

**Material Specification for
Aggregates Hot Mixed, Hot Laid Asphaltic Concrete**

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TS 1003.01 SCOPE

This specification covers the requirements for aggregates for use in hot mixed, hot laid asphaltic concrete.

TS 1003.02 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 1151 Material Specification for Superpave, Stone Mastic and Warm Mix Asphalt

Ontario Provincial Standard Specifications

OPSS 1001 Material Specification for Aggregates – General
OPSS.MUNI 1003 Material Specification for Aggregates – Hot Mix Asphalt

Ontario Ministry of Transportation, Form

PH-CC-449 Aggregate Test Data – Hot Mix Asphalt

Ontario Ministry of Transportation, Laboratory Testing Manual

LS-312 Fractionation of Unextracted Reclaimed Asphalt Pavement (RAP) and Hot Mix
Aggregate for Testing or Incorporation in Other Test Samples
LS-601 Material Finer than 75 µm Sieve in Mineral Aggregates by Washing
LS-602 Sieve Analysis of Aggregates
LS-604 Relative Density and Absorption of Coarse Aggregate
LS-606 Soundness of Aggregate by Use of Magnesium Sulphate
LS-607 Percent Crushed Particles in Processed Coarse Aggregate
LS-608 Percent Flat and Elongated Particles in Coarse Aggregate
LS-609 Petrographic Analysis of Coarse Aggregate
LS-613 Determination of Insoluble Residue of Carbonate Aggregates
LS-614 Freezing and Thawing of Coarse Aggregates
LS-617 Determination of Percent Particles with Two or More Crushed Faces and
Uncrushed Particles in Processed Coarse Aggregate
LS-618 Resistance of Coarse Aggregate to Degradation by Abrasion in the Micro-Deval
Apparatus
LS-619 Resistance of Fine Aggregate to Degradation by Abrasion in the Micro-Deval
Apparatus
LS-624 Guidelines for the Use of Control Charts for Construction Aggregates
LS-625 Guidelines for Sampling of Granular Materials
LS-629 Uncompacted Void Content of Fine Aggregate
LS-703/704 Liquid Limit, Plastic Limit and Plasticity Index of Soils

ASTM International

D 4791-10 Standard Method of Test for Flat Particles, Elongated Particles, or Flat and
Elongated Particles in Coarse Aggregate
D 5821-01(2006) Standard Method of Test for Determining the Percentage of Fractured Particles in
Coarse Aggregate

American Association of State Highway and Transportation Officials (AASHTO)

T 176-08 Standard Method of Test for Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test

Aggregate Producers Association of Ontario

Commercial Aggregate Source Book and Membership Directory

TS 1003.03 DEFINITIONS

For the purpose of this specification, the definitions given in specification TS 310 and TS 1150, and the following definitions apply:

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

Bench means a ledge parallel to stratigraphic bedding that in quarries forms a single level of operation above which rock is excavated from a contiguous face.

Blending Method means a production process for monitoring coarse and fine aggregates used in the mix whereby the combined materials are sampled from the cold feed stream at the HMA facility after mixing prior to the addition of liquid asphalt cement.

CCIL means the Canadian Council of Independent Laboratories.

Chip Product means an aggregate co-product from the crushing operation with 100 per cent passing the 9.5 mm sieve, predominantly passing the 4.75 mm sieve, and retained on the 2.36 mm sieve.

Consensus Property means an aggregate property required for use in a Superpave mix.

Control Chart means a graphical method used to monitor the central tendency and the variability of a material characteristic in order to control production.

Duplicate Samples means two samples taken at the same time and location, one to be used for quality assurance testing and the other for referee testing.

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

Hot Mix Asphalt (HMA) means hot mixed, hot laid asphaltic concrete. The terms are used interchangeably. HMA may include recycled or specialty mixes.

Mean means the arithmetic average of a set of data.

Physical Property means an inherent attribute or feature of an aggregate material. Tests are carried out to determine a material's resistance to weathering or degradation or both. Physical properties are generally not affected by aggregate production processes.

Quality Assurance (QA) means a system or series of activities carried out by the City to ensure that materials received from the Contractor meet the specified requirements.

Quality Control (QC) means a system or series of activities carried out by the Contractor to ensure that materials supplied to the Contract meet the specified requirements.

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

Referee Testing means testing of a material property or attribute for the purpose of resolving acceptance.

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

Steel Slag means the non-metallic product resulting from the production of steel in a basic oxygen furnace or an electric arc furnace.

Stone Mastic Asphalt or Stone Matrix Asphalt (SMA) means HMA consisting of a gap-graded, stone-on-stone coarse aggregate skeleton with an asphalt binder rich mortar.

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.

TS 1003.04 DESIGN AND SUBMISSION REQUIREMENTS

TS 1003.04.01 Submissions

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

TS 1003.04.02 Source(s) of Aggregates

At least 10 Working Days prior to the commencement of the asphalt paving work, the Contractor shall notify the Contract Administrator as to the commercial aggregate source(s) for the aggregates to be used in the asphalt mix types for the Work.

TS 1003.04.03 Test Data

At least 10 Working Days prior to the commencement of the asphalt paving work, the Contractor shall provide the Contract Administrator with test results, from a quality control (QC) laboratory meeting the requirements of subsection TS 1003.06.02, herein, demonstrating conformance of the aggregates with the requirements of this specification. Test results shall be submitted using MTO Form PH-CC-449 (suitably modified for the Contract) or equivalent, for either the stockpile method or control chart method as appropriate, according to OPSS.MUNI 1003.

TS 1003.05 MATERIALS

TS 1003.05.01 General

The requirements of OPSS 1001 shall apply to the Contract. Materials shall be according to this specification when tested according to the MTO Laboratory Testing Manual "LS" test number identified in following subsections.

Aggregates shall only be obtained from commercial aggregate sources that comply with the OPSS.MUNI 1003 requirements for aggregate processing, handling, stockpiling and quality control (stockpile and/or control chart method).

Note: Contractors should note that the APAO publishes a Commercial Aggregate Source Book and Membership Directory.

Aggregates may be gravels, crushed gravels, quarried rock, or from reclaimed asphalt pavement (RAP), provided the source is of such a nature and extent as to ensure acceptable processed aggregates of a consistent gradation and quality.

Note: Contractors should note that washed screenings may not meet the gradation and/or physical requirements for 100 per cent crushed fine aggregates (manufactured sand).

When reclaimed asphalt pavement is used in hot mix, it shall be processed for such use, and shall be obtained solely from asphalt concrete removed from existing pavements, consisting of aggregates and asphalt cement, shall not be material that has been rejected from a job site and shall not contain any steel slag material.

Steel slags, iron blast furnace slags, nickel slags and copper slags are not acceptable for use in hot mix.

RST from any source is not permitted for use in hot mix.

Irrespective of compliance with the physical requirements of this specification, aggregates may be accepted or rejected on the basis of field performance.

For Superpave 12.5 FC1, a minimum of 85 per cent of the total aggregate in the mix retained on the 2.36 mm sieve shall be produced from a source named on the MTO pre-qualified products list.

For Superpave 12.5 FC2:

- a) Coarse and fine aggregates in the mix shall be produced from crushed bedrock material supplied from a source named on the MTO pre-qualified products list.
- b) Coarse aggregate may be obtained from a different source than the fine aggregate.
- c) When RAP is used, the coarse aggregate portion of the RAP may be derived from a different source or sources than the rest of the coarse aggregate. In all other cases, blending of coarse aggregates from different sources is not permitted, except for the chip product.
- d) Blending of fine aggregate from different sources is permitted providing the aggregate particles retained on the 4.75 mm sieve as part of the blended fine aggregate comprise less than 20 per cent by mass of the total amount of coarse aggregate.

For SMA:

- a) Coarse and fine aggregates shall be produced from crushed bedrock material supplied from sources shown in Table 1.
- b) Coarse and fine aggregates shall be obtained from the same source.

Table 1: SMA – coarse and fine aggregate sources

Source name	Inventory number	Owner
Methuen Township Quarry	B02-071	MRT Aggregate Incorporated
Brockville Quarry	B15-039	Lafarge Canada Incorporated
Rosewarne Quarry	B17-013	Fowler Construction Company Limited
Bruce Mines Quarry	B22-072	Ontario Trap Rock-Bruce Mines Limited
Havelock Quarry	C01-054	Drain Brothers Excavating Limited
Marmora Quarry	C01-058	Aecon Construction and Materials Limited
Rideau Road Quarry	O05-067	R.W. Tomlinson Limited
Boyce Quarry	O05-070	Dibblee Paving and Materials Limited
Ottawa Quarry	O05-072	Aecon Construction and Materials Limited
Hawthorne Quarry	O05-155	Lafarge Canada Incorporated

TS 1003.05.02 Fine Aggregate**TS 1003.05.02.01 Gradation Requirements**

Fine aggregates shall be graded so that when combined with other aggregates, they consistently meet the overall gradation of the HMA specified in the Contract Documents.

TS 1003.05.02.02 Physical Requirements

Fine aggregates shall be composed of clean, hard, durable particles meeting the requirements shown in Table 2, unless the blending method has been selected.

When the Contract Administrator has received a written request from the Contractor to use the blending method, acceptance for physical properties shall be based on the total combined fine aggregate. In this case the total combined fine aggregate shall meet the requirements shown in Table 2. In addition, for each individual fine aggregate component of the blend, the maximum loss shall not exceed 35 per cent, when tested according to LS-619.

Table 2: Physical property requirements for fine aggregates

Laboratory test	MTO test number	SMA 9.5, SMA 12.5, and SP 12.5 FC2	SP 4.75, and SP12.5 FC1	SP 9.5 and SP 12.5	SMA 19.0, SP 19.0, and SP 25.0
Acid insoluble residue, minimum % (materials retained on 2.36 mm sieve)	LS-613	---	---	60 ¹	---
Micro Deval abrasion, % maximum loss ²	LS-619	15	20	25	25
Plasticity index, maximum	LS-703/704	0	0	0	0

Note 1: The requirements listed below are only applicable to surface courses placed in the area to the north and west of a boundary defined by the north shore of Lake Superior, the north shore of the St. Mary's River, the south shore of St. Joseph Island, the north shore of Lake Huron easterly to the north and east shore of Georgian Bay (excluding Manitoulin Island), along the Severn River to Washago and a line easterly passing through Norland, Burnt River, Burleigh Falls, Madoc, and hence easterly along Highway 7 to Perth and northerly to Calabogie and easterly to Arnprior and the Ottawa River:

- a. When a fine aggregate for use in a surface course mix is obtained from a gravel pit or quarry source which contains carbonate rock type (e.g., limestone and dolostone) then blending with aggregate from non-carbonate rock types shall be required to increase the soluble residue content to meet the minimum 60% requirement. The method of blending shall be uniform and shall be subject to approval by the Owner.
- b. When the fine aggregate for use in a surface course mix is obtained from a non-carbonate gravel or quarry source, blending with carbonate rock types is not permitted.

Note 2: When the blending method has been selected, this requirement applies to the total fine aggregate blend. In addition, when the blending method has been selected, the Micro-Deval Abrasion loss for each individual fine aggregate in stockpile, prior to blending, shall not exceed 35%.

TS 1003.05.03 Coarse Aggregate

TS 1003.05.03.01 Gradation Requirements

Coarse aggregates shall be graded so that when combined with other aggregates, they consistently meet the overall gradation of the HMA specified in the Contract Documents.

TS 1003.05.03.02 Physical Requirements

Coarse Aggregates for use in HMA binder and leveling courses shall meet the physical property requirements shown in Table 3.

Table 3: Physical property requirements for coarse aggregates – binder course

Laboratory test	MTO test number	SP 4.75, SP 9.5, SP 19.0, and SP 25.0	SMA 19.0
Wash pass 75 µm sieve, % maximum loss ¹	LS-601 Guideline B	1.3	1.3
Absorption, % maximum	LS-604	2.0	2.0
Flat and elongated particles, % maximum at 4:1	LS-608	20 ²	15
Unconfined freeze-thaw, % maximum loss ³	LS-614	15	15
Micro-Deval abrasion, % maximum loss	LS-618	21	21
Alternative requirement for unconfined freeze-thaw loss, LS-614			
Magnesium sulphate soundness, % maximum loss	LS-606	15	15

Note 1: When quarried rock is used as a source of coarse aggregate, a maximum of 2.0% passing the 75 µm sieve shall be permitted.

Note 2: For Ontario Traffic Categories D and E, Superpave 19.0 shall be 15% maximum.

Note 3: This requirement shall be waived by the Owner when the aggregate meets the alternative magnesium sulphate soundness requirements, LS-606.

Coarse aggregates for use in HMA surface courses shall meet the physical property requirements shown in Table 4.

Table 4: Physical property requirements for coarse aggregates – surface course

Laboratory test	MTO test number	SP 12.5 FC1	SMA 9.5, SMA 12.5, SP 12.5 FC1, and SP 12.5 FC2			SP 4.75, SP 9.5, and SP 12.5
		Gravel	Quarry			
			Dolomitic Sandstone	Traprock, Diabase, and Andesite	Meta-Arkose, Meta-Gabbro, and Gneiss	
Wash pass 75 µm sieve, % maximum loss ¹	LS-601 Guideline B	1.0	1.0	1.0	1.0	1.3 ¹
Absorption, % maximum	LS-604	1.0	1.0	1.0	1.0	2.0
Flat and elongated particles, % maximum at 4:1	LS-608	15	15	15	15	20
Petrographic number (HL), maximum	LS-609	120	145	120	145	--- ²
Insoluble residue retained 75 µm sieve, % minimum	LS-613	---	45	---	---	---
Unconfined freeze-thaw, % maximum loss ³	LS-614	6	7	6	6	6 ³
Micro-Deval abrasion, % maximum loss	LS-618	10	15	10	15	17
Alternative requirement for unconfined freeze-thaw loss, LS-614						
Magnesium sulphate soundness, % maximum loss	LS-606	---	---	---	---	12

Note 1: When quarried rock is used as a source of coarse aggregates, a maximum of 2.0% passing the 75 µm sieve shall be permitted.

Note 2: The requirements listed below are only applicable to surface courses placed in the area to the north and west of a boundary defined by the north shore of Lake Superior, the north shore of the St. Mary's River,

the south shore of St. Joseph Island, the north shore of Lake Huron easterly to the north and east shore of Georgian Bay (excluding Manitoulin Island), along the Severn River to Washago and a line easterly passing through Norland, Burnt River, Burleigh Falls, Madoc, and hence easterly along Highway 7 to Perth and northerly to Calabogie and easterly to Arnprior and the Ottawa River:

- a. When a fine aggregate for use in a surface course mix is obtained from a gravel pit or quarry source which contains carbonate rock type (e.g., limestone and dolostone) then blending with aggregate from non-carbonate rock types shall be required to increase the soluble residue content to meet the minimum 60% requirement. The method of blending shall be uniform and shall be subject to approval by the Owner.
- b. When the fine aggregate for use in a surface course mix is obtained from a non-carbonate gravel or quarry source, blending with carbonate rock types is not permitted.

Note 3: This requirement shall be waived by the Owner when the aggregate meets the alternative magnesium soundness requirements, LS-606.

A chip product shall also meet the appropriate physical property requirements of this specification unless:

- a) the chip product is derived:
 - i. for Superpave 12.5 FC2 and SMA 12.5 or SMA 9.5, from the same sources as the primary coarse aggregate used in the mix; or
 - ii. for Superpave 12.5 FC1, from an aggregate source listed on the MTO pre-qualified products list; or
 - iii. for all other mixes, either from an aggregate source listed on the MTO pre-qualified products list or from a coarse aggregate in the mix that meets all of the applicable physical property requirements; and
- b) according to the gradation determined from the mix design, the retained 4.75 mm fraction of the chip product does not exceed 15 per cent by mass of the total cumulative combined coarse aggregate fraction of the mix including any aggregate derived from RAP.

TS 1003.05.04 Consensus Property Requirements for Fine and Coarse Aggregates

For Superpave HMA, the fine aggregate portion of the combined HMA aggregate, including aggregate derived from RAP which has been fractionated and proportioned according to LS-312 and the mix design, shall meet the consensus property requirements of AASHTO T 176 and LS-629 shown in Table 5 for the traffic category specified in the Contract Documents. However, for AASHTO T 176 only, the combine fine aggregate portion shall exclude any fine aggregate that is derived from RAP.

For Superpave HMA, the coarse aggregate portion of the combined HMA aggregate, including any coarse aggregate derived from RAP, which has been fractionated and proportioned according to LS-312 and the mix design, shall meet the consensus property requirements shown in Table 5 for the traffic category specified in the Contract Documents.

Table 5: Consensus property requirements for Superpave aggregates (including RAP)

Ontario Traffic Category ¹	Fine Aggregate			Coarse Aggregate		
	AASHTO T 176 Sand Equivalent Method 1 % minimum ²	LS-629 Uncompacted Void Content % minimum		ASTM D 4791 Flat and Elongated Particles, % maximum at 5:1	ASTM D 5821 Fractured Particles in Coarse Aggregate, % minimum ⁴	
		≤ 100 mm ³	> 100 mm ³		≤ 100 mm ³	> 100 mm ³
A	40	---	---	---	55/-	-/-
B	40	40	40		75/-	50/-
C	45	45 ⁵	40	10	85/80	60/-
D	45	45 ⁵	15		95/90	80/75
E	50	45 ⁵	45 ⁵		100/100	100/100

Note 1: The Ontario Traffic Category shall be as specified in the Contract Documents.

Note 2: When the total combined fine aggregate includes aggregate derived from RAP, this requirement shall be met prior to blending with RAP.

Note 3: Denotes the depth of the top of lift below final pavement surface. If less than 25% of a layer is within 100 mm of the surface, the layer may be considered to be below 100 mm.

Note 4: 85/80 denotes that 85% of the coarse aggregate has one fractured face and 80% has two or more fractured faces.

Note 5: An uncompacted void content of 43% is acceptable provided that the selected mix satisfies the mix volumetrics specified in TS 1151.

TS 1003.05.05 Filler

Filler shall consist of baghouse dust, mineral filler, fly ash, hydrated lime, Portland cement or other fine material as designated and currently approved by the City for use in hot mix. Mineral filler shall consist of thoroughly dry dust produced from rock sources acceptable for coarse aggregates meeting the physical requirements listed in Table 4 and 5, and shall meet the following gradation requirements:

- Passing 600 µm sieve size 100%;
- Passing 75 µm sieve size not less than 80%; and
- Not more than 20% passing 20 µm sieve, SMA only.

TS 1003.06 LABORATORY TESTING

TS 1003.06.01 General

The Contractor shall be responsible for all aggregates quality control (QC) testing and associated costs. The City will designate an aggregate quality assurance (QA) laboratory and will be responsible for all costs associated with quality assurance testing.

TS 1003.06.02 Laboratory Requirements

The aggregates QC and QA testing laboratories shall hold CCIL/APAO, Type C or Type D certification for the applicable test methods.

TS 1003.07 PRODUCTION

TS 1003.07.01 Aggregate Processing, Handling and Stockpiling

The commercial aggregate source(s) shall be according to the aggregate processing, handling and stockpiling requirements of OPSS.MUNI 1003.

TS 1003.07.02 Quality Control

The commercial aggregate source(s) shall be according to the quality control requirements of OPSS.MUNI 1003.

TS 1003.08 QUALITY ASSURANCE

TS 1003.08.01 General

Quality assurance (QA) testing may be carried out by the City for purpose of ensuring that the aggregates used in the Contract asphalt mix type(s) conform with the gradation or physical requirements or both of this specification.

TS 1003.08.02 Sampling

Aggregate samples for QA will be taken by the Contractor at the asphalt plant, or in the absence of a stockpile(s) at the asphalt plant, from a stockpile(s) at the commercial aggregate source(s). The sampling shall be carried out under the supervision of the Contract Administrator, and the samples shall be delivered to the QA laboratory.

TS 1003.08.03 Testing and Retention of Samples

Aggregate testing will be carried out at the City's QA laboratory to ensure that the aggregates conform to the requirements of this specification. Following the preparation of the test samples, the QA laboratory shall retain all remaining aggregates for possible referee testing.

TS 1003.08.04 Acceptance

The Contractor's submission of test data, subsection TS 1003.04.03, herein, will be used to accept aggregates in the work, except where aggregates QA testing or referee testing has been carried out.

When QA test results show that the aggregate(s) meets the requirements of this specification, the aggregate(s) shall be accepted.

When QA test results show that the aggregate(s) does not meet the requirements of this specification, the Contract Administrator will notify the Contractor that material(s) from the commercial aggregate source(s), including material(s) in existing stockpiles or in the work, shall not be accepted. The Contractor then has the option of either removing the material(s) from the Work or requesting referee testing as outlined in subsection TS 1003.08.05, herein.

TS 1003.08.05 Referee Testing

When aggregate samples tested by the City do not meet the requirements of this specification, the Contractor has the option of selecting a new commercial aggregate source(s) or invoking referee testing. The Contractor shall notify the Contract Administrator of the selected option within two Working Days following notification.

When referee testing is selected, the City will select a mutually agreed upon third-party referee laboratory, meeting the requirements of subsection TS 1003.06.02, herein, within three Working Days following notification of the intent to use a referee. Retained referee materials shall be delivered to the referee laboratory from the QA laboratory by the Contract Administrator.

Referee testing will be carried out in the presence of the Contract Administrator. Where applicable, the referee laboratory will also test a control aggregate sample for each test method required. The Contractor may observe the testing at no extra cost to the City. Comments on any nonconformity in the test methods must be made and corrected at the time of referee testing. Referee test results will be binding on both the City and the Contractor.

TS 1003.08.06 Disposition of Aggregate(s) Not Accepted

When referee test results show that the aggregate(s) meets the requirements of this specification, the material will be accepted.

When the referee test results show that the aggregate(s) does not meet the requirements of this specification, the material from the commercial aggregate source(s), including materials in existing stockpiles or in the Work, shall not be accepted. The Contractor shall remove the material from the Work at no extra cost to the City.

At the City's option, the Contractor may negotiate a reduced price payment in lieu of removal provided that: the referee test values do not exceed the requirement for Magnesium Sulphate Soundness (LS-606) or Unconfined Freeze-Thaw (LS-614) value by more than 25 per cent of the specified value; or exceed the requirement for the Micro-Deval Abrasion (LS-618) value by more than 10 per cent of the specified value. For example, where the magnesium sulphate requirement value is 12, a reduced payment may be negotiated provided the referee test value does not exceed 15. The minimum price reduction will be 10 per cent of the Contract Price for the applicable asphalt mix type(s) in the Pricing Form. This price reduction will be assessed independently of any other price adjustment provisions for the Contract.

The cost of referee testing shall be borne by the Contractor unless the testing confirms aggregate(s) conformance with this specification, in which case the costs will be borne by the City.

TS 1003.09 OWNER PURCHASE OF MATERIAL – Not Used