MIX DESIGN METHOD FOR ASPHALT CONCRETE PAVEMENT

1.0 SCOPE

1.1 This Method is used in the laboratory mix design of bituminous mixtures. This test method is for use with mixtures containing penetration and viscosity or performance grade asphalt cements and aggregate up to 25 mm maximum size. This method also addresses the treatment of reclaimed asphalt pavement (RAP) for mix design purposes (section 7). This design procedure is based on the Marshall method of design as detailed in the applicable documents section below.

1.2 This test method covers the measurement of resistance to plastic flow of cylindrical specimens of bituminous paving mixtures loaded laterally by means of the Marshall apparatus. Specimens are prepared in accordance with this method and tested for stability and flow.

1.3 This method allows the designer a visual evaluation of the mix at various asphalt contents, as well as the determination of density and voids properties.

Note: Alberta Transportation measures the percent asphalt content of bituminous paving mixtures based on the weight of dry aggregate.

2.0 APPLICABLE DOCUMENTS

2.1 Asphalt Institute's MS-2, Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types

2.2 AASHTO PP6 Standard Practice for Grading or Verifying the Performance Grade of an Asphalt Binder

2.3 ASTM C127 Standard Test Method for Specific Gravity and Absorption of Coarse Aggregate

2.4 ASTM C128 Standard Test Method for Specific Gravity and Absorption of Fine Aggregate

2.5 ASTM C131 Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

2.6 ASTM D5 Standard Test Method for Penetration of Bituminous Materials

2.7 ASTM D70 Standard Test Method for Density of Semi-Solid Bituminous Materials

2.8 ASTM D1188 Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures using Paraffin-Coated Specimens

2.9 ASTM D1559 [89] Standard Test Method for Resistance to Plastic Flow of Bituminous Mixtures using Marshall Apparatus

2.10 ASTM D1856 Standard Test Method for Recovery of Asphalt from Solution by Abson Method

2.11 ASTM D2041 Standard Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures

2.12 ASTM D2170 Standard Test Method for Kinematic Viscosity of Asphalts (Bitumens)

2.13 ASTM D2171 Standard Test Method for Viscosity of Asphalts by Vacuum Capillary Viscometer

2.14 ASTM D2726 Standard Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures

2.15 ASTM D3203 Standard Test Method for Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures

2.16 ATT-25 Sieve Analysis, 80 000 μm minus

2.17 ATT-26 Sieve Analysis, 20 000 μm minus

2.18 ATT-50 Percent Fractures

2.19 TLT-107 Determination of Detrimental Matter Content in Coarse Aggregate

2.20 TLT-212 Mixing and Compaction Temperature of Asphalt Cements

2.21 TLT-300 Recycling Asphalt Concrete Pavement

2.22 TLT-306 Retained Stabilities

2.23 TLT-311 Asphalt Film Thickness in Bituminous Mixtures

2.24 TLT-314 Percent Manufactured Fines in Bituminous Mixtures

2.25 TLT-412 Liquid Limit, Plastic Limit, and Plasticity Index of Soils

3.0 OUTLINE OF METHOD

3.1 The design procedures requires that:

- the aggregate meet the requirements of the project as specified in the contract;
- the test specimens are mixed and compacted at the appropriate temperatures based on the viscosity of the asphalt;
- the test specimens are compacted at the specified number of blows;
- the Marshall stability and flow are determined at a temperature of 60°C;
- the effect of water on stability and flow is determined by subjecting a set of test specimens to a 24 hour immersion period in a bath maintained at 60°C;
- the design asphalt content is chosen to be that which satisfies the mix design characteristics for the specified asphalt concrete mix type.

4.0 APPARATUS

4.1 The equipment used is as per the equipment listed in the above mentioned publications and design methods. Contractors or consultants are not required to duplicate the equipment listed below but should note how it is used to prevent heat loss, aid in cooling, or prevent segregation of mix. The equipment includes:

4.1.1 one large forced air oven for heating aggregate,

4.1.2 one large forced air oven for heating molds, pans, etc., and asphalt mixture,

4.1.3 one small oven for heating asphalt cement,

4.1.4 one large hot plate for heating tampers,

4.1.5 one large hot plate for heating distribution pan containing asphalt mixture,

4.1.6 one small hot plate with a sand bath to maintain rods, trowels and scoops sufficiently hot,

4.1.7 Hobart mixer equipped with mixing bowl (12 qt. capacity) and wire stirrer,

4.1.8 balance, 30 kg capacity for weighing aggregate and asphalt to nearest 1 gram, 4.1.9 balance, 4 kg capacity for weighing mixture for individual specimen to nearest 0.1 gram,

4.1.10 one large distribution pan, designed to prevent segregation when weighing individual samples from batches,

4.1.11 twelve tarred bread pans for batch mixing,

4.1.12 two round metal pans and two wide mouth funnels for filling molds,

4.1.13 marking crayons (black and orange) and cardboard ends for molds,

4.1.14 terri welder gloves,

4.1.15 two large flexible spatulas and trowels,

4.1.16 one scoop, flat bottomed,

4.1.17 one round nose steel rod,

4.1.18 one metal pitcher for pouring asphalt,

4.1.19 two mechanical compaction pedestals,

4.1.20 four mechanical hammers,

4.1.21 twenty-four mold assemblies,

4.1.22 thermometers, dial type with metal stems for determining the temperature of aggregate and bituminous mixture,

4.1.23 extrusion jack for extruding compacted specimens from molds,

4.1.24 two table fans for cooling specimens.

Notes: Mixing equipment should be in a "seasoned" or "buttered" state (i.e. the residue from previous mixing should not be completely removed from the equipment). No allowance should be made to the asphalt added for the material sticking to the sides of the pan.

To assure breaking heads meet ASTM dimensional requirements, a template with scribed lines is used to check the conformity of the breaking head.

5.0 AGGREGATE PREPARATION

5.1 Seven to ten bags (280-400 kg) of aggregate are required for the test method. The bags should contain materials representative of each component and should be in similar proportions to those estimated for the combined design gradation. Typically this would be four (4) bags of coarse, two (2) bags of each type of fines, and two (2) bags of blend sand.

5.2 Upon receiving the material, the necessary data from the sample identification sheet is recorded and a MST design number is assigned to the materials.

5.3 The samples are oven dried.

5.4 After drying, the aggregate is weighed and the coarse component of each sample type is separated into four fractions (+10000 μm, -10000 to +5000 μm, -5000 to +1250 μm, and -1250 μm) by using a Gilson shaker or other sieving equipment.

5.5 The material from each fraction is placed in large pans and the total weight of each fraction recorded. An average split of each fraction is obtained and a washed sieve analysis performed.

5.6 The gradation of the aggregate is calculated based on the total weight of the aggregate. This gradation is compared to:

- the average field gradation submitted with each bag sample,
- the job average field gradation determined from quality control gradation reports.

5.7 The aggregate is recombined to give the desired gradation in the following quantities:

5.7.1 Seven 5000 g samples for the Marshall stability specimens:

- five samples are used for the 35 minute soaked Marshall specimens with each batch at a different asphalt content, ranging from lean to rich, in increments of 0.5% asphalt,
- one sample is used for the 24 hour soaked specimens at the approximate asphalt design content,
- one spare sample for an additional point if required.

Note: The 5000 g samples used for Marshall stability testing are pre-wet to approximately 3 % moisture content. The aggregate samples are thoroughly mixed and oven dried to simulate field conditions.

5.7.2 Three 2500 g samples, to be used for determining the maximum theoretical density, at asphalt contents ranging from 0.3% above to 0.3% below the estimated design asphalt content.

5.7.3 One 2000 g sample for washed sieve analysis and fracture count to confirm the design gradation (ATT-50).

5.7.4 One 1000 g sample for uncompacted void content of fine aggregate (TLT-125).

5.7.5 One 1750 g (minimum) sample of the coarse aggregate component of each sample type for the determination of detrimental matter content in coarse aggregate (TLT-107).

5.7.6 Two 2500 g samples for coarse aggregate bulk specific gravity (ASTM C127), where the +10,000 μm and -10,000 +5,000 μm fractions are combined at the average field grading. Test results are reported to the nearest 0.001.

5.7.7 Two 1000 g samples for the fine aggregate bulk specific gravity and apparent specific gravity (ASTM C128), where the -5000 to +1250 μm and -1250 μm fractions are combined at the average field grading. Test results are reported to the nearest 0.001. The apparent specific gravity of the fines is used to estimate the bulk specific gravity of the mineral filler (-80 μm).

Notes: The bulk specific gravities may also be tested and calculated for each individual fine and coarse aggregate component of a sample type. Such a determination would facilitate mix design calculations in the event that a new mix design is required.

The bulk specific gravity (BSg) of the combined aggregate is calculated as follows:

$$\text{Combined BSg} = \frac{\%\text{Coarse Agg.} + \%\text{Fine Agg.} + \%\text{Filler} + \%\text{Product}_i}{\dfrac{\%\text{Coarse Agg.}}{BSg_{coarse}} + \dfrac{\%\text{Fine Agg.}}{BSg_{fine}} + \dfrac{\%\text{Filler}}{BSg_{filler}} + \dfrac{\%\text{Product}_i}{BSg_i}}$$

5.7.8 One 1000 g sample for the Atterberg limits (TLT-412) where the entire sample is razzed, sieved on the 400 μm sieve and the material passing the 400 μm is tested for plasticity.

6.0 PROCEDURE

The procedures used are as per those used in the referenced publications and design methods with the following modifications.

6.1 Forming Specimens

6.1.1 The aggregate batches are placed in an oven set at the mixing temperature plus 5°C for a minimum of four (4) hours prior to the start of forming the specimens. This ensures that the aggregate is dry and will allow for loss of heat during preparation. A four litre pail of asphalt of the type, grade and supplier to be used on the project is placed in an oven maintained at the mixing temperature for one (1) hour prior to mixing. The molds, round pots, bread pans and wide mouthed funnels are also heated to the mixing temperature. The Marshall tampers are set on a large hot plate, maintained at the compaction temperature. All mixing equipment such as scoops, spatulas, and tamping rods are kept warm in a hot sand bath. The blending pan is kept on the hot plate continually throughout the test.

Note: For penetration and viscosity grade asphalt cements, the asphalt mixing and compaction temperatures are determined according to TLT-212 or from supplier data. For performance grade asphalt cements, the supplier's recommended mixing and compaction temperatures are to be used.

6.1.2 Twenty-four specimens are formed for the following purposes:

- four at each of the five asphalt contents for the 35 minute soaked specimens,
- four at the estimated design asphalt content for the 24 hour soaked specimens.

6.1.3 Weigh the heated aggregate and place it in the heated mixing bowl. Form a crater in the centre of the aggregate.

6.1.4 Place the mixing bowl containing the aggregate on the balance and add the required amount of heated asphalt.

6.1.5 Mix the sample for 1½ minutes using the mechanical mixer. If hand mixing is used, the sample should be mixed quickly and thoroughly until the aggregate is uniformly coated with asphalt cement. The mixing bowl should be kept heated during hand mixing to avoid heat loss.

6.1.6 Transfer the mix to a flat bottomed distribution pan, specifically designed to reduce segregation, when weighing mixture for individual specimens.

6.1.7 Using a flat bottomed scoop, weigh four (4) samples of approximately 1200g into heated bread pans.

Note: In order to maintain the specimen height as close to 63.5 mm as possible at increasing asphalt contents, the weight of mix used for the remaining batches is increased by 2 g per 0.5% asphalt content increment; i.e. 1202, 1204, 1206 and 1208 grams.

6.1.8 Place the bread pans in an oven maintained at the compaction temperature plus 3°C, and insert a calibrated dial thermometer into each pan of mix.

6.1.9 Once the mix reaches compaction temperature, it is poured into a heated round pot and stirred gently to ensure a homogenous mixture

6.1.10 Place a cardboard disc (100 mm diameter) in the bottom of a heated mold. Use a heated wide-mouth funnel on the mold and <u>quickly</u> dump the entire mix from the round pot into the mold.

6.1.11 Spade the mixture vigorously with a flexible heated spatula 15 times around the perimeter. Then spade the mixture with a heated round nose rod 10 times over the interior. Care must be taken to prevent segregation - harsh mixtures may not require rodding.

6.1.12 Smooth the surface of the mix with a heated trowel to a slightly rounded shape, and place a disc marked with the MST design number on top of the mixture.

6.1.13 Apply the required number of blows with a heated compaction hammer. Remove the collar and baseplate and reverse and reassemble the mold. Apply the same number of blows to the face of the reversed specimen.

6.1.14 After compaction, remove the base plate, collar and cardboard discs.

6.1.15 Identify the specimen by marking the top with an indelible marker with the MST number, briquette number and asphalt content.

6.1.16 Allow mold and specimen to cool such that it can be safely handled with bare hands. Table fans may be used to assist cooling.

6.1.17 Extrude the specimen using an extrusion jack and place on a clean, flat surface.

6.1.18 Individual specimens should be cleaned of loose material.

6.1.19 Each batch is processed separately as described in steps 6.1.3 to 6.1.18. However, all batches are completed in succession; i.e. when one batch is being compacted the next batch is being mixed.

6.2 Visual Inspection

6.2.1 The visual inspection is performed when the specimens have cooled sufficiently (room temperature). This inspection is used as a check when determining the design asphalt content.

6.2.2 Each sample is visually inspected and evaluated in terms of asphalt content; i.e. lean, normal(-), normal, normal(+), rich and bleeding. Any noteworthy conditions such as large voids, segregation, crushed rock, chipped edges, flushing, skewed surface, etc., are also recorded.

6.3 Density Determination

6.3.1 An immersed bulk specific gravity is carried out for each specimen in accordance with ASTM D2726 (or ASTM D1188 for a porous mix). Weights are recorded to the nearest 0.1 g. For simplicity and consistency with field testing, the bulk specific gravity values are multiplied by 1000 kg/m^3 and reported as density.

6.3.2 Maximum Theoretical Density (MTD) and Absorption are determined in duplicate at three (3) different asphalt contents (0.3% above, at, and 0.3% below the estimated design asphalt content – for example if the estimated design asphalt content is 6.0%, batches are prepared at 5.7%, 6.0% and 6.3%). The pre-weighed and oven dried 2500 g samples are used for MTD testing. Two 1200 g samples are weighed in bread pans for each asphalt content. The samples are placed in an oven maintained at 135°C for four (4) hours prior to adding the heated asphalt cement. Testing is carried out in accordance with ASTM D2041 (the Theoretical Maximum Specific Gravity is determined and recorded as the MTD).

Prepare a graphical plot of the MTD values versus asphalt content. Draw a straight line which gives the best fit for all values. Calculate the asphalt absorption, using the bulk specific gravity of aggregate, asphalt specific gravity, asphalt content and MTD values as follows:

$$\text{Asphalt Absorption} = 100\,\frac{G_{SE} - G_{SB}}{G_{SE}\,G_{SB}}\;x\;G_A$$

Where:
G_{SE} = effective specific gravity of aggregate
G_{SB} = bulk specific gravity of aggregate
G_A = specific gravity of asphalt

$$\text{Effective Specific Gravity of Aggregate} = \frac{100}{\dfrac{100 + W_A}{G_{STM}} - \dfrac{W_A}{G_A}}$$

Where:
G_{STM} = MTD
W_A = asphalt content (based on weight of dry aggregate)

Plot the absorption curve under the MTD curve.

6.4 Stability and Flow

6.4.1 After the weights and measurements have been obtained the specimens are tested for stability and flow. The testing of the samples is a standard procedure (ASTM D1559 [89]); however, samples are prepared for testing in two ways:

- 35 minute soak at 60°C using four (4) specimens at each of the five (5) asphalt contents.
- 24 hour soak at 60°C using four (4) specimens at the estimated design asphalt content.

Note: The standard preparation for the stability test is the placement of the briquettes at 30 second intervals into the water bath. Specimens are removed from the water bath and tested in the same order of placement.

6.4.2 The Retained Stabilities test (TLT-306) is an Alberta Transportation procedure to check for moisture susceptibility problems by comparing the Marshall stability values of the 24 hour versus the 35 minutes soaked specimens.

6.4.3 Marshall stability and flow index

6.4.3.1 The Marshall stability is the maximum load resistance (compressive strength) of the specimen at 60°C. The flow index or flow value is the total movement or deformation in units of 0.25 mm occurring in the specimen between no load and maximum load. The equipment used for testing the 102 mm diameter by 63.5 mm high specimens is an electrically powered device. It is designed to apply a load to the test specimen through semi-circular heads at a rate of strain of 50.8 mm per minute.

6.4.3.2 The Marshall stability apparatus is operated as follows:

6.4.3.2.1 Thoroughly clean the guide rods and inside surface of the test heads prior to testing, and lubricate the guide rods so that the upper test head slides freely over them.

6.4.3.2.2 Remove the first test specimen from the water bath, place it in the lower testing head, then fit the upper testing head into position and centre the complete assembly in the loading device.

6.4.3.2.3 Turn the recorder drive switch on and apply the testing load to the specimen at a constant rate of 50.8 mm per minute until failure occurs. The point of failure is defined by the maximum load reading obtained. Report in Newtons.

Note: The elapsed time for testing the specimen must not exceed 30 seconds.

7.0 RAP

The design of ACP mixtures containing RAP will require tests in addition to those in a standard Marshall procedure.

7.1 RAP testing for mix design

7.1.1 The asphalt rheology design is optional if the percent RAP being added is 10.0 or less. If rheological design is required, the appropriate virgin asphalt grade is selected according to TLT-300, section 5.0.

7.1.2 The specific gravity of the virgin binder is used as the specific gravity of the blended binder.

7.1.3 The virgin aggregate is treated and tested as per sections 5.1 to 5.6 and 5.7.5 to 5.7.8; i.e. dried, split, washed sieve, detrimental matter, bulk specific gravities and Atterberg limits.

7.1.4 Section 4.0 of TLT-300 provides the aggregate requirements for ACP containing RAP. If no historical records are available indicating an acceptable quality of the extracted RAP aggregate, it is tested for detrimental matter content and L.A. Abrasion if the RACP contains greater than 10% RAP.

7.1.5 The gradation and asphalt content of the RAP are determined according to the frequencies and test methods in Specification 3.16, Table 3.16.3.3 (Notes: pre-existing RAP stockpiles shall be sampled using a backhoe; if milling is concurrent with paving, RAP samples shall be obtained by coring the pavement prior to milling). A fracture count on each sample is also performed. The average gradation, asphalt content and fracture count of all test results is used as the RAP gradation, asphalt content and % fractures for mix design purposes.

7.1.6 The extracted RAP aggregate and virgin aggregate are combined at the desired gradation and tested as per sections 5.7.3 and 5.7.4; i.e. washed sieve, fracture count and uncompacted void content.

7.1.7 The bulk specific gravity of the virgin aggregate is determined by test and the bulk specific gravity of the RAP aggregate shall be determined from its historical construction records. If such records are not available, the bulk specific gravity of the RAP aggregate shall be determined according to Note 3 of AASHTO PP28, using the average of 2 test results of the maximum theoretical specific gravity of the RAP, and using an assumed absorption of 1.0%. The effective specific gravity of the RAP aggregate shall not be used in lieu of bulk specific gravity.

7.1.8 The bulk specific gravity of the combined aggregate in the mix (coarse, fine, filler and RAP aggregate) is then determined as per the calculation in section 5.7.7.

Note: For Superpave mix designs, the preparation and testing of the RAP aggregate prior to mix design is covered in TLT-300, section 4.0.

7.2 RAP preparation for mix design

7.2.1 Combine all the RAP to ensure the sample is representative.

7.2.2 Determine the moisture content of the RAP (ATT-15).

7.2.3 Weigh the virgin aggregate and RAP into the required batch sizes as determined in (7.3).

7.2.4 Mix the 5000 g combined sample thoroughly and oven dry to mixing temperature.

7.2.5 Proceed with regular MST procedures.

7.3 Sample calculation for determining aggregate and asphalt proportions with RAP

7.3.1 Prepare a 5000 g batch sample with a RAP to Virgin ratio R/V of 30/70 with an estimated design asphalt content of 5.0% (based on dry weight of aggregate). For this example the asphalt content of the RAP is 6.0%.

7.3.2 weight of RAP: (30 ÷ 100) x 5000 = 1500 g

7.3.3 weight of virgin aggregate: (70 ÷ 100) x 5000 = 3500 g

7.3.4 weight of aggregate in RAP: 1500 ÷ 1.06 = 1415 g
(where 1.06 = 1 + [(asphalt content of RAP) ÷ 100])

7.3.5 total weight of aggregate: 3500 + 1415 = 4915 g

7.3.6 total weight of RAP binder: 5000 – 4915 = 85 g

7.3.7 percent RAP binder in the mix: (85 ÷ 4915) x 100 = 1.7%

7.3.8 asphalt required for 5%: (5 ÷ 100) x 4915 = 246 g

7.3.9 virgin asphalt to add: 246 - 85 = 161 g

7.3.10 percent asphalt added: (161 ÷ 4915) x 100 = 3.3%

7.3.11 percent total asphalt in mixture: 1.7 + 3.3 = 5.0%

8.0 INTERPRETATION OF TEST DATA

8.1 Values are obtained for bulk specific gravity, stability, flow, air voids and Voids in Mineral Aggregate (VMA) and Voids Filled with Asphalt (VFA) for each group of specimens.

8.2 Graphs are prepared with the % asphalt content as the ordinate versus:

- density, kg/m^3
- stability (N)
- flow (mm)
- air voids (V_a, %) (ASTM D3203)
- % VMA $= 100 - \frac{\text{bulk sp gr of compacted mixture}}{\text{bulk sp gr of aggregate}} \, x \, \frac{100}{100 + \%\ \text{asphalt}} \, x100$
- % VFA = $\frac{100(VMA - V_a)}{VMA}$

In each graphical plot, connect the plotted values with a smooth curve that provides the best fit for all values.

8.3 Trends and relations of test data

8.3.1 With increasing asphalt content, the density curve rises to a definite peak and then begins to fall. The asphalt in the mixture acts like a lubricant, allowing the aggregate particles to be more tightly compacted up to a certain point after which the asphalt films become so thick that they in effect cause a separation of the aggregate particles. Since there are fewer coarse particles within any given volume, the result is a decrease in density.

8.3.2 The stability curve behaves much the same way as the density curve. By increasing the density, the number of particle contact points are increased, consequently increasing stability. The stability increases to a maximum, then begins to decrease because thick films are responsible for decreasing the number of aggregate particle contacts.

8.3.3 The flow curve is generally bowled shaped. The higher flow values at the low asphalt contents are the result of compaction of the specimen under stress. As the thickness of the asphalt films is increased to that of the optimum asphalt content, the flow decreases to a minimum. Beyond this point the aggregate begins in a sense to float in the asphalt, which allows particle movement or deformation of the specimen under stress.

8.3.4 The air voids curve gradually slopes downward from lean to rich. As the asphalt increases, a greater percentage of the VMA is filled with asphalt; consequently, there are less air voids in the compacted mixture.

8.3.5 The VMA curve is typically bowled shaped. The minimum value of the VMA curve is generally at the approximate design asphalt content. The VMA is important to the attainment of a durable mix. One can achieve excellent stabilities with asphalt contents that are too low to provide proper asphalt film thickness on the aggregate, which in turn results in poor coating, bonding and waterproofing of the aggregate.

8.3.6 Aggregate that produces a low VMA can be improved by modifying the proportions to produce a more desirable gradation. For a given aggregate moving the gradation curve away from the maximum density line (0.45 power) will increase the VMA.

8.3.7 The VFA curve typically increases with increasing asphalt content.

8.3.8 Recycled Asphalt Concrete Pavement Marshall design specimens exhibit the following trends when compared to ACP Marshall design specimens with similar gradation and asphalt content:

- higher Marshall stability,
- higher Marshall density resulting in lower V.M.A.,
- higher retained stability,
- appears dry when compared to a virgin design of similar void characteristics.

8.4 Determination of Design Asphalt Content

The determination of the design asphalt content is governed by the requirements of Specification 3.50, table 3.50.3.2. The design asphalt content is determined from the graphical plots. The main objectives in the selection of the asphalt content are to provide a mixture that has suitable void characteristics and adequate stability and flow.

9.0 CALCULATIONS

9.1 The percent Air Voids in compacted bituminous mixtures is calculated at each asphalt content.

9.2 The percent Voids in Mineral Aggregate (VMA) is calculated at each asphalt content.

9.3 The percent Voids Filled with Asphalt (VFA) is calculated at each asphalt content.

9.4 The Asphalt Film Thickness (TLT-311) is calculated at the design asphalt content.

9.5 The percent Manufactured Fines (TLT-314) is calculated at the Job Mix Formula gradation.

9.6 The percent Fractures (2 faces and 1 face if required) of all +5000 μm materials is calculated at the Job Mix Formula gradation.

9.7 The percent uncompacted voids of the fine aggregate is calculated at the Job Mix Formula gradation.

9.8 The detrimental matter content of the coarse aggregate is calculated at the Job Mix Formula gradation.

9.9 The Bulk Specific Gravity (density) is calculated for the aggregate at the Job Mix Formula gradation.

9.10 The Absorption is calculated for the aggregate at the Job Mix Formula and the asphalt percentage to be used.

9.11 The Plasticity Index is determined for the virgin aggregate component only of the Job Mix Formula gradation.

9.12 The Retained stability is calculated at the estimated design asphalt content.

10.0 REPORT

10.1 The mix design report provides the information as outlined in section 3.50.3.3 of Specification 3.50, Asphalt Concrete Pavement – EPS. The mix design report also includes:

- graphs for the MST design curves as per section 6.3.2,
- results from curves drawn for each asphalt content,
- all aggregate gradation charts and test results,
- other results as highlighted in section 7.0.

10.2 For mix designs using RAP, the final report shall include the percent virgin asphalt content to be added along with the total percent asphalt content. The RAP source name(s) and location(s), its asphalt content and gradation, the bulk specific gravity of the RAP aggregate and the percentage by weight of RAP used in the design shall also be reported. RAP rheological test results, mix design rheology, all blending charts (including rejuvenator charts) and other requirements of TLT-300 section 5.4 shall also be included.

10.3 A summary sheet should be provided identifying the general project information and highlighting the design recommendations including the design proportions, Job Mix Formula gradation and the MST mix properties at the design asphalt content.

11.0 DESIGN CRITERIA

11.1 The mix design shall meet the criteria of table 3.50.3.2 of Specification 3.50, or as otherwise specified, at the recommended design asphalt content for the Asphalt Concrete Mix Type specified.