# NOTES TO THE SPECIFICATION FOR DENSE GRADED AND STONE MASTIC ASPHALTS

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NOTES FOR IMPLEMENTATION AND USE OF SPECIFICATION CLAUSES

1 GENERAL

1.1 Preliminary

These notes are for the guidance of the Engineer and Contractor and do not form part of the contract. Specification clauses are contained in Section 2 of this document.

1.2 Scope

The specification has been prepared for the manufacture, supply and placing of dense graded asphalt mixes (also referred to as asphaltic concrete or AC) and stone mastic asphalt (SMA), asphalt for road works and related applications. Different criteria apply to quality of components and asphalt mix design according to the application. The nominal maximum aggregate size and types of mixes to be used shall be specified in the Schedule of Job Details. A guide to the selection of mixes is given in clause 3.

The intended use of the materials may also involve the application of different construction requirements and these should also be nominated in the Schedule of Job Details. Guidelines for the application of such requirements are given in the notes to the relevant specification clauses.

Careful consideration of the Schedule of Job Details is required to ensure that asphalt is fit for purpose, of the appropriate type and quality, and provided in a cost effective manner.

This specification will normally be used as contract documentation in conjunction with a standard General Conditions of Contract such as NZS 3910. Contract documentation may also include other works. The terms used in the specification guidelines are generally consistent with NZS 3910, and include Principal, Engineer and Contractor. Where these terms are in conflict with those otherwise used, a general interpretation clause shall be inserted in the contract documents.

1.3 Quality Systems

Depending on project type and performance risk, the Principal may undertake an audit of a Contractor’s Quality System and/or Quality Plan as part of prequalification or contract acceptance procedures. The Principal may also establish additional procedures for surveillance of contract activity and audit/verification of quality of materials and testing.

2 MATERIALS

2.1 Aggregate

Coarse and Fine aggregate fractions are specified in accordance with existing practice in New Zealand. Criteria are identical to previous NZTA specifications (M/10, P/23) (see Specification Table 2.1, Table 2.2 and Table 3.3). Note that coarse aggregate components for SMA mixes are required to comply with the Crushing Resistance, Weathering Resistance and Shape requirements of NZTA M/6 specification.

The relative density (specific gravity) of the combined aggregates is determined using ASTM C127 for coarse aggregate fractions and ASTM C128 for fine aggregate fractions. Determination of the relative density of the fine aggregates using ASTM C128 normally includes the portion of the fine aggregate passing the 0.075 mm test sieve. However for some materials removing the portion of fine aggregate passing the 0.075 mm test sieve by washing prior to testing can improve the accuracy of the test result. Appendix X1 of ASTM C128 discusses this practice. Consequently some testing agencies may choose to wash the fine aggregate when determining the relative density of the fine aggregates.

2.2 Mineral Filler

Some asphalt specifications show confusion over the role and specification of filler in asphalt mixes. By strict definition, filler is that mineral matter passing the 0.075 mm sieve and includes filler sized
particles derived from aggregates as well as added fine materials such as lime, fly ash, etc. In practice, materials used as added filler are comprised predominantly of particles smaller than 0.075 mm but can also contain a proportion of coarser particles. Tests applied to added filler materials apply to the complete sample, not just that portion passing the 75 micron sieve.

Added filler is specified by particle size distribution only as is normal practice in New Zealand.

2.3 Binder

A guide to selection of binder type is provided in Table N3.6, Table N3.7 or Table N3.8. Reclaimed Asphalt Pavement (RAP) a guide to the application of design and manufacturing requirements for RAP in asphalt is provided by clause 3.5.

3 MIX DESIGN

3.1 General

This specification has been prepared to incorporate performance-based design criteria developed through the national research programs of AAPA, Austroads and ARRB Transport Research.

The outcome of that research program has been published as Austroads AGPT04B Guide to Pavement Technology Part 4B Asphalt (an updated version of the former APRG 18 "Selection and Design of Asphalt Mixes: Australian Provisional Guide"). Guidelines for application of performance tests are given in Table N3.9.

The Austroads mix design procedure has two main elements:
(a) Laboratory compaction using gyratory compaction in place of Marshall or Hubbard Field.
(b) Performance-related tests on compacted materials.

While the Austroads method was developed around the Gyropac™ compaction apparatus, New Zealand laboratories have standardised on the later Servopac™ apparatus. Accordingly, asphalt mixes designed using gyratory compaction in accordance with this specification shall use the Servopac™ compaction apparatus.

The general volumetric requirements for asphalt mixes (requirements for component materials, grading limits, binder content, and voids relationships) remain largely unchanged so that asphalt mixes should therefore not change greatly from those previously used, particularly where there is a satisfactory record of performance. The new procedures should, however, provide greater reliability and prediction of performance behaviour.

Gyratory compaction enables ready selection of different compaction levels to match expected service conditions as well as being able to simulate long term heavy traffic loadings by extended compaction. Gyratory compaction is also considered to achieve particle alignment that is a better representation of field compaction of asphalt. The specification does, however, provide for the use of Marshall compaction where that method of compaction is preferred. It is important that only one set of criteria is applied, either Marshall or gyratory compaction. In due course it is expected that gyratory compaction will become more common than Marshall.

The mechanical properties of Marshall and Hubbard Field 'Stability' and 'Flow' do not directly measure fundamental properties but provide empirical relationships that have been found to correlate with asphalt mixes, which provide suitable levels of field performance. The new mix design procedures provide for a range of tests on performance-based properties that include:
(a) Resilient modulus of laboratory compacted samples or cores using MATTA indirect tensile test.
(b) Moisture sensitivity of gyratory compacted samples.
(c) Wheel tracking of laboratory compacted slabs or field samples.
(d) Fatigue testing and flexural stiffness of beams cut from laboratory compacted slabs or field samples.

AGPT04B provides for three levels of design depending on the intended application. In summary, the major test requirements for each level, adapted for New Zealand, are outlined by Table N3.1 below.
Table N3.1  Major Testing Requirements for Design Levels

<table>
<thead>
<tr>
<th>Design Level</th>
<th>Traffic</th>
<th>Standard Tests</th>
<th>Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td>Light</td>
<td>Standard Tests</td>
<td>Compaction, density and voids determinations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Optional Tests</td>
<td>Voids at maximum cycles</td>
</tr>
<tr>
<td>Level 2</td>
<td>Medium</td>
<td>Standard Tests</td>
<td>Level 1 tests above, and:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>•  Resilient Modulus</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>•  Moisture sensitivity</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>•  Voids at maximum cycles</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Optional Tests</td>
<td>Wheel tracking</td>
</tr>
<tr>
<td>Level 3</td>
<td>Heavy</td>
<td>Standard Tests</td>
<td>Levels 1 and 2 tests above, and:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>•  Wheel tracking</td>
</tr>
<tr>
<td></td>
<td>Very Heavy</td>
<td>Optional Tests</td>
<td>Fatigue</td>
</tr>
</tbody>
</table>

Resilient Modulus testing is a mix design tool. It shall not be used as a specification criterion in asphalt specifications as raw material properties may not allow specified moduli to be met in an economic or technically viable manner. However reported modulus values may be considered for use as inputs to pavement design algorithms but caution is advised. The Austroads method determines Resilient Modulus using indirect tensile testing whereas the Shell method for pavement design uses flexural modulus. These methods of determining asphalt modulus are not necessarily directly comparable. Note that the use of modulus values is relevant to structural asphalt layers only.

Wheel tracking testing provides data on the deformation resistance of an asphalt mix. This testing is particularly relevant for heavily trafficked pavements (high wheel loadings, high traffic counts or both) or where trafficking is highly channelized. Refer to NZTA technical memorandum TM6003 located at http://www.nzta.govt.nz/resources/roading-bitumens/docs/roading-bitumens-replacement.pdf

3.2 Traditional Mixes

Table 3.2 of this specification allows for the continued use of asphalt mixes designed under earlier iterations of this specification (i.e. NZTA M/10:2005). However, mixes designed to comply with Table 3.2 can now be designed using differing compactive effort in the Marshall apparatus compared with traditional New Zealand practice where only 75-blow compaction was used. The intention is that these mixes will be replaced with those designed under the Austroads mix design method. Unless the Engineer has documented reasons for continuing with traditional mixes, it is expected that all mix designs will follow the Austroads approach by 2018.

Table 3.5 allows reduced numbers of blows in the Marshall apparatus for reduced loadings. This will result in mixes with increased binder content, giving improved durability, but reduced resistance to deformation. Conversely, mixes designed using 75-blow of the Marshall apparatus will tend to have lower durability but better deformation resistance.

Consequently it is recommended that selection of the compactive effort used during the mix design process be based on the expected duty of the mix, as shown by Table 3.4 and Table 3.5.

Designation of asphalt mixes is changed in this document from the previous “all passing” size, to the nominal mix size, used by NZTA P/11 and Austroads. The nominal size of an asphalt mix is an indication of the maximum particle size present and is usually expressed as a convenient whole number above the largest sieve size to retain more than 0% and less than 10% of the aggregate material.

3.3 Aggregate Grading and Binder Content

The aggregate grading and binder content ranges shown in Table 3.1, Table 3.2 and Table 3.3 of the specification are targets for design purposes. Application of production tolerances can result in actual production being outside those limits. Table 3.1 restricts the proportion of finer materials in order to provide good texture for dense graded wearing course mixes for medium and heavy traffic and increased deformation resistance in heavier trafficked applications. Table 3.2 allows increased proportions of finer materials in dense graded mixes for all lesser trafficked applications.

The binder content ranges are in terms of total binder in contrast to previous versions of M/10, which used effective binder content. The volume of effective binder is controlled, however, by the VMA and air void requirements. The effective binder volume, which is used in pavement design, is calculated from Effective Binder volume = VMA – Air voids.
The Engineer may allow the use of asphalt mixes with a design target outside the ranges shown where it can be shown that all the other performance requirements can be adequately met. Such departures would normally involve discussions with the client.

3.4 Mix Properties: Selection of Mix Type, Binder Type and Testing Requirements

The principle factors influencing the performance characteristics of asphalt mixes are the selection and quality of components, and the volumetric properties of the mix (nominal size, grading, binder content and voids relationships). External factors such as traffic, appropriate treatment selection and pavement condition must also be considered.

The specification provides for different voids criteria for dense graded mixes (Level 1 of the Austroads design procedure) based on traffic categories. Four traffic categories of Light, Medium, Heavy and Very Heavy have been chosen and a guide to their selection is shown in the Table N3.2 below. The relevant traffic category shall be nominated in the Schedule of Job Details.

The mix type, nominal mix size, mix design procedure and binder type shall also be nominated in the Schedule of Job Details. For most wearing course and structural asphalt applications, dense graded asphalt mix types are used. Other mix types are used as wearing courses to provide particular surface characteristics for particular applications as follows:

(a) Open graded porous asphalt is used as a porous wearing course to reduce water spray and tyre noise levels on motorways and other high-speed roads. Note that open graded porous asphalt will be specified in accordance with NZTA P/11 specification.

(b) Stone mastic asphalt (SMA) is used to provide good surface texture and good deformation resistance on heavily trafficked roads. Smaller nominal sizes can also be used as a durable, well-textured surface in lightly trafficked applications.

A detailed guide to selection of different wearing course types for particular surface characteristics is provided in the Austroads “Guide to the Selection of Road Surfacings” AGPT03-09. A treatment selection tool may be found on the NZTA web site www.nzta.govt.nz.

The nominal size can be determined as a function of the layer thickness or the layer thickness selected on the basis of the nominal size required for a particular application. A guide to selection of layer thickness and nominal size is shown in Table N3.3.

Guides to selection of binder types for dense graded wearing and base course applications are shown in Table N3.6 and Table N3.7, and Table N3.8 for other mix types. Not all binder types may be available in all locations. Modified binders require delivery in minimum quantities and special handling and storage requirements. The specification of modified binders may, therefore, not be practical for small projects or remote locations.

It should be noted that the compaction levels and design air voids for dense graded asphalt mixes differ depending on the traffic category and application (see Table 3.4 and Table 3.5). These differences are applied to both gyratory and Marshall compacted specimens. The contract shall specify the traffic category and mix application on the basis of the field conditions. The Engineer will select the mix design procedure (gyratory or Marshall) appropriate to the specified field conditions.

A minimum air void level of 2.0% at 250 cycles (Table 3.4) is specified as an indicator of the influence of long term compaction under heavy traffic and potential for in-situ voids to reach critical levels.
Table N3.2  
**Guide to Traffic Category**

<table>
<thead>
<tr>
<th>Indicative Traffic Volume</th>
<th>Structural design level</th>
<th>Free flowing vehicles</th>
<th>Stop/start OR climbing lane OR slow moving</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial vehicles/lane/day</td>
<td>&lt; 100</td>
<td>&lt; 5x10^2 ESAs</td>
<td>Light</td>
</tr>
<tr>
<td>100 - 500</td>
<td>5x10^2 - 5x10^3 ESAs</td>
<td>Medium</td>
<td>Heavy</td>
</tr>
<tr>
<td>500 - 1000</td>
<td>5x10^3 - 2x10^4 ESAs</td>
<td>Heavy</td>
<td>Very Heavy</td>
</tr>
<tr>
<td>&gt; 1000</td>
<td>&gt; 2x10^4 ESAs</td>
<td>Very Heavy</td>
<td>Very Heavy</td>
</tr>
</tbody>
</table>

Note:  
Traffic category is based on Austroads vehicle classification system.

Table N3.3  
**Guide to Selection of Nominal Size of DG Mixes For Light/Medium Applications**

<table>
<thead>
<tr>
<th>Nominal Size (mm)</th>
<th>Previous Designation</th>
<th>New Designation</th>
<th>Typical Layer Thickness (mm)</th>
<th>Typical Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Mix 10</td>
<td>DG 7</td>
<td>20 – 35</td>
<td>General purpose wearing course in light traffic applications, where thin layers and fine surface texture are required</td>
</tr>
<tr>
<td>10</td>
<td>Mix 15</td>
<td>DG 10</td>
<td>30 – 50</td>
<td>General purpose wearing course for medium traffic applications</td>
</tr>
<tr>
<td>14</td>
<td>Mix 20</td>
<td>DG 14</td>
<td>45 – 75</td>
<td>Base and intermediate course applications</td>
</tr>
<tr>
<td>20</td>
<td>Mix 25</td>
<td>DG 20</td>
<td>60 – 100</td>
<td>General purpose base and intermediate course mix laid in thicker layers than DG 14 above</td>
</tr>
</tbody>
</table>

Note:  
(a) The minimum typical layer thicknesses above are based on 3 times the nominal size. Placement of mixes at this minimum layer thickness can result in increased layer permeability.  
(b) Minimum layer thicknesses must be increased for coarser asphalt mixes. Refer to Table 3.1, Table 3.2 and Table 3.3 for minimum layer thicknesses for specific asphalt mixes.  
(c) The use of modified binders may require the use of thicker layer thicknesses for workability reasons.

Table N3.4  
**Guide to Selection of Nominal Size of AC Heavy Traffic Asphalt Mixes**

<table>
<thead>
<tr>
<th>Nominal Size (mm)</th>
<th>Designation</th>
<th>Typical Layer Thickness (mm)</th>
<th>Typical Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>AC 10</td>
<td>35 – 50</td>
<td>General purpose wearing course in light and medium traffic applications</td>
</tr>
<tr>
<td>14</td>
<td>AC 14</td>
<td>50 – 75</td>
<td>Wearing course mix for heavier traffic applications. Also some intermediate course applications depending on layer thickness</td>
</tr>
<tr>
<td>20</td>
<td>AC 20</td>
<td>70 – 100</td>
<td>General purpose base and intermediate course mix for wide range of use</td>
</tr>
<tr>
<td>28</td>
<td>AC 28</td>
<td>95 – 150</td>
<td>Base and intermediate course but less commonly used than 20 mm. Control of segregation can sometimes be an issue</td>
</tr>
</tbody>
</table>

Note:  
(a) The minimum typical layer thicknesses above are based on 3.5 times the nominal size. Placement of mix layers at the minimum layer thickness will result in increased layer permeability.  
(b) The use of modified binders may require the use of thicker layer thicknesses for workability reasons.
Table N3.5  Guide to Selection of Nominal Size of Stone Mastic Asphalt Mixes

<table>
<thead>
<tr>
<th>Nominal Size (mm)</th>
<th>Designation</th>
<th>Typical Layer Thickness (mm)</th>
<th>Typical Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>SMA 7</td>
<td>30 – 45</td>
<td>General purpose wearing course in light and medium traffic applications</td>
</tr>
<tr>
<td>10</td>
<td>SMA 10</td>
<td>40 – 60</td>
<td>Wearing course mix for heavier traffic applications. Also some intermediate course applications depending on layer thickness</td>
</tr>
<tr>
<td>14</td>
<td>SMA 14</td>
<td>55 – 85</td>
<td>General purpose base and intermediate course mix for wide range of use</td>
</tr>
</tbody>
</table>

Note:
(a) The minimum typical layer thicknesses above are based on 4 times the nominal size to allow development of the coarse aggregate skeleton and to provide for reduced permeability.
(b) The use of modified binders may require the use of thicker layer thicknesses for workability reasons.

Table N3.6  Guide to Selection of Binder Type For Dense Graded Wearing Course Applications

<table>
<thead>
<tr>
<th>Traffic Category</th>
<th>Typical Binder Penetration Grade</th>
<th>Recommended Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light</td>
<td>80/100</td>
<td>Residential streets, carparks and foot traffic</td>
</tr>
<tr>
<td>Medium</td>
<td>80/100, 60/70</td>
<td>Normal conditions and lower traffic ranges. Good general purpose mix for wide range of applications</td>
</tr>
<tr>
<td>Heavy</td>
<td>60/70, 40/50, PMB</td>
<td>High performance mixes for more critical traffic applications. Modified binders may be specified for enhanced fatigue life, or stiffness and deformation resistance depending on the application</td>
</tr>
<tr>
<td>Very Heavy</td>
<td>60/70, 40/50, PMB</td>
<td>Special applications such as very heavily trafficked intersections and heavy-duty industrial pavements</td>
</tr>
</tbody>
</table>

Note:
(a) Table N3.6 is a guide. Modified binders can be specified for all situations depending on site demands and economics.

Table N3.7  Guide to Selection of Binder Type For Dense Graded Intermediate and Base Course Applications

<table>
<thead>
<tr>
<th>Traffic Category</th>
<th>Binder Grade</th>
<th>Recommended use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light and Medium</td>
<td>80/100</td>
<td>General purpose mixes for cooler conditions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>General purpose mixes for most light and medium traffic applications</td>
</tr>
<tr>
<td>Medium/Heavy (high fatigue base)</td>
<td>80/100, 60/70</td>
<td>Special high bitumen content sub-base layer providing high fatigue resistance. To avoid rutting, this mix shall not be used within 125 mm of surface. The layer thickness shall not generally exceed 70 mm or one third of the structural pavement depth</td>
</tr>
<tr>
<td>Heavy</td>
<td>60/70, 40/50</td>
<td>General purpose mix for heavy traffic applications</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High stiffness base for use in heavy duty pavements</td>
</tr>
<tr>
<td>Very Heavy</td>
<td>60/70, 40/50, Multigrade or PMB</td>
<td>Special applications such as heavy-duty industrial pavements and hard standing areas</td>
</tr>
</tbody>
</table>

Note:
(a) Table N3.7 is a guide. Modified binders can be specified for all situations depending on site demands and economics.
Table N3.8  
Guide to Selection of Binder Type For Other Mix Types

<table>
<thead>
<tr>
<th>Mix Type</th>
<th>Traffic Category</th>
<th>Binder Grade</th>
<th>Recommended use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stone Mastic Asphalt</td>
<td>Light or Medium</td>
<td>60/70</td>
<td>Wearing course for light and medium trafficked roads where well-textured mix is required</td>
</tr>
<tr>
<td></td>
<td>Heavy or Very Heavy</td>
<td>60/70 40/50</td>
<td>Wearing course for heavily trafficked roads providing high levels of texture and rut resistance</td>
</tr>
<tr>
<td></td>
<td>Very Heavy (Special applications)</td>
<td>PMB</td>
<td>Enhanced wearing course performance in heavily trafficked applications</td>
</tr>
</tbody>
</table>

Note:

(a) Table N3.8 is a guide. Modified binders can be specified for all situations depending on site demands and economics.

3.5 Design and Manufacture of Asphalt Mixes Incorporating Reclaimed Asphalt Pavement (RAP)

As a general rule, no special requirements need apply to the use of RAP in hot mix asphalt where the percentage of RAP does not exceed 15% of the total mix.

Where RAP is to be added in proportions up to 15% of the total mix, the mix design shall be validated by either a single-point laboratory validation or by volumetric testing of plant-produced mix.

Where RAP is to be added in proportions greater than 15%, but not more than 30% of the total mix for a current mix design, a laboratory mix design must be completed. The use of bitumen binder of one class or grade softer than that otherwise specified may be needed to provide suitable compensation for the influence of hardened binder in the RAP and produce asphalt mixes of comparable stiffness, fatigue resistance and deformation resistance to mixes manufactured with virgin materials although this may not necessarily be needed.

The use of RAP in proportions greater than 15% of the total mix shall only be permitted where the Contractor can demonstrate suitable manufacturing plant and quality control procedures. The use of softer binders or rejuvenating agents to achieve a binder of comparable performance to that otherwise specified, and testing to validate the properties of the manufactured asphalt.

Where RAP is added in proportions greater than 30% additional mechanical testing is required to demonstrate that the performance of these mixes is not compromised. Such testing could include, but is not limited to:

(a) Resilient modulus of laboratory compacted specimens using the method of AS 2891.13.1;
(b) Fatigue testing and flexural stiffness using the four-point beam apparatus comparing the RAP mix to the same mix made using virgin materials. Such testing should provide evidence that the fatigue life of the RAP mix is equal to or better than the virgin mix, or;
(c) Complex shear modulus of laboratory compacted specimens using the dynamic shear rheometer or the Superpave shear tester;
(d) Fatigue testing as above using advanced devices such as the Asphalt Mixture Performance Tester.

A guide to blending of binders or rejuvenating agents to achieve a target binder viscosity is provided in the “Austroads Asphalt Recycling Guide” (AP-44/97) and “Austroads Framework Specifications for Asphalt Recycling” (AP-T02). Caution must be used in determining targets for blending of binders as fresh binder or rejuvenator may not be fully combined with the aged binder during the asphalt manufacture process. Consequently, mix performance characteristics imparted by binder stiffness, particularly fatigue and rutting resistance, may be somewhat intermediate between that of the fresh binder and that predicted from the stiffness or viscosity calculated or determined by extraction and testing of the blended binder.
3.6 Approval of Job-Mix Formula

In addition to the tests listed in Table 3.10 of the specifications that are required to be reported from a production trial batch, the Contractor may also be required to report the results of Moisture Sensitivity Testing. A typical minimum value for the Moisture Sensitivity Test is a Tensile Strength Ratio of 75%.

A guide to applications where Level 2 and Level 3 tests (see AGPT04B) may be relevant is provided in Table N3.9 below. Some of these tests are expensive and only capable of being performed in a limited number of research laboratories. Specifiers shall therefore consider the balance between the cost of providing test data and the use to which the information is to be put. Where testing is required, the tests shall be nominated in the Schedule of Details and a separate schedule item provided for the cost of testing.

Table N3.9  Guide to Applications Where Level 2 and Level 3 Mix Design Tests May Be Considered

<table>
<thead>
<tr>
<th>Mix Type</th>
<th>Resilient Modulus at 25°C</th>
<th>Moisture Sensitivity</th>
<th>Fatigue Life at 20°C and 400 Micro Strain</th>
<th>Wheel Tracking Test at 60°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic Category</td>
<td>Application</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light</td>
<td>Wearing and base</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Medium</td>
<td>Wearing and base</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>High fatigue base</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Heavy</td>
<td>Wearing and base</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>High fatigue base</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Very Heavy</td>
<td>Wearing and base</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

The Engineer may allow the use of asphalt mixes with properties outside the specified ranges where it can be shown that all the other performance requirements can be adequately met. Such departures would normally involve discussions with the client.

4 MANUFACTURING

Asphalt mixing and compaction temperatures are a function of the grade of bitumen used in the mix. Typical mixing and compaction temperatures are as follows:

Table N4.1  Typical Asphalt Mixing and Compaction Temperatures

<table>
<thead>
<tr>
<th>Binder</th>
<th>Mixing Temperature (°C)</th>
<th>Compaction Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>80/100 bitumen</td>
<td>155</td>
<td>144</td>
</tr>
<tr>
<td>60/70 bitumen</td>
<td>162</td>
<td>150</td>
</tr>
<tr>
<td>40/50 bitumen</td>
<td>170</td>
<td>158</td>
</tr>
<tr>
<td>Modified binders</td>
<td>Manufacturer’s recommendations</td>
<td>Manufacturer’s recommendations</td>
</tr>
</tbody>
</table>

These temperatures depend on the viscosity of the binder in the mix. Modified or specialist binders will require adjustment to mix temperatures.

Mixing temperatures may require adjustment upwards for cold conditions or long distance transportation. Effective compaction can be obtained for mixes at temperatures well below those listed above so mix delivered to site at temperatures below the compaction temperatures above can be placed successfully.

Advances in asphalt manufacture such as “Warm Mix Asphalts” (WMA) have been shown to allow significantly reduced mixing and compaction temperatures.
5 SAMPLING AND TESTING OF ASPHALT PRODUCTION

5.1 General

The purpose of inspection and testing is to provide reasonable assurance to the purchaser that the quality of component materials comply with the standards specified, and that the manufactured asphalt is in accordance with the designated job-mix formula.

Manufacturing compliance can be assessed at two levels:
(a) Verification that the job-mix formula has been replicated, i.e. use of conforming components and combination in the design proportions to achieve the job-mix formula grading and binder content.
(b) Verification that the design targets have been met, i.e. testing of compacted samples for volumetric properties and other specified properties.

For many applications, compliance with the job-mix formula grading and binder content is adequate. It is considered best practice in New Zealand to monitor production consistency by also using the Maximum Specific Gravity (MSG).

The manufacturer should not rely solely on the sampling and testing done for compliance purposes as the measures of process quality control. The specification provides an incentive to the manufacturer to undertake suitable measures to improve the level of conformity and consistency of manufactured product by reducing the frequency of testing for compliance purposes where the manufacturer is using a suitable statistical process control system and where the results of compliance tests show an appropriate level of consistency in meeting the specification requirements. A guide to statistical process control systems is provided in AAPA Implementation Guide IG-3: Asphalt Plant Process Control Guide.

The use of statistical process control and other measures, such as the Roading New Zealand Asphalt Plant Accreditation Scheme (APAS), are strongly encouraged.

For SMA mixes the acceptance criteria above are based on previous practice in New Zealand. However, they shall be regarded as interim and subject to future review based on process control systems such as APAS.

Careful management of raw material quality is essential for SMA mixes as minor changes in aggregate particle size distribution or particle shape can significantly affect the properties of the SMA.

6 PLACING

6.1 Preparation of Surface

Road surfaces must be clean to ensure a good bond between new asphalt and the existing surface.

6.2 Tack Coating and Membrane Sealing

Tack coating for normal asphalt applications comprises a light application of bitumen emulsion to ensure adequate adhesion between layers. Residual binder application rate is normally between 0.1 and 0.2 L/m². The type of bitumen emulsion for normal applications should suit the conditions of use. Generally, rapid setting cationic emulsion is used in cooler regions where damp conditions may be encountered. In warmer or drier conditions, slower setting cationic emulsions and anionic emulsions may combine easier handling with satisfactory performance. Bitumen emulsion used for tack coating can be diluted with water to assist uniform coverage, provided that the residual binder application rate is achieved.

Tack coating is generally not necessary when placing over newly placed, untrafficked asphalt.

In cases where the existing surface has questionable water resistance New Zealand practice has been to apply a membrane first. This is generally 1.0 L/m² of penetration grade bitumen, but this can be increased in some instances. This sheet of binder is then covered with a sparse layer of fine sealing chip, normally NZTA M/6 Grade 5, to keep the asphalt laying plant's tyres from contacting the membrane binder. The need for a membrane or tack coat shall be specified in the contract.
specification.

Consideration should be given to the binder selection, to reduce the risk of flushing and loss of texture.

6.3 Spreading

The specification provides for asphalt to be placed when pavement surface temperatures are as low as 5°C. Placing in cool conditions increases the difficulty in obtaining good standards of work and, where practicable, work involving thin layers (40 mm or less) or PMB binders shall be programmed to be done when such conditions are less likely to occur.

The selection and use of automatic level control for asphalt paving should normally be determined by the Contractor, taking into account the applicability to site conditions and the geometric requirements of the finished result. The Schedule of Job Details provides for specification of particular level control devices, if required.

Typical applications of automatic controls are as follows:
(a) Joint Matcher. Suitable for use on most classes of work to reduce manual effort.
(b) Travelling Beam (Generally 9.0 m). Assists in removing minor irregularities within the length of the beam. Suitable for a wide range of work, except for short runs and restricted working space. Improved shape correction may involve increased quantities of asphalt.
(c) Cross-fall. Limited applications where a set cross-fall is desired from a reference on one side of the paver.
(d) Computerised Electronic Control (e.g. “Paveset”). Enables paver to operate to predetermined profile. Needs accurate survey and well-maintained equipment.
(e) Fixed Stringline. Enables paver to operate to set profile. Requires accurate survey and additional personnel for setting up and maintaining lines. Presence of stringlines can severely restrict movement of spreading vehicles.

6.4 Compaction

Selection of compaction equipment is the responsibility of the Contractor.

6.5 Joints

Joints are the weakest part of the pavement. Cold joints should be minimised by planning of works to achieve a minimum number of construction joints and, where practicable, maximum use of hot or warm joints.

7 PRODUCTION AND CONSTRUCTION TRIAL

A production and construction trial is usually only applicable to major projects where a transportable plant is specifically set up for the project. Preliminary trials may also be called for on major project works to be supplied from fixed plants, where a plant has not been used to supply that class of work or where the use of new sources of materials and mix designs are involved.

A separate schedule item shall be included for payment for production and construction trials.

8 FINISHED PAVEMENT PROPERTIES

Finished Pavement Properties requirements are to be specified in contract documents. To date the guidelines specified in the Austroads guide have not been used in New Zealand. NZTA Technical Memorandum TM7003 specifies roughness requirements for finished pavement construction for New Zealand highway pavements.

Where appropriate, compaction of the asphalt pavements is measured by determining the pavement air voids by testing core specimens or using a nuclear densometer. Locations for testing shall be selected using ASTM D5361, which requires locations to be selected on a stratified random basis. The Engineer may be present during the location selection and sampling process.

If the pavement lot is found to be non-compliant the Engineer should carry out further investigations to confirm the non-compliance. Further investigations should include:
(a) Examination of asphalt test results obtained at the plant.
(b) Review of site quality assurance documentation.
(c) Review of environmental conditions during construction.
(d) Visual inspection of core specimens.
(e) Other alternative quantitative methods such as effective porosity and permeability testing.
(f) Visual assessment of the site.

Acceptance of pavement compaction is based on a statistical process. Consequently taking additional core specimens invalidates this process.

If the non-compliance is confirmed then:
(a) A reduction in payment may be agreed with the Contractor proportional to the percent defective, or;
(b) If the actual quality level is significantly outside prescribed limits and is totally unacceptable the lot should be replaced.

Engineers shall carefully consider the disadvantages of lot replacement due to the waste of non-renewable resources and disruptions to the travelling public. Replacement shall only be required if the lot quality is such that pavement will be severely impacted.

8.1 Testing of Cores

Core air voids are calculated from the core Bulk Specific Gravity (relative density) and the Maximum Theoretical Specific Gravity (relative density) using ASTM D3203.

There are four test methods generally used to measure core density but they return different bulk specific gravities, and consequently air voids, depending on core surface texture and amount of interconnected voids, if any. These methods are ASTM D2726 (water displacement), ASTM D6752 (vacuum sealing), ASTM D1188 (coated specimens) and ASTM D3549 (mensuration).

The default method for determining core density is ASTM D2726. However, this method requires the use of alternative methods for determining specimen volume if core water absorption exceeds the maximum specified level. These alternative methods can return different values for specimen volumes depending on the specimen surface texture. Consequently the air voids results may include some or all of the specimen surface texture and return higher values than would have been obtained using ASTM D2726 (water displacement).

It is required that testing laboratories report the voids derived from water displacement even if water absorption exceeds the maximum level. Such results should be suitably annotated. The characteristic air voids for the lot shall be reported with and without these results.

It is recommended that:
(a) Specimen height and diameter should also be measured and recorded using ASTM D3549.
(b) Testing using ASTM D1188 or D6752 should be considered if core water absorptions could exceed the maximum levels.

Maximum specific gravity values used to calculate specimen air voids should be derived from the testing of mix from the production lot rather than using values obtained during the mix design process.

Engineers must carefully review and understand the basis of core specimen air voids and if necessary seek advice from qualified and experienced asphalt technologists so that compliant asphalt pavements are not inappropriately rejected due to test method effects.

Where water absorption invalidates a test result for a core in a lot, the Engineer may require the entire lot to be cored again and the lot air voids to be determined using ASTM D6752 (vacuum sealing) or ASTM D1188 (coated specimens). The Engineer shall consider the impact of the revised testing methodology on the results and, if needed, the Engineer shall adjust the acceptance criteria. The Engineer shall determine if the cost of this work is borne by the contractor or the client using the principles contained in NZS 3910.

8.2 Ride Quality

The ride quality requirements at roundabouts and intersections shall take into account the design and pre-existing pavement shape and geometrics. Such areas shall be excluded from post-construction roughness testing.
The use of the straight edge is designed mainly for the control of joints on the finished pavement surface but it can also be used where a roughness meter cannot be used due to geometry or length restraints. In these cases, where the Engineer considers that the ride quality is poor, then the straight edge can be used as a more objective measure of poor ride.

9  MEASUREMENT AND PAYMENT

Payment is normally on the basis of mass determined from an approved weighing system. Alternatively, on new works where asphalt is being placed to a specified thickness, the mass can be determined on the basis of measured area, thickness and density.

Additional clauses may also be inserted to apply a scheduled rate of reduction in payment for failure to comply with manufacturing targets, compacted density and ride quality requirements to compensate for reduced service life.

10  APPENDIX (SCHEDULE OF JOB DETAILS)

10.1 Measurement and Payment

Indicate the method of measurement applicable (specification clause 11).

10.2 Special Job Requirements

If specific job conditions require changes to this specification, special clauses shall be prepared and inserted in the Schedule of Job Details for the following:

(a) Any special design requirements, if applicable (specification clause 3.3);
(b) Reporting requirements for mix design tests other than standard volumetric data. A separate schedule item shall be provided for the cost of such testing (specification clause 3.3);
(c) Any particular conditions or restrictions to mix types or applications of RAP in asphalt (specification clause 2.4);
(d) Any special requirements for use of automatic paver control, if applicable (specification clause 9.5.3);
(e) Requirements for production and construction trial, if applicable. A separate schedule item is also required for the cost of such trial (specification clause 7);
(f) Special requirements for measurement of ride quality, if applicable. A separate schedule item shall be provided for the cost of testing, where testing is to be provided by the Contractor (specification clause 10.4);
(g) Special requirements for payment for non-complying materials, if applicable (specification clause 11.1).