SPECIFICATION FOR OPEN GRADED POROUS ASPHALT

1. **SCOPE**

This specification describes the required properties of open graded porous asphalt for use as a surfacing course for road pavements. This mix type is intended to be used as a surfacing where there is a requirement for texture depth, noise reduction and/or splash and spray suppression.

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

2. **RELATED DOCUMENTS**

2.1 TNZ M/1 Specification for Roading Bitumens
2.2 Asphalt Institute Mix Design Methods for Asphalt Concrete and other Hot-Mix Types (MS-2)
2.3 Standards New Zealand NZS 4407 Methods of Sampling and Testing Road Aggregates
2.4 AS2891.2.2 Methods of Sampling and Testing Asphalt – Sample Preparation – Compaction of Asphalt Test Specimens Using a Gyratory Compactor
2.5 ASTM C127 Standard Test Method for Specific Gravity and Absorption of Coarse Aggregate
2.6 ASTM C128 Standard Test Method for Specific Gravity and Absorption of Fine Aggregate
2.7 ASTM D979 Standard Practice for Sampling Bituminous Paving Mixtures
2.9 ASTM D2041 Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
2.10 ASTM D2172 Quantitative Extraction of Bitumen From Bituminous Paving Mixtures
2.11 ASTM D3203 Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures
2.12 ASTM D3549 Standard Test Method for Thickness or Height of Compacted Bituminous Paving Mixture Specimens
2.13 ASTM D4867 Standard Test Method for Effect of Moisture on Asphalt Concrete Paving Mixtures
2.14 APRG 18 Selection and Design of Asphalt mixes (AP-T20)
2.15 APGT / T 235 Binder Drain-down (%)
3. DEFINITIONS

3.1 Porous Asphalt

Porous Asphalt is an open graded mixture of coarse and fine aggregates, mineral filler and a bituminous based binder produced hot in a mixing plant. It is delivered, spread and compacted while hot.

In this specification three types of porous asphalt are defined:
PA 15HS this mix has a lower air void content and higher shear strength than the other mixes. It can thus withstand higher traffic shear stress.
PA 20 This mix has a minimum design air void content of 20% and is intended for use in most locations. It can be used with or without polymer or additive modification.
PA 25HV This mix must have binder modification to withstand the abrasive stress of traffic. It is a high air void mix with a minimum design air voids content of 25% although design air voids of approximately 30% will give enhanced noise reducing properties.

3.2 Twin Layer

In this system a layer of mix with a maximum particle size of 16 or 20mm is laid 30-50mm thick. On top of this layer a 20-30mm thick layer of a mix with a smaller top size is laid. The intention of the system is to:
1. Increase the void content of the surfacing to absorb noise
2. Use a small sized aggregate in the surfacing to reduce noise
3. Use the smaller voids on the top layer to trap detritus and use the large voids in the bottom mix to allow water to flush the detritus – thus maintaining the drainage and noise properties of the system.

3.3 Coarse Aggregate

Coarse Aggregate is comprised of aggregate components retained on a 4.75mm test sieve. The source rock from which the components are manufactured shall comply with the requirements of Table 4.1.

3.4 Fine Aggregate

Fine aggregate is the fraction of aggregate components passing the 4.75mm test sieve, excluding mineral fillers.

3.5 Mineral Filler

Mineral Filler is finely ground particles of limestone, hydrated lime, Portland cement or other non-plastic mineral matter, predominantly finer than 0.075mm that is added to the mix.
3.6 **Binder**

Binder is penetration grade bitumen complying with TNZ M/1 specification. If polymer modification is required then this is included in the specific contract requirements.

3.7 **Specified Mix Envelope**

The Specified Mix Envelope (SME) is the porous asphalt particle size distribution and bitumen content limits as set out in Table 5.1.

3.8 **Job Mix Formula**

The Job Mix Formula (JMF) is the combined aggregate particle size distribution and bitumen content that falls within the SME and produces a mix that complies with the volumetric and mechanical criteria of Table 5.2.

Note that particle size distribution acceptance limits derived from application of the permissible variations of Table 7.1 to the JMF particle size distribution may allow test results to fall outside the SME envelopes of Table 5.1. This is acceptable.

4. **MATERIALS**

4.1 **Testing**

All sampling and laboratory testing required demonstrating that materials used, and that the resulting mix complies with this specification shall be performed by a laboratory accredited to ISO 17025 (e.g. IANZ Accreditation).

4.2 **Coarse Aggregate**

Coarse aggregate shall consist of crushed stone or crushed gravel or a combination of the two, produced from hard durable rock or river boulders. Synthetic aggregates can be used as long as they comply with the requirements of this specification. The source rock from which individual components are produced shall comply with Table 4.1 and the blended coarse aggregate shall comply with the requirements of Table 4.2:

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Test Method</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crushing Resistance</td>
<td>NZS 4407 Test 3.10</td>
<td>230 kN minimum</td>
</tr>
<tr>
<td>Weathering Resistance</td>
<td>NZS 4407 Test 3.11</td>
<td>AA or BA</td>
</tr>
<tr>
<td>Polished Stone Value</td>
<td>BS EN 1097 Part 8</td>
<td>*see below</td>
</tr>
</tbody>
</table>

* refer to specific contract requirements for minimum Polished Stone Value

At least 85% by mass of the coarse aggregate shall comply with the specified minimum Polished Stone Value.
The Cleanness value of the combined coarse aggregate shall be measured during the mix design process. This measured value minus 5 shall then be the minimum required during production of the mix.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Test Method</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particle Shape</td>
<td>NZS 4407 Test 3.13</td>
<td>2.25 maximum</td>
</tr>
<tr>
<td>Broken faces</td>
<td>NZS 4407 Test 3.14</td>
<td>98% minimum</td>
</tr>
</tbody>
</table>

### 4.3 Fine Aggregate

Fine aggregate shall consist of particles of sand, crushed stone, crushed gravel, crushed synthetic aggregate or a mixture of these materials. The parent material from which any crushed fine aggregate is produced shall comply with the crushing resistance criteria of Table 4.3.

### 4.4 Mineral Filler

Mineral Filler (if used) shall consist of finely ground particles of limestone, hydrated lime, Portland cement or other non-plastic mineral matter, complying with Table 4.4. Pumice and other similar absorbent materials are not acceptable. The mineral filler shall be thoroughly dry and free from lumps. The Mineral Filler shall predominantly be all passing the 0.600 mm sieve.

### 4.5 Binder

The bitumen used in the asphaltic concrete mixture shall be 80/100 or 60/70 grade compliant with TNZ M/1 Specification modified if required as detailed in the specific contract requirements. The bitumen may be modified also through the use of adhesion agent, polymers, fibres, etc. Modification of the binder is required for the HV mixes. The modifier type and content is the responsibility of the contractor.

### 5. MIX DESIGN

Penetration grade bitumen mixing and compaction temperatures shall be modified to attain binder viscosities of 1 Pa.s ± 0.1 Pa.s and 2 Pa.s ± 0.2 Pa.s respectively. The determination of the design bitumen content shall be made in accordance with the principles given in Section 4.12 of APRG report No 18 (AP-T20). The binder drain down test shall be performed at $10^0\text{C}$ above the mixing temperature and then ensuring that the other criteria in Table 5.2 are achieved. If the time from manufacture to
laying is expected to be significantly greater than one hour then the drainage time may be increased to model the expected storage and transport time.

For polymer modified binders the design binder content will be the same as that obtained with penetration grade binder but the other criteria in Table 5.2 must be achieved with the modified binder.

The particle size distribution of the Job Mix Formula shall comply with the Specified Mix Envelopes requirements of Table 5.1.

Test specimens shall be made using the method of ASTM D6926. The specimens shall be compacted using 50 compaction blows on each side of the specimen. *Alternatively specimens can be compacted using a Servopac compaction at 80 cycles*, in accordance with AS 2891.2.2

For polymer modified binders the mixing and compaction temperatures shall be as recommended by the manufacturer.

Specimen volume shall be determined by mensuration to ASTM D3549 and air voids shall be calculated in accordance with ASTM D3203.

Retained tensile strength shall be determined in accordance with ASTM D4867, except that the air void limits for saturation are waived. Saturation shall be performed by placing the compacted specimen complete with mould in distilled or deionised water at 60° ± 1°C for 24 hours. When samples have been prepared using gyratory compaction samples will be required to be transferred into a suitable sleeve to prevent sample slumping in the 60°C bath. After the saturation time, the specimens shall be cooled, removed from the mould or sleeve and placed in the 25° ± 1°C water bath for 1 hour before testing for retained strength.

*Abrasion loss shall be determined using the cantabro test at 25°C in accordance with Test method AGPT / T 236 Asphalt Particle Loss (%).*

*Durability of Polymer modified mixes shall be assessed using the ageing procedure given in the appendix and then testing for abrasion loss using AGPT / T 236.*

The volumetric and physical data of the mixture shall be provided to the Engineer prior to commencement of work.
Table 5.1: Porous Asphalt Specified Mix Envelopes

<table>
<thead>
<tr>
<th>Sieve Size (mm)</th>
<th>PA 10 HS</th>
<th>PA 10</th>
<th>PA 14</th>
<th>PA 7 HV</th>
<th>PA 10 HV</th>
<th>PA 14 HV</th>
<th>PA 20 HV</th>
</tr>
</thead>
<tbody>
<tr>
<td>26.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>19</td>
<td></td>
<td></td>
<td></td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>85-100</td>
</tr>
<tr>
<td>13.2</td>
<td>100</td>
<td>100</td>
<td>85-100</td>
<td>100</td>
<td>85-100</td>
<td>85-100</td>
<td>10-25</td>
</tr>
<tr>
<td>9.5</td>
<td>85-100</td>
<td>85-100</td>
<td>35-50</td>
<td>100</td>
<td>85-100</td>
<td>10-25</td>
<td>10-25</td>
</tr>
<tr>
<td>6.7</td>
<td></td>
<td></td>
<td></td>
<td>85-100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.75</td>
<td>30-40</td>
<td>20-40</td>
<td>12-22</td>
<td>10-30</td>
<td>10-30</td>
<td>7-20</td>
<td>7-20</td>
</tr>
<tr>
<td>2.36</td>
<td>19-25</td>
<td>5-15</td>
<td>5-15</td>
<td>5-15</td>
<td>5-15</td>
<td>5-15</td>
<td>5-15</td>
</tr>
<tr>
<td>0.075</td>
<td>2-5</td>
<td>2-5</td>
<td>2-5</td>
<td>1-5</td>
<td>1-5</td>
<td>1-5</td>
<td>1-5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Effective Binder Content % by mass min</th>
<th>PA 10 HS</th>
<th>PA 10</th>
<th>PA 14</th>
<th>PA 7 HV</th>
<th>PA 10 HV</th>
<th>PA 14 HV</th>
<th>PA 20 HV</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.5</td>
<td></td>
<td></td>
<td></td>
<td>4.5</td>
<td>4.5</td>
<td>4.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Minimum Thickness of Asphalt (mm)</td>
<td>25</td>
<td>25</td>
<td>30</td>
<td>20</td>
<td>25</td>
<td>30</td>
<td>50</td>
</tr>
</tbody>
</table>

Table 5.2: Laboratory Mixture Design Volumetric and Physical Requirements

<table>
<thead>
<tr>
<th>Criteria</th>
<th>PA</th>
<th>PA HV</th>
<th>PA HS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retained Tensile Strength (%)</td>
<td>75 min.</td>
<td>75 min.</td>
<td>75 min.</td>
</tr>
<tr>
<td>Binder drainage (%)</td>
<td>0.1-0.3</td>
<td>0.1-0.3</td>
<td>0.1-0.3</td>
</tr>
<tr>
<td>Cantabro loss max %</td>
<td>15</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Max ratio of cantabro loss before and after ageing*</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

Where the mix does not comply with the durability cantabro loss ratio the mix may still be used with approval of the Engineering policy manager if other evidence of durable performance can be demonstrated. The durability criteria only apply to mixes using polymer modified binders.

6. PRODUCTION

The manufacturing plant shall be calibrated and operated to consistently produce a uniform mixture within the tolerances specified by Table 7.1.

If the period of time between production and laying exceeds 1.5 hrs the contractor shall provide details of how they will mitigate drain down and segregation problems in the contract documents.
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.

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. Any 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 M/1 specification. Polymer modified binder shall be handled and stored in accordance with the manufacturers recommendations.

Where the binder is penetration grade bitumen the aggregate shall not be heated above 135°C. The temperature at which the viscosity of the bitumen is 1 Pa.s shall be the mixing temperature. For polymer modified binders the mixing temperature shall be as recommended by the manufacturer.

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 mix measured at the plant shall be within ±10°C of the mixing temperature.

7. TESTING

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 bitumen content and particle size distribution with test results falling within the mix control envelope, formed by applying the tolerances of Table 7.1 to the JMF.

Bitumen content shall be measured using the method of ASTM D2172 or approved alternative. Suitable alternatives include the solvent extraction method generally designated ADL 4.02/15a and Ignition using a furnace (ASTM D6307). Note that if the Ignition method is used, appropriate calibration offsets must be established.
Table 7.1: Mix Control Envelope Tolerances

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Permissible Variation from JMF (% by mass of total mixture)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Individual Results</td>
</tr>
<tr>
<td>Aggregate passing 4.75 mm and larger</td>
<td>± 5.0</td>
</tr>
<tr>
<td>Aggregate passing 2.36 mm</td>
<td>± 3.0</td>
</tr>
<tr>
<td>Aggregate passing 0.075 mm</td>
<td>± 2.0</td>
</tr>
<tr>
<td>Bitumen Content</td>
<td>± 0.5</td>
</tr>
</tbody>
</table>

8. **TACK COAT**

Where a general tack coat or membrane seal is required, the material and rate of application are defined in the "Specific Contract Requirements" section of this specification.

Vertical surfaces against which hot mix asphalt is to be placed shall not be tack coated.

9. **LAYING**

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.

No paving shall be carried out without the prior agreement of the Engineer 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 occurs, 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 his own expense.
10. **COMPACTION**

10.1 **Equipment**

Rolling shall be carried out with tandem non-vibrating steel tyred roller or rollers weighing not less than 6 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.

10.2 **Thickness and Surface Requirements**

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 plans and specifications. 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 Engineer.

Geometric design considerations excepted, no part of the finished surface shall deviate more than 5 mm from a 3 m 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 5 mm 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 3 m straight edge. The Contractor will be 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.

11. **BASIS OF PAYMENT**

All miscellaneous items, lodgings, supervision, contingencies, sampling and testing, conveyance of plant and incidental work, plus general overhead and administration are incorporated in the unit rates listed in the schedule.
11.1 **Payment for Preparation of Surface for Open Graded Porous Asphalt**

Payment for preparing the existing surface will be made at the unit scheduled rate on the total area in square metres, prepared as specified and covered by completed and accepted new open graded porous asphalt and shall include the lay down trial area.

11.2 **Payment for Tack Coat for Open graded porous asphalt**

Payment for tack coat material will be made at the unit scheduled rate on the total area in square metres, tacked coated as specified and covered with completed and accepted new open graded porous asphalt material and shall include the lay down trial area.

11.3 **Payment for Open graded porous asphalt Material**

Payment for the open graded porous asphalt material will be made at the unit scheduled rate in tonnes of open graded porous asphalt material used in the completed and accepted works. Where specified quantities shall be calculated from dimensions given in the contract documents. Payment will not be made for material exceeding the net amount required by more than the percentage allowed for in the tolerances as specified in the contract documents.