



MATERIAL SPECIFICATION FOR SUPERPAVE AND STONE MASTIC ASPHALT MIXTURES

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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 (WMA), recycled mixes, and mixes for miscellaneous work according to the Superpave and stone mastic asphalt (SMA) mix design methodology.

1151.02 REFERENCES

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

Ontario Provincial Standard Specifications, Construction

OPSS 313 Hot Mix Asphalt - End Result

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-284	Recovery of Asphalt from Solution by Rotary Evaporator
LS-292	Quantitative Determination of Asphalt Cement Content by Ignition and Analysis of Remaining Aggregate from Bituminous Paving Mixtures
LS-309	Superpave Mix Design
LS-311	Stone Mastic Asphalt Mix Design
LS-316	Practice for Mix Check
LS-318	Practice for Warm Mix Asphalt (WMA) Mix Design
LS-321	Method for Calculation of Asphalt Film Thickness
LS-602	Sieve Analysis of Aggregates
LS-603	Resistance to Degradation of Coarse Aggregate by Abrasion and Impact in the Los Angeles Abrasion Machine

MTO Forms:

PH-CC-251	Method to Calculate Asphalt Film Thickness
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American Association of State Highway and Transportation Officials (AASHTO)

M 325-08	Standard Specification for Designing Stone Matrix Asphalt (SMA)
T 305-14	Determination of Draindown Characteristics in Uncompacted Asphalt Mixtures

National Asphalt Pavement Association (NAPA)

QIS 122	Designing and Constructing SMA Mixtures — State-of-the-Practice
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1151.03 DEFINITIONS

For the purpose of this specification, the definitions in OPSS 313, OPSS 1101, and 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 Anti-Stripping Treatment (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 Anti-Stripping Treatment (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 Replacement means the asphalt cement from the RAP contributing to the total asphalt cement content in the mix, expressed as a percentage.

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.

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

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

Nominal Maximum Aggregate Size means one sieve size larger than the first sieve to retain more than 10% by mass.

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

Roof Shingle Tabs (RST) means ground roof shingle scrap generated when new shingles are trimmed during production

1151.04 DESIGN AND SUBMISSION REQUIREMENTS

1151.04.01 Design Requirements

1151.04.01.01 General

A laboratory that has current CCIL Type A certification, AMRL, or AMRL equivalent certification shall be used to conduct all mix designs and mix checks.

Superpave mixes shall be designed using the procedures specified in LS-309, with the exception of WMA mixes. WMA mixes shall be designed using the procedures specified in LS-318 at the anticipated WMA production temperature. In the mix design procedure, all references to reclaimed asphalt pavement (RAP) content shall be deleted and replaced with % binder replacement.

Superpave materials, mix designs, and the JMF shall be according to the requirements specified in Tables 1, 2, and 3 for the HMA mix type specified in the Contract Documents.

The use of roof shingle tabs (RST) is not permitted in the HMA.

SMA mixes shall be designed using the procedures specified in LS-311. The SMA materials, mix designs, and the JMF shall be according to the requirements specified in Tables 1, 4, and 5 for the SMA mix type specified in the Contract Documents. Cellulose or mineral fibres shall be used as a stabilizing additive in dosage rates of 0.3% or 0.4%, respectively, by mass of the total mixture. Regardless of the type of fibre used, the manufacturer's recommendations for any product used shall be followed.

The composition of the HMA may be modified as permitted in Table 6.

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

$$\% \text{ binder replacement} = \frac{[(\% \text{ asphalt cement content of RAP} \times \% \text{ RAP by mass of mix}) / (\% \text{ total asphalt cement content of mix})]}{1}$$

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

Density testing of aggregates and RAP shall be conducted for the purpose of developing the mix design for each mix type in the Contract. Such testing shall be performed during production of each aggregate, RAP, or during stockpiling of the materials at the HMA plant.

In addition, if the composition of the mix is modified by including RAP, the high and low grade of performance graded asphalt cement (PGAC) required shall be lowered by 6 °C when:

% Binder Replacement > 20 %

The JMF selected for use shall produce HMA that meets all the requirements as specified in the Contract Documents.

1151.04.01.02 Changes to the Job-Mix Formula and the Mix Design

Changes to the JMF shall be permitted subject to the conditions as specified in the Contract Documents.

A new mix design shall be completed according to the Mix Design clause, when:

- a) A material is eliminated.
- b) A new material is added.
- c) A material source is changed.
- d) The net impact of all adjustments to the original JMF exceeds any of the maximum field adjustments as specified in the Contract Documents.
- e) The allowable time period has been exceeded and the use of the mix design has not been extended.

1151.04.01.03 Anti-Stripping Treatments

1151.04.01.03.01 General

The AST shall treat the mix components at the greater of the dosages specified in the Aggregate Anti-Stripping Treatment clause, the Asphalt Cement Anti-Stripping Treatment clause, or as specified in the Contract Documents.

1151.04.01.03.02 Moisture Sensitivity

Moisture sensitivity shall meet the tensile strength ratio requirements specified in Tables 3 and 4.

1151.04.01.03.03 Aggregate Anti-Stripping Treatment

1151.04.01.03.03.01 General

Irrespective of any moisture sensitivity testing that shows that AST-AGG is not required, hydrated lime or an approved AST-AGG from the ministry's DSM 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 ministry's DSM shall be the minimum used for all aggregates to be incorporated into SMA and Superpave 12.5FC 2.

1151.04.01.03.03.02 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) one percent by mass of total dry aggregate, or
- c) the listed dosage from the ministry's DSM.

1151.04.01.03.03.03 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 ministry's DSM.

1151.04.01.03.04 Asphalt Cement Anti-Stripping Treatment

When AST-AGG is not required in the mix, AST shall be used in the mix if:

- a) Mix moisture sensitivity testing indicates an AST is required; or
- b) the Contract Documents note that an AST is required.

The amount of AST to be used in the mix shall be the greater of:

- a) The amount required to meet the moisture sensitivity requirements; or
- b) the listed minimum dosage from the ministry's DSM.

1151.04.02 Submission Requirements

1151.04.02.01 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 that the mix exceeds 75% if the percentage of the mix comprising quartzite and dolomitic sandstone aggregates, or combinations thereof, is more than 75%. The Hamburg test results shall be submitted with the mix design, or up to 30 Days after submission of the original WMA mix design.

The % Binder Replacement shall be calculated and submitted with the mix design.

For SMA mix, the technical data sheet for the supplied fibres shall be submitted with the mix design.

The asphalt film thickness (T_F) shall be calculated according to LS-321 and submitted on form PH-CC-251 along with the mix design. The calculated asphalt film thickness shall be shown on the mix design summary sheet.

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 7, 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 7.

The mix shall not be placed until the Contract Administrator gives written confirmation that the submitted mix design documents and JMF meet the Contract requirements. Within four 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.

1151.04.02.02 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 as specified in the Contract Documents. The materials shall be delivered within two Days of the request made by the Contract Administrator or within two 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 two 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 8.

1151.04.02.03 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.
- 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.

1151.05.02 Aggregates

Aggregates shall be according to OPSS 1003.

1151.05.02.01 Reclaimed Asphalt Pavement

The aggregate contained in the RAP, where permitted in an HMA, shall be according to the aggregate requirements of OPSS 1003 for the mix type as specified in the Contract Documents.

Any RAP that is contaminated with deleterious material shall not be used and shall be removed from the work. The RAP shall be stockpiled conforming to the stockpiling requirements for coarse aggregates according to OPSS 1001, except that when the material is stockpiled on a compacted granular pad, the top 75 mm of the pad shall be the coarse aggregate that is required for a new (virgin) mixture of the tendered hot mix item.

The use of RAP that is obtained from existing stockpiles that do not have a foundation conforming to the above paragraph shall be permitted provided that the bottom 0.3 m of the stockpile is not incorporated into the work.

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

1151.05.03 Silicone

Silicone oil, when added to the asphalt cement, 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, such as those detailed in QIS 122. The use of rock wool, asbestos, fiberglass, and fibres contained in RST, is prohibited.

1151.07 PRODUCTION

1151.07.01 Anti-Stripping Treatments

1151.07.01.01 Asphalt Cement Anti-Stripping Treatments

If the AST-AC is added by the asphalt cement supplier at the refinery depot, the Contract Administrator shall be provided with the AST-AC and PGAC documentation from the asphalt cement supplier in the form of a weigh bill or bill of lading, confirming the type and concentration of the AST-AC for each tanker of asphalt cement.

If the AST-AC is added at the HMA plant, the Contract Administrator shall be provided with documentation from the HMA plant confirming the type and concentration of the AST-AC, accompanied by an approved statement of calibration for the metering device and a continuous record of the process prior to placement of mix containing AST-AC for each batch of asphalt cement with AST-AC added.

1151.07.01.02 Aggregate Anti-Stripping Treatments

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 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 as specified in the Contract Documents, and that are free of clumps and balls prior to entering the dryer at the HMA plant.

1151.07.02 Preparation of the Mixture

Proportioning and mixing of materials shall 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.

**TABLE 1
Aggregate Gradation**

HMA Type	Percentage Passing by Dry Mass of Aggregates									
	Sieve Size mm									
	50.0	37.5	25.0	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, 12.5FC 1 and 12.5FC 2	-	-	-	100	90-100	45-90	50-65 (Note 1)	39-58 (Note 1)	-	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
SMA 9.5	-	-	-	-	100	70-95	30-50	20-30	(Note 2)	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

Notes:

- For mixes that have been specified in the Contract Documents as coarse graded, the allowable range of percentage by mass passing the 4.75 mm sieve shall be 45-55, and for the 2.36 mm sieve the allowable range will be 28-58.
- For the SMA 9.5 mm, the maximum percentage passing the 1.18 mm, 0.600 mm, and 0.300 mm sieves is 21, 18, and 15 respectively.

**TABLE 2
Superpave Gradation Primary Control Sieve Points**

HMA Type	Primary Control Sieve mm	PCS Control Point at % Passing
Superpave 4.75	-	-
Superpave 9.5	2.36	47
Superpave 12.5, 12.5FC 1, and 12.5FC 2	2.36	39
Superpave 19.0	4.75	47
Superpave 25.0	4.75	40
Superpave 37.5	9.5	47

**TABLE 3
Superpave HMA Properties**

Traffic Category (Note 1)	% of Theoretical Maximum Specific Gravity			VMA % minimum						VFA (Note 2) %	Dust to Binder Ratio (Note 3)	Minimum Tensile Strength Ratio %
				Nominal Maximum Aggregate Size mm								
	N _{initial}	N _{design}	N _{max}	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 4)	0.6-1.2	80
B	≤ 90.5									65-78		
C	≤ 89.0 (Note 5)									65-75 (Note 6)		
D												
E												

Notes:

- Traffic category as specified in the Contract Documents.
- For Traffic categories C, D, and E Superpave 9.5 mixes shall have a VFA range of 73 to 76%, while Superpave 4.75 mixes shall have a VFA range of 75 to 78%.
- 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 in Table 2, the dust-to-binder ratio shall be 0.8 to 1.6.
- For Traffic category A, Superpave 25.0 mixes shall have a VFA range of 67 to 80%.
- The percent of Theoretical Maximum Specific Gravity at N_{initial} of ≤ 89.5 shall be permitted at the Contractor's option with the understanding that the contractor may be exposed to quality issues related to constructability including, but not limited to, mix tenderness and stability for paving equipment.
- Superpave 37.5 mixes shall have a VFA range of 64 to 75%.

**TABLE 4
Properties for all SMA Mix Types**

% Air Voids (Note 1)	Minimum VMA %	VCA of the Compacted Mixture %	Maximum Draindown at Production Temperature (Note 2) %	Minimum Tensile Strength Ratio %
4.0	17	Less than the VCA in the dry rodded condition.	0.3	70

Notes:

- SMA mixes shall be designed with 100 gyrations, unless the mix aggregates have an L.A. Abrasion value according to LS-603 of greater than 30%, then the SMA mix shall be designed with 75 gyrations.
- Tested according to AASHTO T 305.

TABLE 5
SMA Minimum Asphalt Content for
Aggregates with Varying Bulk Specific Gravities

Combined Aggregate Bulk Relative Density	Minimum Asphalt Content Based on Mass, %
2.40	6.8
2.45	6.7
2.50	6.6
2.55	6.5
2.60	6.3
2.65	6.2
2.70	6.1
2.75	6.0
2.80	5.9
2.85	5.8
2.90	5.7
2.95	5.6
3.00	5.5

TABLE 6
Maximum % Binder Replacement

Traffic Category (Note 1)	Binder Course 150 mm or More Below Pavement Surface	Binder Course Within 150 mm of Pavement Surface	Surface Course
A, B	40%	40%	0%
C, D	40%	20%	0%
E	40%	20%	0%

Notes:

1. Traffic category as specified in the Contract Documents.

TABLE 7
One Point Mix Check Requirements

Mix and Aggregate Property	Requirements
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}	$\pm 0.5\%$ from submitted mix design
VMA	$\pm 1.0\%$ 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 Strength Ratio	Not less than 0.8

TABLE 8
Sample Quantities for Mix Design Monitoring

Material	Quantity (Note 1)
Asphalt Cement	4 litres evenly split between 2 containers
Aggregate	75 to 100 kg of each type
RAP	75 to 100 kg required when RAP contained in the mix
Fines material passing 75 μ m sieve	5 to 10 kg when the mix is to be produced with a plant that returns fines to the mix
Mineral Filler	5 to 10 kg sample for SMA mixes
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
Notes:	
1. Each material sample receptacle shall have a maximum mass of 30 kg.	