specific gravity and density of the mix for each trial blend

(x) The air voids of the compacted mix for each trial blend

(xi) The Effective design binder content by volume (Vbe)

(xii) The tensile strength ratio at the design binder content

(xiii) The asphalt particle loss at the design binder content.

7.2 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 Effective binder content at the design binder content complies with the requirements of Table 5 for the appropriate porous asphalt grade.
(d) 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.
(e) 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.

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.

7.3 Asphalt Mix Design Validation

Asphalt mix designs shall be valid for six months. Validation shall be extended where testing no more than six months old confirms:

(a) The asphalt mix particle size distribution complies with the requirements, and
(b) The asphalt mix binder content complies with the requirements of Table 10 below, and
(c) Volumetric testing confirms that the air voids of the asphalt mix comply with the requirements of Table 7, 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, a sample of mix must be prepared in the laboratory, or a plant production trial carried out to confirm the compliance of the volumetric properties of the asphalt mix.

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

7.4 Approval to Use Previously Designed Mix

The Principal will 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 7.3 are met, and
(b) The in-service performance of the asphalt mix has been satisfactory.

8 Production

8.1 General

Open-graded porous asphalt mixes shall be produced using an asphalt plant. The plant shall be calibrated and operated to consistently produce a uniform mixture within the tolerances specified by Table 10.

Aggregates shall be stored at the plant in such a manner that each separate aggregate component and stockpile is physically separate. Conditions of storage shall be arranged so that the aggregate stockpiles are not contaminated, nor subject to deterioration.

The binder shall be heated at the plant to a temperature at which it can be properly handled by the pumping system. Unmodified bitumen heated above 175°C or held for more than 8 hours above 162°C shall be rejected and not used unless subsequent testing shows compliance with NZTA M01-A specification. Modified or proprietary binders shall be handled and stored in accordance with the temperatures published in the manufacturer's technical data sheet.

The plant shall have dedicated pumps and accurately calibrated flow metering equipment such that the blended binder and epoxy additives are supplied into the mixer at the prescribed rate. All of the binder components shall be intimately and homogeneously combined prior to injection of the binder into the mixer.

The mixing temperature for the open-graded porous asphalt shall be:

(a) For NZTA M01-A compliant binders the temperature at which the viscosity of the bitumen is 1 Pa.s,
(b) For epoxy-modified bitumen, the temperature as specified by the binder manufacturer and documented in the quality plan.

The temperature of the porous asphalt mix discharging from the mixing plant shall not be more than 15°C above the mixing temperature and the average temperature of any truck load of open-graded porous asphalt measured at the plant shall be within ±10°C of the mixing temperature.

If the period of time between production and laying exceeds 1.5 hours the contractor shall provide details in the Quality Plan of how they will mitigate potential drain down and segregation problems.

If mix is to be stored prior to transportation and laying, storage bins shall be designed and controlled to prevent segregation and minimise degradation of the mix.

8.2 Plant Calibration

8.2.1 General

The manufacturing plant shall be calibrated and operated to consistently produce a uniform mixture within the tolerances specified by Table 10.

Evidence must be provided that the binder pumps and flow meters are properly calibrated to deliver the correct proportions of bitumen and for epoxy-modified porous asphalt, the epoxy components.

8.2.2 Binder Supply

All pumps and associated metering and control systems associated with supplying the binder components to the plant shall be calibrated in a manner satisfactory to the Principal prior to commencement of production. The calibration results shall be promptly made available to the Principal on request.

The pumps and metering systems shall be regularly recalibrated during the production of epoxy-modified porous asphalt at a rate not less than once per 50 tonnes of binder used.

9 Testing

9.1 NZTA M01-A Binders

For NZTA M01-A binders, the binder shall be sampled and tested as required by NZTA Q05 specification.

9.2 Epoxy-Modified Bitumen

At least one sample (of at least 1 litre) of the epoxy-modified bitumen binder shall be taken and tested. For subsequent production one sample for every 200 tonnes of plant production shall be taken and tested. The binder samples shall be taken from a suitable sampling port after mixing of all binder components but before mixing with aggregate in the plant. The design of the sampling port shall be such that it can be swept or

purged of residual material between sampling times and the sampling procedure must ensure any material trapped in dead volume in the sampling port does not result in contamination of subsequent samples. Samples shall not be reheated and must be tested within 72 hours after collection.

The epoxy binder samples shall be tested for the epoxy content following the procedure set out in method NZTA T21. The calibration and curing curves specified in NZTA T21 shall be calculated using the same diluting bitumen grade and epoxy components (approved epoxy formulation) used in the plant production. The time between calculation of the calibration and curing curves and commencement of plant production shall not exceed 6 months. The measured epoxy bitumen component concentration shall fall within ±5% of the epoxy dosage rate as required by 5.3.1 above and the component ratio difference, β_{diff} shall be within ±0.2 of the component proportions specified by the epoxy bitumen supplier. Refer to NZTA T21 clause 4.3 for the procedure to determine these criteria.

Table 9: Requirements for Epoxy Bitumen

Acceptance Criteria	Epoxy Bitumen Concentration (%)	Epoxy Bitumen Component Ratio Difference β_{diff} (%)
Permissible Variation	±5 maximum	
Variation from Calibration Standard Mean Ratio	±0.2 maximum	

9.3 Open-Graded Porous Asphalt Mix

Samples of the porous asphalt shall be drawn from production lots and tested. Samples shall be taken in accordance with ASTM D979 or equivalent and shall be obtained from the mixing plant. The samples shall be tested for binder content and particle size distribution with test results falling within the mix control envelope, formed by applying the tolerances of Table 10 to the design blend particle size distribution and binder content.

The frequency of sampling and testing shall be once sample for every 200 tonnes of production 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 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.

The binder content and the aggregate particle size distribution shall be measured using one of the methods listed in the Related Documents.

Table 10: Mix Control Envelope Tolerances

Criteria	Permissible Variation from Design Blend (% by mass of total mixture)	
	Individual Results	Average of Three Consecutive Tests
Aggregate passing 4.75mm and larger	± 5.0	± 3.0
Aggregate passing 2.36mm	± 3.0	± 2.0
Aggregate passing 0.075mm	± 2.0	± 1.0
Binder Content	± 0.5	± 0.3

10 Waterproofing Seal

Where an open-graded porous asphalt wearing course is to be constructed over a granular or water-susceptible pavement a waterproofing layer shall be placed over the substrate. This layer may be either a layer of dense asphaltic concrete compliant with NZTA M10 specification or a chip seal system as below.

The minimum residual binder content in the chip seal layer shall be at least 3.0L/m². The seal may be constructed in several layers, but the first seal layer shall be designed and placed as a single-coat, or racked-in, seal. Any preparatory treatment, such as a primer, shall not be considered as the first coat seal.

The seal structure should be trafficked as much as possible, prior to placement of the open-graded porous asphalt wearing course to maximise compaction of the seal layer(s) and hence waterproofness.

11 Tack Coat

If required tack coating shall be specified by the contract. 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 residual binder unless otherwise specified.

Precautions shall be taken to protect kerbs, channels, adjoining structures, traffic and parked vehicles from tack coat spray. Vertical surfaces against which the open-graded porous asphalt is to be placed shall not be tack coated.

12 Placement

12.1 Ambient Conditions for Placing

Open-graded porous 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 Principal on procedures used to compensate for rapid cooling of asphalt materials.

12.2 Construction

The open graded porous asphalt material shall, where practical, 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 courses 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 that leaves tracks or indented areas that cannot be corrected in normal operation or which produce flushing or other permanent blemishes or fails to produce a satisfactory surface shall not be used.

The Quality Plan shall set limits on porous asphalt temperatures, control of layer thickness and the compaction process. No paving shall be carried out without the prior agreement of the Principal of 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 include in the Quality Plan a detailed paving plan to be followed by the paver. This shall include details on the procedure to be used to minimise stopping of the paver.

Segregation of materials shall not be permitted. If segregation is observed, the spreading operation shall be immediately suspended until the cause is determined and corrected. Any area of segregation that 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.

13 Compaction

13.1 Compaction Temperature

The compaction temperature for the porous asphalt shall be:

(a) For NZTA M01-A compliant binders, as stated in the quality plan,
(b) For epoxy-modified bitumen, as recommended by the binder manufacturer and stated in the quality plan.

13.2 Equipment

Rolling shall be carried out with tandem non-vibrating steel tyred roller or rollers weighing not less than six tonnes and exerting a load of not less than 2700 kg per metre of drive roll width.

The Contractor shall include in the Quality Plan details of the rollers and rolling procedures that will be used.

14 Thickness and Surface Requirements

14.1 General

The final surface shall be of a uniform texture conforming to the lines, grades and cross-sections shown on the plans. The roughness of the completed surface shall comply with the specific contract requirements.

Thickness shall be carefully controlled during construction and shall be in full compliance with the requirements of the contract. The minimum thickness of the open-graded porous asphalt over any high point of the pavement shall not be less than the minimum thicknesses of Table 5. During compaction, preliminary tests as an aid for controlling the thickness shall be made by inserting a flat blade or spike, correctly graduated, through the material to the top of the previously placed base, or by other means acceptable to the Principal.

14.2 Measurement of Thickness

Where specified in the Contract, layer thickness shall be determined using the method of ASTM E3209. The thickness measurements shall be performed after completion of the compaction. The layer thickness is defined as the difference in elevation between a 70 mm diameter reflector resting on the underlying surface (e.g. chipseal) and the plane where the measurement device contacts the top of the final porous asphalt surface.

The exposed drop-off at the edge of the open-graded porous asphalt shall not exceed 30mm in height. Where the layer depth means that the exposed drop-off could exceed 30mm then the edge shall be raked back, or a bevel formed using a roller or a milling machine, or other means satisfactory to the Principal to reduce the drop-off height. Where an exposed drop-off at the edge of the layer of greater than 10 mm in height is present, then the distance between the outer edge of the lane marking and the beginning of the drop–off shall be, wherever practicable, at least 0.5m.

Geometric design considerations excepted, no part of the finished surface shall deviate more than 5mm from a 3m straight edge lying under its own weight on the road surface parallel to or perpendicular to the road centreline.

Any irregularities that vary more than 5mm from this straight edge longitudinally or transversely shall be corrected. Irregularities that develop before the completion of rolling shall be remedied by loosening the surface mix and removing or adding material as may be required. Should any irregularities, defects, surface projections or mismatched joints remain after final compaction, the material shall be removed promptly, and sufficient new material laid to form a true and even surface.

To achieve a satisfactory finished surface it is essential that the pavement be checked regularly before and during the final compaction operation with the aid of a 3m straight edge. The Contractor is required to have such a straight edge on the site of the works and to use it in the control of the final rolling operation.

14.3 High-Performance Low-Noise Surfaces

Where a high-performance low-noise (“LN”) surface has been specified in the Contract, the layer thickness shall be measured as per clause 14.2 and the following requirements.

14.3.1 Thickness Measurement Locations

The layer thickness shall be measured every 20m ± 2m along each paved lane. The lateral offset shall alternate between the left and right sides of each lane, measured 0.8m ± 0.2m from the respective lane edge as shown in Figure 1.

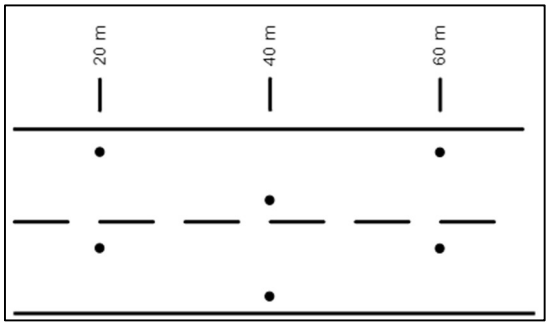

Figure 1: Thickness measurement locations (black dots) alternating between the left and right sides of each paved lane.

The horizontal coordinates of each thickness measurement shall be recorded using a suitable surveying method having a horizontal accuracy better than 50cm.

14.3.2 Acceptance Criteria

The layer thickness for a lane shall be deemed acceptable if:

(a) no more than 25% of the thickness measurements along the lane are below the minimum thickness required for the high-performance low noise “LN” surface, and
(b) no more than 4 consecutive measurements along the lane are below the minimum thickness required for the high-performance low noise “LN” surface.

14.3.3 Reporting

The tabulated thickness results for each lane with corresponding coordinates for all thickness measurement locations shall be included in the quality assurance documentation.