Material Specification for Superpave, Stone Mastic and Warm Mix Asphalt

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TS 1151.01 SCOPE

This specification covers the requirements for the materials, equipment and methods to be followed for proportioning and mixing hot mixed, hot laid asphaltic concrete for pavement construction and related uses, according to the Superpave mix design methodology.

TS 1151.02 REFERENCES

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

City of Toronto Standard Specifications

TS 310	Construction Specification for Hot Mixed, Hot Laid Asphaltic Concrete Paving
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

Ontario Provincial Standard Specifications, Construction

OPSS 102	General Specification for Weighing of Materials
OPSS 314	General Specification for Untreated Granular Sub base, Base, Surface Shoulder and Stockpiling

Ontario Provincial Standard Specifications, Material

OPSS 1001	Material Specification for Aggregates – General
OPSS 1103	Material Specification for Emulsified Asphalt
OPSS 1150	Material Specification for Hot Mix Asphalt

Ontario Ministry of Transportation, Designated Sources for Materials List

DSM#3.05.10	Antistripping Additives

Ontario Ministry of Transportation, Laboratory Testing Manual

LS-265	Percent Air Voids in Compacted Dense Bituminous Pavement Mixtures
LS-266	VMA in Compacted Bituminous Mixtures
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-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 Standards

M 320-05	Standard Specification for Performance Graded Asphalt Binder
MP 8-05	Standard Specification for Designing Stone Matrix Asphalt (SMA)
PP 28-03	Practice for Designing Superpave Volumetric Design of HMA
PP 41-02(2004)	Standard Practice for Designing Stone Matrix Asphalt (SMA)
R 35-04	Standard Practice for Superpave Volumetric Design for Hot Mix Asphalt
T 84-00(2004)	Specific Gravity and Absorption of Fine Aggregate
T 85-91(2004)	Specific Gravity and Absorption of Coarse Aggregate

T 166-05	Bulk Specific Gravity of Compacted Asphalt Mixtures Using Saturated Surface-Dry Specimens
T 209-05	Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
T 275-91(2000)	Bulk Specific Gravity of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
T 283-03	Resistance of Compacted Bituminous Mixtures to Moisture Induced Damage
T 304-96(2004)	Uncompacted Void Content of Fine Aggregate
T 305-97(2001)	Determination of Draindown Characteristics in Uncompacted Asphalt Mixtures
T 312-04	Preparing and Determining the Density of Hot Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor

American Society for Testing and Materials

C 612-04	Standard Specification for Mineral Fiber Block and Board Thermal Insulation
D 6752-03	Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method

Asphalt Institute

Superpave Series:

SP-2	Superpave Mix Design Method

National Cooperative Highway Research Program

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

Ontario Hot Mix Producers Association

Environmental Practices Guide

TS 1151.03 DEFINITIONS

For the purpose of this specification, the definitions given in TS 310, TS 1003 and TS 1101, and the following definitions apply:

Advisory Clause means the information provided [Note:] to assist Contractors.

Blending Material means any coarse or fine aggregate added to the aggregates originally selected in order to obtain the physical requirements of a hot mix(es).

Commercial Aggregate Source means a source of aggregate meeting the requirements of TS 1003.

Crushed Material means particles of aggregate having at least two well-defined faces resulting from fracture and meeting the requirements of TS 1003.

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 per axle load.

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 and 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.

Prolonged Storage means the storage of hot mix in storage bins for more than two hours, after batching

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 µm 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 method using the Superpave gyratory compactor.

Voids in the Coarse Aggregate (VCA) means 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 asphalt concrete mixture at a temperature typically 20 to 50 °C lower than conventional hot mix asphalt.

TS 1151.04 DESIGN AND SUBMISSION REQUIREMENTS

TS 1151.04.01 Submissions

Any required submissions shall be in writing. All information and test data forms must be legible. Faxed or e-mail copies are acceptable provided the original is submitted to the Contract Administrator within three Working Days following receipt of the fax or e-mail message.

TS 1151.04.02 Designation of the Mix(es)

TS 1151.04.02.01 *Mix Designs*

TS 1151.04.02.01.01 *General*

At least 15 Working Days prior to the commencement of the asphalt paving work, the Contractor shall notify the Contract Administrator as to:

a) where the stockpiles of the various aggregates, which are representative of the materials to be used in the Work, are available for sampling;

b) the dates upon which the production of the hot mix(es) is to commence;

c) the sources asphalt cement suppliers of the Performance Graded Asphalt Cement (PGAC), if any, and antistripping additives, to be used in the Work; and

d) factors, such as previous experience with the materials and hot mix designs, that will be of assistance to the Contract Administrator in having hot mix designs completed.

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. This specification pertains to the mix types shown in Table 1.

Table 1: 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 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 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 5.

TS 1151.04.02.01.02 *Superpave Mix Design Method*

The Contractor shall use a laboratory that has current CCIL Type A Certification with CCIL Superpave Certified Technician 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 job mix formula's.

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.

Superpave mixes shall be designed using procedures specifying in AASHTO R 35 with the exception that all references to AASHTO T 84 and AASHTO T 85 will be replaced by LS-604 and LS-605 respectively. Reference to AASHTO T 304 will be replaced by LS-629. The density of each coarse and fine aggregate of any single-sized chip fraction if warranted, shall be determined using the procedures in this LS test methods. However, the mix design shall also include the determination of the density of the blended coarse and blended fine aggregate.

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.

TS 1151.04.02.01.03 *Stone Mastic Asphalt Mix Design Method*

SMA mixes shall be designed in accordance with AASHTO MP 8 and AASHTO PP 41.

TS 1151.04.02.01.04 *Warm Mix Asphalt Mix Design Method*

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.

TS 1151.04.02.02 *Mix Design Submission*

The proposed mix design and Job Mix Formula (JMF) shall be submitted in writing to the Contract Administrator a minimum of 10 Working 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 15 Working Days, which commence when all of the required samples and documents have been submitted.

TS 1151.04.02.03 *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 one Working 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 2.

Table 2: Permitted field adjustment to a JMF

JMF property	Maximum field adjustment[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, 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.

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 Working Days, which commence when all of the required samples and documents have been submitted.

TS 1151.04.02.04 *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 AASHTO PP 28. 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 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 AASHTO T 283, with specimens prepared according to AASHTO T 312.

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 per cent by volume as described in AASHTO T 166, then the bulk specific gravity is according to AASHTO T 275, LS-306, or ASTM D 6752.

o) Theoretical maximum specific gravity by AASHTO T 209.

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 ± 5 mm.

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

TS 1151.04.02.05 *Documents – Warm Mix Asphalt*

A minimum of 10 Working Days prior to paving with WMA, the following information shall be submitted to the Contract Administrator in writing, in addition to the document submission requirements given in clause TS 1151.04.02.04 :

a) The name of the WMA technology selected for use on the Contract.

b) The complete name and address of the WMA technology supplier, if applicable.

c) Details on how the requirements of this specification shall be met.

d) If applicable, the type and dosage of WMA additives, how the additives are to be incorporated to produce the WMA technology and supplier's established recommendations for usage.

TS 1151.04.02.06 *Anti-Stripping Additive*

The Contractor shall determine the need for and the amount of anti-stripping additive required using AASHTO T 283.

The need for and the amount of anti-stripping additive 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 anti-stripping additive either specified in the Contract Documents or determined through mix design procedure shall be a percentage of the total asphalt cement required.

The amount of anti-stripping additive required shall be as follows:

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

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

c) Minimum dosage requirements specified in the Contract Documents.

Whenever an anti-stripping additive is required, the following applies:

a) For all Superpave 12.5 FC2 and SMA mixes, or other mixes consisting of more than 75 per cent dolomitic sandstone or meta-arkose aggregates, the anti-stripping additive shall be hydrated lime (Ca(OH)2) with a minimum dosage requirement of 1% by mass of the total dry aggregate.

b) For all other aggregates, the anti-stripping additive may be hydrated lime or a chemical agent.

c) When hydrated lime is used, the aggregates shall be treated with hydrated lime slurry within the same construction season during which it will be used.

Anti-stripping additive shall be used according to supplier information. The following information on the hydrated lime anti-stripping additive shall be provided to the Contract Administrator:

a) Documentation that the hot mix shall be produced in accordance to 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 the hydrated lime is to be used and how the hydrated lime is to be incorporated into the mix.

TS 1151.04.02.07 *Plant Produced Trial Batches*

The Contractor shall make pre-asphalt paving plant trial batches, after the submitted mix design has been reviewed and approved by the Contract Administrator, from which hot mix samples will be tested by the Contract Administrator to ensure that each plant produced hot mix type meets the requirements as specified in the Contract Documents. Each trial batch shall be representative of consistent hot mix production and shall be a minimum of two pugmill batches of the size that will be used during hot mix production for batch plants, or a minimum of five tonnes for drum mixing plants. The remainder of the trial batches shall be disposed of by the Contractor. Such trial batches shall be produced until a complete laboratory mix compliance check indicates conformance with the design mix proportions and properties for each hot mix type to be used. Compliance checks will include Tensile Strength Ration (TSR) testing as per AASHTO T 283 for those mix types incorporating an antistripping additive. Up to two trial batches for each hot mix type will be paid for as shown in the Pricing Form. Should more than two trial batches be required for any hot mix type, the Contractor shall bear both the cost of the trial batches and laboratory mix compliance checks for such additional batches.

If the Contractor elects to use more than two hot mix plants for the production of a hot mix type, the Contractor shall bear the cost of all the trial batches and all the laboratory mix compliance checks for such additional plant(s). Contractors should note that only materials from the same sources may be used in a hot mix type produced in more than one plant.

All mix sampling and testing for the Contract shall be done by qualified technicians in an asphalt laboratory(ies) with Canadian Council of Independent Laboratories (CCIL) Type A Certification.

TS 1151.05 MATERIALS

TS 1151.05.01 Supply of Materials

Prior to starting the work, the Contractor shall supply the Contract Administrator with material safety data sheets (MSDS) for all materials to be incorporated in the Work.

TS 1151.05.02 Grade of PGAC

Each grade of performance graded asphalt cement (PGAC) required for the Contract shall be according to TS 1101.

TS 1151.05.03 Aggregates

All aggregates required for the Contract hot mix types shall be according to TS 1003.

TS 1151.05.04 Reclaimed Asphalt Pavement

RAP, when permitted in a Superpave HMA, shall be according to the aggregate requirements of OPSS.MUNI 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.

TS 1151.05.05 Blending Materials

If required, blending material(s) shall be used in order that the hot mix(es) meet(s) the physical requirements of this specification. The blending material(s) shall according to TS 1003. All costs associated with the use of blending material(s) will be deemed to be included in the unit price(s) for hot mix in the Pricing Form.

TS 1151.05.06 Fillers and Additives

The filler incorporated in SMA shall be limestone dust (mineral filler) or dolomitic limestone dust (mineral filler) according to AASHTO MP8.

The fibre incorporated in SMA shall be cellulose fibre or mineral fibre according to AASHTO MP8.

When and where specified in the Contract, filler and/or additive requirements for other hot mix types shall be given by a special provision.

TS 1151.05.07 Silicones

Silicone oil, if added to the PGAC, shall not be used with a concentration of more than three parts per million parts of PGAC, and only with the written approval of the asphalt cement supplier(s). The use of silicone oil in a hot mix(es) shall be noted on the weigh ticket for the hot mix.

TS 1151.05.08 Fibres

Cellulose or mineral fibres shall be used as a stabilizing additive in dosage rates of 0.3 per cent or 0.5 per cent by mass of the total mix respectively. Cellulose and mineral fibres shall meet the properties shown in Tables 3 and 4 respectively.

Table 3: Physical requirements for cellulose fibres according to AASHTO MP 8

Property	Requirement
Sieve Analysis, Method A or B:	
Method A, Alpine Sieve Analysis (Note 1)	
Fibre Length	6 mm maximum
Passing 0.150 mm sieve	70% ± 10%
Method B, Mesh Screen Analysis (Note 2)	
Fibre Length	6 mm maximum
Passing 0.850 mm sieve	85% ± 10%
0.425 mm sieve	65% ± 10%
0.106 mm sieve	30% ± 10%
Ash Content (Note 3)	18% ± 5% non-volatiles
pH (Note 4)	7.5 ± 1.0
Oil Absorption (Note 5)	5 ± 1.0, times fibre mass
Moisture Content (Note 6)	Less than 5% by mass

Note 1: Method A, Alpine Sieve Analysis – This test is performed using an Alpine Air Jet Sieve, Type 200 LS. A representative 5 gram sample of fibre is sieved for 14 minutes at a controlled vacuum of 75 kPa of water. The portion remaining on the screen is weighed.

Note 2: Method B, Mesh Screen Analysis – This test is performed using standard 0.850, 0.425, 0.250, 0.180, 0.150, and 0.106 mm sieves, nylon brushes, and shaker. A representative 10-gram sample of fibre is sieved, using a shaker and two nylon brushes on each screen. The amount retained on each sieve is weighed and the percentage passing calculated.

Note 3: Ash Content – A representative 2-3 gram sample of fibre is placed in a tared crucible and heated between 595 and 650 °C for not less than 2 hours. The crucible and ash are cooled in a desiccator and reweighed.

Note 4: pH Test – 5 grams of fibre is added to 100 ml of distilled water, stirred and let sit for 30 minutes. The pH is determined with a probe calibrated with pH buffer of 7.0.

Note 5: Absorption Test – 5 grams of fibre is accurately weighed and suspended in an excess of mineral spirits for not less than 5 minutes to ensure total saturation. It is then placed in a screen mesh strainer with an approximately 0.5 mm2 opening size and shaken on a wrist action shaker for 10 minutes, approximately 32 mm motion at 240 shakes per minute. The shaken mass is then transferred without touching to a tared container and weighed. Results are reported as the amount the fibres are able to absorb, i.e., the number of times its own weight.

Note 6: Moisture Content – 10 grams of fibre are weighed and placed in a 121 °C forced air oven for two hours. The sample is then reweighed upon removal from the oven.

Table 4: Mineral fibre quality requirement according to AASHTO MP 8

Property	Requirement
Sieve Analysis	
Fibre Length (Note 1)	6 mm maximum mean test value
Thickness (Note 2)	0.005 mm maximum mean test value
Shot Content (Note 3)	
Passing 0.250 mm sieve	90% ± 5%
Passing 0.063 mm sieve	70% ± 10%

Note 1: The fibre length is determined according to the Bauer McNett fractionation of AASHTO MP 8.

Note 2: The fibre thickness is determined by measuring at least 200 fibres in a phase contrast microscope.

Note 3: Shot content is a measure of non-fibrous material. The shot content is determined on vibrating sieves. Two sieves, 0.250 mm and 0.063 mm are typically used. For additional information see ASTM C 612.

TS 1151.05.09 Composition and Properties of Hot Mix Types

TS 1151.05.09.01 *General*

The hot mix shall be of uniform consistency and consist of coarse and fine aggregates, as required for the hot mix type, mixed with PGAC.

All testing of hot mix shall be in accordance with current MTO procedures. The design Traffic Categories for the asphalt mixes are given in Table 5.

Table 5: Superpave and SMA design traffic category by ESALs

Traffic category	20 year design ESAL's	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 roads.
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.

TS 1151.05.09.02 *RAP Proportions*

The use of RAP is allowed, as follows:

a) Up to 30% by mass of RAP is permitted for Superpave 19 and 25 binder mixes.

b) When 31% to 50% by mass of RAP is proposed for Superpave 19 and 25 binder mixes, written approval by the Contract Administrator must be obtained for the mix design, including PGAC modification.

c) Over 50% by mass of RAP is not permitted for any mix.

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

TS 1151.05.09.03 *Gradation, PGAC Content Requirements for Hot Mix Types*

The aggregates shall be combined in such proportions as to produce a hot mix conforming with the gradation requirements given in Table 6 and Table 7.

Table 6: 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 7: Superpave gradation primary control sieve (PCS) points

Mix type	Primary control sieve (mm)	PCS control point at % passing
SP 9.5	2.36	47
SP 12.5, SP 12.5 FC1, SP 12.5 FC2	2.36	39
SP 19.0	4.75	47
SP 25.0	4.75	40

The PGAC content for the hot mix asphalt shall be as per the requirements in Table 8.

Table 8: Minimum PGAC content for Superpave

Mix type	PGAC content for bid purposes	Minimum PGAC content for mix design
SP 9.5	5.7	5.6
SP 12.5, SP 12.5 FC1, SP 12.5 FC2	5.2	5.1
SP 19.0	4.9	4.8
SP 25.0	4.7	4.6

TS 1151.05.09.04 *Physical Requirements for Hot Mix Types*

The Superpave hot mix shall be according to the physical requirements given in Table 9 when designed using the compactive effort specified in Table 10. The SMA hot mix shall be according to the physical requirements given in Table 11.

Table 9: 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								65-78	
C	≤89.0								65-75 (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 4, 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 75% to 78%.
Superpave 9.5 mixes shall have a VFA range of 73% to 76%.

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 10: Superpave compactive effort

Ontario Traffic Category	Number of gyrations		
	N_{inital}	N_{design}	N_{max}
A	6	50	75
B and C	7	75	115
D	8	100	160
E	9	125	205

Note: The traffic category are according to Table 5.

Table 11: SMA HMA 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.

TS 1151.05.10 Additional Design Considerations for Warm Mix Asphalt

The materials used in the production of WMA shall be according to requirements for Superpave and SMA mixes included in this specification.

The Contractor shall be responsible for the following:

a) Identifying and using a plant and equipment capable of producing the WMA according to the WMA technology supplier`s instructions for the use of its WMA technology.

b) Obtaining from the WMA technology supplier all the information required for the proper design, preparation, handling, storage, and use of the WMA materials, including Material Safety Data Sheets.

c) Obtaining materials; producing mixes; and the transportation, storage, and use of all materials.

d) Ensuring that the WMA is produced according to the WMA technology supplier's recommendations to prevent any deleterious effects to the finished product.

e) Using an anti-stripping additive recommended by the WMA technology supplier when an anti-stripping additive is to be incorporated into the WMA.

The WMA shall be produced within the temperature range recommended by the WMA technology supplier to achieve target compaction in the field and to meet the requirements specified in the Contract Documents.

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 (September 2017), 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 95 "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 R35-15).

TS 1151.06 EQUIPMENT

TS 1151.06.01 General Inspection Requirements

All equipment shall be available for inspection, testing and approval before operations commence.

The Contract Administrator shall have access, at all working times, to any or all parts of the equipment, for all purposes pertaining to the Contract.

Note: Contractors should note the importance of adopting and following the OHMPA Environmental Practices Guide.

TS 1151.06.02 Requirements for all Hot Mix Plants

TS 1151.06.02.01 *Inspection Requirements*

Stairways to the mixer platform and to the PGAC storage tank inspection openings, and ladders to other plant units, shall be placed at all points required for accessibility to all plant operations. Ample and unobstructed space shall be provided on the mixing platform. A platform shall be provided in the vicinity of the plant to permit inspection and sampling of the hot mix before delivery of the load.

TS 1151.06.02.02 *Equipment for Preparation*

Tanks for storage of PGAC shall be capable of heating the PGAC under effective and positive control at all times and maintaining it in a temperature range between 120°C and 165°C. The actual working temperature shall not vary by more than ± 5°C when the amount of PGAC added to the mix is measured volumetrically.

A circulating system of adequate size shall be provided for the PGAC ensure proper and continuous circulation between working tank and mixer during the entire operating period. A sampling valve shall be included between the working tank and the mixer. There shall be a separate tank and recirculating line for each grade of PGAC to be used in the work. Each tank shall have a calibrated dipstick to show the quantity of PGAC remaining in it by reading from the inspection opening cover down.

Note: Contractors should note that the presence of residual PGAC of a different source, grade or type can cause significant problems with the quality and testing of PGAC.

TS 1151.06.02.03 *Cold Feed System*

Bin dimensions shall be such as to provide a free flow of aggregates at all times. An individual cold feed bin shall be provided for each size, type or gradation of aggregate. Each bin shall be equipped with individual gate controls so as to provide accurate and positive proportioning. Partitions of sufficient height to eliminate intermingling of the aggregate shall be provided between adjoining bins. If the cold feed bins are being fed with a front-end loader, the width of each bin must be at least 0.5 m wider than the width of the loader bucket.

Vibratory pan feeders will not be acceptable for proportioning fine aggregates. A variable speed control will be permitted only if properly designed to give total and proportional control of the cold feed system.

TS 1151.06.02.04 *Drier*

A rotary drier, of sufficient capacity to heat the aggregate to the required temperature, shall be provided for drying and heating the aggregate.

TS 1151.06.02.05 *Control Unit*

Satisfactory means shall be provided to incorporate the required quantity of PGAC into the mix. All measuring devices shall be sensitive to a 0.5 per cent variation above or below the actual mass required.

TS 1151.06.02.06 *Thermometric Equipment*

Each PGAC storage tank shall be equipped with a thermometer set just above the discharge pipe. The indicator dial, graduated from 100 to 200°C in 2°C increments, shall be mounted where it is clearly visible.

The plant shall be further equipped with a thermometric instrument so placed at the discharge chute of the drier as to register the temperature of the hot aggregate, except for drum mixers where the temperature of the hot mix shall be registered. The indicator dial of this measuring device shall be clearly visible to the plant operator at all times.

TS 1151.06.02.07 *Dust Collector*

All plants shall be equipped with a primary, dry dust collection system and a wet or dry secondary dust collection system meeting current Ontario Ministry of the Environment and Climate Change (MOECC) requirements.

Normally, all dust collected shall be uniformly returned to the mix, except that dust collected in a secondary wet scrubber system shall be wasted. With the permission of the Contract Administrator, a portion of the dry dust can be wasted from the dust collection system, provided that the remainder shall be uniformly returned to the mix.

TS 1151.06.02.08 *Hot Mix Storage Bins*

If the Contractor elects to use a hot mix storage bin (silo), it shall be designed, constructed and operated so that there shall be no segregation of, or damage—hardening of PGAC—to, the hot mix.

Prolonged storage, up to 20 hours, of hot mix in a storage bin (silo) is permitted, subject to the Contractor providing the Contract Administrator with a written certificate, with supporting technical data from the silo manufacturer and/or an asphalt laboratory with Canadian Council of Independent Laboratories (CCIL) Type A Certification, stating that the silo which is to be used is suitable for the intended purpose and will not damage the hot mix.

Regardless, prolonged storage of more than two hours for Superpave 12.5 FC2 SMA is not permitted.

TS 1151.06.02.09 *Moisture Content of Hot Mix*

The moisture content of the hot mix, as discharged from the hot mix plant, shall be less than 0.2 per cent. The moisture content of the hot mix shall be determined according to MTO LS-282 or LS-292.

TS 1151.06.02.10 *Filler and Fibre Addition*

For SMA production, the hot mix plant shall be suitably equipped for the uniform, mechanical addition of filler and fibre, in the correct proportions.

Note: Contractors should note that practical experience indicates that satisfactory SMA production requires consistent and accurate introduction of the filler and fibre during SMA production.

TS 1151.06.02.11 *Acceptance and Uniformity*

The hot mix plant shall be designed, operated and coordinated so as to provide, as nearly as possible, continuous plant operation.

The Contract Administrator may discontinue the use of a hot mix plant(s) during the progress of the Work if the hot mix type is not produced uniformly and according to this specification. When the Contract Administrator discontinues the use of a hot mix plant(s), production will not be acceptable for City work until corrective measures, demonstrated satisfactorily to the Contract Administrator, are carried out at the Contractor's cost and location.

TS 1151.06.03 Special Requirements for Batch Plants

TS 1151.06.03.01 *Screens*

Screens capable of screening all aggregates to the sizes required for proportioning each type of hot mix, and having capacities in excess of the hourly capacity of the mixer, shall be provided. Screens shall have square openings and shall be kept clean.

TS 1151.06.03.02 *Aggregate Storage Bins*

All plants shall have a combined hot aggregate storage bin capacity of not less than nine times the capacity of the mixer.

The plant shall contain a minimum of three hot aggregate storage bins arranged to ensure separate and adequate storage of appropriate fractions of the aggregate. Each bin shall be equipped with an overflow chute to prevent any backing up of the aggregate into other bins. An oversize chute shall also be provided to prevent oversize aggregate from becoming incorporated into the mix.

Each bin shall be provided with a suitable device for obtaining test samples.

TS 1151.06.03.03 *Weigh Hopper*

The plant shall include a means for accurately weighing each bin size of aggregate in a weigh hopper suspended on scales and ample in size to hold a full batch without running over.

TS 1151.06.03.04 *Plant Scales*

Plant scales for weighing aggregates and PGAC shall be of a standard make and design. Scales for weighing aggregates shall be accurate and sensitive to 0.5 per cent of the maximum load required, and shall have a positive means of balancing the tare mass of the hopper and asphalt bucket. The Contractor shall at least annually, at the Contractor's expense, verify the accuracy of the scales.

TS 1151.06.03.05 *Mixer Unit*

The plant shall include a batch mixer of an approved twin shaft pugmill type that shall be capable of producing a uniform mix within the tolerances required. The clearance of the blades from the inner surfaces of the pugmill liners shall not exceed 20 mm. The mixer shall be constructed to prevent leakage of the contents. The mixer shall be fitted with separate dry and wet mixing cycle timers and locking devices so that PGAC cannot be discharged, and the pugmill gate cannot be opened, until the desired mixing times have elapsed.

TS 1151.06.04 Special Requirements for Drum Mixing Plants

TS 1151.06.04.01 *Aggregate Feed System*

A positive interlocked automatic shutoff shall be provided so that the plant shuts down automatically after a 15 second delay if there is any disruption in the flow of aggregate from any cold feed bin.

A vibrating screen of adequate capacity shall be provided to remove oversize aggregate and any deleterious materials from the combined cold feed.

TS 1151.06.04.02 *Control Unit*

A flow switch shall be installed in the delivery system that will automatically stop the plant if an interruption occurs in the PGAC.

A PGAC metering system shall be provided that will deliver the desired mass of PGAC to the mixer regardless of variations in material temperature or specific gravity.

TS 1151.06.04.03 *Calibration*

The plant should be equipped with a suitable device to permit the flow of aggregates to be completely and safely diverted into a suitable hopper or directly into a bucket of a front end loader from which samples can be obtained for gradation testing. The PGAC feed system shall be equipped with a calibration system that will enable the PGAC to be bypassed into a container that can be weighed. Adequate scales for this purpose shall be provided by the Contractor.

The belt scale on the cold feed conveyor shall be calibrated to the scale manufacturer's tolerance at the start of the Work.

The plant shall not be operated outside the production range within which the belt scale manufacturer guarantees the accuracy of the scale.

TS 1151.06.04.04 *Mix Discharge Control*

The moisture content of the mix, as discharged from the drum, shall be according to clause TS 1151.06.02.09, herein.

The temperature of the mix, as discharged from the drum, shall be continuously recorded.

The system used to transfer the mix from the drum mixer to the hot mix storage bin or trucks or both shall be designed, constructed and operated so that there shall be no segregation of, or damage—hardening of PGAC—to, the mix.

A system for wasting unacceptable mix shall be provided between the drum mixer discharge and hot mix storage bin or trucks or both.

TS 1151.07 PRODUCTION

TS 1151.07.01 Preparation of the Hot Mix

TS 1151.07.01.01 *Aggregate Stockpile Requirements*

Before any production of a hot mix type is started, stockpiles of each size and gradation of aggregate involved shall be provided at the asphalt plant site, each sufficient for two full days' production, or the total amount, of the hot mix type involved, whichever is the lesser. After asphalt paving operations have commenced, there shall be sufficient aggregates in stockpiles before each day's asphalt paving begins for all of that day's production. The stockpiles shall be free draining and developed so as to prevent the mixing of the various aggregates.

TS 1151.07.01.02 *Handling, Feeding and Drying of Aggregates*

Feeding of material directly from any aggregate processing plant to the hot mix plant cold storage bins shall not be permitted. Aggregates shall be loaded into the cold feed bins so as to prevent the mixing of separated sizes of aggregates. Mixing of aggregates by clam, or loading of more than one type of material into a single bin, shall not be permitted. The feeding of the aggregate from the stockpile to the cold feed bin by means of a dragline shall not be permitted.

For batch plants, the aggregates shall be dried and heated in the drier and separated by screening into hot storage bins. When fed to the plant mixer, aggregates shall be at a temperature consistent with proper mixing and placing.

Surfaces of dried aggregate shall be free of carbon or unburnt fuel oil. The aggregate shall be sufficiently dried as evidenced by the lack of noticeable steaming, slumping, bubbling, or foaming of the hot mix, and the absence of any visible free water on the tailgate of truck boxes. Regardless, the hot mix shall meet the maximum allowable moisture content requirement of TS 1151.06.02.09, herein.

TS 1151.07.01.03 *Proportioning, Mixing and Temperature*

TS 1151.07.01.03.01 *General*

The proportioning and mixing of aggregates and PGAC shall be of a sufficient accuracy and time to produce a uniform homogeneous mix in which all aggregate particles are thoroughly and uniformly coated.

The temperature of the mix as discharged from the hot mix plant shall be controlled to ensure that the hot mix is not overheated and will meet the compaction temperature requirement at the paver screed based on the PGAC viscosity temperature relationship and/or asphalt cement supplier's recommendations.

A mix which does not comply with this specification or as specified in the Contract Documents, and a mix which cannot be incorporated in the work according to this specification or as specified in the Contract Documents shall be rejected.

TS 1151.07.01.03.02 *Requirements for SMA Mixes*

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.

TS 1151.08 QUALITY ASSURANCE

TS 1151.08.01 General

The Contractor is responsible for obtaining QA, QC and referee HMA samples using sample plates and other methods approved by the Contract Administrator for the plant produced Superpave and SMA mixes. Samples shall be taken in accordance with the Contract Documents under the direction and in the presence of the Contract Administrator. Samples shall be placed in an appropriate container supplied by the Contractor. The Contract Administrator may apply security seals to the samples prior to transportation. All QA samples shall be delivered within 4 hours of sampling to the location specified in the Contract Documents.

All QA testing shall be completed in a certified laboratory that is CCIL Type B and C, or AMRL accredited, or equivalent.

When WMA mix is used and the selected WMA technology requires that additives be added to the asphalt cement, acceptance of the asphalt cement shall be based on the samples that contain the WMA additive. Acceptance of WMA emulsion shall be based on testing the asphalt cement residue obtained from the WMA emulsion.

TS 1151.08.02 Aggregate Gradation Requirements

Gradation, and PGAC content test results for hot mix samples, tested by the Contract Administrator or their designated laboratory (MTO LS-282 or LS-292), shall meet the job-mix formula tolerance requirements given in Table 12. The Designated Large Sieve (DLS) for each mix type is given in Table 13.

Table 12: Tolerances on the full job-mix formula aggregate gradation and PGAC content

Mix Type	Attribute	Tolerances on the Job-Mix Formula		
		Acceptable	Borderline	Rejectable
SMA 9.5, SMA 12.5, SP 9.5 and SP 12.5	DLS, 4.75 mm sieve size	< 5.0	5.0 to 7.5	> 7.5
	0.600 mm sieve size	< 3.5	3.5 to 5.0	> 5.0
	0.075 mm sieve size	< 2.0	2.0 to 3.0	> 3.0
SMA 19.0, SP 19.0 and SP 25.0	DLS, 4.75 mm sieve size	< 7.0	7.0 to 10.0	> 10.0
	0.600 mm sieve size	< 4.5	4.5 to 6.0	> 6.0
	0.075 mm sieve size	< 2.0	2.0 to 3.0	> 3.0
All Mixes	PGAC Content	< 0.3	---	≥ 0.3

Table 13: Designated large sieve for mix types

Mix type	Designated large sieve (mm)
SMA 9.5, SP 9.5	4.75
SMA 12.5, SP 12.5, SP 12.5 FC1, SP 12.5 FC2	9.5
SMA 19.0, SP 19.0	12.5
SP 25.0	19.0

TS 1151.08.03 PGAC Content and Aggregate Gradation, Acceptance/Rejection

If the hot mix is borderline for gradation (Table 11), the Contractor shall be warned by the Contract Administrator, and shall take immediate corrective action through process control at the hot mix plant. Contractors should note that a significant change in aggregate(s) gradation or properties may require a job-mix formula modification, which shall be provided to the Contract Administrator in writing for review and approval.

If the hot mix is rejectable for PGAC content or gradation the mix represented by the test shall be removed and replaced by the Contractor with acceptable hot mix of the same type and compacted to the satisfaction of the Contract Administrator, at no extra cost to the City.

In the case of a dispute between the QA and QC testing results, the Contractor may request, in writing with technical reasons, to have the referee sample tested at a mutually agreed upon third party laboratory. If the referee testing results are in agreement with the QA testing results, the referee testing will be considered to have been carried out at the cost of the Contractor.

TS 1151.08.04 Physical Properties Requirements

TS 1151.08.04.01 *General*

Superpave mix properties test results for hot mix samples, completed by the Contract Administrator (based on AASHTO M323), shall meet the requirements of Table 8. SMA mix properties test results for hot mix samples, completed by the Contract Administrator, shall meet the requirements of Table 10.

Hot mix samples, incorporating an antistripping additive, shall have a Tensile Strength ration (TSR) of 80 per cent, as determined by AASHTO T 283.

TS 1151.08.04.02 *Acceptance/Rejection*

If the Superpave physical properties do not meet the requirements of Table 8 and SMA physical properties do not meet the requirements of Table 10, but the air voids are borderline as per Table 13, the Contractor shall be warned by the Contract Administrator, and shall take immediate corrective action.

If the air voids are rejectable as per Table 14, the mix represented by the test shall be removed and replaced by the Contractor with acceptable hot mix of the same type and compacted to the satisfaction of the Contract Administrator, at no extra cost to the City. Disputes will be handled according to subsection TS 1151.08.03, herein.

Table 14: Air void criteria for plant produced hot mix asphalt types

Mix type	Acceptable %	Borderline %	Rejectable %
Superpave Mixes	2.5 to 4.5	2.0 to 2.4 and 4.6 to 5.0	< 2.0 and > 5.0
SMA Mixes	3.0 to 5.0	2.0 to 2.9 and 5.1 to 6.0	< 2.0 and > 6.0

TS 1151.08.05 Overheating of Hot Mix

The Contract Administrator will monitor the hot mix plant operations and hot mix temperatures to check for any potential overheating of the hot mix that may harden the PGAC. The Contract Administrator may use AASHTO PP6 bending beam rheometer testing of recovered PGAC to assist in this monitoring procedure. The Contractor shall immediately correct any overheating of hot mix when notified by the Contract Administrator.

TS 1151.09 OWNER PURCHASE OF MATERIAL – Not Used