Amendment to OPSS.MUNI 1151 (Apr 2018) – Material Specification for Superpave and Stone Mastic Asphalt Mixtures

1151.02 REFERENCES

Section 1151.02 of OPSS.MUNI 1151 is amended by the deletion of the following:

Ontario Provincial Standard Specification, Material

OPSS 1003	Aggregates – Hot Mix Asphalt
OPSS 1101	Performance Graded Asphalt Cement

Section 1151.02 of OPSS.MUNI 1151 is amended by the addition of the following:

City of Toronto Standard Specifications

TS 1003	Material Specification for Aggregates – Hot Mixed, Hot Laid Asphaltic Concrete
TS 1101	Amendment to OPSS.MUNI 1101 (Nov 2016) – Material Specification for Performance Graded Asphalt Cement

1151.03 DEFINITIONS

Section 1151.03 of OPSS.MUNI 1151, the existing definition for Hot Mix Asphalt (HMA) types is deleted in its entirety and replacing it with the following:

Hot Mix Asphalt (HMA) Types means Superpave and SMA mixes, including Superpave 4.75, 9.5, 12.5, 12.5 FC1, 12.5 FC2, 19.0 and 25.0 and SMA 9.5, 12.5, and 19.0.

Section 1151.03 of OPSS.MUNI 1101 is amended by the addition of the following definition:

Business Day means Working Day according to City Toronto General Conditions of Contract.

Lot means a daily production of a specific quantity of material or a specific amount of construction normally from a single source and produced by the same process.

1151.04 DESIGN AND SUBMISSION REQUIREMENTS

1151.04.01 Mix Requirements for Design Purposes

Subsection 1151.04.01 of OPSS.MUNI 1151 is amended by deleting the first and third sentence in its entirety and replacing it with the following:

The Superpave mix designs shall be according to the requirements specified in Tables 1, 2, 4, 5, 9 and 11.

The JMF for Superpave mixes shall be according to the requirements specified in Tables 2, 4, and 5 and 11.

1151.04.01.01 RAP Proportions

Clause 1151.04.01.01 of OPSS.MUNI 1151 is deleted in its entirety and replacing it with the following

The amount of RAP allowable by mass in a mix will be calculated by the Binder Replacement method according to the following formula:

$$\%\ Binder\ Replacement = \frac{\%\ Binder\ Content\ of\ RAP\ x\ \%\ RAP\ in\ Mix}{\%\ Total\ Binder\ Content\ of\ Mix}\ x\ 100\%$$

The use of RAP is allowed, as follows:

Up to 15% by mass of RAP is permitted for Superpave 19 and 25 binder mixes.

When 16% to 30% by mass of RAP is proposed for Superpave 19 and 25 binder mixes, but less than 30%, low grade of the PGAC should be lowered by 6°C

If the composition of the mix is modified by including RAP to exceed 15% by Binder Replacement, Appendix B shall be used. If the RAP proportion is more than 15% but does not exceed 30%, then both the high and low temperature grade of the PGAC shall be lowered by one grade, i.e. 6 °C as per Appendix B.

RAP is not permitted in Superpave 4.75, 9.5, 12.5, 12.5 FC1, 12.5 FC2 and SMA mixes.

Over 30% by mass of RAP is not permitted for any mix.

Section 1151.04 of OPSS.MUNI 1151 is amended by the addition of the following:

1151.04.01.02 Minimum PGAC Content

The minimum PGAC content shall be as specified in Table 11.

Table 11: Minimum PGAC content for Superpave

Mix type	Minimum PGAC content for mix design
SP 4.75	Note a
SP 9.5	5.6
SP 12.5, SP 12.5 FC1, SP 12.5 FC2	5.1
SP 19.0	4.8
SP 25.0	4.6

Note a: There is no minimum asphalt cement requirement for Superpave 4.75. However, the asphalt mix shall meet the volumetric properties as specified in Table 5 of TS 1151.

1151.04.02.02.04 Warm Mix Asphalt Design Method

Clause 1151.04.02.02.04 of OPSS.MUNI 1151 is amended by the addition of the following:

The Contractor shall be responsible for the following:

a) Selecting the WMA technology to be used on this Contract from recognized WMA technologies or from the WMA technologies specified in the Contract Documents. The current recognized additive based WMA technologies are:

- Advera
- Evotherm DAT
- Evotherm 3G (J1,M1)
- Hyper Therm
- Sasobit

b) The WMA mix design and the job mix formula at the anticipated WMA production temperature, both of which shall be according to the requirements detailed in the Contract Documents, except as amended in by this specification. The WMA mix design Procedure shall be based on the National Cooperative Research Program (NCHRP) Report 691, "Mix Design Practices for Warm Mix Asphalt", 2011, Appendix A, except as may be amended in the Contract Documents.

c) Ensuring that, during the verification of the WMA mix design, the WMA technology does not adversely affect the asphalt cement performance grade and the WMA mixture performance.

Contractors should note these aspects of particular concern with WMA mix designs that differ from the Superpave HMA mix design procedures as follows:

a) Volumetric Properties – for HMA mixes with 1.0 percent asphalt cement (binder) absorption or less, the volumetric properties of WMA developed with the procedures developed under NCHRP Project 09-43 were essentially the same as those obtained from a conventional HMA Superpave design. This supports the current practice of substituting a WMA process into an approved HMA mix design. However, the compact ability, moisture sensitivity, and rutting resistance of the WMA may be significantly different than those of the HMA. Each of these should be directly evaluated as recommended in NCHRP Report 691 (AASHTO R 35-15).

b) Asphalt Cement Performance Grade Selection (PGAC) – the procedure for PGAC selection given in TS 1101 (April 2018), should generally be followed. However, for some WMA processes with very low production temperatures and very low initial oxidation at the asphalt plant, asphalt concrete pavement rutting can be of concern and may require an increase in the high temperature grading of the PGAC to meet rutting resistance requirements. It should be noted that the change in rutting resistance of asphalt mixes using WMA technologies is process specific and should be checked as recommended with NCHRP Report 691 (AASHTO R 35-15).

c) RAP Incorporation with WMA – it is generally assumed that the RAP asphalt cement and new asphalt cement do mix at WMA process temperatures, noting that the amount of RAP blending is the subject of research on both HMA and WMA. However, it is considered appropriate to design WMA mixes containing RAP in the same way as HMA, accounting for the contribution of RAP aged asphalt cement to the total asphalt cement content of the mix. RAP aged asphalt cement and new asphalt cement continues to blend while the WMA is held at the elevated temperature. To ensure that this blending occurs, a limit should be placed on the maximum stiffness of the RAP aged asphalt cement for WMA. The RAP aged asphalt cement should have a high temperature grade that is less than the planned field compaction.

d) Specimen Preparation – the sample preparation is specific to the WMA process which governs whether the additives are added to the asphalt cement, to the mix, or to the wet aggregate. In order to ensure sufficient blending between the RAP aged asphalt cement and new asphalt cement at the mix design stage, a two hour conditioning time at the compaction temperature should be used in the laboratory.

e) Evaluation of Coating and Compatibility – the evaluation should be done at the WMA optimum (design) asphalt cement content. The evaluation of the WMA coating is carried out using AASHTO T 195 “Determining the Degree of Particle Coating of Bituminous-Aggregate Mixture” which is a measure of the fully coated coarse aggregate particles in the mix. Compatibility is evaluated for WMA instead of a viscosity based compaction temperature for HMA.

f) Moisture Sensitivity – moisture sensitivity is one off the two major concerns with WMA technologies, with rutting resistance the other. Moisture sensitivity should be evaluated in accordance with TS 1151. Since it has been found that the moisture sensitivity of WMA mixes in the field can be lower than for laboratory prepared mixes, the moisture sensitivity of field mixes should also be checked as recommended in NCHRP Report 691 (AASHTO R 35-15).

g) Rutting Resistance – the rutting resistance of WMA mixes should be evaluated with the Asphalt Mixture Performance Tester (Flow Number Test), or equivalent as recommended in NCHRP 691 (AASHTO R 35). If a mix does not meet the rutting resistance criteria, an adjustment is required as described in NCHRP Report 691 (AASHTO R 35-15).

1151.04.02.04 Changes to the Job-Mix Formula and the Mix Design

Clause 1151.04.02.04 of OPSS.MUNI 1151 is amended by the addition of the following sentences to the first paragraph:

Requests for JMF revisions shall be submitted in writing by the Contractor and identify the lot / sublot for which the revision is to commence. Requests for revisions to completed lots is not permitted.

1151.05 MATERIALS

1151.05.01 Asphalt Cement

Subsection 1151.05.01 of OPSS.MUNI 1151 is amended by deleting the first sentence in its entirety and replacing it with the following:

Asphalt cement shall be performance graded asphalt cement according to TS 1101.

1151.05.02 Aggregates

Subsection 1151.05.02 of OPSS.MUNI 1151 is amended by deleting the first sentence in its entirety and replacing it with the following:

Aggregates shall be according to TS 1003.

1151.06 EQUIPMENT

1151.07 PRODUCTION

Section 1151.07 of OPSS.MUNI 1151 is amended by the addition of the following subsection:

1151.07.02 Requirements for SMA Mixtures

The hot mix plant shall be dedicated to SMA mix production during SMA paving operations and shall not be used to produce other hot mix types during this asphalt paving. The prolonged storage of SMA mixes in hot mix storage bins (silos) shall not be permitted.

The hot mix plant shall be cleaned out, and brought to a uniform SMA mix production, within specification, before any SMA mix is incorporated into the asphalt paving.

Note: Contractors should note that control of fine aggregate and dust at the hot mix plant is particularly important to satisfactory SMA mix production.

TABLE 2 Superpave Aggregate Gradation Control Points

Table 2 of OPSS.MUNI 1151 is deleted in its entirety and replacing it with the following:

Table 2: Gradation requirements for hot mix types

MTO sieve designation	Percentage passing by dry mass										
	SP 4.75	**SP 9.5**	**SP 12.5**	**SP 12.5 FC1**	**SP 12.5 FC2**	**SP 19.0**	**SP 25.0**	**SP 37.5**	**SMA 9.5[1]**	**SMA 12.5**	**SMA 19.0**
50.0 mm								----			
37.5 mm							100	---			
25.0 mm						100	90-100	---			100
19.0 mm			100	100	100	90-100	19-90	---		100	90-100
12.5 mm	100	100	90-100	90-100	90-100	23-90	---	---	100	90-100	50-88
9.5 mm	95-100	90-100	28-90	45-90	45-90	---	---	---	70-95	50-80	25-60
4.75 mm	90-100	32-90	---	45-60	45-60	---	---	---	30-50	20-35	20-28
2.36 mm	---	32-67	28-58	28-58	28-58	23-49	19-45	---	20-30	16-24	16-24
1.18 mm	30-60	---	---	---	---	---	---	---	---	---	---
75 µm	6-12	2-10	2-10	2-10	2-10	2-8	1-7	---	8-12	8-11	8-11

Note 1: For the SMA 9.5, the Upper Gradation Control Points are 21, 18, and 15 percent passing for the 1.18 mm, 0.600 mm, and 0.300 mm sieve, respectively.

TABLE 5 Superpave HMA Volumetric Properties

Table 5 of OPSS.MUNI 1151 is deleted in its entirety and replacing it with the following:

Table 5: Superpave HMA volumetric properties

Ontario Traffic Category	% of Theoretical Maximum Specific Gravity			Voids in Mineral Aggregate (VMA) % Minimum (Note 4)					Voids Filled With Asphalt (VFA) %	Dust to Binder Ratio (Note 1)
				Nominal Maximum Aggregate Size (mm)						
	N_{inital}	N_{design}	N_{max}	25.0	19.0	12.5	9.5	4.75		
A	≤91.5	96.5	≤98.0	12.0	13.0	14.0	15.0	16.0	70-80 (Note 2)	0.6-1.2
B	≤90.5								67-81	
C	≤89.5								67-78 (Note 3)	
D										
E										

Note 1: For Superpave 4.75 mixes, the dust-to-binder ratio shall be 0.9 to 2.0. Superpave mixes with gradations that pass beneath the PCS Control Point specified in Table 7, the dust-to-binder ratio shall be 0.8-1.6.

Note 2: For Traffic Category A, Superpave 25.0 mixes shall have a VFA range of 67% to 80%.

Note 3: Superpave 4.75 mixes shall have a VFA range of 78% to 81%.
Superpave 9.5 mixes shall have a VFA range of 76% to 79%.

Note 4: Density testing of the coarse and fine aggregate shall be carried out in accordance with LS 604 and LS 605 respectively using the procedure for blended aggregates.

TABLE 6 SMA Volumetric Properties

Table 6 of OPSS.MUNI 1151 is deleted in its entirety and replacing it with the following:

Table 6: SMA volumetric properties

% Air Voids (Note 1)	Voids in Mineral Aggregate (VMA) % Minimum			Voids in Coarse Aggregate (VCA) of the Compacted Mix %	Maximum Draindown at Production Temperature (Note 2) %
	Nominal Maximum Aggregate Size (mm)				
	19.0	12.5	9.5		
3.5		17.0		Less than the VCA in the dry rodded condition	0.3

Note 1: SMA mixes shall be designed with 100 gyrations unless the mix aggregates have a LS-603 value greater than 30%, then the SMA mix shall be design with 75 gyrations.

Note 2: Tested in accordance with AASHTO T 305.

TABLE 8 Permitted Field Adjustment to a JMF

Table 8 of OPSS.MUNI 1151 is deleted in its entirety and replacing it with the following:

Table 8: Permitted field adjustment to a JMF

JMF Property	Maximum field adjustment (Note a)
Percent asphalt cement content, all mixes except SMA	± 0.2
Percent asphalt cement content, SMA only	± 0.4
Percent RAP	−5.0
Percent passing 26.5 mm, 25.0 mm, 19.0 mm and 16.0 mm sieves	± 5.0
Percent passing 13.2 mm, 12.5 mm and 9.5 mm sieves	± 4.0
Percent passing 4.75 mm, 2.36 mm and 1.18 mm sieves	± 3.0
Percent passing 600 µm sieves	± 3.0
Percent passing 300 µm and 150 µm sieves	± 2.0
Percent passing 75 µm sieve, all mixes except SMA	± 1.0
Percent passing 75 µm sieve, SMA only	± 2.0

Note a: The maximum field adjustment is applied against the actual JMF property value.

APPENDIX 1151-A, Commentary for OPSS.MUNI 1151, April 2018

Table in Appendix 1151-A, Commentary for OPSS.MUNI 1151 is deleted in its entirety and replacing it with the following:

Table: Hot mix types

Hot mix type	Typical use and properties
Superpave 4.75	Fine, surface, and levelling mixes similar to the traditional sand mixes for miscellaneous applications. Superpave 4.75 is similar to the traditional HL 2.
Superpave 9.5	Fine, surface, padding, and levelling mixes for Traffic Category A and B roads and driveways. Superpave 9.5 is similar to the traditional HL 3 Fine.
Superpave 12.5	Surface mix for Traffic Category B and C roads. Superpave 12.5 is similar to the traditional HL 3 and HL 4 mixes according to OPSS 1150.
Superpave 12.5 FC1	Surface mix for use on Traffic Category C roads that provides superior rutting resistance and skid resistance through aggregate selection. Superpave 12.5 FC1 is similar to the traditional HL 1 mix according to OPSS 1150.
Superpave 12.5 FC2	Surface course mix for use on Traffic Category D and E roads that provides superior rutting resistance and skid resistance through aggregate selection. Superpave 12.5 FC2 is similar to the traditional DFC mix according to OPSS 1150.
Superpave 19.0	Binder course mix for Traffic Category A, B, C, D, and E roads. Superpave 19.0 is similar to the traditional HL 4, HL 8, and (HS) HL 8 mixes according to OPSS 1150.
Superpave 25.0	Large stone binder course mixes for use when thicker binder course lifts are required.
SMA 9.5 and 12.5	Gap-graded premium surface course mix with high frictional resistance, enhanced rutting resistance, water spray reduction, and potential noise reduction for Traffic Category D and E roads. 100% crushed aggregates from the DSM are used for both fine and coarse fraction.
SMA 19.0	Gap-graded premium binder course mix with enhanced rutting resistance for Traffic Category D and E roads. 100% crushed aggregates are used for both fine and coarse fraction.

Note A: The Traffic Categories are as per Table 1.

MATERIAL SPECIFICATION FOR SUPERPAVE AND STONE MASTIC ASPHALT MIXTURES

TABLE OF CONTENTS

1151.01 SCOPE

This specification covers the requirements for the materials, equipment, and processes for proportioning and mixing hot mix asphalt (HMA) including warm mix asphalt, recycled mixes, and mixes for miscellaneous work according to the Superpave and SMA mix design methodology.

1151.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

1151.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

Appendix 1151-A is a commentary appendix to provide designers with information on the use of the specification in a Contract.

1151.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Material

OPSS 1001	Aggregates - General
OPSS 1003	Aggregates - Hot Mix Asphalt
OPSS 1101	Performance Graded Asphalt Cement

Ontario Ministry of Transportation Publications

Designated Sources for Materials (DSM) Manual

MTO Laboratory Testing Manual:

LS-282	Quantitative Extraction of Asphalt Cement and Analysis of Extracted Aggregate from Bituminous Paving Mixtures
LS-292	Quantitative Determination of Asphalt Cement Content by Ignition and Analysis of Remaining Aggregate From Bituminous Paving Mixtures
LS-306	Bulk Relative Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
LS 309	Superpave Mix Design
LS 311	Stone Mastic Asphalt Mix Design
LS-313	Method of Test for Preparing and Determining the Density of Hot Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor
LS 316	Mix Check

LS 318 Practice for Warm Mix Asphalt (WMA) Mix Design
LS 602 Sieve Analysis of Aggregates
LS-603 Resistance to Degradation of Coarse Aggregate by Abrasion and Impact in the Los Angeles Abrasion Machine
LS-604 Relative Density and Absorption of Coarse Aggregate
LS-605 Relative Density and Absorption of Fine Aggregate
LS-629 Uncompacted Void Content of Fine Aggregate

American Association of State Highway and Transportation Officials

T 305 14 Determination of Drain down Characteristics in Uncompacted Asphalt Mixtures
M 320-05 Standard Specification for Performance Graded Asphalt Binder
T 166-05 Bulk Specific Gravity of Compacted Asphalt Mixtures Using Saturated Surface-Dry Specimens
T 283-03 Resistance of Compacted Bituminous Mixtures to Moisture Induced Damage

T 305-14(2014) Determination of Drain down Characteristics in Uncompacted Asphalt Mixtures
T 312-15 Standard Method of Test for Preparing and Determining the Density of Asphalt Mixture Specimens by Means of the Superpave Gyratory Compactor

ASTM International

C 612-14 Standard Specification for Mineral Fiber Block and Board Thermal Insulation
D 6752-11 Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method

Asphalt Institute Publications

Superpave Series:
SP-2 Superpave Mix Design Method
NAPA QIS-122 Designing and Constructing SMA Mixtures

National Cooperative Highway Research Program

NCHRP Report 452 Recommended Use of Reclaimed Asphalt Pavement in the Superpave Mix Design Method, Technician's Manual

1151.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

AMRL means the AASHTO Materials Reference Laboratory.

Anti Stripping Treatment (AST) means a treatment used to minimize stripping of asphalt cement from HMA aggregates, and can be either AST-AGG or AST-AC.

Aggregate AST-AGG (AST-AGG) means an AST applied directly to the HMA aggregates prior to incorporating them into the mix or dryer at the HMA plant.

Asphalt Cement AST-AC (AST-AC) means an AST added directly to the asphalt cement to be used in the mix, prior to incorporating it into the mixer at the HMA plant.

Binder Course means an HMA course between a surface course and either a granular base course or stabilized base course, an existing pavement, or another HMA binder course.

Binder Replacement means the methodology used to determine changes in the PGAC grade required based on the contribution of asphalt cement from the RAP added to the mix.

CCIL means the Canadian Council of Independent Laboratories.

Coarse Aggregate means that portion of aggregate material retained on the 4.75 mm sieve, when tested according to LS 602.

Deleterious Material means materials other than reclaimed asphalt pavement, and that includes but is not limited to the following: ceramic, clay brick, clay tile, glass, gypsum, gypsum plaster, plastic, reclaimed concrete material, wallboard, and wood.

Drain down means that portion of SMA mix, fines, and asphalt cement that separates and flows downwards through the mix.

Equivalent Single Axle Load (ESAL) means equating the damage to a pavement structure caused by the passage of a non-standard load to a standard 80 kN axle load.

Field Adjustment to the JMF means adjustments to the target gradation or asphalt cement content or both of a mix without a redesign of the HMA, resulting in a revised job-mix formula (JMF).

Fine Aggregate means that portion of aggregate material passing the 4.75 mm sieve when tested according to LS 602.

Hot Mix Asphalt (HMA) Types means Superpave and SMA mixes, including Superpave 4.75, 9.5, 12.5, 12.5 FC1, 12.5 FC2, 19.0, 25.0, and 37.5 and SMA 9.5, 12.5, and 19.0.

Job-Mix Formula (JMF) means the percentage passing on each designated sieve of the total mass of aggregate and the amount of asphalt cement as a percentage by mass of the mix that are based on specified mix design procedures that when mixed result in a paving mix that is according to this specification.

Levelling Course means an HMA course of variable thickness used to eliminate transverse and longitudinal irregularities on an existing surface prior to placing an HMA binder or surface course.

Maximum Aggregate Size means one sieve size larger than the nominal maximum size.

Mix Design means the design of the proportions of aggregates, asphalt cement, and additives when uniformly mixed results in an acceptable HMA in accordance with the specified method.

Mixes for Miscellaneous Work means HMA used for miscellaneous work such as the paving of shoulders, boulevards, and sidewalks and the construction of curb and gutter and spillways. These mixes do not meet normal HMA gradation and mix design requirements.

Nominal Maximum Aggregate Size (NMAS) means one sieve size larger than the first sieve to retain more than 10%.

Performance Graded Asphalt Cement (PGAC) means an asphalt binder that is an asphalt-based cement produced from petroleum residue, either with or without the addition of non-particulate modifiers according to AASHTO M 320.

Primary Control Sieve (PCS) means the sieve defining the break point between fine and coarse-graded mixes for each nominal maximum aggregate size.

RAP Content means the amount of RAP expressed as a percentage by mass of the mix.

Reclaimed Asphalt Pavement (RAP) means the processed HMA material that is recovered by partial or full depth removal.

Stone Mastic Asphalt (SMA) Hot Mix Types means SMA 9.5, 12.5, and 19.0 mixes.

Stone Mastic Asphalt or Stone Matrix Asphalt (SMA) means HMA consisting of two parts of a coarse aggregate skeleton and an asphalt binder rich mortar. The mix has a gap graded aggregate skeleton with coarse aggregate stone-on-stone contact.

Stone Mastic Asphalt (SMA) Mortar means a mix of asphalt cement and any additives; filler, including all material passing the 75 □m sieve from the dry sieving of all aggregate components, including any commercial filler; and fibres blended by volume to the proportions required by the JMF.

Superpave means an acronym for Superior Performing Asphalt Pavements. It is an alternative system to the Marshall method for specifying material components and asphalt mix design using the Superpave gyratory compactor.

Surface Course means the HMA wearing course of any flexible or composite pavement.

Voids in the Coarse Aggregate (VCA) means the volume in-between the coarse aggregate particles which includes filler, fine aggregate, air voids, asphalt binder, and fibres. For SMA, the coarse aggregate particles refer to that portion retained on the 4.75 mm sieve.

Warm Mix Asphalt (WMA) means warm mixed, warm laid asphaltic concrete produced using technologies that allow for the mixing, handling and compaction of the asphaltic concrete mixture at a temperature of 20 to 50 °C lower than conventional HMA.

1151.04 DESIGN AND SUBMISSION REQUIREMENTS

1151.04.01 Mix Requirements for Design Purposes

~~The Superpave mix designs shall be according to the requirements specified in Tables 1, 2, 4, 5, and 9.~~

The SMA mix designs shall be according to the requirements specified in Tables 1, 3, 6, 7, and 8.

~~The JMF for Superpave mixes shall be according to the requirements specified in Tables 2, 4, and 5.~~

The JMF for SMA mixes shall be according to the requirements specified in LS-311 and Tables 3 and 6.

1151.04.01.01 RAP Proportions

The amount of RAP allowable by mass in a mix will be calculated by the Binder Replacement method according to the following formula:

$$\%\ Binder\ Replacement = \frac{\%\ Binder\ Content\ of\ RAP \times \%\ RAP\ in\ Mix}{\%\ Total\ Binder\ Content\ of\ Mix} \times 100\%$$

RAP is not permitted in SMA, 12.5 FC1, and 12.5 FC2 mixes, unless specified in the Contract Documents. Up to 15% of RAP is allowed in other surface course mixes and up to 30% of RAP is allowed in binder course mixes.

If the composition of the mix is modified by including RAP to exceed 15% by Binder Replacement, Appendix B shall be used. If the RAP proportion is more than 15% but does not exceed 30%, then both the high and low temperature grade of the PGAC shall be lowered by one grade, i.e. 6 °C as per Appendix B.

Over 30% by mass of RAP is not permitted for any mix.

1151.04.02 Mix Design

1151.04.02.01 General

The mix design shall be the responsibility of the Contractor. The JMFs selected for use by the Contractor shall produce HMA that is in accordance to the requirements of this specification.

1151.04.02.02 Mix Design Method

1151.04.02.02.01 General

The Contractor shall use a laboratory that has current CCIL Type A Certification with CCIL Superpave Certified Technicians or AMRL equivalent certification or other equivalent certified laboratory acceptable to the Contract Administrator to conduct all mix designs, designate the mix proportions, and prepare the JMFs.

The aggregate gradations used for the mix design may be provided by the Contractor or may be from the actual gradations of the mix design aggregate samples. However, when the mix is to be produced from a plant that returns fines to the mix or the aggregate gradations change during production due to aggregate breakdown, appropriate adjustments shall be made to the mix design gradations.

When a mix contains additives and the source of asphalt cement changes from that used in the mix design, tests shall be re-done to verify the dosage of such additives.

1151.04.02.02.02 Superpave Mix Design Method

Superpave mixes shall be designed using procedures specifying in LS-309.
The calculation of Voids in Mineral Aggregated (VMA) shall be based on the densities of the blended coarse and blended fine aggregate.

RAP as processed and ready for use in an HMA shall be tested by the Contractor using test LS-282 or LS-292 to determine the average percentage asphalt cement and the average gradation for the extracted reclaimed asphalt pavement aggregates.

1151.04.02.02.03 Stone Mastic Asphalt Mix Design Method

SMA mixes shall be designed in accordance with LS-311.

1151.04.02.02.04 Warm Mix Asphalt Design Method

Warm Mix Asphalt shall be designed in accordance with LS-318.

1151.04.02.03 Mix Design Submission

The proposed mix design and JMF shall be submitted in writing to the Contract Administrator a minimum of 10 Business Days prior to the start of the paving operation. The mix shall not be placed until the Contract Administrator provides permission to construct hot mix using the submitted JMF. The Contract Administrator shall provide in writing the above permission or the reason why the permission is being withheld within 10 Business Days, which commence when all of the required samples and documents have been submitted.

1151.04.02.04 Changes to the Job-Mix Formula and the Mix Design

Changes to the JMF shall be permitted when it has been determined that the mix properties specified in the Contract Documents are not being met. All changes are subject to the conditions specified below.

Changes to the material proportions based on process control test results shall be permitted without a new mix design, but further hot mix production shall be subject to conditions imposed by the Contract Administrator. In this situation, when the Contractor changes the JMF, the revised JMF shall be submitted to the Contract Administrator. The Contract Administrator shall review the revised JMF for conformance to the mix properties with the Contract requirements. Within 1 Business Day of the modified JMF being received in full by the Contract Administrator, the Contract Administrator shall provide in writing conditional permission to construct HMA or the reason why permission is being withheld.

When the Contractor submits a new mix design it must be accompanied by samples for monitoring purposes, if required; a Mix Design Report; and the supporting documents as detailed in the Documents subsection. New mix design and mix designation documents and a new JMF shall be completed when:

a) A material is eliminated.

b) A new material is added.

c) Changes to the material proportions have not resulted in correction of the problems with the mix.

d) The net impact of all adjustments to the original JMF exceed any of the maximum field adjustments specified in Table 8.

New mix design, new JMF documents, and new samples for monitoring purposes shall be delivered to the Contract Administrator. The new mix design shall be accepted or rejected within 5 Business Days, which commence when all of the required samples and documents have been submitted.

1151.04.03 Samples for Monitoring Purposes

When requested by the Contract Administrator in writing, representative samples of the materials to be used in the work shall be provided to the Contract Administrator at the same time that the mix design and JMF documents are submitted.

The samples shall be labelled with the Contract number, material type, material source, and date of sampling. The samples of coarse aggregate and fine aggregate shall be identified.

Each material sample shall be packaged separately and the samples shall be in clean, closed containers that shall not rupture when lifted or handled. Each filled sample container shall have a maximum mass of 25 kg.

The minimum sample quantities shall be as specified in Table 9.

1151.04.04 Density of Hot Mix Aggregates

Density testing of the coarse and fine aggregates shall be carried out in accordance with LS-604 and LS-605 respectively using the procedure for blended aggregates.

1151.04.05 Documents

The Contract Administrator shall be provided with a copy of the mix design and JMF documents that shall be signed, dated, and certified correct by the person accountable for the engineering and management responsibility for the laboratory that conducted the work. When the Owner has a Bituminous Mix Design Report form, the Contract Administrator shall provide it to the Contractor for submission along with other supporting documents. Information shall be provided in a legible manner. For Superpave mixes, the

documentation required with the mix design submission is covered by LS-309. The documents shall include, but are not limited to, the following information:

a) Contract number, item number, and mix type for which the mix design and JMF were completed and a description of the usage of the mix on the Contract.

b) All test results, mix design work sheets, and graphs.

c) Material proportions and sources, including the Owner's Mineral Aggregate Inventory for the aggregate sources, when such information is available. The amount of RAP in percent by mass and volumetric data shall also be included.

d) Designation of the fine aggregate and the coarse aggregate.

e) PGAC and source and percent by mass of the required new asphalt cement.

f) A graph of the temperature-viscosity relationship for the PGAC that is to be used in the mix.

g) Information on additives, including source, type, percent by mass of asphalt cement, and test results according to LS-309, with specimens prepared according to LS-313.

h) Information regarding fines that are returned to the mix, aggregate breakdown during production, and the resultant change in the aggregate gradations.

i) Complete gradations for all coarse and fine aggregates.

j) For Superpave mixes, excluding SMA, the volumetric properties for the mix selected in accordance with Table 5. Graphs shall be submitted for the air voids, voids in mineral aggregate, voids filled with asphalt, dust-to-asphalt ratio, bulk relative density, maximum relative density, and the gyratory curves of the mix plotted against asphalt cement content.

k) For SMA mixes, the volumetric properties for the mix selected in accordance with Table 6. Graphs shall be reported for the air voids, voids in mineral aggregate, bulk relative density, and maximum relative density plotted against asphalt cement content.

l) Aggregate absorptions.

m) Bulk specific gravity and saturated surface dry density for each aggregate.

n) Mix bulk specific gravity by AASHTO T 166. If the percent water absorbed by the specimen is found to exceed 2% by volume as described in AASHTO T 166, then the bulk specific gravity is according to LS-306, or ASTM D 6752.

o) Theoretical maximum specific gravity by LS-309.

p) When RAP is permitted for use, extracted bulk relative density, percentage asphalt cement, and gradation for the RAP used in the mix.

q) All visual observations made during the design process with particular attention and comments regarding stripping and coating for both the coarse and fine aggregates.

r) The mixing and compaction temperature used in the mix design and the compaction temperature of the reheated mix to be employed in the testing of the production mix.

s) The typical mix weight to produce a gyratory specimen with a height of 115 mm $\pm$ 5 mm.

t) For SMA mixes, the drain down test results according to AASHTO T 305.

1151.04.06 Anti Stripping Treatment

1151.04.06.01 General

The Contractor shall determine the need for and the amount of AST treatment required using AASHTO T 283.

The need for and the amount of AST required shall not be affected by any previous determination made with respect to the same or any other aggregate source.

Regardless of the hot mix type, the amount of AST either specified in the Contract Documents or determined through mix design procedure shall be a percentage of the total dry aggregate or total asphalt cement required.

The amount of AST required shall be based on the following:

a) For Superpave mixes, excluding SMA, amount required to provide a minimum of 80% Tensile Strength Ratio as determined by AASHTO T 283.

b) For SMA mixes, amount required to provide a minimum of 70% Tensile Strength Ratio as determined by AASHTO T 283.

c) Minimum dosage requirements specified in the Contract Documents.

AST shall treat the mix components at the greater of the dosages specified in the Aggregate AST-AGG clause, the Asphalt Cement AST-AC clause, or as specified in the Contract Documents.

AST shall be used according to supplier information.

1151.04.06.02 Moisture Sensitivity

Moisture sensitivity shall meet the tensile strength ratio requirements specified in Table 5 or Table 6.

1151.04.06.03 Aggregate Anti Stripping Treatment (AST-AGG)

1151.04.06.03.01 General

Irrespective of any moisture sensitivity testing that shows that AST-AGG is not required, hydrated lime shall be used in all mixes consisting of more than 75% quartzite and dolomitic sandstone aggregates, or combinations thereof.

Irrespective of any moisture sensitivity testing that shows that AST-AGG is not required, the AST-AGG dosage and type shown in the DSM List Aggregates: Surface Friction Courses shall be the minimum used for all aggregates to be incorporated into SMA and Superpave 12.5FC 2.

For all other aggregates, the AST-AGG may be hydrated lime or an approved Aggregate AST-AGG from the MTO DSM listing.

1151.04.06.03.02 Hydrated Lime

When hydrated lime is used as the AST-AGG, the dosage shall be the greater of:

a) The amount determined to meet the moisture sensitivity requirements, or

b) The listed dosage from the DSM List Aggregates: Surface Friction Courses, or

c). One percent by mass of total dry aggregate if the mix has more than 75% quartzite and dolomitic sandstone aggregates, or combinations thereof.

The following information on the hydrated lime AST-AGG shall be provided to the Contract Administrator:

a) Documentation that the hot mix shall be produced as specified in the Contract Documents.

b) Amount of hydrated lime to be used as determined in the mix design procedures expressed as a percentage of the specified aggregate.

c) Complete information on how hydrated lime is to be incorporated into the mix.

1151.04.06.03.03 Alternate Aggregate Anti Stripping Treatment

When an alternate is used as the AST-AGG in place of hydrated lime, the dosage shall be the greater of:

a) The amount determined to meet the moisture sensitivity requirements; or

b) The listed dosage from the DSM List Aggregates: Surface Friction Courses.

1151.04.07 Submission Requirements

1151.04.07.01 Mix Design

A copy of all mix design and JMF documents, signed, dated, and certified correct by the person accountable for the engineering and management responsibility for the laboratory that conducted the work, shall be submitted to the Contract Administrator. The mix design shall include a statement if the percentage of the mix comprising quartzite and dolomitic sandstone aggregates, or combinations thereof, is more than 75%. The flow number test results shall be submitted with the mix design, or up to 1 month after submission of the original WMA mix design

The mix design shall be valid for a maximum of 14 months from when the mix design was prepared. To extend use of the mix design for each calendar year past the initial 14 months, a One Point Mix Check for the properties listed in Table 10 using the methodology in LS 316 as applicable, shall be submitted to the Contract Administrator The mix must meet the requirement and tolerances given in Table 10.

The mix shall not be placed until the Contract Administrator gives a written confirmation that the submitted mix design documents and JMF meet the Contract requirements. Within 4 Business Days following the delivery of all required documentation, the Contract Administrator shall provide written confirmation that the mix design and all samples meet the Contract requirements or; advise of any requirements that have not been met.
Confirmation of conformance to Contract requirements of the submitted mix design does not constitute any guarantee that the mix can be produced or constructed or both to Contract requirements, and does not relieve the Contractor of the responsibility for ensuring the specified quality of Materials and workmanship.

1151.04.07.02 Material Samples

At the written request of the Contract Administrator, one set of material samples representative of those used for mix design shall be submitted to the laboratory specified in the Contract Documents. The materials shall be delivered within 2 Days of the request made by the Contract Administrator or within 2 Days of submission of the mix design to the Contract Administrator, whichever is later.

For the One Point Mix Check, new samples for aggregate density determination shall be submitted within 2 Days of submission of the mix check to the Contract Administrator.

Each material sample shall be packaged separately and each filled sample container shall not exceed a mass of 30 kg.

The sample quantities are specified in Table 11

1151.04.07.03 Warm Mix Asphalt

For WMA, the following information shall be submitted to the Contract Administrator in writing with the mix design:

a) The WMA technology to be used.

b) Complete name and address of the WMA supplier.

c) The type and dosage of WMA additives, if applicable, and how the additives are incorporated to produce the WMA.

d) The WMA technology supplier's established recommendations for usage.

1151.05 MATERIALS

1151.05.01 Asphalt Cement

Asphalt cement shall be performance graded asphalt cement according to OPSS 1101.

The supply and use of performance graded asphalt cement shall be as specified in the Contract Documents.

1151.05.02 Aggregates

Aggregates shall be according to OPSS 1003.

Both the coarse and fine aggregates used for SMA shall be crushed from the same source and shall be as listed in the MTO DSM.

1151.05.02.01 Reclaimed Asphalt Pavement

RAP, when permitted in a Superpave HMA, shall be according to the aggregate requirements of OPSS 1003 for the HMA type specified in the Contract Documents. Absorption, freeze thaw, and magnesium sulphate requirements do not apply to RAP.

RAP that is contaminated with deleterious material shall not be used and shall be removed from the Work. RAP shall be stockpiled conforming to the stockpiling requirements for coarse aggregates according to OPSS 1001.

Process control sampling and testing of the RAP shall be as specified in the Contract Documents.

1151.05.03 Silicone

When added to the asphalt cement, silicone oil shall be less than five parts per million of asphalt cement.

1151.05.04 Filler

Filler shall be according to OPSS 1003.

1151.05.05 Fibres

Fibres shall be either cellulose or mineral fibres, and appropriate for use in the SMA mix design, according to NAPA QIS 122. The use of rock wool, asbestos and fibreglass is prohibited.

1151.06 EQUIPMENT

1151.06.01 Requirements for All Mixing Plants

The equipment shall be such that the HMA produced shall meet this specification and shall demonstrate adequate control and documentation of the HMA materials, mixing temperature, and storage for monitoring and production purposes.

When required by the Contract Administrator, all equipment shall be on the site and available for inspection before operations are commenced and during production operations.

1151.06.02 Truck Scales

Truck scales shall be as specified in the Contract Documents.

1151.07 PRODUCTION

1151.07.01 General

The HMA shall be produced to meet the submitted JMF or the adjusted JMF that was accepted in writing by the Contract Administrator.

The Contractor shall be responsible for the quality and characteristics of the mix. If the hot mix produced does not meet the requirements of this specification, hot mix production shall stop and appropriate corrections shall be made to the process.

The Contractor is responsible for the process control and condition of all materials during the handling, blending, and mixing operations. The Contractor is responsible for determining and making all necessary adjustments in proportioning materials used to produce HMA to meet the Contract requirements.

1151.07.02 Operational Constraints

The JMF is the target to which the HMA shall be compared to determine the acceptance of the aggregate gradation and asphalt cement content. HMA shall not be placed until the Contract Administrator provides permission in writing to proceed with a submitted JMF.
The JMF shall remain in effect until the Contract Administrator receives any requested changes in writing and approves them.

1151.07.03 Handling of Materials

1151.07.03.01 Aggregate Stockpile Requirements

Before any production of the mix is started, stockpiles of each size and gradation of aggregate shall be provided at the asphalt plant site. Each stockpile shall contain sufficient aggregate for one full day's production of hot mix, before that day's paving begins.

1151.07.03.02 Aggregates

1151.07.03.02.01 General

Aggregates shall be loaded into the cold feed bins in a manner that prevents the mixing of separate sizes of aggregates.

1151.07.03.02.02 Batch and Continuous Mixing Plants

The heated and dried aggregate shall be at a temperature consistent with proper mixing and laying of the mix. Surfaces of all dried aggregates shall be free of carbon or unburnt fuel oil.

1151.07.03.03 Asphalt Cement Antistripping Treatment (AST-AC)

1151.07.03.03.01 Liquid AST-AC

AST-AC shall be handled and mixed with the asphalt cement according to the manufacturer's recommendations.

The Contractor shall provide the Contract Administrator with the following documentation:

a) Verification that the chemical AST-AC shall remain stable in the heated asphalt cement for a minimum of 4 Days.

b) Type and dosage of AST-AC used.

c) Time, date, and temperature when anti-stripping was added to the asphalt cement.

If the liquid AST-AC is added to the asphalt cement at the refinery or asphalt cement depot, the Contractor shall provide the Contract Administrator with the above documentation in the form of a waybill or bill of lading that accompanies each tanker of asphalt cement delivered.

If liquid AST-AC is added to the asphalt tank at the hot mix plant, the liquid agent may be added to the asphalt tank by an in-line metering device or by another means, provided the above documentation is given to the Contract Administrator for each batch of asphalt cement to which anti-stripping agent is added.

If a liquid AST-AC is not added to the asphalt tank, a continual record of the process for adding the additive shall be provided to the Contract Administrator in addition to the above documentation each time liquid AST-AC is metered into the asphalt cement.
The Contract Administrator shall be provided with an approved statement of calibration for any metering device used to add the liquid AST-AC.

1151.07.03.04 Aggregate Anti Stripping Treatment (AST-AGG)

Aggregate treated and stored from a previous construction season may be used only after the Contract Administrator agrees to a written proposal that verifies the effectiveness of the stored aggregate. The proposal shall include the sampling protocol used and test results from those samples that show that the aggregates meet the moisture sensitivity requirements of this specification.

When hydrated lime or an alternative AST-AGG is used, it shall be added to all aggregates requiring AST by one of the following processes:

a) Blending During Aggregate Production

Hydrated lime or an alternative AST-AGG can be mixed with aggregate at the pit or quarry prior to delivery of the aggregate to the HMA plant. The mixing shall be sufficient to ensure uniform and complete adhesion of the AST-AGG to the aggregate.

b) Blending At the HMA Plant

The AST-AGG may be homogeneously mixed with aggregate prior to entering the dryer at the HMA plant. The HMA plant shall be equipped with suitable pumps, mixers and spray bars for introducing the required quantity of AST-AGG to the aggregates. Mixing shall be accomplished with a pugmill or a drum type mixer.

Regardless of the process or mixing equipment used, the process shall result in the production of aggregates that are uniformly and homogeneously coated with the quantity of the AST-AGG specified in the Contract Documents, and that are free of clumps and balls prior to entering the dryer at the HMA plant.

1151.07.04 Preparation of the Mixture

Proportioning and mixing of materials shall be of sufficient accuracy and duration to produce a uniform homogeneous mixture in which all particles of the aggregate are thoroughly and uniformly coated.

The maximum temperature of the mixture after it is discharged from the mixing chamber shall not exceed the maximum specified mixing temperature from the mix design by more than 20 °C, to a maximum of 170°C. For WMA, the maximum temperature of the mixture after it is discharged from the mixing chamber shall not exceed the maximum specified mixing temperature of the unmodified asphalt cement by more than 20 °C, to a maximum of 170°C.

1151.08 QUALITY ASSURANCE

1151.08.01 General

The Contractor shall obtain for the Contract Administrator, within 1 Business Day of submission of request in writing, the right to enter upon the premises of any of the material manufacturers, suppliers, plants, laboratories, or equipment for purposes pertaining to the work, to carry out such inspection, sampling, and testing as specified or as requested by the Contract Administrator.

TABLE 1
Superpave and SMA Design Traffic Categories by ESALs

Ontario Traffic Category	**20-Year Design ESALs** (Note 1)	**Typical Applications**
A	Less than 0.3 million	Low volume roads, parking lots, driveways, and residential roads.
B	0.3 to 3 million	Minor collector roads.
C	3 to 10 million	Major collector and minor arterial roads.
D	10 to 30 million	Major arterial roads and transit routes.
E	Greater than 30 million	Freeways, major arterial roads with heavy truck traffic, and special applications such as truck and bus climbing lanes or stopping areas.

Note:

1. Equivalent Single Axle Load (ESAL) for the projected traffic level expected in the design lane over a 20-year period, regardless of the actual design life of the pavement.

TABLE 2
Superpave Aggregate Gradation Control Points

Hot Mix Asphalt Type	Percentage Passing by Dry Mass of Aggregates									
	Sieve Size mm									
	50.0	**37.5**	**25**	**19.0**	**12.5**	**9.5**	**4.75**	**2.36**	**1.18**	**0.075**
Superpave 4.75	-	-	-	-	100	95-100	90-100	-	30-60	6-12
Superpave 9.5	-	-	-	-	100	90-100	32-90	32-67	-	2-10
Superpave 12.5	-	-	-	100	90-100	28-90	-	28-58	-	2-10
Superpave 12.5 FC1 and 12.5 FC2	-	-	-	100	90-100	45-90	45-60	28-58	-	2-10
Superpave 19.0	-	-	100	90-100	23-90	-	-	23-49	-	2-8
Superpave 25.0	-	100	90-100	19-90	-	-	-	19-45	-	1-7
Superpave 37.5	100	90-100	15-90	-	-	-	-	15-41	-	0-6

TABLE 3
SMA Aggregate Gradation Control Points

Hot Mix Asphalt Type	Percentage Passing by Dry Mass of Aggregates							
	Sieve Size mm							
	37.5	**25**	**19.0**	**12.5**	**9.5**	**4.75**	**2.36**	**0.075**
SMA 9.5	-	-	-	100	70-95	30-50	20-30	8-12
SMA 12.5	-	-	100	90-100	50-80	20-35	16-24	8-11
SMA 19.0	-	100	90-100	50-88	25-60	20-28	16-24	8-11

Note:

A. For the SMA 9.5 mm the Upper Gradation Control Points are 21, 18, and 15 percent passing for the 1.18 mm, 0.600 mm, and 0.300 mm sieves, respectively.

TABLE 4
Superpave Gradation Primary Control Sieve (PCS) Points

Hot Mix Asphalt Type	Primary Control Sieve mm	PCS Control Point At % Passing
Superpave 4.75	-	-
Superpave 9.5	2.36	47
Superpave 12.5, 12.5 FC1, and 12.5 FC2	2.36	39
Superpave 19.0	4.75	47
Superpave 25.0	4.75	40
Superpave 37.5	9.5	47

TABLE 5
Superpave HMA Volumetric Properties

Ontario Traffic Category	% of Theoretical Maximum Specific Gravity			Voids in Mineral Aggregate (VMA) % minimum (Note 4)						Voids Filled With Asphalt (VFA) %	Dust to Binder Ratio (Note 1)	Minimum Tensile Strength Ratio %
	$N_{initial}$	N_{design}	N_{max}	Nominal Maximum Aggregate Size mm								
				37.5	25.0	19.0	12.5	9.5	4.75			
A	□91.5	96.0	□98.0	11.0	12.0	13.0	14.0	15.0	16.0	70-80 (Note 2)	0.6-1.2	80
B	□90.5									65-78		
C	□89.5									65-75 (Note 3)		
D												
E												

Notes:

1. For Superpave 4.75 mixes, the dust-to-binder ratio shall be 0.9 to 2.0. Superpave mixes with gradations that pass beneath the PCS Control Point specified in Table 4, the dust-to-binder ratio shall be 0.8-1.6.

2. For Traffic Category A, Superpave 25.0 mixes shall have a VFA range of 67% to 80%.

3. Superpave 4.75 mixes shall have a VFA range of 75% to 78%.
   Superpave 9.5 mixes shall have a VFA range of 73% to 76%.
   Superpave 37.5 mixes shall have a VFA range of 64% to 75%.

4. Density testing of the coarse and fine aggregate shall be carried out in accordance with LS-604 and LS-605 respectively using the procedure for blended aggregates.

TABLE 6
SMA Hot Mix Asphalt Volumetric Properties

% Air Voids (Note 1)	**Voids in Mineral Aggregate (VMA) % minimum**			**Voids in Coarse Aggregate (VCA) of the Compacted Mix %**	**Maximum Draindown at Production Temperature** (Note 2) **%**	**Minimum Tensile Strength Ratio %**
	Nominal Maximum Aggregate Size mm					
	19.0	**12.5**	**9.5**			
4.0	17			Less than the VCA in the dry rodded condition.	0.3	70

Notes:

1. SMA mixes shall be designed with 100 gyrations unless the mix aggregates have a LS-603 value greater than 30%, then the SMA mix shall be designed with 75 gyrations.

2. Tested according to AASHTO T 305.

TABLE 7
Superpave Compactive Effort

Ontario Traffic Category (Note 1)	**Number of Gyrations**		
	$N_{initial}$	N_{design}	N_{max}
A	6	50	75
B and C	7	75	115
D	8	100	160
E	9	125	205

Note:

1. The traffic categories are according to Table 1.

TABLE 8
Permitted Field Adjustment to a JMF

JMF Property	**Maximum Field Adjustment** (Note 1)
Percent asphalt cement content, all mixes except SMA	± 0.2
Percent asphalt cement content, SMA only	± 0.4
Percent RAP	–5.0
Percent passing 26.5 mm, 25.0 mm, 19.0 mm, and 16.0 mm sieves	± 5.0
Percent passing 13.2 mm, 12.5 mm, and 9.5 mm sieves	± 4.0
Percent passing 4.75 mm, 2.36 mm, and 1.18 mm sieves	± 3.0
Percent passing 600 μm, 300 μm, and 150 μm sieves	No limits
Percent passing 75 μm sieve, all mixes except SMA	± 1.0
Percent passing 75 μm sieve, SMA only	± 2.0

Note:

1. The maximum field adjustment is applied against the actual JMF property value.

TABLE 9
Minimum Sample Quantities for Mix Design Monitoring

Material	Quantity
Asphalt cement	4 litres evenly split between 2 containers
Aggregate	75 kg of each type
RAP	75 kg required when RAP contained in the mix
Fines material passing 75 □m sieve	5 kg when the mix is to be produced with a plant that returns fines to the mix
Mineral Filler	5 kg sample for SMA
Any other material samples, including anti-stripping agents and fibres, to be used in HMA	Quantity large enough to allow for a complete mix design

TABLE 10
One Point Mix Check Requirements

Material	Quantity
Gradation of component aggregates	For information only
Bulk Relative Density (BRD) of (blended) coarse aggregate and (blended) fine aggregate, and the resulting BRD of the combined aggregate	For information only
Bulk Relative Density and Maximum Relative Density of Mix	For information only
Air voids at N_{design}	±0.5% from submitted mix design
VMA	±1.0% from submitted mix design and not less than contract design minimum
VFA	Within specified mix design range
$\%G_{mm}$ at $N_{initial}$	Not more than contract design maximum
$\%G_{mm}$ at N_{max}	Not more than contract design maximum
Dust Proportion	Within specified mix design range
Tensile Stength Ratio	Not less than 0.8

Appendix 1151-A, Commentary for OPSS.MUNI 1151, April 2018

Note: This appendix does not form part of the standard specification. It is intended to provide information to the designer on the use of this specification in a Contract.

Designer Action/Considerations

The designer should refer to the Superpave and Stone Mastic Asphalt (SMA) hot mix types and typical uses are provided in the following table:

Hot Mix Asphalt Type	Typical Hot Mix Use and Properties
Superpave 4.75	Fine, surface, and levelling mixes similar to the traditional sand mixes for miscellaneous applications.
Superpave 9.5	Fine, surface, padding, and levelling mixes for Traffic Category A and B roads and driveways.
Superpave 12.5	Surface mix for Traffic Category B and C roads. Superpave 12.5 is similar to the traditional HL 3, HL 3 Fine, and HL 4 mixes according to OPSS 1150.
Superpave 12.5 FC1	Surface mix for use on Traffic Category C roads that provides superior rutting resistance and skid resistance through aggregate selection. Superpave 12.5 FC1 is similar to the traditional HL 1 mix according to OPSS 1150.
Superpave 12.5 FC2	Surface mix for use on Traffic Category D and E roads that provides superior rutting resistance and skid resistance through aggregate selection. Superpave 12.5 FC2 is similar to the traditional DFC mix according to OPSS 1150.
Superpave 19.0	Binder course mix for Traffic Category A, B, C, D, and E roads. Superpave 19.0 is similar to the traditional HL 4, HL 8, and HDBC mixes according to OPSS 1150.
Superpave 25.0 and 37.5	Large stone binder course mixes for use when thicker binder lifts are required.
SMA 9.5 and 12.5	Gap-graded premium surface course mix with high frictional resistance, enhanced rutting resistance, water spray reduction, and potential noise reduction for Traffic Category D and E roads. 100% crushed aggregates from the DSM are used for both fine and coarse fraction.
SMA 19.0	Gap-graded premium binder course mix with enhanced rutting resistance for Traffic Category D and E roads. 100% crushed aggregates are used for both fine and coarse fraction.
Note: A. The traffic categories are according to Table 1 of OPSS 1151.	

The designer should specify the following in the Contract Documents:

- Percentage of RAP in excess of 15%. (1151.04.01.01)

- If the designer chooses to use RAP in SMA 12.5 FC1 and 12.5 FC2 mixes it should be specified (1151.04.01.01)

- Supply and use of performance graded asphalt cement. (1151.05.01)

Appendix 1151-A

Coarse graded Superpave mixes generally tend to have lower asphalt cement (AC) contents. To promote adequate compaction in the field and for long-term durability, it is recommended that Superpave mixes be designed below the primary control sieve (PCS), i.e., coarse gradation should be placed with a lift thickness of 3 to 4 times the nominal maximum aggregate size (NMAS). SMA mixes are designed as coarse graded mixes, therefore, SMA should also be placed at 3 to 4 times NMAS.

The designer should specify the minimum suggested lift thickness for each HMA type as provided in the following table:

Asphalt Layer	**Hot Mix Asphalt Type**	**Minimum Suggested Compacted Layer Thickness** (Note 1) **mm**
Surface Course Mixes	Superpave 4.75	25
	Superpave 9.5	30 - 40
	Superpave 12.5, 12.5 FC1, and 12.5 FC2	40 - 50
	SMA 9.5	30 - 40
	SMA 12.5	40 - 50
Base Course Mixes	Superpave 19.0	50 - 80
	Superpave 25.0	60 - 100
	Superpave 37.5	100 - 150
	SMA 19.0	60 - 80

Note:

1. The designer should be aware that the lower minimum value is for finer graded mixes and the upper minimum value is for coarser graded mixes.

Mixes with VMA exceeding the minimum value specified in OPSS 1151, Table 4, by more than 2% may be prone to flushing and rutting. Unless, satisfactory experience with high VMA mixes is available, mixes with VMA greater than 2% above the minimum specified should be avoided.

For SMA mixes, the designer should refer to the appropriate guidelines according to National Asphalt Pavement Association (NAPA), QIS 122, Designing and Constructing SMA Mixes, State-of-the-Practice.

The designer should ensure that the Ontario Provincial Standards General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

None

Appendix 1151-B, Use of over 15% RAP with OPSS.MUNI 1151, April 2018

Note: This is a non-mandatory Additional Information Appendix intended to provide supplementary requirements for the OPS specification in a municipal contract, when the appendix is invoked by the Owner. It is written in mandatory language to permit invoking it by reference in the Contract Documents. If the appendix has not been invoked by reference in the Contract Documents, it does not apply.

Supplemental Requirements for the PGAC for over 15% RAP in Municipal Contracts

For mixes containing more that 15% RAP by Binder Replacement, Table 1 of LS-307 is modified as follows.

Table 1 - PGAC Selection Guidelines for Hot Mix Asphalt Incorporating RAP

Level	RAP Content	**Recommended New PGAC Grade**
I	Equal to or Below 15%	Use the same PGAC grade as for a new mix; based on location (zone) and traffic level.
II	16 to 30%	Reduce both the high and low temperature by one grade (e.g. if a PG 58-28 would normally be used, select a PG 52-34)