

Ontario Provincial Standards for Roads and Public Works



- Volume 6 -

PROVINCIAL-ORIENTED

MATERIAL SPECIFICATIONS



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MANUAL REVISION RECORD

Provincial-Oriented

Volume 6 – Material Specifications

This record should remain in the manual at all times. Revisions are numbered sequentially. This sheet should be filled in after each revision has been placed into the manual. It will quickly indicate to users whether the contents of the manual are up-to-date.

REVISION NUMBER	REVISION DATE	ENTERED BY	REVISION NUMBER	DATE	ENTERED BY
1	APR 2010	Included in new manuals	27		
2	NOV 2012	Included in new manuals	28		
3	APRIL 2013	Included in new manuals	29		
4	NOV 2013	Included in new manuals	30		
5	NOV 2014	Included in new manuals	31		
6	APRIL 2015	Included in new manuals	32		
7	NOV 2015	Included in new manuals	33		
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REVISION INFORMATION SHEET

ONTARIO PROVINCIAL STANDARDS FOR ROADS AND PUBLIC WORKS

VOLUME 6 PROVINCIAL-ORIENTED MATERIAL SPECIFICATIONS

MANUAL REVISION #7

NOVEMBER 2015

UPDATING ONTARIO PROVINCIAL STANDARDS FOR YOUR USE

Each roads and public works owner (Owner) is responsible for determining implementation dates and directions for use of Ontario Provincial Standards; therefore, manual holders are cautioned about immediately discarding superseded and cancelled standards.

A NOTE TO DESIGNERS OF MUNICIPAL CONTRACTS REGARDING APPENDICES

There are a number of OPS specifications published with appendices containing supplemental requirements that modify the specification. These specifications contain information written for use in provincial contracts. The appendices contain supplemental requirements that modify the provincial requirements so the specifications can be used in municipal contracts. The specifications are easily identified, as the table of contents for each specification lists the appendix containing the supplemental requirements (e.g., Supplemental Requirements for Using OPSS XXX in Municipal Contracts).

Designers of municipal contracts should review each specification to determine if the supplemental requirements should be invoked in their contracts. To ensure completeness of municipal Contract Documents, designers should invoke the appendices by referencing them in the Contract Documents.

ACCESSING AND OBTAINING ONTARIO PROVINCIAL STANDARDS

The Ontario Provincial Standards for Roads and Public Works (OPS) manuals and the latest published updates for each of the eight OPS manuals are available as follows:

- Available electronically on the OPS/MTO website. Online access to the current, updated, and archived standards; indexes; OPS User Notes; and publication Revision Information Sheets are available free of charge at the site.
(<http://www.raqs.mto.gov.on.ca/techpubs/ops.nsf/OPSHomepage>)
- Hard-copy format available from Publications Ontario by telephone at 1-800-668-9938 or online. Updates and OPS manuals are available for a cost-recovery fee.
(www.publications.serviceontario.ca)

- The eight OPS manuals of standards are available on one CD in PDF format. The OPS drawings published in Volumes 3 and 4 are available in AutoCAD format on a separate CD. These CDs are available from Publications Ontario or by telephone at 1-800-668-9938 or online for a cost-recovery fee. The updates are not available on CDs as an update package.
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At the Publications Ontario web page, you can type “Ontario Provincial Standards,” “OPS,” “OPSS,” or “OPSD” in the search box, and all related products for the Ontario Provincial Standards will be listed, click on the item you wish to purchase, add the item to your cart, then follow the instructions to complete your order. If trying to order an OPS product online from Publications Ontario and it is shown as Out of Stock, you can backorder the product by telephone at 1-800-668-9938.

In order to receive the Municipal Engineers Association (MEA) purchase price, MEA members should visit the MEA website (www.municipalengineers.on.ca/) for the MEA Publications Ontario order form for hard-copy manuals and CDs.

MTO employees should contact Simon Leung, Account Representative at Publications Ontario, by email (simon.leung@ontario.ca) to set up an account in order to receive the MTO purchase price for technical publications, including the Ontario Provincial Standards.

Links to Publications Ontario and the Ontario Provincial Standards on the MTO Library website are available on the OPS website (www.ops.on.ca). Also on this site under News and Activities are notices for updates and changes in OPS.

Questions should be directed by email to Ontario.Prov.Standards@ontario.ca.

YOU SHOULD REGISTER YOUR OPS MANUALS AND CDs

Users of OPS do not receive notices of OPS updates as they had in the past. Methods of notification from Publications Ontario for the future are being investigated, and you will be informed of them as they become available. In the interim, an email will be sent to OPS users who have registered their OPS manuals and CDs with OPS.

Owners of OPS manuals, who have not yet done so, are requested to register their OPS hard-copy manuals and CDs with OPS by email at Ontario.Prov.Standards@ontario.ca. The registration form and submission instructions are available on the OPS website (www.ops.on.ca), Miscellaneous Info, OPS Forms.

WAITING TO HEAR FROM YOU

If you have a suggestion to revise a standard or you have a standard that works in your ministry, municipality, or area, send it to the Head, OPS Administration, for review and possible inclusion into the Ontario Provincial Standards.

THIS MANUAL IS REVISED AS FOLLOWS:

Index Pages Volume 6

Remove the entire index and replace with the attached revised index.

Standard Specifications Volume 6

Superseded/Cancelled (Remove)		Revised/New (Insert)		Remarks
OPSS.PROV	Dated	OPSS.PROV	Dated	
1841	November 2014	1841	Notice to Users of OPSS.PROV 1841	“MATERIAL SPECIFICATION FOR NON-PRESSURE POLYVINYL CHLORIDE PIPE PRODUCTS” OPSS.PROV 1841 has been replaced by OPSS 1841 in OPS Volume 2.



**ONTARIO
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STANDARD
SPECIFICATION**

**VOLUME 6 INDEX
PROVINCIAL-ORIENTED
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APR 2013	1003	Aggregates - Hot Mix Asphalt
NOV 2012	1004	Aggregates - Miscellaneous
APR 2013	1006	Aggregates - Surface Treatment
APR 2013	1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
DIVISION 11 - BITUMENS		
NOV 2014	1101	Performance Graded Asphalt Cement
APR 2007	1151	Superpave and Stone Mastic Asphalt Mixtures
DIVISION 12 - SEALS, BEARINGS, WATERSTOPS		
APR 2015	1205	Clay Seal
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DIVISION 13 - CEMENT AND CONCRETE		
NOV 2014	1303	Admixtures for Concrete
NOV 2014	1350	Concrete - Materials and Production
DIVISION 14 - METAL		
NOV 2014	1440	Steel Reinforcement for Concrete
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DIVISION 19 - ENVIRONMENTAL		
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DIVISION 21 - CLOTHING, CLOTH, AND THE LIKE		
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DIVISION 22 - UNASSIGNED		
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NOV 2014	2301	Impressed Current Cathodic Protection System for Bridge Structures
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MATERIAL SPECIFICATION FOR AGGREGATES - CONCRETE

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1002.01 SCOPE

This specification covers material requirements for aggregates for use in hydraulic cement concrete.

1002.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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

1002.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

1002.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Material

OPSS 1001 Aggregates - General

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:

- LS-412 Scaling Resistance of Concrete Surfaces Exposed to De-icing Chemicals
- LS-601 Material Finer than 75µm 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-608 Percent Flat and Elongated Particles in Coarse Aggregate
- LS-609 Petrographic Analysis of Coarse Aggregate
- LS-610 Organic Impurities in Sands for Concrete
- LS-613 Determination of Insoluble Residue of Carbonate Aggregates
- LS-614 Freezing and Thawing of 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-620 Accelerated Detection of Potentially Deleterious Alkali-Silica Reactive Aggregate by Expansion of Mortar Bars
- LS-625 Guidelines for Sampling of Granular Materials

MTO Aggregate Sources Lists (ASL):

Aggregate Sources List for Structural Concrete Fine and Coarse Aggregates
Aggregate Sources List for Concrete Base/Pavement Coarse Aggregates

MTO Forms:

PH-D-10 Aggregate Sample Data Sheet

CSA Standards

A23.2-1A	Sampling Aggregates for Use in Concrete *
A23.2-12A	Relative Density and Absorption of Coarse Aggregate *
A23.2-14A	Potential Expansivity of Aggregates; Procedure for Length Change Due to Alkali-Aggregate Reaction in Concrete Prisms *
A23.2-23A	Method of Test for the Resistance of Fine Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus *
A23.2-24A	Method of Test for Resistance of Unconfined Coarse Aggregate to Freezing and Thawing
A23.2-25A	Test Method for Detection of Alkali-Silica Reactive Aggregate by Accelerated Expansion of Mortar Bars *
A23.2-26A	Determination of Potential Alkali-Carbonate Reactivity of Quarried Carbonate Rocks by Chemical Composition *
A23.2-27A	Standard Practice to Identify Potential for Alkali-Reactivity of Aggregates and Measures to Avoid Deleterious Expansion in Concrete *
A23.2-29A	Method of Test for the Resistance of Coarse Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus *

* [Part of A23.1-09/A23.2-09 - Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete]

ASTM International

C 87/C 87M-10	Effect of Organic Impurities in Fine Aggregate on Strength of Mortar
C 330/C 330M-09	Lightweight Aggregates for Structural Concrete
C 666/C 666M-03 (2008)	Resistance of Concrete to Rapid Freezing and Thawing

1002.03

DEFINITIONS

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

Alkali-Aggregate Reaction (AAR) means a chemical reaction that occurs in concrete between alkalis in the cement (e.g., sodium and potassium) and minerals in the aggregate. This reaction may cause deleterious expansion and cracking of the concrete. AAR includes alkali-carbonate and alkali-silica reactions.

Air-Cooled Blast Furnace Slag means the material resulting from solidification of molten blast furnace slag under atmospheric conditions. Subsequent cooling may be accelerated by application of water to the solidified surface.

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.

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.

Manufactured Sand means fine aggregate produced by crushing bedrock or containing crusher screenings.

Mineral Filler means a finely pulverized, inert, inorganic mineral or rock (e.g., limestone powder) having physical and mineralogical properties suitable for use in concrete.

Nominal Maximum Size means the largest sieve listed in the applicable specification upon which any material is permitted to be retained.

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 Owner to ensure that Materials received from the Contractor meet the requirements specified in the Contract Documents.

Self-Consolidating Concrete means a highly flowable, yet stable concrete that can spread readily into place, fill formwork, and encapsulate the reinforcement without any mechanical consolidation and without undergoing segregation or excessive bleeding.

Siliceous Aggregates means rock particles containing or composed of silica (SiO_2) or minerals with silica in the crystal structure as silicate (SiO_4).

1002.05 MATERIALS

1002.05.01 General

Aggregates shall be according to OPSS 1001. Aggregates shall be according to this specification when tested according to the MTO, CSA, and ASTM test methods identified herein.

Except as noted below or elsewhere in the Contract Documents, aggregates may be sands, gravel, quarried rock, or air-cooled blast furnace slag; provided the source is of such nature and extent to ensure acceptable processed aggregates of a consistent grading and quality. When any change in the character of the aggregate occurs or when the performance of aggregate meeting the requirements of this specification is found to be unsatisfactory, use of the aggregate shall be discontinued until a reappraisal by the Contractor, with the approval of the Contract Administrator, proves the source to be satisfactory.

Steel slag is prohibited for use as aggregate in hydraulic cement concrete. Air-cooled blast furnace slag is prohibited for use as aggregate in concrete pavements.

Irrespective of compliance with the physical property requirements of this specification, aggregates may be accepted or rejected based on the demonstrated performance of the aggregate in accelerated freeze-thaw testing according to LS-412 and ASTM C 666/C 666M, or demonstrated past field performance in hydraulic cement concrete. The structure or pavement with which satisfactory field performance is demonstrated shall have been in the same environment and application to that in which the aggregate is proposed for use and shall be at least 15 years old. In the case of rejection, the structure or pavement may be of any age. Field performance shall be evaluated according to CSA A23.2-27A, Attachment A2, Guidelines for Evaluating the Field Performance of Aggregates: Field and Laboratory Testing.

1002.05.02 Fine Aggregate

1002.05.02.01 General

Manufactured sand made with carbonate rock (e.g., limestone and dolostone) shall not be accepted for use in a hydraulic cement concrete surface exposed to vehicular traffic due to the risk of polishing, unless the acid insoluble residue as determined by LS-613 is greater than 50%.

1002.05.02.02 Grading Requirements

Unless the Contract Administrator has agreed to allow a special grading, fine aggregates shall meet the requirements shown in Table 1. The fineness modulus for any sample shall not vary by more than 0.20 from the sample upon which initial acceptance was based.

1002.05.02.03 Mineral Filler

Mineral fillers shall be limited to use in self-consolidating concrete. When mineral fillers are added to the mix, they shall be inert, non-plastic, free of clay, and added as a separate ingredient to the mix.

1002.05.02.04 Physical Property Requirements

Fine aggregate shall meet the physical property requirements shown in Table 2.

1002.05.03 Coarse Aggregate

1002.05.03.01 Grading Requirements

1002.05.03.01.01 General

Coarse aggregate grading requirements shown in Tables 3 and 4 represent the upper and lower limits allowed.

1002.05.03.01.02 Concrete Structures, Sidewalks, Curb and Gutter

The nominal maximum aggregate size shall be 19.0 mm, unless specified elsewhere in the Contract Documents. Grading of the coarse aggregate shall meet the requirements shown in Table 3. It is acceptable to stockpile aggregates in individual size fractions and blend them in the mix to meet the grading requirements.

1002.05.03.01.03 Concrete Pavement and Concrete Base

The grading of coarse aggregates used in concrete pavement and concrete base shall meet the requirements for 37.5 and 19 mm aggregate shown in Table 4. Aggregates shall be stockpiled as individual size fractions and blended in the mix to meet the combined grading requirements shown in Table 4.

1002.05.03.01.04 Concrete Patches, Refacing, and Overlays

The nominal maximum aggregate size shall be 13.2 mm for concrete patches, refacing, and overlays 100 mm or less in thickness. When the thickness of the repair exceeds 100 mm, the nominal maximum aggregate size shall be 19 mm. Grading of the coarse aggregate shall be within the limits shown in Table 3.

1002.05.03.02 Physical Property Requirements

Coarse aggregate shall meet the physical property requirements shown in Table 5. When coarse aggregate contains more than 15% passing the 4.75 mm sieve, material finer than 4.75 mm shall also meet the physical property requirements shown in Table 2.

1002.05.03.02.01 Scaling Resistance

Coarse aggregate composed of more than 80% siliceous aggregates as determined by LS-609 shall be tested in a salt scaling test according to LS-412 together with either the fine aggregate that the coarse aggregate is intended to be used with, or a fine aggregate from the same geographic area as the coarse aggregate.

For the purposes of this specification, the concrete for LS-412 shall be proportioned with 355 kg/m³ of Type GU hydraulic cement and shall have a plastic air content of 7.0 ± 1.5% and a slump of 80 ± 20 mm.

The maximum permitted loss shall be 0.80 kg/m² after 50 cycles of freezing and thawing.

This test shall be done at the time of first use of a source for aggregate in concrete. The need for data to demonstrate compliance with this requirement shall be waived by the Contract Administrator if the source is on the current Ontario Ministry of Transportation Regional Aggregate Sources List for Structural Concrete Fine and Coarse Aggregates or Aggregate Sources List for Concrete Base/Pavement Coarse Aggregates. Irrespective of the waiving of this requirement, the warranty provisions of the Contract Documents shall apply.

1002.05.03.02.02 D-Line Cracking

Coarse aggregate from carbonate (e.g., limestone and dolostone) bedrock quarries for concrete pavement and concrete base except for aggregate produced from the Oxford, Gull River, or Bobcaygeon Formations shall be tested for resistance to freezing and thawing according to ASTM C 666/C 666M Procedure A.

For the purposes of this specification, ASTM C 666/C 666M shall be conducted using the following parameters:

- a) The concrete for the test shall be proportioned to the combined grading shown in Table 4, with 325 kg/m³ of Type GU hydraulic cement, a plastic air content of $6.5 \pm 1.5\%$, and a slump of 50 ± 20 mm.
- b) The fine aggregate shall be that which is intended for use with the coarse aggregate or a fine aggregate from the same geographic area as the coarse aggregate.
- c) A minimum of three beams shall be tested.
- d) Procedure A shall be modified so that each freeze cycle takes 10.5 ± 1 hour.
- e) The test shall be conducted for 350 cycles.

The average change in length of the beams tested shall be no more than $\pm 0.0350\%$. The average fundamental transverse frequency (FTF) shall not be less than 90% of the FTF at an age of 14 Days.

This test shall be done at the time of first use of a source for aggregate in concrete pavement or concrete base. The bench within the quarry from which the aggregate is selected for testing shall be identified by the Contractor. Approval of aggregate shall only apply to the bench of the quarry from which the aggregate was taken. Aggregate processed from other benches within the same quarry shall require testing according to ASTM C 666/C 666M Procedure A, as modified above, prior to use. The need for data to demonstrate compliance with this requirement shall be waived by the Contract Administrator if the source is on the current Ontario Ministry of Transportation Regional Concrete Aggregate Sources List for Concrete Base/Pavement Coarse Aggregate. Irrespective of the waiving of this requirement, the warranty provisions of the Contract Documents shall apply.

1002.05.03.02.03 Deleterious Expansion Other than Alkali Aggregate Reaction

Aggregates that produce excessive expansion or cracking of concrete through reactions other than AAR shall not be used in concrete. The total content of lime (CaO), periclase (MgO), and glass in the aggregate shall be less than 0.001% by mass. The content of gypsum and anhydrite shall be less than 1.0% by mass. Steel slag is prohibited.

1002.05.03.03 Lightweight Aggregate

Lightweight aggregate shall be according to ASTM C 330/C 330M.

1002.07 PRODUCTION

1002.07.01 Aggregate Processing, Handling, and Stockpiling

Processed aggregates shall be separated into fine and coarse aggregates and stockpiled separately. Aggregates separated during processing, aggregates secured from different sources, aggregates from the same source but of different gradings, or from a new bench in a quarry, or aggregates resulting from a significant change in production that affects physical quality shall be stockpiled separately.

Aggregates that have become mixed with foreign matter of any description, or aggregates that have become mixed with each other, shall not be used and shall be removed from the stockpile immediately.

Aggregate shall be retained in stockpiles for at least 24 hours before use. Suitable stockpile locations include the construction site and the site of batching of the concrete. Other locations may be used for stockpiles provided they are acceptable to the Contract Administrator.

1002.08 QUALITY ASSURANCE

1002.08.01 General

The laboratory designated by the Owner shall carry out QA testing for purposes of ensuring that aggregates used in the Work are according to the physical property and grading requirements of this specification. Individual test results shall be forwarded to the Contractor, as they become available.

The Owner shall be responsible for all costs associated with testing for QA purposes, unless otherwise specified in this specification.

1002.08.02 Alternative to LS-614

LS-614 shall be used for acceptance, unless written notification to the Contract Administrator to replace it with LS-606 for acceptance is received prior to sampling of the applicable materials for QA purposes. Provided the Contract Administrator has received such a request, LS-606 shall be used. Otherwise, conformance to LS-614 shall be required.

When notification is provided after QA testing using LS-614 has been initiated, the Contractor shall then be charged \$600.00 for each test initiated, which includes the cost of the testing using LS-614, administrative charges, and additional sampling, if required.

1002.08.03 Special Grading For Fine Aggregate

Prior to samples being taken for QA purposes, the Contractor may provide a written request to the Contract Administrator to use a fine aggregate with a grading that falls outside the limits shown in Table 1. Such a request shall include test data necessary to demonstrate that the material shall produce concrete of acceptable quality and meet all relevant requirements specified elsewhere in the Contract Documents. The assessment of performance shall include, but not be limited to, the following tests: compressive strength, splitting tensile strength, and drying shrinkage.

1002.08.04 Sampling

Sampling shall be according to CSA A23.2-1A and LS-625. QA samples shall be taken from stockpiles located at the concrete plant, or in the absence of a stockpile at the plant, from stockpiles at the aggregate source.

The Contractor shall provide new or clean sample bags or containers that are constructed to prevent the loss of any part of the material or contamination or damage to the contents during shipment. Sample containers shall be securely fastened. Metal or cardboard containers are unacceptable. The sample shall be identified both inside and outside of the sample container. Data to be included with the sample shall be according to MTO form PH-D-10.

All QA samples shall be duplicate samples. At least one set of QA samples from individual stockpiles of each aggregate shall be randomly obtained during production for every lot of 5,000 m³, or part thereof, of each concrete mix used in the Work. In the event that the Contractor is unavailable to take samples, no further material shall be placed in the Work until the required QA samples have been taken. The Contract Administrator shall seal each sample container at the time and place of sampling.

The Contractor shall deliver all samples to the appropriate laboratory in a condition that is suitable for testing.

One of the duplicate QA samples shall be randomly selected for testing by the QA laboratory. The QA laboratory shall retain the remaining sample for referee testing purposes.

1002.08.04.01 Sample Size

The mass of each QA sample shall meet the requirements of Table 6. When more than 30 kg is required, the total sample shall be recombined by the QA laboratory prior to testing.

1002.08.05 Acceptance

The aggregates within a lot of concrete shall be deemed to be acceptable if all of the test results for the samples of aggregates representing that lot meet all applicable requirements of this specification.

If a tested sample of aggregates representing a lot of concrete does not meet all of the requirements of this specification, then a reduced price payment of \$10.00 shall be given for each cubic metre of concrete left in the work that includes any of the aggregates within that lot, as long as the applicable results for that sample:

- a) do not exceed the requirement for LS-614 or LS-606 if it has been accepted by the Owner as an alternative to LS-614, by more than 25% of the specified value.
- b) do not exceed a petrographic number of 135 for concrete pavement and 150 for structural concrete when tested according to LS-609.
- c) do not exceed the requirement for LS-618 by more than 10% of the specified value.
- d) meet all other requirements of this specification.

Should the test results for any sample of aggregates representing a lot of concrete not meet the requirements listed above, then all of the aggregates within that lot shall be considered rejectable and any concrete that includes those aggregates shall be removed from the Work at no cost to the Owner.

Irrespective of the negotiation of a reduced price payment, the warranty provisions of the Contract Documents shall apply.

1002.08.06 Referee Testing

The Contractor may invoke referee testing for one or more attributes by submitting a written request to the Contract Administrator within 5 Business Days following notification that the aggregate does not meet the requirements of this specification.

Referee testing shall be carried out as specified herein and elsewhere in the Contract Documents.

The retained duplicate QA sample shall be used for referee testing.

All referee test results shall replace the respective QA test results for acceptance of the applicable lot and shall be binding on both the Owner and the Contractor.

If a lot is not accepted at full payment based on the referee test results, the Contractor shall then be responsible for the cost of referee testing of that lot including transportation of the referee samples at the rates specified elsewhere in the Contract Documents. In all other cases, the Owner shall bear the cost of the referee testing and the cost of transporting the samples of that lot.

TABLE 1
Grading Requirements for Fine Aggregates (Note 1), LS-602

MTO Sieve Designation	Percent Passing
9.5 mm	100
4.75 mm	95-100
2.36 mm	80-100
1.18 mm	50-85
600 µm	25-60
300 µm	10-30
150 µm	0-10
75 µm	0-3 (Natural Sand) 0-6 (Manufactured Sand)
Note: 1. Fine aggregates shall have no more than 45% passing any sieve and retained on the next consecutive sieve. The fineness modulus shall be a minimum of 2.3 and a maximum of 3.1.	

TABLE 2
Physical Property Requirements for Fine Aggregates

MTO or CSA Test Number	Laboratory Test	Acceptance Limit
LS-610	Organic Impurities, Organic plate number (Note 1)	3
LS-619 or CSA A23.2-23A	Micro-Deval Abrasion, % maximum loss	20
LS-620 or CSA A23.2-25A	Accelerated Mortar Bar, % maximum at 14 Days (Notes 2 and 3)	0.150
CSA A23.2-14A	Concrete Prism Expansion, % maximum at 1 year (Notes 2 and 4)	0.040
Notes: 1. A fine aggregate producing a colour darker than standard colour No. 3 shall be considered to have failed this requirement. A failed fine aggregate may be used if comparative mortar specimens prepared according to ASTM C 87/C 87M meet the following requirements: a) Mortar specimens prepared using unwashed fine aggregate shall have a 7-Day compressive strength that is a minimum of 95% of the strength of mortar specimens prepared using the same fine aggregate washed in a 3% sodium hydroxide solution. Type GU hydraulic cement shall be used. b) Setting time of the unwashed fine aggregate mortar specimens shall not differ from washed fine aggregate mortar specimens by more than 10%. 2. The need for data to demonstrate compliance with this requirement shall be waived by the Contract Administrator, if the aggregate source is on the current Ontario Ministry of Transportation Regional Aggregate Sources List for Structural Concrete Fine and Coarse Aggregates. 3. An aggregate that fails this requirement may be accepted, provided the requirements of CSA A23.2-14A are met. 4. An aggregate need only meet this requirement if it fails the requirements of CSA A23.2-25A. Test data shall have been obtained within the past 18 months from aggregate that is from the same source and processed in the same manner as the material intended for use.		

TABLE 3
Grading Requirements for Coarse Aggregate, LS-602
Structural Concrete, Sidewalks, Curb and Gutter

Nominal Maximum Size	19.0 mm	16.0 mm	13.2 mm	9.5 mm	6.7 mm
MTO Sieve Designation, mm	Percent Passing				
26.5	100	-	-	-	-
19.0	85-100	100	100	-	-
16.0	65-90	96-100	-	-	-
13.2	-	67-86	90-100	100	100
9.5	20-55	29-52	40-70	85-100	-
6.7	-	-	-	-	75-100
4.75	0-10	0-10	0-15	10-30	40-80
2.36	-	-	-	0-10	0-20

TABLE 4
Grading Requirements for Coarse Aggregate, LS-602
Concrete Pavement or Concrete Base

Nominal Maximum Size	37.5 mm	19.0 mm	Combined
MTO Sieve Designation mm	Percent Passing		
53.0	100	-	100
37.5	90-100	-	95-100
26.5	20-55	100	-
19.0	0-15	85-100	35-70
9.5	0-5	20-55	10-30
4.75	-	0-10	0-5

TABLE 5
Physical Property Requirements for Coarse Aggregate

MTO or CSA Test Number	Laboratory Test	Acceptance Requirements (Note 1)	
		Pavement	Structures, Sidewalk, Curb and Gutter, and Concrete Base
LS-601 (Guideline A)	Wash Pass 75µm, % maximum - for gravel - for crushed rock	1.0 2.0	1.0 2.0
LS-604 or CSA A23.2-12A	Absorption, % maximum	2.0	2.0 (Note 2)
LS-608	Flat and Elongated Particles, % maximum	20	20
LS-609	Petrographic Number, Concrete, maximum	125	140
LS-614 or CSA A23.2-24A	Unconfined Freeze-Thaw, % maximum loss (Note 3)	6	6
LS-618 or CSA A23.2-29A	Micro-Deval Abrasion, % maximum loss	14	17 (Note 2)
LS-620 or CSA A23.2-25A	Accelerated Mortar Bar Expansion, % maximum at 14 Days (Notes 4 and 5)	0.150 (Note 6)	0.150 (Note 6)
CSA A23.2-14A	Concrete Prism Expansion Test, % maximum at one year (Notes 4 and 7)	0.040	0.040
CSA A23.2-26A	Potential Alkali-Carbonate Reactivity of Quarried Carbonate Rock (Note 8)	Chemical composition shall plot in the non-expansive field of Fig. 1 of test method	
Alternative Requirement for LS-614			
LS-606	Magnesium Sulphate Soundness Loss, 5 Cycles, % maximum (Note 3)	12	12
Notes: 1. When a concrete surface is subject to vehicular traffic, the physical requirements for "Pavement" shall apply to the aggregate used. 2. For air-cooled blast-furnace slag aggregate, the allowable maximum value for Micro-Deval shall be 21% for structures and the allowable maximum value for Absorption shall be according to the Owner's requirements for slag aggregate. 3. The Owner shall waive the requirements for LS-614, Unconfined Freeze-Thaw, provided the Contractor has submitted a written request that the coarse aggregate meet the alternative requirements for LS-606, magnesium sulphate soundness. 4. The need to demonstrate compliance with this requirement shall be waived by the Contract Administrator if the source is on the current Ontario Ministry of Transportation Regional Aggregate Sources List (ASL) for Structural Concrete Fine and Coarse Aggregates or the Aggregate Sources List of Concrete Base/Pavement Coarse Aggregates. If the aggregate is potentially expansive due to alkali-carbonate reaction, as determined by CSA A23.2-26A, the aggregate shall meet the requirements of CSA A23.2-14A, even though it may be shown as a coarse aggregate on the ASL for Structural Concrete Fine and Coarse Aggregates or the ASL for Concrete Base/Pavement Coarse Aggregates. 5. An aggregate that fails to meet these requirements shall be accepted by the Contract Administrator, provided the requirements of CSA A23.2-14A are met. 6. If the aggregate is a quarried sandstone, siltstone, granite or gneiss, the expansion shall be less than 0.080% after 14 Days. For quarried aggregates of the Gull River, Bobcaygeon, Verulam, and Lindsay Formations, the expansion shall be less than 0.100% after 14 Days. 7. An aggregate needs to meet this requirement only if it fails the requirements of either CSA A23.2-25A, or CSA A23.2-26A. The test data shall have been obtained within the past 18 months from aggregate from the same location within the source as that to be used in the Work. If this test is conducted to show that an aggregate deemed potentially expansive by CSA A23.2-26A does not exceed 0.040% after one year, then chemical analysis, CSA A23.2-26A, shall be provided to show that the aggregate intended for use has the same chemical composition as the material tested in CSA A23.2-14A. 8. This requirement only applies to aggregate quarried from the Gull River and Bobcaygeon Formations of southern and eastern Ontario. These dolomitic limestones outcrop on the southern margin of the Canadian Shield from Midland to Kingston and in the Ottawa-St. Lawrence Lowlands near Cornwall.			

TABLE 6
Sample Size

Material	Minimum Mass, kg (Note 1)
Fine aggregate	15
19 mm coarse aggregate	25
37.5 mm coarse aggregate	50
Note: 1. Individual sample containers shall hold no more than 30 kg of aggregate. When more than 30 kg is required, additional sample containers shall be used.	

Appendix 1002-A, April 2013
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



MATERIAL SPECIFICATION FOR AGGREGATES - HOT MIX ASPHALT

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APPENDICES

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1003.01 SCOPE

This specification covers material requirements for aggregates for use in hot mix asphalt (HMA).

1003.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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

1003.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

1003.02 REFERENCES

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

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, Materials

OPSS 1001 Aggregates - General

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:

- LS-282 Quantitative Extraction of Asphalt Cement and Analysis of Extracted Aggregate From Bituminous Paving Mixtures
- LS-312 Fractionation of Unextracted Reclaimed Asphalt Pavement (RAP) and Hot Mix Aggregates for Testing or Incorporation in Other Test Samples.
- LS-601 Material Finer than 75µm 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-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-616 Petrographic Analysis of Fine 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-625 Guidelines for Sampling of Granular Materials
- LS-629 Uncompacted Void Content of Fine Aggregate

- LS-630 Determination of Amount of Contamination of Coarse Aggregate
LS-631 Qualitative Determination of Presence of Plastic Fines in Aggregates

Designated Sources for Materials (DSM)

DSM #3.05.25 Asphalt - Aggregates: Coarse for Superpave 12.5 FC1, Superpave 12.5 FC2, HL1, DFC;
Fine for Superpave 12.5 FC 2, DFC

MTO Forms:

PH-D-10 Aggregate Sample Data Sheet

ASTM International

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

American Association of State Highway and Transportation Officials (AASHTO)

- T176-08 Standard Method of Test for Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test

1003.03 DEFINITIONS

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

Aggregate means as defined in OPSS 1001.

Air-Cooled Blast Furnace Slag means the material resulting from solidification of molten blast-furnace slag under atmospheric conditions. Subsequent cooling may be accelerated by application of water to the solidified surface.

Bench means a relatively horizontal ledge or platform in a quarry that forms a single level of operation above which rock is excavated from a contiguous face.

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

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

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

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

Copper Slag means the non-metallic product resulting from the production of copper.

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.

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

Hot Mix Asphalt (HMA) means as defined in OPSS 313.

Nickel Slag means the non-metallic product resulting from the production of nickel.

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

Quality Assurance (QA) means as defined in OPSS 313

Reclaimed Asphalt Pavement (RAP) means as defined in OPSS 313.

Roof Shingle Tabs (RST) means as defined in OPSS 313.

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 (SMA) means as defined in OPSS 313.

Superpave (Superpave™) means as defined in OPSS 313.

1003.05 MATERIALS

1003.05.01 General

Aggregates shall be according to OPSS 1001 and shall meet all of the requirements of this specification when tested using the applicable MTO, AASHTO, and ASTM test methods identified herein.

Except as noted below or elsewhere in the Contract Documents, aggregates may be sands, gravels, quarried rock, the aggregate portion of RST, or the aggregate portion of RAP, provided that the source or sources are of such nature and extent to ensure acceptable processed aggregates of a consistent grading and quality. When any change in the character of the aggregate occurs or when the performance of aggregate meeting the requirements of this specification is found to be unsatisfactory, use of the aggregate shall be discontinued until a reappraisal by the Contractor, with the approval of the Contract Administrator, proves the source to be satisfactory.

Steel slag, air-cooled blast furnace slag, nickel slag and copper slag are prohibited for use in HMA. RAP containing steel slag aggregate, RST containing asbestos, and post consumer shingle material shall not be permitted.

When RAP is used in HMA, it shall meet the requirements specified elsewhere in the Contract Documents and shall consist of aggregates and asphalt cement that contain no more than 0.5% by mass of any steel slag material or other contamination (e.g., wood, hydraulic cement concrete, crack sealant, earth) as determined by LS-630.

If one or more of the aggregates to be used in the mix require an anti-stripping agent, then all aggregates, with the exception of RAP or RST or both, shall be treated with the same anti-stripping agent, as specified elsewhere in the Contract Documents.

When an aggregate stockpile consists of both fine and coarse aggregate in which either component is greater than 15% by mass of the total, both the fine aggregate and coarse aggregate shall meet the respective physical property requirements of this specification. When the grading of the aggregate prevents a fine or coarse aggregate sample from being prepared to meet the requirements of a specific test method, a letter of explanation shall be provided to the Contract Administrator describing how the quality of the fine or coarse aggregate is to be assured and evaluated in the absence of testing. Such a letter is not required when the blending method option has been selected.

For Superpave 12.5FC 1, a minimum of 85% of the total combined aggregate in the mix retained on the 2.36 mm sieve shall be produced from crushed bedrock or gravel material supplied from a source named on the DSM #3.05.25.

For Superpave 12.5FC 2, both the coarse and fine aggregates in the mix shall be produced from crushed bedrock material supplied from sources named on the DSM #3.05.25. Coarse aggregate for Superpave 12.5FC 2 may be obtained from a different source than the fine aggregate. When RAP is used in Superpave 12.5FC 2, 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 for Superpave 12.5FC 2 from different sources shall not be permitted. Blending of fine aggregates for Superpave 12.5FC 2 from different sources is permitted provided that aggregate particles retained on the 4.75 mm sieve as part of the blended fine aggregate comprise less than 20% by mass of the total amount of coarse aggregate.

For SMA surface courses, both the coarse and fine aggregates shall be produced from crushed bedrock material supplied from sources shown in Table 1. In addition, both the coarse and fine aggregates shall be obtained from the same source. Aggregate derived from RST may be from a different source than the rest of the aggregates for SMA surface courses.

1003.05.02 Fine Aggregate

1003.05.02.01 Grading

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

1003.05.02.02 Physical Property Requirements

Each fine aggregate component of the mix shall be composed of clean, hard, durable particles.

Excluding fine aggregate derived from RAP or RST or both, each fine aggregate component of the mix shall meet the applicable physical property requirements shown in Table 2, unless the blending method option has been selected.

When the Contract Administrator has received a written request from the Contractor to use the blending method option, acceptance for physical properties shall be based on the total combined fine aggregate from samples taken according to the Sampling for Blending Method clause. 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%, when tested according to LS-619.

Regardless of whether or not the Contractor has requested to use the blending method option, when RAP or RST or both is used in the mix, the fine aggregate fraction of the combined aggregates extracted from samples of HMA shall meet the applicable physical property requirements shown in Table 6.

1003.05.02.03 Consensus Property Requirements

The fine aggregate portion of the combined HMA aggregate including aggregate derived from RAP or RST or both that have been properly fractionated and proportioned according to LS-312 and the mix design, shall meet the consensus property requirements for AASHTO T176-08 and LS-629 shown in Table 3 for the traffic category specified elsewhere in the Contract Documents. However, for AASHTO T176-08 only, the combined fine aggregate portion shall exclude any fine aggregate that is derived from RAP or RST or both.

1003.05.03 Coarse Aggregate

1003.05.03.01 Grading

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

1003.05.03.02 Physical Property Requirements

Except when the blending method option has been selected, each coarse aggregate component shall respectively meet the physical property requirements shown in Table 4 for surface course mixes and Table 5 for binder or levelling course mixes.

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

- a) The chip product is derived from one of the following:
 - i. For Superpave 12.5FC 2, SMA 12.5 or SMA 9.5, from the same source as the primary coarse aggregate used in the mix.
 - ii. For Superpave 12.5FC 1, from an aggregate source listed on the DSM #3.05.25.
 - iii. For all other mixes, either from an aggregate source listed on the DSM #3.05.25 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% by mass of the total cumulative combined coarse aggregate fraction of the mix including any aggregate derived from RAP.

When the blending method option has been selected, acceptance for physical properties shall be based on the total combined coarse aggregate fraction from samples obtained according to the Sampling for Blending Method clause. In this case, the coarse aggregate fraction of the blended samples excluding RAP, shall respectively meet the requirements shown in Table 4 for surface course mixes or in Table 5 for binder or levelling course mixes.

Regardless of the method selected for QA acceptance, when RAP is used in the mix, the coarse aggregate fraction of the combined aggregates extracted from samples of HMA shall meet the applicable physical property requirements shown in Table 6.

1003.05.03.03 Consensus Property Requirements

The coarse aggregate portion of the combined HMA aggregate, including any coarse aggregate derived from RAP that has been properly fractionated and proportioned according to LS-312 and the mix design, shall meet the consensus property requirements according to ASTM D 4791 and ASTM D 5821 shown in Table 3, for the traffic category specified elsewhere in the Contract Documents.

1003.05.04 Filler

Filler shall consist of mineral filler, hydrated lime, Portland cement, or other material as specified and currently approved by the Owner for use in HMA. For SMA, the filler shall be mineral filler.

Mineral filler shall be produced from rock sources acceptable for coarse aggregates meeting the physical property requirements shown in Table 4. Mineral filler shall be sufficiently dry that it flows freely, be free from agglomerations, be non-plastic according to LS-631, as well as inert. Mineral filler shall also meet the following grading requirements according to LS-601 and LS-602:

- a) 100% passing the 600 µm sieve.
- b) Not less than 70% passing the 75 µm sieve.

In addition, the mineral filler for SMA mixes shall be of grading and properties to be capable of producing asphalt mortar properties meeting the appropriate requirements as specified elsewhere in the Contract Documents.

1003.07 PRODUCTION

1003.07.01 Aggregate Processing, Handling, and Stockpiling

Aggregates separated during processing, aggregates secured from different sources, and aggregates from the same source, but of different gradings, shall be stockpiled separately. When screenings from primary and secondary crushers are produced separately, they shall be stockpiled separately.

Aggregates that have become mixed with foreign material of any description, or aggregates from different stockpiles that have become mixed with each other, shall not be used and shall be removed from the stockpile immediately.

Aggregates shall be retained in stockpiles for at least 24 hours prior to use. Suitable stockpile locations are the site of mixing of the HMA, the aggregate source, or any other location acceptable to the Contract Administrator.

1003.08 QUALITY ASSURANCE

1003.08.01 General

The laboratory designated by the Owner may carry out QA testing for purposes of ensuring that aggregates used in the Work conform to the physical property, consensus property, and grading requirements of this specification. The Owner shall be responsible for all costs associated with testing for QA purposes, unless otherwise indicated in this specification. Individual test results shall be forwarded to the Contractor, as they become available.

When an anti-stripping agent is used, test samples for physical property requirements shall be taken prior to the addition of the anti-stripping agent. If this is not practical for samples that are coated in hydrated lime, the lime shall be removed by washing prior to testing. In this case, the requirements for LS-601 are waived.

1003.08.02 Alternative to LS-614

LS-614 shall be used for acceptance, unless written notification to the Contract Administrator to replace it with LS-606 for acceptance is received prior to sampling of the applicable materials for QA purposes. Provided that the Contract Administrator has received such a request, LS-606 shall be used. Otherwise, conformance to LS-614 shall be required.

When notification to replace LS-614 is received after QA testing using LS-614 has been initiated, the Contractor shall then be charged \$600.00 for each test initiated, which includes the cost of the testing using LS-614, administrative charges, and additional sampling, if required.

1003.08.03 Blending Method Option

The Contractor may select to have QA acceptance of the total combined aggregate conducted according to the blending method.

The blending method option shall only be available if the Contractor provides appropriate facilities and equipment for QA sampling.

To select this method, the Contractor shall notify the Contract Administrator in writing along with a description of the sampling facilities and equipment a minimum of 2 Business Days prior to paving.

When the blending method option has been selected, sampling shall be according to the Sampling for Blending Method clause.

1003.08.04 Sampling

Unless otherwise specified, all QA aggregate samples shall be taken at the hot mix plant from individual stockpiles, according to the Stockpile Method clause. Each QA sample shall be treated as discrete samples and not combined or blended with any other sample. In the absence of individual stockpiles at the plant, QA samples shall be taken at the aggregate source.

All samples shall be duplicate samples.

The Contractor shall provide new or clean sample bags or containers that are constructed to prevent the loss of any part of the material or contamination or damage to the contents during shipment. Metal or cardboard containers are unacceptable for samples of aggregates. QA samples shall be identified both inside and outside of the sample container. Data to be included with QA samples shall be according to MTO Form PH-D-10.

For every lot of 20,000 tonnes or part thereof of each HMA mix during production, at least one set of duplicate QA samples of each aggregate used in the mix shall be randomly obtained. In addition, when RAP or RST or both are included in the mix, one duplicate QA sample of the following shall also be obtained:

- a) RAP
- b) RST
- c) HMA

In the event that the Contractor is unavailable to take any of the samples, no further materials shall be placed in the Work until they have been taken. The Contract Administrator shall seal each QA sample container at the time and place of sampling.

In addition to the duplicate samples taken for QA purposes, a third sample shall be taken for Superpave 12.5FC 1, Superpave 12.5FC 2, SMA 9.5, and SMA 12.5 aggregates at the time the QA samples are taken. These additional samples shall be shipped, no later than one Business Day from the date of sampling to the MTO Soils and Aggregates Section, Materials Engineering and Research Office, Room 15, Building C, 1201 Wilson Avenue, Downsview, Ontario M3M 1J8.

During the production of each lot of SMA surface course mix, the Contractor shall obtain a random sample of both the mineral filler and the baghouse fines, minimum 2 kg of each material, and ship the samples no later than one Business Day from the date of sampling to the MTO Soils and Aggregates Section at the address provided above. Each sample shall be shipped in a triple-sealed metal container of suitable size, which shall be properly identified, and shall include the name of the paving Contractor, highway, lot number, and the contact information of the person responsible for the sampling.

The Contractor shall deliver all samples to the appropriate laboratory in a condition that is suitable for testing.

One of the duplicate QA samples shall be randomly selected for testing by the QA laboratory. The QA laboratory shall retain the remaining sample for referee testing, if required.

1003.08.04.01 Sample Size

The mass of the each QA sample shall meet the requirements shown in Table 7. When more than 30 kg of material is required, the total sample shall be recombined prior to testing.

1003.08.04.02 Stockpile Method

The stockpiles from which the QA samples are to be taken shall contain a minimum quantity of 500 tonnes of each aggregate, or at least 10% of the total quantity of aggregate needed for each HMA mix, unless otherwise directed by the Contract Administrator. QA sampling from stockpile shall be according to LS-625.

1003.08.04.03 Sampling for Blending Method

When the blending method option has been selected, QA samples of the blended aggregates to be used in the Work, excluding RAP, shall be taken at the hot mix plant from the cold feed, prior to the addition of liquid asphalt cement. Cold feed samples shall be taken at a time determined by the Contract Administrator.

Suitable facilities for cold feed sampling of blended aggregates include:

- a) A belt sweep sampler.
- b) A sample box capable of passing under the discharge end of a conveyor belt.
- c) Reversing the direction of movement of a secondary belt feeding into the aggregate drier and capturing material in a bucket of a loader.
- d) Stopping the belt and completely removing all material from a sufficient length of belt by scooping, followed by sweeping with a fine brush to capture all materials.
- e) Other suitable sampling facilities acceptable to the Owner.

Such noted techniques may require reducing the aggregate to appropriate sample size according to LS-625.

1003.08.05**Acceptance**

The aggregates within a lot of HMA shall be deemed to be acceptable if all of the test results for the samples of aggregates representing that lot meet all applicable requirements of this specification.

If a tested sample of aggregates representing a lot of HMA does not meet all of the requirements of this specification, then a reduced price payment of 10% of the tender price shall be given for each tonne of HMA left in the Work that includes any of the aggregates within that lot, as long the applicable test results for that sample:

- a) Do not exceed the requirement for LS-614, or LS-606 if it has been accepted by the Owner as an alternative to LS-614, by more than 25% of the specified value.
- b) Do not exceed the requirement for LS-618 by more than 10% of the specified value.
- c) Do not exceed the requirement for LS-619 by more than 15% of the specified value.
- d) Meet all other requirements of this specification.

Should the test results for any sample of aggregates representing a lot of HMA not meet the requirements listed above, then all of the aggregates within that lot shall be considered rejectable and any HMA that includes those aggregates shall be removed from the Work at no cost to the Owner.

Irrespective of a reduced price payment, the warranty provisions of the Contract Documents shall apply.

1003.08.06**Referee Testing**

The Contractor may invoke referee testing for one or more attributes by submitting a written request to the Contract Administrator, within 5 Business Days following notification that the aggregate does not meet the requirements of this specification.

Referee testing shall be carried out, as specified herein and elsewhere in the Contract Documents.

The retained duplicate QA sample shall be used for referee testing.

All referee test results for a lot shall replace the respective QA tests for acceptance of the applicable lot and shall be binding on both the Owner and the Contractor.

If a lot is not accepted at full payment based on the referee test results, then the Contractor shall be responsible for the cost of the referee testing of that lot, including the cost of transporting the samples to the referee laboratory, at the rates specified elsewhere in the Contract Documents. In all other cases, the Owner shall bear the cost of the referee testing and the cost of transporting the samples of that lot.

TABLE 1
SMA Surface Courses - 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

Table 2
Physical Property Requirements for HMA Fine Aggregates

MTO Laboratory Test Number	MTO Laboratory Test	SMA 9.5 and 12.5; and Superpave 12.5FC 2	Superpave 12.5FC 1	SMA 19.0; and Superpave 9.5, 12.5, 19.0, 25.0, and 37.5
LS-613	Acid Insoluble Residue for retained 2.36 mm fraction, minimum % retained on 75µm sieve	-	-	60 (Note 1)
LS-619	Micro-Deval Abrasion, % maximum loss (Note 2)	15	20	25
LS-631	Plastic Fines	NP	NP	NP

Notes:

1. The requirements listed below are only applicable to surface courses placed in the Thousand Islands Parkway; Highway 33 from west of Bath to Picton; Highway 35 from County Road 121 northerly to Norland; and 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 the fine aggregate for use in a surface course mix is obtained from a gravel pit or quarry source which contains any carbonate rock types (e.g., limestone, dolostone, etc.) then blending with aggregate from non-carbonate rock types shall be required to increase the acid insoluble residue content to meet the minimum 60% requirement for the fraction retained on the 2.36 mm sieve. The method used for blending shall produce a uniform blend and 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.
2. When the blending method option has been selected, this requirement applies to the total fine aggregate blend. In addition, when the blending method option has been selected, the Micro-Deval abrasion loss for each individual fine aggregate in stockpile, prior to blending, shall not exceed 35%.

Table 3
Consensus Property Requirements for HMA Coarse and Fine Aggregates,
Including RAP or RST or Both

Traffic Category	Fine Aggregate			Coarse Aggregate		
	AASHTO T176 Sand Equivalent Method 1, % minimum (Note 1)	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 (Note 3)	
		≤100mm (Note 2)	>100mm (Note 2)		≤100mm (Note 2)	>100mm (Note 2)
A	40	-	-	-	55/-	-/-
B	40	40	40	10	75/-	50/-
C	45	45 (Note 4)	40		85/80	60/-
D	45	45 (Note 4)	40		95/90	80/75
E	50	45 (Note 4)	45 (Note 4)		100/100	100/100

Notes:

1. When the total combined fine aggregate includes aggregate derived from RAP or RST or both, this requirement shall be met prior to blending with RAP or RST or both.
2. Denotes the depth of the top of lift below the 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.
3. 85/80 denotes that 85% of the coarse aggregate has one fractured face and 80% has two or more fractured faces.
4. An uncompacted void content of 43% is acceptable provided that the selected mix satisfies the mix volumetrics specified elsewhere in the Contract Documents.

Table 4
Physical Property Requirements for HMA Coarse Aggregates for Surface Courses,
SMA 9.5 and 12.5; and Superpave 9.5, 12.5, 12.5FC 1, and 12.5FC 2

MTO Laboratory Test Number	Laboratory Test	Superpave 9.5 and 12.5	Aggregate Type			
			Gravel (Superpave 12.5FC 1 only)	Quarried Rock (SMA 9.5 and 12.5; and Superpave 12.5FC 1 and 12.5FC 2)		
				Dolomitic Sandstone	Traprock, Diabase, Andesite	Meta-arkose, Meta-gabbro, Gneiss, Granite
LS-601	Wash Pass 75µm sieve, Guideline B, % maximum loss	1.3 (Note 1)	1.0	1.0	1.0	1.0
LS-604	Absorption, % maximum	2.0	1.0	1.0	1.0	1.0
LS-608 (Note 2)	Flat and Elongated Particles, % maximum (4:1)	20	15	15	15	15
LS-609, Part A	Petrographic Number (HL), maximum	(Note 3)	120	145	120	145
LS-613	Acid Insoluble Residue retained 75µm sieve, % minimum	-	-	45 (Note 4)	-	-
LS-614	Unconfined Freeze-Thaw, % maximum loss	6 (Note 5)	6	7	6	6
LS-618	Micro-Deval Abrasion, % maximum loss	17	10	15	10	15
Alternative Requirement for LS-614						
LS-606	Magnesium Sulphate Soundness, % maximum loss	12 (Note 5)	-			

Notes:

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.
2. These requirements shall be waived if RAP is included in the surface course and LS-608 is being carried out on the fraction of the combined aggregates retained on the 4.75 mm sieve, as required in Table 6.
3. The requirements listed below are only applicable to surface courses placed in the Thousand Islands Parkway; Highway 33 from west of Bath to Picton; Highway 35 from County Road 121 northerly to Norland; and 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 the coarse aggregate for use in a surface course mix is obtained from a gravel pit or quarry containing more than 40% carbonate rock types (e.g., limestone, dolostone, etc.) then blending with aggregate from non-carbonate rock types shall be required to increase the minimum non-carbonate rock type content of the coarse aggregate to 60%, as determined by petrographic examination (LS-609). In cases of dispute, LS-613 shall be used with a minimum acid insoluble residue of 60%. The method used for blending shall produce a uniform blend and be subject to approval by the Owner.
 - b) When the coarse aggregate for use in a surface course mix is obtained from a non-carbonate source, blending with carbonate rock types is not permitted.
4. This requirement shall be waived, if RAP is included in the mix and LS-613 is being carried out on the fraction of the combined aggregates retained on the 4.75 mm sieve, as required in Table 6.
5. For Superpave 9.5 and 12.5, the Owner shall waive the requirements for LS-614, Unconfined Freeze-Thaw, provided the Contractor has submitted a written request that the coarse aggregate meet the alternative requirements for LS-606, Magnesium Sulphate Soundness.

Table 5
Physical Property Requirements for HMA Coarse Aggregates for Binder Courses,
SMA 19.0; and Superpave 9.5, 12.5, 19.0, 25.0, and 37.5

MTO Test Number	Laboratory Test	SMA 19.0; and Superpave 9.5, 12.5 19.0, 25.0, and 37.5
LS-601	Wash Pass 75µm sieve, Guideline B, % maximum	1.3 (Note 1)
LS-604	Absorption, % maximum	2.0
LS-608	Flat and Elongated Particles, % maximum (4:1)	20 (Note 2)
LS-614	Unconfined Freeze-Thaw, % maximum loss (Note 3)	15
LS-618	Micro-Deval Abrasion, % maximum loss	21
Alternative Requirement for LS-614		
LS-606	Magnesium Sulphate Soundness, % maximum loss (Note 3)	15
Notes: 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. 2. This requirement shall be waived if RAP is included in the binder course and LS-608 is being carried out on the fraction of the combined aggregates retained on the 4.75 mm sieve, as required in Table 6. 3. The Owner shall waive the requirements for LS-614, Unconfined Freeze-Thaw, provided the Contractor has submitted a written request that the coarse aggregate meet the alternative requirements for LS-606, Magnesium Sulphate Soundness.		

Table 6
Physical Property Requirements for Coarse and Fine Aggregates
When RAP or RST or Both is Incorporated in HMA

MTO Test Number	Laboratory Test	Surface Course			Binder Course
		SMA 9.5 and 12.5 (Note 1) and Superpave 12.5FC 2	Superpave 12.5FC 1	Superpave 9.5 and 12.5	SMA 19.0; and Superpave 9.5, 12.5, 19.0, 25.0, and 37.5
Bulk RAP/RST Sample Contamination Assessment					
LS-630 (Note 2)	Contamination, % maximum	0.5	0.5	0.5	0.5
Aggregates Extracted From Samples of HMA (Note 3)					
Combined Aggregates Passing the 4.75 mm Sieve					
LS-613	Acid Insoluble Residue for retained 2.36 mm fraction, minimum % retained on 75µm sieve	-	-	60 (Note 4)	-
LS-616, Part B (Note 5)	Petrographic analysis, minimum % of Category 1 retained on 2.36 mm sieve	90	85	-	
	Petrographic analysis, minimum % of Category 1 retained on 1.18 mm sieve	85	-	-	
Combined Aggregates Retained on the 4.75 mm Sieve					
LS-608	Flat and Elongated Particles, % maximum (4:1),	15	15	20	20
LS-609, Part B (Note 5)	Petrographic Analysis, minimum % of Category 1 retained on 4.75 mm sieve	95	-	-	-
	Petrographic Analysis, minimum % of Category 1 and/or Category 4 retained on 4.75 mm sieve	-	95	-	
	Petrographic Analysis, maximum % of Category 2 retained on 4.75 mm sieve	-	-	40 (Note 4)	
LS-613	Acid Insoluble Residue, minimum % retained on 75µm sieve	45 (Note 6)	45 (Note 6)	60 (Note 4)	-

Notes:

1. RAP is not allowed in SMA surface courses.
2. LS-630 shall be carried out with the following modifications:
 - a) A minimum 5 kg test sample of RAP, inclusive of any fine aggregate fractions, shall be obtained by splitting a representative sample that was obtained according to LS-625;
 - b) The RAP sample shall not be immersed in water but, instead, shall be dried at 40 °C for 24 hours;
 - c) The dry RAP test sample (coarse and fine fractions) shall be visually examined as a whole, any contaminants manually removed, if present, and the total and percentage by mass of the contaminants that are present shall be reported.
3. All of the aggregates used for the following tests shall be extracted from hot mix using LS-282 and then split on the 4.75 mm sieve, prior to testing.
4. The requirements listed below are only applicable to surface courses placed in the Thousand Islands Parkway; Highway 33 from west of Bath to Picton; Highway 35 from County Road 121 northerly to Norland; and 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 the aggregate fraction passing the 4.75 mm sieve contains any carbonate rock types (e.g., limestone, dolostone, etc.) then blending with aggregate from non-carbonate rock types shall be required to increase the acid insoluble residue content to meet the minimum requirement of 60% for the fraction retained on the 2.36 mm sieve. The method used for blending shall produce a uniform blend and be subject to approval by the Owner
 - b) When the aggregate fraction retained on the 4.75 mm sieve contains more than 40% carbonate rock types (e.g., limestone, dolostone, etc.) then blending with aggregates from non-carbonate rock types shall be required. The blend shall increase the non-carbonate rock type content of the coarse aggregate to a minimum of 60% of the retained 4.75 mm portion, as determined by petrographic examination (LS-609). The method used for blending shall produce a uniform blend and be subject to approval by the Owner. In cases of dispute over carbonate content, LS-613 shall be carried out and a minimum acid insoluble residue of 60% obtained.
5. Acceptable rock types/lithologies that are present shall include lithologies that are consistent with the following aggregates for surface courses listed on DSM #3.05.25:
 - a) Category 1 aggregates or their acceptable major mineral components or both listed in Table 1 of LS-616 Part B for fine aggregates.
 - b) Category 1 aggregates listed in Table 2 of LS-609 Part B, for coarse aggregates used in Superpave 12.5FC 2.
 - c) Category 1 or Category 4 aggregates listed in Table 2 of LS-609 Part B, for coarse aggregates used in Superpave 12.5FC 1.
6. This requirement shall apply when the aggregate fraction retained on the 4.75 mm sieve contains any aggregate that's been derived from dolomitic sandstone.

Table 7
Field Sample Size

Material	Minimum Mass, kg (Note 1)
Fine aggregate	15
Coarse aggregate	25
RAP	10
RST	5
Combined coarse and fine aggregate sampled from the cold feed, prior to the addition of asphalt cement.	45
Filler/ Baghouse Fines	2
Hot Mix Asphalt	25
Note: 1. Individual sample containers shall hold no more than 30 kg of aggregate. When more than 30 kg is required, additional sample containers shall be used.	

Appendix 1003-A, April 2013
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



MATERIAL SPECIFICATION FOR AGGREGATES - MISCELLANEOUS

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APPENDICES

1004-A	Commentary
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1004.01 SCOPE

This specification covers material requirements for aggregates for use as clear stone, granular sheeting, gabion stone, mortar sand, rip-rap, rock protection, truck arrester bed aggregate and winter sand.

1004.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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

1004.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

1004.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Material

OPSS 1001 Aggregates - General
OPSS 1010 Aggregates - Base, Subbase, Select Subgrade and Backfill Material

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:

LS-601 Materials 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-607 Determination of Percent Crushed Particles in Processed Coarse Aggregate
LS-608 Determination of Percent Flat and Elongated Particles in Coarse Aggregate
LS-610 Organic Impurities in Sands for Concrete
LS-614 Freezing and Thawing of Coarse Aggregate
LS-616 Petrographic Analysis of Fine 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-625 Guidelines for Sampling of Aggregate Materials
LS-631 Determination of Presence of Plastic Fines in Aggregates

MTO Forms:

PH-D-10 Aggregate Sample Data Sheet

ASTM International

C 87/87M-10 Effect of Organic Impurities in Fine Aggregate on Strength of Mortar
D 6473-10 Standard Test Method for Specific Gravity and Absorption of Rock for Erosion Control

1004.03 DEFINITIONS

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

Clear Stone means a graded aggregate intended for use in drainage, backfill, bedding, and other applications.

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.

Gabion Stone means a graded fractured rock aggregate intended for use in gabion baskets and gabion mats.

Granular Sheetting means a graded granular aggregate material intended for use as a protective surface layer on erodible soil slopes.

Mortar Sand means a fine aggregate intended for application in Portland cement based mortars.

Nominal Maximum Size means the largest sieve in the applicable specification upon which material is permitted to be retained.

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.

Pit-Run Material means material excavated directly from an existing bank in a pit and delivered to the job site without further processing, i.e., crushing, screening, washing, and classifying.

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

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

Rip-Rap means a well graded, fractured rock or crushed reclaimed concrete intended for use as slope protection in hydraulic channels.

Rock Protection means a well graded, fractured rock or crushed reclaimed concrete intended for use as general slope protection.

Spheroidal Particle means when the ratio of the greatest dimension in the longitudinal axis compared to the least dimension in a plane perpendicular to the longitudinal axis is less than 2:1.

Truck Arrester Bed Aggregate means a single-sized aggregate used in runaway truck lanes to slow and stop the progress of vehicles.

Winter Sand means a fine aggregate intended for application to roadways during winter conditions to improve frictional properties of the pavement surface.

1004.05 MATERIALS

1004.05.01 General

The requirements of OPSS 1001 shall apply to this specification.

All aggregate source materials shall be clean, hard, durable particles free of earth, humus, clay or other coatings, clay lumps, shale or shaley partings and other deleterious materials. Aggregates may be sands, gravels, cobbles, boulders, or quarried rock. Reclaimed asphalt pavement, reclaimed hydraulic cement concrete, glass, other reclaimed materials, and slag materials shall not be used. When reclaimed materials are permitted by this specification or specified in the Contract Documents, they shall be homogeneously blended. When reclaimed hydraulic cement concrete is permitted, it shall not contain loose reinforcing material and shall be free of protruding metal.

When any change in the character of the aggregate occurs or when the performance of aggregate meeting the requirements of this specification is found to be unsatisfactory, use of the aggregate shall be discontinued until a reappraisal by the Contractor, with the approval of the Contract Administrator, proves the source to be satisfactory.

Irrespective of compliance or non-compliance with the gradation and physical property requirements of this specification, aggregates may be accepted or rejected on the basis of field performance, as determined by the Owner.

1004.05.02 Clear Stone

Clear stone may be 53.0 mm, 19.0 mm Type I, 19.0 mm Type II, 16.0 mm, 13.2 mm, or 9.5 mm and shall meet the physical property requirements shown in Table 1 and the gradation requirements shown in Table 2.

1004.05.03 Granular Sheetting

Granular sheetting shall meet the physical property requirements shown in Table 3 and the gradation requirements shown in Table 4.

1004.05.04 Mortar Sand

Mortar sand shall consist of natural sand, or with the approval of the Contract Administrator, other inert materials with similar characteristics, or combinations thereof, having hard, strong, durable particles.

Mortar sand shall meet the physical property requirements shown in Table 5 and the gradation requirements shown in Table 6.

1004.05.05 Gabion Stone, Rip-Rap and Rock Protection

Gabion stone, rip-rap and rock protection shall be produced from crushed or fractured bedrock fragments with 100% fractured faces or crushed from cobbles or boulders greater than 300 mm diameter and shall not deteriorate when exposed to air and water and shall be resistant to deterioration by cycles of wetting, drying, freezing, and thawing.

Reclaimed hydraulic cement concrete may be used in non-watercourse applications.

Gabion stone, rip-rap and rock protection shall meet the physical property requirements shown in Table 7 and the gradation requirements shown in Table 8.

1004.05.06 Truck Arrester Bed Aggregate

Truck arrester bed aggregate shall be pit-run material meeting the physical property requirements shown in Table 9 and the gradation requirements shown in Table 10. In addition, truck arrester bed aggregate shall meet the following shape requirements:

- a) Rounded particles shall be a minimum of 30% by mass. Rounded particles shall be determined by the procedure given in LS-607, reporting the percentage of rounded particles instead of crushed particles. The test specimen size shall be a minimum of 3,000 g passing the 26.5 mm sieve and retained on the 19 mm sieve.
- b) Spheroidal particles shall be a minimum of 50% by mass. Spheroidal particles shall be determined by the procedure given in LS-608, using a figure-eight calliper in which the ratio of the opening at one end to that at the other end is 2:1 instead of 4:1. The test specimen size shall be a minimum of 3,000 g passing the 26.5 mm sieve and retained on the 19 mm sieve.

1004.05.07 Winter Sand

Winter sand shall meet the physical property requirements shown in Table 11 and the gradation requirements shown in Table 12.

1004.07 PRODUCTION

1004.07.01 Aggregate Processing, Handling, and Stockpiling

Aggregates separated during processing shall be placed in individual stockpiles. Processed aggregates secured from different sources and aggregates from the same source but of different gradations shall be placed in individual stockpiles.

Aggregates that have become mixed with foreign matter of any description or aggregates from different stockpiles that have become mixed with each other shall not be used and shall be removed from the stockpile immediately.

1004.08 QUALITY ASSURANCE

1004.08.01 General

Each aggregate, with the exception of mortar sand, shall be randomly sampled in lots according to Table 13.

When the quantity of aggregate material is insufficient for a complete lot and the quantity is:

- a) Less than one-half the quantity of a complete lot, then that quantity shall be added to the previous lot.
- b) Greater than or equal to one-half the quantity of a complete lot, then that quantity shall form its own lot.

Mortar sand shall be sampled and tested at the discretion of the Contract Administrator.

The Contract Administrator shall be allowed access to all sampling locations.

The laboratory designated by the Owner shall carry out testing for purposes of ensuring that aggregates used in the Work are according to the physical property and grading requirements of this specification. The Owner shall be responsible for all costs associated with testing for QA purposes, unless otherwise indicated in this specification. Individual test results shall be forwarded to the Contractor, as they become available.

Test data for each aggregate type shall be managed independently. When more than one source is used for supplying material, test data from each source and product shall be managed independently.

1004.08.02 Sampling

Sampling shall be according to LS-625 and taken at the time and location determined by the Contract Administrator. Samples shall be of sufficient mass to conduct the necessary gradation and physical property tests of the material. Minimum sample sizes for most aggregate types shall be according to Table 14.

Unless otherwise indicated, all QA samples shall be taken from individual stockpiles at the source. Each QA sample shall be treated as a discrete sample and not combined or blended with any other sample. When material contains blended or reclaimed aggregates or both, QA sampling shall be performed on the final blended product.

All samples shall be duplicate samples.

The Contractor shall provide new or clean sample bags or containers that are constructed to prevent the loss of any part of the material or contamination or damage to the contents during shipment. Metal or cardboard containers are unacceptable. QA samples shall be identified both inside and outside of the sample container. Data to be included with QA samples shall be according to the requirements of MTO Form PH-D-10.

At least one set of QA samples shall be obtained for each aggregate used in the Work. The Contract Administrator shall seal each QA sample container at the time and place of sampling.

The Contractor shall deliver all samples to the appropriate laboratory in a condition that is suitable for testing.

1004.08.03 Testing and Retention of Samples

When the Contract Administrator has elected to carry out QA testing, one of the duplicate samples shall be randomly selected for testing by the QA laboratory. The QA laboratory shall retain the remaining sealed sample for possible referee testing, if required.

1004.08.03.01 Winter Sand

Following delivery, winter sand shall be subject to a visual inspection of the stockpile to determine the presence of oversize material. Oversize particles may be confirmed with a 9.5 mm sieve.

1004.08.04 Acceptance

QA test results shall be used for acceptance purposes, except when referee testing of any aggregate or a visual examination of winter sand has been carried out.

When QA test results show that the material meets the applicable gradation and physical property requirements of this specification, the material shall be accepted.

When QA test results show that the material does not meet the applicable requirements of this specification, then all the aggregates in that lot shall be considered rejectable and removed from the Work at no cost to the Owner.

The Contract Administrator shall notify the Contractor that material represented by the test result shall not be accepted. This notification shall take place in writing within 3 Business Days of receipt of the non-conforming data.

1004.08.05 Referee Testing

The Contractor may invoke referee testing for one or more attributes by submitting a written request to the Contract Administrator, within 5 Business Days following notification that the aggregate does not meet the requirements of this specification.

Referee testing shall be carried out, as specified herein and elsewhere in the Contract Documents.

The retained duplicate QA sample shall be used for referee testing.

All referee test results for a lot shall replace the respective QA tests for acceptance of the applicable lot and shall be binding on both the Owner and the Contractor.

If a lot is not accepted at full payment based on the referee test results, then the Contractor shall be responsible for the cost of the referee testing of that lot, including the cost of transporting the samples to the referee laboratory, at the rates specified elsewhere in the Contract Documents. In all other cases, the Owner shall bear the cost of the referee testing and the cost of transporting the samples of that lot.

TABLE 1
Physical Property Requirements for Clear Stone

MTO Laboratory Test	MTO Test Number	Nominal Maximum Size			
		53 mm	19 mm		16 mm, 13.2 mm, and 9.5 mm
			Type I	Type II	
Wash Pass 75 µm Sieve, Guideline B, % maximum	LS-601	2.0	2.0	2.0	2.0
Percent Crushed Particles, % minimum	LS-607	-	50	60	60
Micro-Deval Abrasion, Coarse Aggregate, % maximum loss	LS-618	25	25	25	25

TABLE 2
Gradation Requirements for Clear Stone

Sieve Size	Gradation (LS-602), Percent Passing					
	Nominal Maximum Size					
	53 mm	19 mm		16 mm	13.2 mm	9.5 mm
		Type I	Type II			
63 mm	100	-	-	-	-	-
53 mm	90 - 100	-	-	-	-	-
26.5 mm	-	100	100	-	-	-
19.0 mm	0 - 15	90 - 100	90 - 100	100	-	-
16.0 mm	-	-	65 - 90	96 - 100	100	-
13.2 mm	-	-	-	67 - 86	96 - 100	100
9.5 mm	-	0 - 55	20 - 55	29 - 52	50 - 73	95 - 100
6.7 mm	-	-	-	-	-	20 - 45
4.75 mm	-	0 - 10	0 - 10	0 - 10	0 - 10	0 - 10
75 µm	0 - 2.0	0 - 2.0	0 - 2.0	0 - 2.0	0 - 2.0	0 - 2.0

TABLE 3
Physical Property Requirements for Granular Sheeting

MTO Laboratory Test	MTO Test Number	Requirement
Petrographic Requirement, Fine Aggregate, Part A	LS-616	(Note 1)
Micro-Deval Abrasion, Coarse Aggregate, % maximum loss (Note 2)	LS-618	30
Micro-Deval Abrasion, Fine Aggregate, % maximum loss	LS-619	35
Plastic Fines	LS-631	NP

Notes:

1. For materials north of the French/Mattawa Rivers only: For materials with > 4.0% passing the 75 µm sieve, the amount of mica passing the 150 µm sieve and retained on the 75 µm sieve shall not exceed 10% of the material on that sieve. Prior data demonstrating compliance with this requirement shall be acceptable provided that such testing has been done within the past 5 years and the Contractor can show to the satisfaction of the Owner that field performance has continued to be acceptable.
2. The requirement for the coarse aggregate Micro-Deval abrasion loss test shall be waived if the material has more than 80% passing the 4.75 mm sieve.

TABLE 4
Gradation Requirements for Granular Sheeting

Sieve Size	Gradation (LS-602), Percent Passing
150 mm	100
26.5 mm	50 - 100
13.2 mm	35 - 100
9.5 mm	-
4.75 mm	20 - 80
1.18 mm	10 - 50
300 µm	5 - 25
150 µm	0 - 15
75 µm	0 - 8.0

TABLE 5
Physical Property Requirements for Mortar Sand

MTO Laboratory Test	Test Number	Requirement
Organic Impurities, Organic Plate Number	LS-610	3 (Note 1)
Mortar Strength Test	ASTM C 87/C87M	(Note 2)
Notes: 1. When the fine aggregate for use as mortar sand is subjected to this test, it shall not produce a darker colour than the standard solution or Organic Plate Number 3. However, a fine aggregate failing this test may be approved by the Owner, if it meets the requirements of the Mortar Strength Test according to ASTM C 87. 2. Mortar specimens comprised of fine aggregate for use as Mortar Sand and hydraulic cement shall develop a compressive strength at the age of 7 Days, of not less than 90% of the strength developed by a mortar prepared in the same manner, with the same cement and with graded Ottawa sand having a fineness modulus of 2.40 ± 0.10.		

TABLE 6
Gradation Requirements for Mortar Sand

Sieve Size	Gradation (LS-602), Percent Passing
4.75 mm	100.0
2.36 mm	95 - 100
1.18 mm	60 - 100
600 µm	35 - 80
300 µm	15 - 50
150 µm	2 - 15
75 µm	0 - 5.0

TABLE 7
Physical Property Requirements for Gabion Stone, Rip-Rap and Rock Protection

MTO Laboratory Test	Test Number	Gabion Stone and Rip-Rap	Rock Protection
Specific Gravity, minimum	ASTM D 6473 (Note 1)	2.50	2.50
Absorption, % maximum		2.0	2.0
Flat and Elongated Particles, % maximum	LS-608 (Note 2)	15	15
Micro-Deval Abrasion Coarse Aggregate, Grading A % maximum loss	LS-618 (Note 3)	25	25

Notes:

1. These requirements shall be based on the average test results for at least 5 pieces of rock when the source is macroscopically uniform or at least 8 pieces of rock when the source is macroscopically non-uniform. In addition, no individual piece of tested rock shall have a specific gravity less than 2.30 or an absorption greater than 3.5%.
2. These requirements shall be based on measurements taken of at least 20 randomly-chosen pieces of rock either in stockpile at the source or after being delivered to the site.
3. Testing using LS-618 may be carried out on another aggregate product that is being simultaneously produced from the same crushing stage as Rip-Rap, Gabion Stone or Rock Protection, as long as the other aggregate product being produced is sufficient for sampling and testing, according to the requirements of the procedure. As an example, if the Contractor can show that both Rip-Rap and Granular A which meets the requirements of OPSS 1010, are being simultaneously produced from a primary crusher, a sample of the Granular A may be used for acceptance testing, in-lieu of testing a sample of Rip-Rap.

TABLE 8
Gradation Requirements for Gabion Stone, Rip-Rap and Rock Protection

Mass kg	Approximate Dimension of an Equivalent Cube in cm (Note 1)	Gradation, percent less than mass specified (Note 2)				
		Gabion Stone		Rip-Rap		Rock Protection
		G-3	G-10	R-10	R-50	
330	50.0	-	-	-	-	100
75	30.5	-	-	-	100	↑ Well-Graded ↓
50	26.5	-	-	-	70 - 90	
25	21.0	-	-	-	40 - 55	
15	18.0	-	100	100	-	
10	15.5	-	90 - 100	70 - 90	-	
5	12.5	100	-	40 - 55	-	0 - 10
3	10.5	90 - 100	-	-	-	
2.5	10.0	-	0 - 5	-	0 - 15	
0.5	6.0	0 - 5	-	0 - 15	-	-

Notes:

1. These dimensions are for estimating purposes only and are based on material having a specific gravity of 2.65.
2. The gradation shall be determined by individually weighing a minimum of 20 randomly-chosen stone particles from a sample taken from the stockpile representing a lot then comparing the total mass of the stone particles within each fraction with the total mass of all of the stone particles measured in the sample. For pieces of rock with masses that are larger than 25 kg, the approximate dimension of the equivalent cube determined using an average of the three rectilinear measurements of the piece shall be allowed, in lieu of weighing.

TABLE 9
Physical Property Requirements for Truck Arrester Bed Aggregate

MTO Laboratory Test	MTO Test Number	Requirement
Wash Pass 75 µm Sieve, Guideline B, % maximum	LS-601	1.0
Absorption, % maximum	LS-604	2.0
Unconfined Freeze-Thaw, % maximum loss	LS-614	6
Micro-Deval Abrasion, Coarse Aggregate, % maximum loss	LS-618	21

TABLE 10
Gradation Requirements for Truck Arrester Bed Aggregate

Sieve Size Mm	Gradation (LS-602), Percent Passing
37.5	100
26.5	90 - 100
19.0	0 - 10

TABLE 11
Physical Property Requirements for Winter Sand

Laboratory Test	MTO Test Number	Requirement
Micro-Deval Abrasion, fine aggregate, % maximum loss	LS-619	25 (Note 1)
Notes: 1. When obtained from sources on St. Joseph Island, Manitoulin Island, or areas of Ontario south and west of a boundary delineated by the Severn River, Provincial Highway 12, and Provincial Highway 7 east of Highway 12.		

TABLE 12
Gradation Requirements for Winter Sand

Sieve Size	Gradation (LS-602), Percent Passing
9.5 mm	100.0 (Note 1)
6.7 mm	97 - 100
4.75 mm	90 - 100
2.36 mm	50 - 95
1.18 mm	20 - 90
600 µm	0 - 70
300 µm	0 - 35
150 µm	0 - 15
75 µm	0 - 5.0

Notes:

1. In addition to LS-602, this shall be confirmed by visual inspection of the stockpile.
2. The minimum size of the test sample shall be 5 kg. Following oven drying, the sample shall be sieved on the 9.5 mm, 6.7 mm, and 4.75 mm sieves. Material passing the 4.75 mm sieve shall be split to an appropriate size according to LS-602 for subsequent washing and fine sieving. The final grading shall be calculated according to LS-602 as the percentage of material passing each sieve based on the total mass of the oven dried sample.

TABLE 13
Lot Sizes

Aggregate Type	Units of Measurement	Physical Properties and Gradation (Based on Tender Quantities)		
Clear Stone	tonnes (t)	< 200 t: at CA's discretion	200 – 5000 t: One lot	> 5000 t: 5000 t lots
Gabion Stone	m ³ of gabion baskets	< 100 m ³ : at CA's discretion	100 – 1000 m ³ : One lot	> 1000 m ³ : 1000 m ³ lots
Granular Sheeting	m ²	< 200 m ² : at CA's discretion	200 – 5000 m ² : One lot	> 5000 m ² : 5000 m ² lots
Rip-Rap	m ²	< 200 m ² : at CA's discretion	200 – 5000 m ² : One lot	> 5000 m ² : 5000 m ² lots
Rock Protection	m ³	< 200 m ³ : at CA's discretion	200 – 5000 m ³ : One lot	> 5000 m ³ : 5000 m ³ lots
Truck Arrestor Bed	tonnes (t)	< 5000 t: One lot	> 5000 t: 5000 t lots	
Winter Sand	tonnes (t)	< 500 t: at CA's discretion	500-10000 t: One Lot	> 10000 t: 10000 t lots

TABLE 14
Sample Size Requirements

Aggregate	Nominal Maximum Size mm	Minimum Sample Size kg
Clear Stone	53	80
	19.0	20
	16.0	15
	13.2	15
	9.5	10
Granular Sheeting		25
Mortar Sand		10
RipRap / Gabion Stone / Rock Protection (for physical properties only)		25 (consisting of stone particles from 2 to 5 kg each)
Truck Arrestor Bed Aggregate		75
Winter Sand		10

Appendix 1004-A, November 2012
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



MATERIAL SPECIFICATION FOR AGGREGATES - SURFACE TREATMENT

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APPENDICES

1006-A	Commentary
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1006.01 SCOPE

This specification covers the requirements for aggregates for use in surface treatment.

1006.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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

1006.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

1006.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Materials

OPSS 1001 Aggregates - General

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:

- 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 Aggregate
- LS-618 The 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-625 Guidelines for Sampling of Granular Materials
- LS-631 Qualitative Determination of Presence of Plastic Fines in Aggregates

MTO Forms:

PH-D-10 Aggregate Sample Data Sheet

1006.03 DEFINITIONS

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

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.

Lot means a specific quantity of material from a single source.

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

Quality Assurance (QA) means a system or series of activities carried out by the Owner to ensure that Materials received from the Contractor meet the requirements specified in the Contract Documents.

Slag means for the purposes of this specification, fused silicate material from the processing of ores and includes air-cooled blast furnace slag, blast furnace slag, copper slag, nickel slag, and steel slag.

1006.05 MATERIALS

1006.05.01 Aggregates

Aggregates shall be according to OPSS 1001, unless otherwise specified in this specification.

Aggregates shall be clean, hard durable particles produced from sands, gravels, or quarried rock and shall be free of earth, humus, clay coatings, and clay lumps or fragments of any size or shape.

Aggregates containing slag or composed of slag shall not be acceptable for use as surface treatment aggregates.

At the discretion of the Owner, aggregate may be accepted or rejected for physical properties on the basis of past field performance, according to Note 1 shown in Table 1.

When any change in the character of the aggregate occurs or when the performance of aggregate meeting the requirements of this specification is found to be unsatisfactory, use of that aggregate shall be discontinued until a reappraisal by the Contractor, with the approval of the Contract Administrator, proves the source to be satisfactory.

1006.07 PRODUCTION

1006.07.01 Aggregate Processing, Handling, and Stockpiling

Aggregates separated during processing, aggregates secured from different sources, and aggregates from the same source but of different gradations shall be stockpiled separately. When screenings from primary and secondary crushers are produced separately, they shall be stockpiled separately.

Aggregates that have become mixed with foreign matter of any description or aggregates from different stockpiles that have become mixed with each other shall not be used and shall be removed from the stockpile immediately.

1006.08 QUALITY ASSURANCE

1006.08.01 General

The laboratory designated by the Owner shall carry out QA testing for purposes of ensuring that the aggregates used in the Work are according to the physical property and grading requirements of this specification. The Owner shall be responsible for all costs associated with testing for QA purposes, unless otherwise specified in the Contract Documents. Individual test results shall be forwarded to the Contractor, as they become available.

When a hydrated lime anti-stripping agent is used, test samples for the physical property requirements shall be taken prior to the addition of the hydrated lime. If this is not practical, samples coated in hydrated lime may be taken and the lime removed by washing prior to testing. In this case, the requirements for LS-601 shall be waived.

QA acceptance of aggregates for surface treatment shall be based on lots that are sampled and tested for both physical properties and gradation.

1006.08.02 Alternative to LS-614

LS-614 shall be used for acceptance, unless written notification to the Contract Administrator to replace it with LS-606 for acceptance is received prior to sampling of the applicable materials for QA purposes. Provided the Contract Administrator has received such a request, LS-606 shall be used. Otherwise, conformance to LS-614 shall be required.

When notification is provided after QA testing using LS-606 has been initiated, the Contractor shall then be charged \$600.00 for each test initiated, which includes the cost of the testing using LS-614, administrative charges, and additional sampling, if required.

1006.08.03 Sampling

Aggregates to be used in the Work shall be made available for sampling a minimum of 3 weeks prior to the time of intended use. The Contract Administrator shall have access to all sampling locations at any time with notice to the Contractor. The stockpiles from which the samples are to be taken shall contain at least 10% of the total quantity of aggregate needed or a minimum quantity of 500 tonnes, whichever is greater, unless otherwise directed by the Contract Administrator.

All samples shall be duplicate samples.

At least one set of QA samples of each aggregate and from each individual source shall be randomly sampled from stockpiles according to LS-625 and all other requirements stated elsewhere in the Contract Documents from lots according to the schedule shown in Table 1.

Duplicate QA samples with a minimum mass of 25 kg shall be taken from the stockpiles. Each bag or container shall hold no more than 30 kg of material.

The Contractor shall provide new or clean sample bags or containers that are constructed to prevent the loss of any part of the material or contamination or damage to the contents during shipment. Metal or cardboard containers are unacceptable. The Contract Administrator shall seal each QA sample container at the time and place of sampling.

QA samples shall be identified both inside and outside of the sample container. Data to be included with QA samples shall be according to MTO form PH-D-10.

In the event that the Contractor is unavailable to take the samples, no further materials shall be placed in the Work until they have been taken.

The Contractor shall deliver all samples to the appropriate laboratory in a condition that is suitable for testing.

One of the duplicate QA samples shall be randomly selected for testing by the QA laboratory. The QA laboratory shall retain the remaining sample for referee testing, if required.

1006.08.04 Acceptance

The acceptability of a lot of aggregates for surface treatment may result in payment at full price, payment at a reduced price, or rejection.

A lot of aggregates for surface treatment shall be deemed to be acceptable for physical properties and gradation if all of the test results for the samples representing that lot meet all of the requirements shown in Tables 2 and 3.

If a tested sample of aggregates representing a lot does not meet all of the requirements of this specification, then a reduced price payment of 20% shall be given for that lot, as long as the applicable test results for that sample do not:

- a) exceed the requirement for LS-614, or LS-606 if it has been accepted by the Owner as an alternative to LS-614, by more than 25% of the specified value.
- b) exceed the requirement for LS-618 by more than 10% of the specified value.
- c) exceed the requirement for LS-619 by more than 15% of the specified value.
- d) identify plastic fines within the material, when determined according to LS-631 and meet the requirements for LS-602 on the 75 µm sieve.
- e) exceed 10% of the specified value for any other requirement stated in this specification.

Should the test results for the sample not meet all of the requirements listed above, then all of the aggregates within that lot shall be considered rejectable and any surface treatment that includes those aggregates shall be removed from the Work at no cost to the Owner.

Irrespective of the negotiation of a reduced price payment, the warranty provisions of the Contract Documents shall apply.

1006.08.05 Referee Testing

The Contractor may invoke referee testing for one or more attributes by submitting a written request to the Contract Administrator within 5 Business Days following notification that the aggregate does not meet the requirements of this specification.

Referee testing shall be carried out as specified herein and elsewhere in the Contract Documents.

The retained QA samples shall be used for referee testing.

All referee test results for a lot shall replace the respective QA tests for acceptance of the applicable lot and shall be binding on both the Owner and the Contractor.

If a lot is not accepted at full payment based on the referee test results, the Contractor shall then be responsible for the cost of referee testing of that lot, including the cost of transporting the samples to the referee laboratory at the rates specified elsewhere in the Contract Documents. In all other cases, the Owner shall bear the cost of the referee testing and the cost of transporting the samples of that lot.

TABLE 1
Lot Schedule for Sampling and Testing (Note 1)

Quantity from Each Source tonnes	Class 1, 2, 3, 4, 5, and 6
< 500	Sampling and testing may be waived at the discretion of the Owner.
500 to 5,000	One lot for both physical properties and gradation.
> 5,000 (Note 2)	Gradation: 5,000 tonne lots up to 20,000 tonnes and 10,000 tonne lots thereafter. Physical Properties: 20,000 tonne lots.
Notes: - The physical property requirements for the lots may be waived at the discretion of the Owner, provided that the Contractor has demonstrated satisfactory field performance for a pavement which is at least 3 years old and constructed in a similar environment for the same application and using the same aggregate that is being proposed. An independent petrographic examination and report shall also be provided to the Owner that demonstrates to the Owner's satisfaction that the aggregate used in the pavement being referred to is the same as the aggregate under consideration for acceptance. - When the quantity of granular material is insufficient for a complete lot and is: - less than one-half the quantity of a complete lot, that quantity shall then be added to the previous lot; or - greater than or equal to one-half the quantity of a complete lot, then that quantity shall form its own lot.	

TABLE 2
Physical Property Requirements

MTO Laboratory Test	MTO Test No.	Class 1 (Note 1)	Class 2 (Note 1)	Class 3 (Note 1)	Class 4	Class 5 (Note 1)	Class 6 (Note 1)
Wash Pass 75 µm sieve, Guideline B, % maximum	LS-601	1.3 (Note 2)	--	1.3 (Note 2)	--	1.3 (Note 2)	1.3 (Note 2)
Absorption, % maximum	LS-604	1.75	--	2.0	--	1.75	1.75
Percent Crushed Particles, % minimum	LS-607	60	60	60	--	60	60
Flat and Elongated Particles, % maximum	LS-608	20	20	20	--	20	20
Petrographic Examination, % non-carbonate of retained 4.75 mm, minimum	LS-609	60 (Note 3)	60 (Note 3)	60 (Note 3)	--	60 (Note 3)	60 (Note 3)
Unconfined Freeze-Thaw, % maximum loss (Note 4)	LS-614	6	15	6	--	6	6
Micro-Deval Abrasion (Coarse Aggregate), % maximum loss	LS-618	17	25	17	--	17	17
Micro-Deval Abrasion (Fine Aggregate), % maximum loss	LS-619	--	30	--	25	--	--
Plastic Fines	LS-631	--	NP	--	NP	--	--
Alternative Requirement to Unconfined Freeze-Thaw Loss, LS-614							
Magnesium Sulphate Soundness (coarse aggregate), % max loss	LS-606	12	15	12	--	12	12
Notes: 1. With the exception of LS-619 and LS-631, the physical property requirements for Class 1, 2, 3, 5, and 6 aggregates noted above shall be conducted on the material retained on the 4.75 mm sieve. 2. When quarried rock is used as a source of coarse aggregate, a maximum of 2.0% passing the 75 µm sieve shall be permitted. 3. The requirements listed below are only applicable to 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's 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 the coarse aggregate for use in surface treatment is obtained from a gravel pit or quarry containing more than 40% carbonate rock type (e.g., limestone and dolostone) then blending with aggregate from non-carbonate rock types shall be required to increase the minimum non-carbonate rock type content of the coarse aggregate to 60%, as determined by petrographic examination, LS-609. In cases of dispute, LS-613 shall be used with a minimum acid insoluble residue of 60%. b) When the coarse aggregate for use in surface treatment is obtained from a non-carbonate source, blending with aggregate from carbonate rock types is not permitted. 4. The Owner shall waive the requirements for LS-614, unconfined freeze-thaw, provided the Contractor has submitted a written request that the coarse aggregates meet the alternative requirements for LS-606, magnesium sulphate soundness.							

TABLE 3
Gradation Requirements, LS-602

MTO Sieve Designation	Percent Passing by Mass					
	Class 1 (Note 1)	Class 2	Class 3	Class 4	Class 5 (Note 1)	Class 6
19.0 mm	--	100	100	--	--	--
16.0 mm	--	98-100	96-100	--	--	100
13.2 mm	100	75-95	67-86	--	--	96-100
9.5 mm	75-100	50-80	29-52	100	100	50-73
6.7 mm	0-40	--	--	--	40-85	--
4.75 mm	0-10	25-50	0-10	70-100	5-25	0-10
2.36 mm	--	--	--	10-100	0-10	--
1.18 mm	--	10-40	--	5-90	0-5	--
600 µm	--	--	--	3-70	--	--
300 µm	--	2-20	--	2-40	--	--
150 µm	--	2-13	--	0-15	--	--
75 µm	(Note 2)	2-7	(Note 2)	0-7	(Note 2)	(Note 2)
Notes: 1. Class 1 and Class 5 aggregates shall be washed according to OPSS 1001. 2. The requirements for percent passing the 75 µm for Class 1, 3, 5, and 6 aggregates are shown in Table 2.						

Appendix 1006-A, April 2013
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



**MATERIAL SPECIFICATION FOR
AGGREGATES - BASE, SUBBASE,
SELECT SUBGRADE, AND BACKFILL MATERIAL**

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1010.09	OWNER PURCHASE OF MATERIAL - Not Used

APPENDICES

1010-A	Commentary
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1010.01	SCOPE
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This specification covers the requirements for granular aggregate materials for use in subgrade, subbase, base, gravel surface course, shouldering and bedding and backfill to sewers, culverts, and other structures.

1010.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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

1010.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

1010.02 REFERENCES

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

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

Ontario Provincial Standard Specifications Material

OPSS 1001 Aggregates - General

Ontario Ministry of Transportation Publications

Laboratory Testing Manual:

LS-601	Material Finer than 75 µm Sieve in Mineral Aggregates by Washing
LS-602	Sieve Analysis of Aggregates
LS-607	Percent Crushed Particles in Processed Coarse Aggregate
LS-614	Freezing and Thawing of Coarse Aggregate
LS-617	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-621	Determination of Amount of Asphalt Coated Particles in Coarse Aggregate
LS-625	Guidelines for Sampling of Granular Materials
LS-630	Determination of Amount of Contamination of Coarse Aggregates
LS-631	Qualitative Determination of Presence of Plastic Fines in Aggregates
LS-709	Determination of Permeability of Granular Soils

MTO Forms:

PH-D-1A	Granular A Gradation Computation Acceptance & Payment Adjustment Sheet
PH-D-1B	Granular B Types I, II & III Gradation Computation Acceptance & Payment Adjustment Sheet
PH-D-1M	Granular M Gradation Computation Acceptance & Payment Adjustment Sheet
PH-D-1O	Granular O Gradation Computation Acceptance & Payment Adjustment Sheet
PH-D-1SSM	SSM Gradation Computation Acceptance & Payment Adjustment Sheet
PH-D-10	Aggregate Sample Data Sheet

1010.03

DEFINITIONS

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

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

Delivery Sample means a random sample taken at the point of loading or discharge from delivery vehicles.

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.

Fines means material passing the 75 μ m sieve when tested according to LS-601 or LS-602.

Gradation Test means a test used to determine the particle size distribution of an aggregate or soil material by sieving.

Lot means a specific quantity of material from a single source or a specified amount of construction assumed to be produced by the same process.

Mean means the arithmetic average of a set of data.

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

Production Property means an attribute or feature of an aggregate or soil material, including gradation, that is introduced through the manufacturing process (i.e., crushing, screening, blending etc.). Tests are carried out to measure the affects of the process on the material.

Quality Assurance (QA) means a system or series of activities carried out by the Owner to ensure that Materials received from the Contractor meet the requirements specified in the Contract Documents.

Random Numbers means numbers generated by chance, and recorded in random number tables.

Random Sample means a sample based on random numbers so that any portion of a lot or subplot has an equal opportunity of being selected.

Range means the difference between the largest and the smallest measurements in a set of data.

Road Sample means a random sample taken from road construction after placement and spreading of the material in the work, but prior to compaction.

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

1010.05 MATERIALS

1010.05.01 General

Aggregates for Granular A, O, B, M and SSM shall be according to OPSS 1001, unless otherwise specified in this specification, and shall conform to the requirements of Table 2 and Table 3 when tested according to the test methods identified herein.

Aggregates shall be clean, hard, durable particles and shall be produced from material free of earth, humus, clay coatings, and clay lumps or fragments of any size or shape. When tested according to LS-630, the total amount of wood shall not exceed 0.1% by mass, and the total amount of clay brick, gypsum, gypsum plaster wallboard and other contaminants shall not exceed a combined total of 1.0% by mass.

When reclaimed asphalt pavement (RAP), post-consumer glass or ceramic material is used, it shall be homogeneously blended in a manner acceptable to the Contract Administrator.

Steel slag shall not be used.

1010.05.02 Granular O

Aggregates for Granular O shall be produced from a quarry or from boulders, cobbles or gravel retained on the 50 mm sieve. Recycled or reclaimed materials, including hydraulic cement concrete, RAP, slag, glass, and ceramic are not permitted.

1010.05.03 Granular A and M

Aggregates for Granular A and M shall be produced from one or a blend of the following:

- a) Boulders, cobbles, gravel, sand, and fines from naturally formed deposits.
- b) A quarry or talus.
- c) Reclaimed hydraulic cement concrete.
- d) Iron blast furnace slag or nickel slag.

Granular A and M aggregates may include up to 30% by mass of asphalt coated particles derived from RAP, and not more than a combined total of 15% by mass of glass or ceramic material or both, unless specified elsewhere in the Contract Documents.

Granular A or M produced with RAP containing steel slag aggregates is acceptable for unpaved shouldering purposes only. Such materials shall be stockpiled separately.

1010.05.04 Granular B

Granular B may be of Type I, Type II, or Type III.

Aggregates for Granular B shall be aggregates produced from one or a blend of the following, subject to the following restrictions:

- a) Boulders, cobbles, gravel, sand, and fines from naturally formed deposits.
- b) A quarry or talus.
- c) Reclaimed hydraulic cement concrete.
- d) Iron blast furnace slag or nickel slag.

Aggregates for Granular B Type I and Type III may include up to 30% by mass of asphalt coated particles derived from RAP, and not more than a combined total of 15% by mass of glass or ceramic material or both. RAP containing steel slag aggregates shall not be permitted.

Aggregates for Granular B Type II shall only be produced from a quarry or from talus, iron blast furnace slag, or nickel slag. Recycled materials shall not be permitted.

1010.05.05 Select Subgrade Material (SSM)

Aggregates for select subgrade material shall be produced only from natural deposits of non-plastic silt, sand, and gravel material. Recycled or reclaimed materials of any type shall not be permitted.

1010.08 QUALITY ASSURANCE

1010.08.01 General

The laboratory designated by the Owner shall carry out QA testing for purposes of ensuring that aggregates used in the Work conform to the physical and production requirements of this specification. Individual test results shall be forwarded to the Contractor, as they become available.

The Owner shall be responsible for all costs associated with testing for QA purposes, unless otherwise specified in this specification.

QA testing for physical properties may be waived by the Contract Administrator when the delivered quantity of Granular A, O, B, M, or SSM is less than 5,000 tonnes.

1010.08.01.01 Sampling

QA samples shall be taken according to the Contract Documents and LS-625 and shall be road samples or delivery samples obtained from the Work at a location determined by the Contract Administrator. When required, the Contractor shall provide a front-end loader to obtain material for QA samples.

When it is not possible to take road or delivery samples, samples of compacted material taken with the permission of the Owner shall be used for QA acceptance purposes.

In the event that the Contractor is unavailable to take a sample, no further materials shall be placed in the Work until the required QA samples have been taken.

QA sampling and testing shall be based on lots that are established for each aggregate type; Granular A, O, B, M, and SSM. When more than one aggregate source is used, separate lots shall also be established for each source. When aggregates are produced from materials that are extracted from within the right-of way, each area within a 1,000 m segment of the right-of-way or within a radius of 500 m of the extraction operation located within the right-of-way shall be considered equivalent to a single aggregate source for QA acceptance purposes. When aggregates are produced with blended or reclaimed materials or both, QA testing shall be performed on the final product.

The Contractor shall provide new or clean sample bags or containers that are constructed to prevent the loss of any part of the material or contamination or damage to the contents during shipment. Metal or cardboard containers are unacceptable. QA samples shall be identified both inside and outside of the sample container. Data to be included with QA samples shall be according to MTO form PH-D-10.

The Contractor shall deliver all samples to the appropriate laboratory in a condition that is suitable for testing.

All QA samples shall be duplicate samples. One of the samples shall be randomly selected for testing by the QA laboratory and the remaining sample shall be retained by the QA laboratory for possible referee testing.

1010.08.01.02 Sample Size

The mass of the each QA sample shall meet the requirements shown in Table 4. When more than 30 kg of material is required, the total sample shall be recombined prior to testing.

1010.08.02 Physical Properties

At least one set of duplicate QA samples of each aggregate to be used in the Work shall be randomly sampled from lots of 25,000 tonnes or part thereof for physical properties. All materials delivered to the Work shall be included within a lot.

1010.08.02.01 Testing of Physical Properties

The QA laboratory shall carry out testing for each physical property requirement shown in Table 2, as applicable for each QA sample.

1010.08.02.02 Acceptance of Physical Properties

The acceptability of a lot for physical properties may result in payment at full price, payment at a reduced price, or rejection.

A lot shall be deemed to be acceptable for physical properties if all of the test results for the samples of aggregates representing that lot meet the requirements shown in Table 2.

If a tested sample of aggregates representing a lot does not meet all of the requirements shown in Table 2, then a reduced price payment of 20% of the tender price shall be given for that lot for physical properties, as long as the lot is not rejectable and the applicable test results for that sample:

- a) do not exceed the requirement for LS-614 by more than 25% of the specified value.
- b) do not exceed the requirement for LS-618 by more than 10% of the specified value.
- c) do not identify plastic fines within the material, when determined according to LS-631 and acceptance test results for LS-602 are not subject to a payment adjustment on the 75µm sieve.
- d) meet all other physical property requirements of this specification.

Should the test results for any sample of aggregates representing a lot not meet the requirements listed above, then all of the aggregates within that lot shall be considered rejectable and any of those aggregates used in the Work shall be removed at no cost to the Owner.

The reduced price payment for the lot given above shall be in addition to any payment reduction determined according to the Acceptance Based on LS-602 and LS-607 clause for production properties.

Irrespective of the negotiation of a reduced price payment, the warranty provisions of the Contract Documents shall apply.

1010.08.03 Production Properties

All lots for production properties shall be divided into four sublots of approximately equal tonnage and one duplicate QA sample shall be randomly obtained from each subplot.

For each tender item, the Contract Administrator shall estimate the quantities of granular materials obtained from each different source or process. Then, for each of those individual sources or processes, the Contract Administrator shall identify the number and size of each lot to be sampled and tested using the lot schedule shown in Table 1.

In addition, if circumstances such as the closure of the construction season or changes in production or delivery result in a lot not being completed, then the Contractor shall notify the Contract Administrator prior to the first sample is taken within that lot, in order for the Contract Administrator to adjust the subplot sizes equally to accommodate the reduced tonnage. If such notification is not given in time, then acceptance shall be based on the number of sampled sublots that are available for the incomplete lot. All lots shall be deemed to be complete at the end of each calendar year.

1010.08.03.01 Testing of Production Properties

The QA laboratory shall conduct sieve analysis according to LS-602 and determine test results for each sieve designation shown in Table 3. The QA laboratory shall also carry out testing for percent crushed particles according to LS-607, particles with two or more crushed faces according to LS-617, and amount of asphalt coated particles according to LS-621, as applicable.

1010.08.03.02 Acceptance of Production Properties

Test results from each subplot within a lot shall be combined to determine the mean and the range of the lot for each test.

1010.08.03.02.01 Acceptance Based on LS-602 and LS-607

All lot means and ranges for test results carried out according to LS-602 and LS-607, as applicable, shall be computed to one decimal place and reported on the appropriate MTO form by the Contract Administrator, as indicated below:

Granular A	PH-D-1A
Granular O	PH-D-1O
Granular B, Types I, II or III	PH-D-1B
Granular M	PH-D-1M
SSM	PH-D-1SSM

The acceptability of a lot based on LS-602 and LS-607 may result in payment at full price, payment at a reduced price, or rejection.

A complete or incomplete lot shall be deemed to meet the applicable requirements for LS-602 and LS-607, if the mean of the test results for that lot is within the limits shown in Table 3 and the range of the test results for that lot is within the limits shown in Table 5.

Lots that are subject to a total payment adjustment factor of more than 25% in respect of lot mean and range are deemed to be rejected and shall be removed from the Work at no cost to the Owner.

When a complete or incomplete lot does not meet the requirements of LS-602 and LS-607, is not subject to removal, but the Contractor chooses to use the lot or for some reason it cannot be totally excluded from the Work, then at the request of the Contractor, an adjusted payment calculated according to the following formula shall be allowed in lieu of removal:

PAYMENT REDUCTION = lot quantity (tonnes) x item price (\$/tonne) x payment adjustment factor (%)

Where:

The lot quantity shall be expressed in tonnes as determined according to Table 6, and the item price shall be according to one of the following:

- a) The contract price for the items having the tender quantity in tonnes.
- b) \$21.50 per tonne for Granular A, O, and M; \$15.50 per tonne for Granular B Type II; \$15.00 per tonne for Granular B Type I and Type III; and \$8.50 per tonne for SSM where bidding is not by tender quantity such as lump sum Contracts.

In addition, the payment adjustment factor, in percent, shall be equal to the sum of the adjustment points determined as follows:

- a) Adjustment points shall be applied for each 0.1% that the mean gradation falls outside the gradation specification limits for each sieve, according to Table 7.
- b) 0.1 adjustment points shall be applied for each 0.1% that the range exceeds the maximum acceptable range for each sieve.
- c) 0.2 adjustment points shall be applied for Granular A or M for each 0.1% that the lot mean falls below the applicable limits for percent crushed.

The reduced price payment for the lot given above shall be in addition to any payment reduction determined according to the Acceptance of Physical Properties clause.

1010.08.03.02.02 Acceptance Based on LS-617 or LS-621

A lot shall be deemed to meet the applicable requirements of this specification for LS-617 or LS-621, if the mean value of the test results for that lot is within the limits shown in Table 3. When the mean value of the test results for that lot does not meet these requirements, the material shall be considered deficient and managed according to the requirements specified elsewhere in the Contract Documents.

1010.08.04 Referee Testing

The Contractor may invoke referee testing for one or more attributes by submitting a written request to the Contract Administrator within 5 Business Days following notification that the lot does not meet the requirements of this specification.

Referee testing shall be carried out as specified herein and elsewhere in the Contract Documents.

The retained duplicate QA samples for all sublots shall be used for referee testing of the lot.

All referee test results shall replace the respective QA tests for acceptance of the applicable lot and shall be binding on both the Owner and the Contractor.

If a lot is not accepted at full payment based on the referee test results, then the Contractor shall be responsible for the cost of the referee testing of that lot, including the cost of transporting the samples to the referee laboratory at the rates specified elsewhere in the Contract Documents. In all other cases, the Owner shall bear the cost of the referee testing of that lot.

Table 1
Lot Schedule for Sampling and Testing

Quantity for Each Source or Process (tonnes)	Gran A, O, and M	Granular B Type I, B Type II, B Type III, and SSM
< 1,000	Sampling and testing may be waived at the discretion of the Contract Administrator	
1,000 - 5,000	One lot	One lot
> 5,000 (Note 1)	5,000 tonne lots up to 20,000 tonnes, and 10,000 tonne lots thereafter	10,000 tonne lots up to 20,000 tonnes, and 20,000 tonne lots thereafter
Note: 1. When the quantity of granular material is insufficient for a complete lot and is: a) less than one-half the quantity of a complete lot, that quantity shall then be added to the previous lot; or b) greater than or equal to one-half the quantity of a complete lot, then that quantity shall form its own lot.		

Table 2
Physical Property Requirements

Laboratory Test	MTO Test Number	Granular					Select Subgrade Material
		A	B		M	O	
			Type I / Type III	Type II			
Unconfined Freeze-Thaw, % maximum loss	LS-614	-	-	-	-	15	-
Micro-Deval Abrasion (Coarse Aggregate), % maximum loss	LS-618	25	30 (Note 1)	30	25	21	30 (Note 1)
Micro-Deval Abrasion (Fine Aggregate), % maximum loss	LS-619	30	35	35	30	25	-
Amount of Contamination	LS-630	(Note 2)					
Plastic Fines	LS-631	NP (Non-Plastic)					
Determination of Permeability, k	LS-709	(Note 3)					
Notes:							
1. The coarse aggregate micro-Deval abrasion loss test requirement shall be waived if the material has more than 80% passing the 4.75 mm sieve. 2. Granular A, B Type I, B Type III, or M may contain up to 15% by mass crushed glass or ceramic material or both. Granular A, O, B Type I, B Type III, and M shall not contain more than 1.0% by mass of any combination of wood, clay brick, gypsum, gypsum wall board, or plaster. Granular B Type II and SSM shall not contain more than 0.1% by mass of wood. 3. For materials north of the French/Mattawa Rivers only, the coefficient of permeability, k shall be greater than 1.0×10^{-4} cm/s or alternatively, when past field experience has demonstrated satisfactory performance. Prior data demonstrating compliance with this requirement for k shall be acceptable provided that such testing has been done within 5 years of the material being used and field performance has continually been shown to be satisfactory.							

**Table 3
Production Requirements**

Lab Test	MTO Test Number	Granular						SSM
		A	B			M	O	
Sieve Analysis, % passing	LS-602 (sieve)		Type I (Note 2)	Type II	Type III (Note 2)			
	150 mm	-	100	-	100	-	-	100
	106 mm	-	-	100	-	-	-	-
	37.5 mm	-	-	-	-	-	100	-
	26.5 mm	100	50.0-100	50.0-100	50.0-100	-	95.0-100	50.0-100
	19.0 mm	85.0-100 (87.0-100) Note 3	-	-	-	100	80.0-95.0	-
	13.2 mm	65.0-90.0 (75.0-95.0) Note 3	-	-	-	75.0-95.0	60.0-80.0	-
	9.5 mm	50.0-73.0 (60.0-83.0) Note 3	-	-	32.0-100	55.0-80.0	50.0-70.0	-
	4.75 mm	35.0-55.0 (40.0-60.0) Note 3	20.0-100	20.0-55.0	20.0-90.0	35.0-55.0	20.0-45.0	20.0-100
	1.18 mm	15.0-40.0	10.0-100	10.0-40.0	10.0-60.0	15.0-40.0	0-15.0	10.0-100
	300 µm	5.0-22.0	2.0-65.0	5.0-22.0	2.0-35.0	5.0-22.0	-	5.0-95.0
	150 µm	-	-	-	-	-	-	2.0-65.0
	75 µm	2.0-8.0 (2.0-10.0) Note 4	0-8.0 (0-10.0) Note 4	0-10.0	0-8.0 (0-10.0) Note 4	2.0-8.0 (2.0-10.0) Note 4	0-5.0	0-25.0
Percent Crushed Particles, % minimum	LS-607	60	-	100	-	60	100	-
2 or more Crushed Faces, % minimum	LS-617	-	-	-	-	-	85 Note 5	-
Asphalt Coated Particles, Coarse Aggregates,% maximum	LS-621	30	30	0	30	30	0	0

Notes:

1. When Granular B is used for granular backfill for pipe subdrains, 100% of the material shall pass the 37.5 mm sieve.
2. When RAP is blended with Granular B Type I or Type III, 100% of the RAP shall pass the 75 mm sieve. Conditions in Note 1 supersede this requirement.
3. When the aggregate is obtained from an iron blast furnace slag source.
4. When the aggregate is obtained from a quarry or blast furnace slag or nickel slag source.
5. When Granular O is produced from boulders, cobbles, or gravel retained on the 50 mm sieve.

**Table 4
Sample Size**

Material	Minimum Mass of Field Samples, kg (Note 1)
Granular O, A, M; Granular B, SSM (100% passing 26.5 mm sieve)	25
Granular B, SSM	50
Notes: 1. Individual sample containers shall hold no more than 30 kg of aggregate. When more than 30 kg is required, additional sample containers shall be used.	

**Table 5
Range Requirements For Gradation (LS-602)**

MTO Sieve	Maximum Acceptable Range						
	Granular						SSM
	A	B Type I	B Type II	B Type III	M	O	
150 mm	-	1	-	1	-	-	1
106 mm	-	-	1	-	-	-	-
37.5 mm	-	-	-	-	-	1	-
26.5 mm	1	-	30.0	-	-	5.0	-
19.0 mm	8.0	-	-	-	1	8.0	-
13.2 mm	20.0	-	-	-	16.0	17.0	-
9.5 mm	20.0	-	-	-	18.0	17.0	-
4.75 mm	18.0	-	22.0	-	18.0	18.0	-
1.18 mm	18.0	-	18.0	-	18.0	12.0	-
300 µm	12.0	50.0	12.0	25.0	12.0	-	-
75 µm	5.0	7.0	5.0	7.0	5.0	4.0	15.0

**Table 6
Lot Quantity Determinations for Adjusted Payments**

Item	Road or Delivery Samples
Items having the tender quantity in tonnes.	The quantity measured for payment by weighing.
All other items.	The weighed quantity when available; otherwise the theoretical quantity calculated by the Contract Administrator using a conversion factor of 2.0 tonnes per cubic metre.

Table 7
Adjustment Points

MTO Sieve Designation	Adjustment Points Per 0.1% Deviation from Specified Limit				
	Granular A	Granular B	Granular M	Granular O	Select Subgrade Material
150 mm	-	0.1 (Note 1)	-	-	0.1
106.5 mm	-	0.1 (Note 2)	-	-	
37.5 mm	-	-	-	0.1	-
26.5 mm	0.1	0.1	-	0.1	0.1
19.0 mm	0.1	-	0.1	0.1	-
13.2 mm	0.1	-	0.1	0.1	-
9.5 mm	0.1	-	0.1	0.1	-
4.75 mm	Excess Passing 0.5 / Insufficient Passing 0.2				0.1
1.18 mm	0.1	0.1	0.1	0.1	0.1
300 µm	0.1	0.1	0.1	-	0.1
150 µm	-	-	-	-	0.1
75 µm	1.0	1.0	1.0	1.0	0.5
Notes: 1. Granular B Type I and Type III only. 2. Granular B Type II only.					

Appendix 1010-A, April 2013
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



MATERIAL SPECIFICATION FOR PERFORMANCE GRADED ASPHALT CEMENT

TABLE OF CONTENTS

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APPENDICES

1101-A	Commentary
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1101.01 SCOPE

This specification covers the requirements for the properties, use, and payment of performance graded asphalt cements.

1101.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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

1101.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

1101.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 313 Hot Mix Asphalt - End Result

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:

LS-227 Determination of Ash Content

LS-299 Determining Asphalt Cement's Resistance to Ductile Failure Using Double-Edge-Notched Tension Test (DENT)

LS-308 Determination of Performance Grade of Physically Aged Asphalt Cement Using Extended Bending Beam Rheometer (BBR) Method

American Association of State Highway and Transportation Officials (AASHTO)

M 320-10 Standard Specification for Performance Graded Asphalt Binder

R 29-08 Grading or Verifying the Performance Grade of an Asphalt Binder

T 40-02 (2012) Sampling Bituminous Materials

TP 70-12 Multiple Stress Creep and Recovery (MSCR) of Asphalt Binder Using a Dynamic Shear Rheometer (DSR)

1101.03 DEFINITIONS

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

Asphalt Binder means modified or unmodified asphalt cement.

Hot Mix Asphalt (HMA) means as defined in OPSS 313.

Independent Laboratory means as defined in OPSS 313.

Lot means as defined in OPSS 313.

Low Temperature Limiting Grade (LTLG) means the warmest of the Limiting Grades, T_L obtained for 1 hour, 24 hours, 72 hours and the two conditioning temperatures according to LS-308, and Form B of LS-308.

Low Temperature Performance Grade (-YY) means the low temperature performance grade specified elsewhere in the Contract Documents and also referred to as the -YY specified for the performance graded asphalt cement where the PGAC Grade specified is PG XX-YY, and the minimum design pavement temperature.

Performance Graded Asphalt Cement (PGAC) means as defined in OPSS 313.

Recompaction Temperature means the temperature to which plant produced mix shall be reheated for testing purposes and shall be the same as the laboratory mix design compaction temperature.

1101.04 DESIGN AND SUBMISSION REQUIREMENTS

1101.04.01 Submission Requirements

1101.04.01.01 PGAC Test Documentation

For each grade of PGAC specified in the Contract Documents, the Contractor shall supply the following items to the Contract Administrator at least 14 Days prior to the first use of each product:

- a) The PGAC supplier and the facility type and location that the product shall be supplied from.
- b) Applicable mixing and compaction temperatures for the product.
- c) The minimum temperature of the HMA immediately after spreading, recommended by the PGAC supplier. This information is required when paving on bridge decks only.
- d) Documentation of construction, storage, and handling requirements, including the material safety data sheet, recompaction temperature, mix discharge temperature, and recommended extraction procedure.
- e) When the PGAC contains any polyphosphoric acid (PPA) and a liquid anti-stripping additive is incorporated into the PGAC at the PGAC supplier's depot:
 - i. Information on how much anti-stripping additive was added to the PGAC.
 - ii. Documentation from the PGAC supplier stating that the PPA modified PGAC with the liquid anti-stripping additive added at the PGAC supplier's depot shall meet all asphalt cement material requirements specified in the Contract Documents, including AASHTO M 320 for the PGAC grade specified.

1101.05 MATERIALS

PGAC shall be according to AASHTO M 320 for the performance grades specified in the Contract Documents when tested using the methods designated in AASHTO R 29, section Test Procedure for Verifying the Nominal Grade of an Asphalt Binder.

When silicone oil is added to the PGAC, it shall be less than 5 parts per million of the PGAC.

PGAC shall be homogeneous, free of water and any contamination and shall not foam when heated to the temperatures specified by the manufacturer for the safe handling and use of the product. It shall be shipped, used, and handled at all times in accordance with the manufacturer's specifications.

PGAC 70-28, 70-34, and 64-34 shall not contain more than 0.5% PPA and shall only be used as a catalyst for the purpose of modification with polymers. Other grades of PGAC shall contain no more than 1.0% PPA. All grades of PGAC shall not contain any orthophosphoric acid.

PGAC grades shall meet the additional requirements shown in Table 1.

1101.07 PRODUCTION

1101.07.01 Sampling and Testing

Sampling shall be as specified in the Quality Assurance section.

1101.08 QUALITY ASSURANCE

1101.08.01 Basis of Acceptance

Material acceptance of asphalt cement for performance grading and the properties and attributes shown in Table 1 shall be based on QA test results conducted by the Owner's designated laboratory, unless superseded by referee test results, subject to the conditions specified in the Contract Documents.

The Contractor shall be provided with test results from the tests completed to determine if the material complies with the requirements of the Contract Documents.

1101.08.02 Anti-Stripping Additive

The Contractor may request that an allowance be made for the impact of the anti-stripping additive on a PGAC grade for QA or referee purposes provided that when production begins the Contractor submits to the Contract Administrator complete AASHTO M 320 test results for the following:

- a) Asphalt cement with anti-stripping additive at the percentage identified in the mix design.
- b) Asphalt cement without the anti-stripping additive.

1101.08.03 Sampling

All test samples shall be obtained during the production of the asphalt mix at the asphalt mix plant from the storage tank which is directly feeding the production of the asphalt mix in accordance with AASHTO T 40 and the asphalt plant's Health and Safety Plan. The asphalt plant's Health and Safety Plan and procedure for sampling shall be discussed at the Pre-Pave Meeting. The QA, referee, and other required samples for possible Owner testing shall be taken at the same time.

The Contract Administrator shall inform the Contractor when the PGAC is required to be sampled.

Sampling frequency and minimum quantities shall be as shown in Table 2. Additional labelling and delivery requirements are provided in Table 2. Samples shall be delivered in a condition suitable for testing.

1101.08.04 Lot Sizes

The Contract Administrator shall determine lot sizes for PGAC in consultation with the Contractor.

PGAC lot sizes shall be based on the HMA tender quantity for each grade of PGAC, with the quantity of PGAC incorporated into 10,000 tonnes of HMA being considered as one lot. When the tender quantity of HMA is insufficient to complete a lot, the following shall apply:

- a) When the total HMA tender quantity is less than 10,000 tonnes, the quantity of PGAC incorporated into the HMA shall be considered as one lot.
- b) When a lot is terminated and the remaining HMA tender quantity is:
 - i. Less than 5,000 tonnes, the quantity of PGAC shall be considered as part of the previous lot.
 - ii. From 5,000 tonnes to less than 10,000 tonnes, the quantity of PGAC represented shall be considered as a separate lot.

A lot shall be terminated when the source of PGAC is changed. A lot may be terminated at the Contract Administrator's option when HMA production for the Contract ceases for a period of 20 Days.

1101.08.04.01 Switching Performance Grades

When switching from the use of one performance grade to a different performance grade, the Contractor may request that the quantity of PGAC in the first tanker load be considered as a separate lot.

This request shall be submitted in writing to the Contract Administrator. The Contract Administrator shall consider only one request for the duration of the Contract.

1101.08.05 Quality Assurance Testing

Test results for lots that do not comply with the performance grading requirements shall be categorized as minor borderline, major borderline, or rejectable. PGAC shall be categorized based on its test result's deviation from the individual design maximum or minimum pavement temperature and the sum of the deviations from the design maximum or minimum pavement temperatures defined as follows. The actual performance grading that is either higher than the maximum design pavement temperature or lower than the minimum design pavement temperature is not considered a deviation.

Minor Borderline: Individual deviations are less than or equal to 3 °C and the sum of deviations is less than or equal to 3 °C.

Major Borderline: Individual deviations are less than or equal to 3 °C and the sum of deviations is more than 3 °C, but less than or equal to 6 °C.

Rejectable: Not complying with either of the above.

Test results for lots that do not comply with asphalt cement acceptance requirements shown in Table 1 shall be categorized according to Table 1. When a Lot does not comply with more than one property, attribute, and PG grading, acceptance of the HMA shall be dealt with using the property, attribute, or PG grading selected by the Owner.

1101.08.06**Referee Testing**

Referee testing by an independent laboratory may be invoked by the Contractor for any lot of PGAC within 5 Days of receiving all the QA test results for the lot, provided the Contractor has taken and delivered all referee samples in a condition suitable for testing.

The referee testing shall determine the actual performance high and low temperatures, rounded to the nearest 0.5 °C of the PGAC and the properties and attributes shown in Table 1. Test results generated by the referee laboratory shall be used to re-evaluate the lot to determine whether the product conforms to the Contract Documents and the disposition of the HMA.

Referee testing costs as specified elsewhere in the Contract Documents shall be borne by the Contractor, unless the referee testing confirms total conformance of the PGAC sample to the Contract Documents when the QA testing did not, in which case the costs shall be borne by the Owner.

1101.08.07**Disposition of HMA Produced with Borderline and Rejectable Lots**

The Owner shall review the test results and determine the disposition of the HMA produced using any PGAC that does not conform to all requirements of the Contract Documents. This shall also include all additional testing requirements for which acceptance requirements have been specified and the identification of any trends evident through the analysis of the additional testing. HMA produced using PGAC, for which test results indicate that the product did not conform to the Contract Documents shall be dealt with as follows:

Minor Borderline: HMA shall be accepted at full payment.

Major Borderline: HMA shall be accepted into the Work, provided that the Contractor accepts a payment reduction, calculated as follows:

Payment Reduction = 5% of HMA contract price x quantity of HMA in the lot.

If the Contractor does not accept the payment reduction for Major Borderline HMA, the HMA shall not be accepted into the Work.

The quantity of HMA shall be in tonnes or square metres as specified for the applicable HMA tender item.

This payment reduction is assessed independently of other payment adjustment provisions specified in the Contract Documents.

If the PGAC in a particular lot has been used for the production of more than one HMA type, the payment reduction shall be calculated using the actual quantities of the HMA types produced with the PGAC, within the lot.

HMA produced using PGAC for which test results are rejectable shall be subject to repair or payment adjustment. The Contract Administrator shall determine if a rejectable lot may remain in the work without repairs, with a payment adjustment accepted by the Owner. When test results indicate non-compliance with the Contract Documents, all costs to the Owner to establish the degree and extent of the non-compliance shall be the responsibility of the Contractor.

When the Contractor changes from one performance grade to a different performance grade and the request for the establishment of a separate lot has been accepted according to the Switching Performance Grades clause, HMA produced with this separate PGAC lot is administered as follows:

- a) The HMA payment shall not be assessed a PGAC payment reduction for borderline deviations from the performance grading requirements.

- b) HMA produced with PGAC that is rejectable shall be removed or its payment shall be adjusted at the discretion of the Contract Administrator.

TABLE 1
Additional Testing Requirements and Acceptance Criteria for All PG Grades

Property and Attributes	Test Method	Results Reported Rounded to the Nearest	Acceptance Criteria	Rejectable
Ash Content, % by mass of residue (%)	LS-227	0.1	≤ 1.0	>1.0

TABLE 2
Sampling Requirements

Samples	Frequency	Minimum Sample Quantity	Labelling	Delivery
QA	Each Lot	2 litres (Note 1)	Label shall include: - Grade - Supplier	- Samples shall be delivered as specified in the Contract Documents. - Samples shall be delivered at the same time.
Referee	Each Lot	2 litres (Note 1)		
Samples for possible Owner testing	First Lot for each grade and source of asphalt cement used on the Contract and for any subsequent Lot requested by the Contract Administrator.	4 litres (Note 2)	Label shall include: - Grade - Supplier - AAT	- Samples shall be delivered at the same time. - Samples shall be delivered within 7 Days of sampling to: Attention: Bituminous Laboratory Room 15, Building C 1201 Wilson Ave. Toronto, ON M3M 1J8

Notes:

- Two litres shall be provided in 2 suitable one litre containers or a container able to hold a minimum of 2 litres.
- Four litres shall be provided in 4 suitable one litre containers or a container able to hold a minimum of 4 litres.

Appendix 1101-A, November 2014
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



**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 methods to be followed for proportioning and mixing hot mix asphalt, recycled mixes, and mixes for miscellaneous work according to the Superpave and SMA mix design methodology.

1151.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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

1151.01.02 Appendices Significance and Use

Appendices are not a mandatory part of this specification unless invoked by the Owner.

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

1151.02 REFERENCES

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

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

Ministry of Transportation, Ontario, Publications

MTO Laboratory Testing Manual:

LS-200 Penetration of Bituminous Materials
LS-282 Quantitative Extraction of Asphalt Cement and Analysis of Extracted Aggregate from Bituminous Paving Mixtures
LS-284 Recovery of Asphalt from Solution by Abson Method or Rotavapor
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 Mix Check
LS-602 Sieve Analysis of Aggregates
LS-603 Resistance To Degradation Of Coarse Aggregate By Abrasion And Impact In The Los Angeles Abrasion Machine

ASTM International

C 612-04 Standard Specification for Mineral Fiber Block and Board Thermal Insulation

American Association of State Highway and Transportation Officials (AASHTO)

MP 8-05 Standard Specification for Designing Stone Matrix Asphalt (SMA)
T 305-01 Determination of Draindown Characteristics in Uncompacted Asphalt Mixtures

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

AMRL means the AASHTO Materials Reference Laboratory.

Anti-Stripping Additive means hydrated lime and liquid anti-stripping additive used to minimize or eliminate stripping of asphalt cement from aggregates in HMA.

Asphalt Binder means as defined in OPSS 1101.

Binder Course means as defined in OPSS 313.

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.

Draindown means as defined in OPSS 313.

Field Adjustment to the JMF means as defined in OPSS 313.

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

Hot Mix Asphalt (HMA) means as defined in OPSS 313.

Independent Laboratory means as defined in OPSS 313.

Levelling Course means as defined in OPSS 313.

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 (NMAS) means one sieve size larger than the first sieve to retain more than 10% by mass.

Performance Graded Asphalt Cement (PGAC) means as defined in OPSS 313.

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

Reclaimed Asphalt Pavement (RAP) means as defined in OPSS 313.

Recycled Hot Mix (RHM) means as defined in OPSS 313.

Roof Shingle Tabs (RST) means as defined in OPSS 313.

SMA Mixes means as defined in OPSS 313.

Stone Mastic Asphalt (SMA) means as defined in OPSS 313.

Stone Mastic Asphalt (SMA) Mortar means as defined in OPSS 313.

Superpave means as defined in OPSS 313.

Surface Course means as defined in OPSS 313.

1151.04 DESIGN AND SUBMISSION REQUIREMENTS

1151.04.01 Design Requirements

1151.04.01.01 Mixture Requirements for Design Purposes

The Superpave mix designs shall be according to the requirements specified in Tables 1, 2, and 3; LS-309; and the traffic category specified in the Contract Documents. The JMF for Superpave mixes shall be according to the requirements specified in Tables 1, 2, and 3.

The SMA mix designs shall be according to the requirements specified in Tables 1, 4, and 5 and LS-311. The JMF for SMA mixes shall be according to the requirements specified in Tables 1, 4, and 5.

1151.04.01.02 Reclaimed Asphalt Pavement Proportions

Maximum RAP proportions in the mix design and JMF shall be according to the requirements of Table 6.

If the Contractor modifies the composition of the mix by including RAP to exceed 20% by mass of the total mixture, the high and low grade of the PGAC required shall both be lowered by 6 °C.

1151.04.01.03 Roof Shingle Tabs Proportions

The Contractor may substitute 0.10% RST for each 1.0% RAP permitted in the mix.

The use of up to 3.0% by mass of RST is permitted in SMA.

1151.04.01.04 Mix Design

1151.04.01.04.01 General

The mix design shall be the responsibility of the Contractor. The job-mix formulae selected for use by the Contractor shall produce HMA that meets all the requirements specified in the Contract Documents.

1151.04.01.04.02 Mix Design Method

1151.04.01.04.02.01 General

The Contractor shall use a laboratory that has current CCIL Type A Certification with CCIL Superpave Certified Technicians or AMRL equivalent certification to conduct all mix designs, mix design conformance, designate the mix proportions, and prepare the job-mix formulae. The Contractor may use a laboratory with other equivalent certification, if acceptable to the Owner.

The aggregate gradations used for the mix design may be provided by the Contractor or may be 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 mixture or the aggregate gradations change during production due to aggregate breakdown, appropriate adjustments shall be made to the mix design gradations.

The Contractor shall conduct density testing of aggregates, RAP, and RST for the purpose of developing the mix design for each mix type in the Contract. Such testing may be performed during production of each aggregate, RAP and RST, or during stockpiling of the materials at the HMA plant. The individual test results, including the date of sampling, shall be included as part of the mix design submission. Only test results generated within 12 calendar months preceding the mix design shall be used.

RAP and RST as processed and ready for use in a 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 RAP and RST aggregates.

1151.04.01.04.02.02 Superpave Mix Design Method

Superpave mixes shall be designed using the procedures specified in LS-309.

1151.04.01.04.02.03 Stone Mastic Asphalt Mix Design Method

SMA mixes shall be designed in accordance with LS-311. 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 Contractor shall follow the manufacturer's recommendations for any product used.

1151.04.01.05 Changes to the Job-Mix Formula and the Mix Design

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

A new mix design shall be completed according to the Mix Design clause under the Submission Requirements subsection, 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 according to OPSS 313.

1151.04.01.06 Anti-Stripping Additives

1151.04.01.06.01 General

Anti-stripping additive shall be added to the mix at the greater of the dosages specified below or as specified in the Contract Documents.

1151.04.01.06.02 Moisture Sensitivity

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

1151.04.01.06.03 Hydrated Lime

Irrespective of any moisture sensitivity testing that shows that anti-stripping additive is not required, hydrated lime ($\text{Ca}(\text{OH})_2$) shall be included in all mixes consisting of more than 75% quartzite and dolomitic sandstone aggregates or combinations thereof.

Coarse and fine aggregates crushed within the last 30 Days shall not be incorporated into SMA or Superpave 12.5FC 2, unless hydrated lime is added to the mix.

When moisture sensitivity testing determines that an anti-stripping additive is required for SMA or Superpave 12.5FC 2 mixes, hydrated lime shall be used as the anti-stripping additive.

When hydrated lime is used as the anti-stripping additive, 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.

1151.04.01.06.04 Liquid Anti-Stripping Additive

When hydrated lime is not required as an anti-stripping additive in the mix and is not used as the anti-stripping additive, liquid anti-stripping additive shall be used in the mix, if

- a) mix moisture sensitivity testing indicates anti-stripping additive is required, or
- b) the Contract Documents note that an anti-stripping additive is required.

The amount of liquid anti-stripping additive to be used in the mix shall be the greater of

- a) the amount required to meet the required Superpave moisture sensitivity requirements, or
- b) 0.5% by mass of asphalt cement.

1151.04.02 Submission Requirements

1151.04.02.01 Mix Design

The Contract Administrator shall be provided with a copy of all mix design and JMF documents, which shall be signed, dated, and certified correct by the person accountable for the engineering and management responsibility for the laboratory that conducted the work.

The mix design submission shall include certification from an independent laboratory stating that:

- a) the independent laboratory prepared all samples and conducted all testing required by the laboratory procedure for the mix check according to LS-316 to determine the values of mix and aggregate properties listed in Table 7; and
- b) the mix meets the requirements and tolerances given in Table 7.

The certification shall bear the seal and signature of the independent laboratory's supervising Engineer. It shall be submitted to the Contract Administrator using MTO Form PH-CC-822IMC, Certificate of Independent Check of Mix Design. It shall be accompanied by the test results and calculated values obtained for the properties listed in Table 7.

The Contract Administrator shall review the mix design and the JMF documents. The mix shall not be placed until the Contract Administrator gives a written confirmation of conformance of the submitted mix design documents and JMF to the Contract requirements for the mix design. Within 4 Business Days, commencing after the day of delivery of all required documents and all samples, the Contract Administrator shall provide the above confirmation or advise the Contractor of any non-conformance to the contract requirements in writing.

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 Samples for Monitoring Purposes

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

Each material sample shall be packaged separately and each filled sample container shall have a maximum mass of 25 kg.

The sample quantities are specified in Table 8.

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 and Roof Shingle Tabs

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

RST, when permitted in a HMA, shall meet the requirements of Table 9.

RAP and RST that are contaminated with deleterious material shall not be used and shall be removed from the work. RAP and RST 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 and RST that are 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 and RST shall be as specified in the Contract Documents.

When RST is used in the HMA, it shall be processed solely from manufactured shingle scrap and shall be free of all contamination.

1151.05.03 Silicone

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

1151.05.04 Filler

Filler shall be according to OPSS 1003.

1151.05.05 Fibres

Fibres shall be either cellulose or mineral fibres. Cellulose and mineral fibres shall meet the requirements shown in Tables 10 and 11, respectively. The use of fiberglass, rock wool, and asbestos is prohibited.

1151.07 PRODUCTION

1151.07.01 Anti-Stripping Additives

1151.07.01.01 Liquid Anti-Stripping Additives

If the liquid anti-stripping additive is added by the asphalt cement supplier at the refinery depot, for each tanker of asphalt cement, the Contractor shall provide the Contract Administrator with the anti-stripping additive and PGAC Document and documentation from the asphalt cement supplier, in the form of a weighbill or bill of lading, confirming the type and concentration of the liquid anti-stripping agent.

If the liquid anti-stripping additive is added at the HMA plant, the Contractor shall provide the Contract Administrator with documentation from the HMA plant confirming the type and concentration of the liquid anti-stripping additive, accompanied by an approved statement of calibration for the metering device and a continuous record of the process prior to placement of mix containing liquid anti-stripping additive for each batch of asphalt cement with the liquid anti-stripping agent added.

1151.07.01.02 Hydrated Lime

When hydrated lime is added to the mix, it shall be added to all aggregates requiring an anti-stripping additive by any of the following methods:

a) Lime Slurry Method:

Hydrated lime shall be homogeneously mixed with aggregate prior to entering the dryer at the HMA plant. The hydrated lime slurry shall consist of approximately one part hydrated lime and three parts water, by mass. The HMA plant shall be equipped with suitable pumps or mixers to maintain the suspension of hydrated lime in the slurry and shall have adequate spray bars for introducing the required quantity of slurry into the aggregates. Mixing shall be accomplished with a pugmill or drum-type mixer, which has a mixing chamber and the capability of retaining material during the mixing process. The aggregates and slurry shall be retained in the mixing chamber until a uniform and homogeneous mixture of slurry and aggregate has been obtained.

b) Wetted Aggregate Method:

Dry hydrated lime shall be homogeneously mixed with wetted aggregate prior to entering the dryer at the HMA plant. The wetted coarse and fine aggregate shall be sufficiently wet to ensure uniform and complete adhesion of lime to the aggregate. Mixing shall be accomplished with a pugmill, a drum-type mixer, or other mixing device approved by the Owner, which has a continuous or batch mixing chamber that retains material during the mixing process until a uniform and homogeneous coating of lime on the aggregate has been obtained. The Contractor shall submit a written request to the Contract Administrator asking for approval of a mixing device at least 15 Days prior to the start of mix production. Processes or mixing devices that do not provide retention time of materials in a mixing chamber shall not be used.

c) Blending During Aggregate Production:

Hydrated lime shall be mixed with wetted aggregate at the pit or quarry prior to delivery of the aggregate to the HMA plant, by a method approved by the Owner prior to the start of any mix production. The blending process shall produce aggregates that are uniformly and homogeneously coated with the quantity of hydrated lime specified in the Contract Documents. The Contractor or the aggregate supplier or both shall implement and maintain a quality control system and records that demonstrate compliance with the Contract. The Owner may reject Materials if they fail to meet the quality control or blending requirements or both.

Regardless of the method or mixing equipment used, the Contractor shall ensure through regular quality control sampling and inspection that the specified quantity of lime is being incorporated into the mixture and that the aggregates possess a uniform and homogeneous coating of hydrated lime free of clumps and balls prior to entering the dryer at the HMA plant.

Aggregate which was treated and stored from a previous season may be used only after the Contract Administrator agrees to a written proposal from the Contractor that verifies the effectiveness of the stored aggregate, including the sampling protocol used, and test results from those samples that indicate that the aggregates meet the moisture sensitivity requirements specified in this specification.

1151.07.02 Preparation of the Mixture

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

The temperature of the mixture as it is discharged from the mixing chamber shall be controlled within the temperature range that corresponds to a viscosity range of $170 \text{ mm}^2/\text{sec} \pm 20 \text{ mm}^2/\text{sec}$ for the incorporated asphalt cement, except for modified asphalt cement the maximum discharge temperature shall be according to the asphalt cement supplier's recommendations.

TABLE 1
Aggregate Gradation

Hot Mix Asphalt Type	Percentage Passing by Dry Mass of Aggregates									
	Sieve Size mm									
	50.0	37.5	25	19.0	12.5	9.5	4.75	2.36	1.18	0.075
Superpave 4.75	-	-	-	-	100	95-100	90-100	-	30-60	6-12
Superpave 9.5	-	-	-	-	100	90-100	32-90	32-67	-	2-10
Superpave 12.5, 12.5FC 1 and 12.5FC 2	-	-	-	100	90-100	45-90	45-55 (Note 1)	28-58	-	2-10
Superpave 19.0	-	-	100	90-100	23-90	-	-	23-49	-	2-8
Superpave 25.0	-	100	90-100	19-90	-	-	-	19-45	-	1-7
Superpave 37.5	100	90-100	15-90	-	-	-	-	15-41	-	0-6
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:										
1. Requirements for the 4.75 mm sieve are in addition to those normally used for Superpave.										
2. 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

Hot Mix Asphalt Type	Primary Control Sieve mm	PCS Control Point At % Passing
Superpave 4.75	-	-
Superpave 9.5	2.36	47
Superpave 12.5, 12.5FC 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 Hot Mix Asphalt Properties

Traffic Category (Note 1)	% of Theoretical Maximum Specific Gravity			Voids in Mineral Aggregate (VMA) % minimum						Voids Filled with Asphalt (VFA) (Note 2) %	Dust to Binder Ratio (Note 3)	Minimum Tensile Strength Ratio %
	N _{initial}	N _{design}	N _{max}	Nominal Maximum Aggregate Size mm								
				37.5	25.0	19.0	12.5	9.5	4.75			
A	≤ 91.5	96.0	≤ 98.0	11.0	12.0	13.0	14.0	15.0	16.0	70-80 (Note 4)	0.6-1.2	80
B	≤ 90.5									65-78		
C	≤ 89.0									65-75 (Note 5)		
D												
E												

Notes:

1. Traffic category as specified in the Contract Documents.
2. 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%.
3. 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 4, the dust-to-binder ratio shall be 0.8-1.6.
4. For Traffic Category A, Superpave 25.0 mixes shall have a VFA range of 67 to 80%.
5. Superpave 37.5 mixes shall have a VFA range of 64 to 75%.

Table 4
Stone Mastic Asphalt Properties

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

Notes:

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

TABLE 5
Stone Mastic Asphalt 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 Reclaimed Asphalt Pavement Proportions by Mass

Traffic Category (Note 1)	Binder Course 150 mm or More Below Pavement Surface	Binder Course Within 150 mm of Pavement Surface	Surface Course Excluding Superpave 12.5FC 2, Superpave 12.5FC 1 and SMA	Superpave 12.5FC 2, Superpave 12.5FC 1 and SMA Surface Course
A, B	40%	40%	20%	0%
C, D	40%	20%	20%	0%
E	20%	0%	0%	0%
Notes:				
1. Traffic category as specified in the Contract Documents.				

TABLE 7
Mix Check Requirements

Mix and Aggregate Property	Requirements (Note 1)
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}	$\pm 0.7\%$ from submitted design
VMA	$\pm 1.0\%$ from submitted design and not more than 0.3% below design minimum
VFA	Within specified mix design range
% G_{mm} at N_{initial}	Not more than design maximum
% G_{mm} at N_{max}	Not more than design maximum
Dust Proportion	Within specified mix design range
Tensile Strength Ratio	Not less than design minimum
Notes:	
1. Design requirements specified in the Contract Documents.	

TABLE 8
Sample Quantities for Mix Design Monitoring

Material	Quantity
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 µm sieve	5 to 10 kg when the mix is to be produced with a plant that returns fines to the mixture
Mineral Filler	5 to 10 kg sample for SMA mixes
RST	10 to 15 kg required when RST contained in the mix
Any other material samples including anti-stripping agents and fibres to be used in HMA	Quantity large enough to allow for a complete mix design

TABLE 9
Requirements for Roof Shingle Tabs

Contents		Requirement
Percent Cellulose or Mineral Fibres by Mass of RST		15-25
Percent Asphalt Cement Content Based on Mass (Note 1)		20-30
Percentage Passing by Dry Mass of Aggregate (Note 2)	9.5 mm sieve	100
	4.75 mm sieve	90-100
	600 µm sieve	45-60
	75 µm sieve	15-25
Notes: 1. Asphalt cement recovered from the RST shall have a minimum penetration of 18 dmm according to LS-200 and LS-284. 2. As determined according to LS-282 or LS-292.		

TABLE 10
Requirements for Cellulose Fibres

Property	Requirement
Sieve Analysis, Method A or B	
Method A, Alpine Sieve Analysis (Note 1) Fibre Length Passing 0.150 mm sieve	6 mm maximum 70 ± 10%
Method B, Mesh Screen Analysis (Note 2) Fibre Length: Passing 0.850 mm sieve Passing 0.425 mm sieve Passing 0.106 mm sieve	6 mm maximum 85 ± 10% 65 ± 10% 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
Notes: - 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. - 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 a 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. - Ash Content. A representative 2-3 gram sample of fibre is placed in a tared crucible and heated between 595 and 650 °C for no less than 2 hours. The crucible and ash are cooled in a desiccator and re-weighed. - A pH test - Five 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. - Absorption Test - 5 grams of fibre is accurately weighed and suspended in an excess of mineral spirits for no 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, number of times its own weight, the fibres are able to absorb. - Moisture Content - 10 grams of fibre are weighed to an accuracy of 0.1 g and placed in a 121 °C forced air oven for two hours. The sample is then re-weighed upon removal from the oven.	

TABLE 11
Requirements for Mineral Fibres

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%
Notes: 1. The fibre length is determined according to the Bauer McNett fractionation of AASHTO MP 8. 2. The fibre thickness is determined by measuring at least 200 fibres in a phase contrast microscope. 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.	

Appendix 1151-A, Commentary for OPSS.PROV 1151, April 2007

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

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



MATERIAL SPECIFICATION FOR CLAY SEAL

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1205.01	SCOPE
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1205.08	QUALITY ASSURANCE - Not Used
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APPENDICES

1205-A	Commentary
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1205.01 SCOPE

This specification covers the requirements of clay seal material for use at the upstream or inlet side of culverts.

1205.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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

1205.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

1205.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Material

OPSS 1010 Aggregates - Base, Subbase, Select Subgrade, and Backfill Material.

ASTM International

D 4318-10 Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
D 5084-10 Permeability of Saturated Soils Using a Flexible Wall Permeameter

1205.03 DEFINITIONS

For the purpose of this specification the following definitions apply:

Bentonite means a commercial term applied to clay deposits containing sodium montmorillonite as the essential mineral.

Clay means a fine textured (i.e., grain size smaller than 0.002 mm) sedimentary or residual deposit consisting of hydrated silicates of aluminum mixed with various impurities, but no organics. It is a cohesive soil and plastic within a wide range of water content.

Geosynthetic Clay Liner means sodium bentonite soils sandwiched between two protective geotextiles.

Liquid Limit means the water content between the semi-liquid and the plastic states of the soil.

Plastic Limit means the water content between the plastic and semi-solid states of the soil.

Plasticity Index means the water content range of a soil at which it is plastic, defined numerically as the liquid limit minus the plastic limit.

1205.04 DESIGN AND SUBMISSION REQUIREMENTS

1205.04.01 Submission Requirements

1205.04.01.01 Natural Clay

The results of the Atterberg Limit Tests (Liquid Limit and Plasticity Index) on the natural clay shall be submitted to the Contract Administrator at least one week prior to the commencement of work. The Atterberg Limits shall be determined using ASTM D 4318.

1205.04.01.02 Clay Mixture

The results of the Atterberg Limit Tests (Liquid Limit and Plasticity Index) and permeability tests on the clay mixture shall be submitted to the Contract Administrator at least one week prior to the commencement of work. The Atterberg Limits shall be determined using ASTM D 4318. The permeability shall be according to ASTM D 5084.

1205.04.01.03 Geosynthetic Clay Liner

Material specifications containing the physical, mechanical, and hydraulic properties of the geosynthetic clay liner shall be obtained from the manufacturer and submitted to the Contract Administrator. The specification shall include the manufacturer's certification and warranty.

1205.05 MATERIAL

1205.05.01 General

Material used shall have plasticity index and liquid limit percentages that are within the hatched area shown in Figure 1. It shall be natural clay, clay mixture, or a geosynthetic clay liner and shall meet the physical requirements as specified below.

1205.05.02 Natural Clay

Not all clays are suitable for use as clay seal. Clay material shall be according to the following:

- a) Liquid limit shall be $> 50\%$.
- b) Plasticity index shall be $> 0.75 \times (\text{Liquid Limit} - 20\%)$.

1205.05.03 Clay Mixture

A mixture of clay and other materials can be used, provided that they meet the physical properties for natural clay and the permeability as determined from the falling head permeameter test does not exceed 1×10^{-5} mm/s.

1205.05.04 Geosynthetic Clay Liner

The geosynthetic clay liner shall have a permeability not exceeding 1×10^{-5} mm/s.

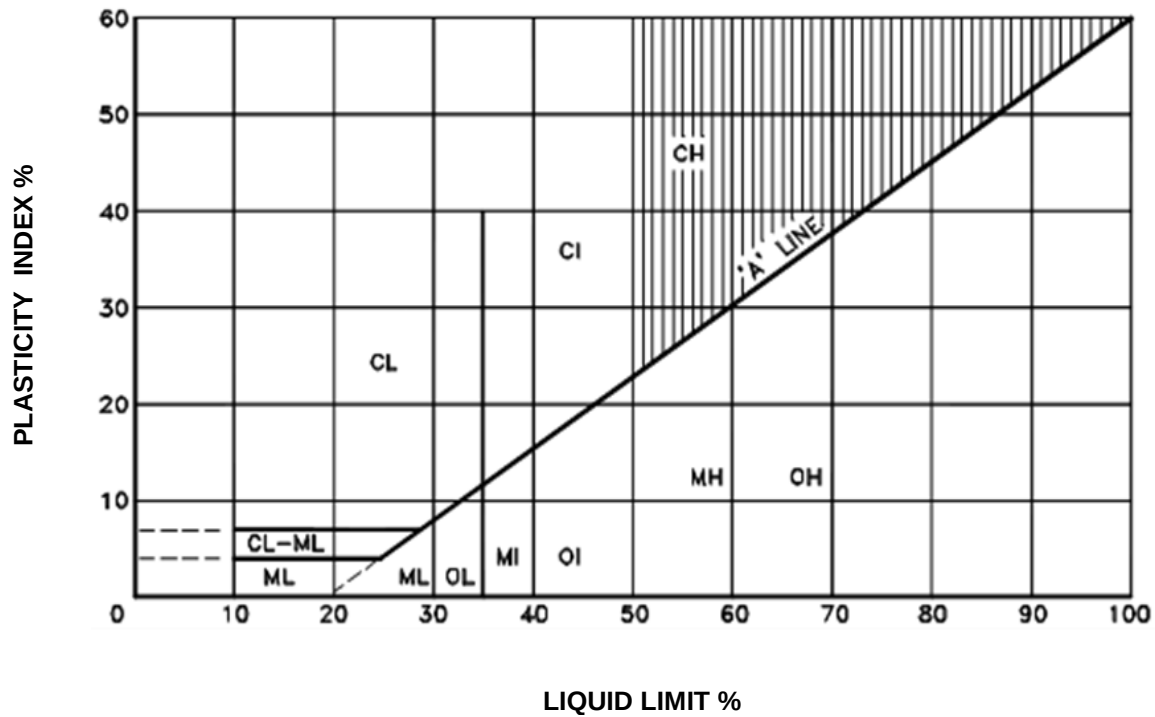


FIGURE 1
Plasticity Chart

LEGEND:

Soil Classifications

- CH - Inorganic Clays of High Plasticity, Fat Clays
- CI - Inorganic Silty Clays of Medium Plasticity
- CL - Inorganic Silty Clays, Gravelly Clays, Sandy Clays, lean Clays
- MH - Inorganic Silts, Highly Compressible Micaceous or Diatomaceous Fine Sandy Silts, Elastic Silts
- MI - Inorganic Compressible Fine Sandy Silt With Clay of Medium Plasticity, Clayey Silts
- ML - Inorganic Silts and Sandy Silts of Slight Plasticity, Rock Flour
- OH - Organic Clays of High Plasticity
- OI - Organic Silty Clays of Medium Plasticity
- OL - Organic Silt of Low Plasticity, Organic Sandy Silts

Appendix 1205-A, April 2015
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



MATERIAL SPECIFICATION FOR DECK JOINT ASSEMBLIES

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1210.09	OWNER PURCHASE OF MATERIAL - Not Used

APPENDICES

1210-A	Commentary
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1210.01 SCOPE

This specification covers the requirements for Materials, design, and fabrication of deck joint assemblies.

1210.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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

1210.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

1210.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 920 Deck Joint Assemblies, Preformed Seals, Joint Fillers, Joint Seals, Joint Sealing Compounds, and Waterstops - Structures

Ontario Provincial Standard Specifications, Material

OPSS 1202 Bearings - Elastomeric and Plain Steel Laminated
OPSS 1203 Bearings - Rotational and Sliding Surface

Ontario Ministry of Transportation Publications

Structural Manual:

Division 1, Exceptions to the Canadian Highway Bridge Design Code CAN/CSA S6 for Ontario

CSA Standards

G30.18-M92 (R2002) Billet - Steel Bars for Concrete Reinforcement
G40.20/G40.21-04 General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel
G164-M92 Hot Dip Galvanizing of Irregularly Shaped Articles
S6-06 Canadian Highway Bridge Design Code
W47.1-03 Certification of Companies for Fusion Welding of Steel
W59-03 Welded Steel Construction (Metal Arc Welding)
W186-M1990 (R2007) Welding of Reinforcing Bars in Reinforced Concrete Construction

ASTM International

A 240/A 240M-07e1	Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels and for General Application
A 325M-05	Standard Specification for Structural Bolts, Steel, Heat Treated 830 MPa Minimum Tensile Strength
D 412-06a	Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
D 471-06	Standard Test Method for Rubber Property - Affects of Liquids
D 573-04	Standard Test Method for Rubber Deterioration in an Air Oven
D 832-07	Standard Practice for Rubber Conditioning for Low Temperature Testing
D 1149-07	Standard Test Method for Rubber Deterioration - Cracking in an Ozone Controlled Environment
D 2240-05	Standard Test Method for Rubber Property - Durometer Hardness
F 835-04e1	Standard Specification for Alloy Steel Socket Button and Flat Countersunk Head Cap Screws

Others

U.S. Military Specification:

MIL-A-907D-93 Antiseize Thread Compound, High Temperature

National Cooperative Highway Research Program (NCHRP):

Report 402 Fatigue Design of Modular Bridge Expansion Joints

1210.03

DEFINITIONS

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

Armouring means an edging to the deck joint comprising of a steel profile permanently attached to the concrete dam corners.

Armouring Angle means the expansion joint angle at the gap.

Bearing means a structural device that transmits a load while permitting translation or rotation or both.

Elastomer means a compound containing virgin polychloroprene or neoprene.

Manufacturer means a fabrication company that is certified by the Canadian Welding Bureau (CWB) according to CSA W47.1, Division 2.1, and supplies deck joint assemblies.

Nosing Angle means the angle that forms the outside edges of the joint blockout.

Preformed Seal means an extruded elastomer that, when retained in recesses in the deck joint assembly, prevents the passage of water and other materials.

Product Drawings means drawings prepared by the manufacturer that have been approved by the Owner for use with the product.

Separation beam means a steel section which conveys wheel loads that spans between support bars.

Support bar means a member upon which a traffic bearing separation beam rests.

1210.04 DESIGN AND SUBMISSION REQUIREMENTS

1210.04.01 Design Requirements

1210.04.01.01 General

Deck joint assemblies shall be designed to function satisfactorily under the critical combinations of the maximum and minimum factored loads, translations, and rotations at the serviceability and ultimate limit states according to CAN/CSA S6 and the Structural Manual, Division 1.

1210.04.01.02 Fasteners and Anchorage

Fasteners and anchorage devices shall be designed to transfer all the static and dynamic loads from each side of the deck joint assembly to the structure.

1210.04.01.03 Preformed Seal

All deck joint assemblies and the bearings in modular deck joint assemblies shall be designed so that the entire preformed seal is replaceable without damage to the structure and without removal of any concrete, welds, or anchorages permanently attached to the structure.

1210.04.01.04 Modular Expansion Joints

The loading for modular expansion joints shall be as follows:

- a) Vertical wheel loads shall be as specified in the (Canadian Highway Bridge Design Code) CHBDC and as follows:
 - i. For strength and serviceability, axle 4 of the CL-625-ONT truck shall be used.
 - ii. For fatigue loading purposes, axles 2 and 3 of the CL-625-ONT truck shall be used.
- b) For fatigue purposes, the requirement of CAN/CSA S6 that only a single truck may be placed in one lane location shall be interpreted as follows:
 - i. For maximum or positive stress at a given location in the joint, the truck may be in one lane at a particular time.
 - ii. For minimum or negative stress at the location mentioned above, the truck may be in another lane at a different time.
 - iii. The calculated fatigue stress range is the algebraic difference between the maximum and minimum stresses above.
- c) For structural components other than joint armouring, the horizontal load shall be 20% of the vertical load specified in point a) above. It shall be applied at the roadway surface and considered individually or in combination with the vertical load, whichever is critical. For joint armouring, the horizontal load shall be as specified in CAN/CSA S6.
- d) The dynamic load allowance shall be as specified in CAN/CSA S6 and shall be applied to both vertical and horizontal wheel loads.
- e) Load factors and load combinations shall be as specified in CAN/CSA S6.
- f) To determine the design stress range of structural response for fatigue loading, the vehicle may be placed anywhere along the length of the expansion joint, but need not be placed closer than 600 mm to a barrier wall or median barrier.

The design requirements for modular expansion joints shall be as follows:

- a) The design shall satisfy the strength, serviceability, and fatigue requirements according to CAN/CSA S6. Fatigue design of modular joints shall also be according to NCHRP Report 402.
- b) The required number of seals shall be determined based on the specified design movement of the joint at serviceability limit states.
- c) For strength purposes at ultimate limit states and to determine the required length of support bar, installation temperature of the joint shall be assumed to be 15 °C. Calculated force effects shall be based on factored movements in relation to the joint's articulation relative to its position at 15 °C.
- d) Modular joints shall be equipped with a mechanism capable of ensuring all openings of the joint are of uniform width as follows:
 - i. Stiffness of the mechanism shall not exceed 8.5 kN/m and shall be shown on both the product and Working Drawings.
 - ii. The width of individual openings shall not vary by more than 6 mm along the length of the joint.
 - iii. The mean widths of openings shall not vary by more than 6 mm.
- e) For fatigue design purposes, the applicable design criteria as specified in the CHBDC shall be as follows:

$$0.62f_{sr} \leq F_{sr}$$

1210.04.02 Submission Requirements

1210.04.02.01 Product Drawings

The deck joint assembly manufacturer shall submit the product drawings for approval.

The product drawings shall indicate all material properties, dimensions, connection attachments, injection hose system, splices, fasteners and accessories, and the individual alphanumeric identification numbers.

The product drawings for modular joints shall bear the seal and signature of an Engineer.

1210.05 MATERIALS

1210.05.01 Bearings

All material forming parts of the bearing component of the deck joint assembly shall be according to OPSS 1202 and OPSS 1203.

The virgin polytetrafluoroethylene (PTFE) element shall have a minimum thickness of 1.5 mm.

1210.05.02 Preformed Seal

The preformed seal shall be manufactured from an elastomer with physical properties shown in Table 1.

Manufacturer's storage and handling requirements shall be followed. The seal shall not be exposed to ultraviolet rays for more than 3 Days prior to installation.

1210.05.03 Steel

Mild steel components shall be according to CSA G40.20/G40.21, Grade 300 W.

Stainless steel shall have a minimum corrosion resistance according to ASTM A 240M.

Steel fasteners other than stainless steel shall be according to ASTM A 325M or ASTM F 835.

1210.05.04 Anchors

Anchors shall be headed type stud shear connectors according to CSA W59, Appendix H.

1210.05.05 Reinforcing Steel Bars

Reinforcing steel bars shall be according to CAN/CSA G30.18, Grade 400W.

1210.05.06 Antiseize Compound

Antiseize compound shall be according to MIL-A-907D.

1210.05.07 Injection Hose System for Deck Joint Assembly

The injection hose system shall be installed on the deck joint assembly for both nosing and armouring angles. This system shall be long enough to extend between the barrier or parapet walls on each side of the structure, including the sidewalks and curbs.

There shall not be bleeder holes in the nosing and armouring angles.

1210.07 PRODUCTION

1210.07.01 General

The deck joint assembly manufacturer shall have a copy of the deck joint assembly Working Drawings as specified in OPSS 920 at the manufacturing plant during the deck joint assembly fabrication.

1210.07.02 Welding

Welding of structural quality steels shall be according to CSA W59.

Welding of stainless steel shall be according to OPSS 1203.

Welding of reinforcing steel bars shall be according to CSA W186-M.

1210.07.03 Fasteners

All steel bolts shall be zinc phosphate coated.

The threaded portion of bolts and the underside of the bolt heads shall be coated with an antiseize compound prior to installation.

1210.07.04 Steel Fabrication

Machining shall be carried out after welding, whenever possible.

All rough flame cut surfaces and metal-to-metal contact surfaces shall be machined ground smooth.

Re-entrant corners that are cut shall be free from notches and shall have the largest practical radius with a minimum radius of 14 mm. Bearing surfaces shall be in contact over the full area of the mating surfaces.

1210.07.05 Corrosion Protection

All structural steel components of the deck joint assembly shall be hot dip galvanized after fabrication according to CAN/CSA G164-M.

1210.07.06 Preformed Seal

The preformed seal shall exceed the required length by 1 m to permit sampling and testing in the field.

1210.07.07 Marking

Each deck joint section shall be marked with the date of manufacture (i.e., yyyy-mm-dd), an individual alphanumeric identification, and a sequential number. The characters shall be die stamped into an exposed surface at the gutter line at the barrier wall or curb. The characters shall not be less than 10 mm high with the indentations not less than 0.5 mm in width and 0.2 mm in depth.

The preformed seal shall be clearly and indelibly stamped every metre with a lot number, date of manufacture (i.e., yyyy-mm-dd), and model number.

1210.07.08 Designation of Lifting Points

The lifting points shall be clearly marked on the deck joint assembly.

TABLE 1
Preformed Seal Physical Requirements

Property	Physical Requirements	Test Procedure
Tensile Strength	Minimum 13.5 MPa	ASTM D 412 Test Method A
Ultimate Elongation	Minimum 250%	ASTM D 412 Test Method A
Hardness, Type A Durometer	55, + 7, -5	ASTM D 2240
Oven Aging Test, 70 h @ 100 °C Change in Tensile Strength	Maximum 20%	ASTM D 573 ASTM D 412 Test Method A
Change in Elongation	Maximum 20%	ASTM D 412 Test Method A
Change in Hardness	Minimum 10 points	ASTM 2240
Permanent set at break	Maximum 10%	ASTM D 412 Test Method A
Low Temperature Crystallization Hardness, Type A Durometer 7 d @ -10 °C Change in Hardness	Maximum 15 points	ASTM D 832 ASTM D 2240
Oil Swell, ASTM Oil No. 3, 70 h @ 100 °C Weight Change	Maximum 45%	ASTM D 471
Ozone Resistance, 20% Strain, 300 pphm in air 70 h @ 40 °C	No cracks	ASTM D 1149 Specimen A
Notes: A. All tests shall be made on specimens prepared from the preformed seals.		

Appendix 1210-A, November 2014
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



MATERIAL SPECIFICATION FOR ADMIXTURES FOR CONCRETE

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1303.03	DEFINITIONS
1303.04	DESIGN AND SUBMISSION REQUIREMENTS
1303.05	MATERIALS
1303.06	EQUIPMENT - Not Used
1303.07	PRODUCTION - Not Used
1303.08	QUALITY ASSURANCE
1303.09	OWNER PURCHASE OF MATERIALS - Not Used

APPENDICES

1303-A	Commentary
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1303.01 SCOPE

This specification covers the materials for use as air entraining, chemical, and superplasticizing admixtures for concrete.

1303.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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

1303.01.02

Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

1303.02

REFERENCES

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

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

Ontario Ministry of Transportation Publications

Designated Sources for Materials (DSM)

Laboratory Testing Manual:

- LS-413 Method of Test for Non-volatile Content of Chemical Admixtures, Latex Admixtures and Curing Compounds
- LS-422 Method of Test for Evaluation of Air Entraining Admixtures for Concrete
- LS-423 Method of Test for Evaluation of Chemical Admixtures for Concrete
- LS-424 Method of Test for Evaluation of Superplasticizing Admixtures

ASTM International

- C 494 Chemical Admixtures for Concrete
- E 70-97 (2002) Test Method for pH of Aqueous Solutions with the Glass Electrode

1303.03

DEFINITIONS

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

Air Entraining Admixture means a type of admixture according to ASTM C 260 that causes development of a system of microscopic air bubbles in concrete during mixing, to increase the workability of the concrete and its resistance to freezing and thawing.

Chemical Admixture means Types A, B, C, D, E, and S admixtures according to ASTM C 494.

Non-Chloride Admixture means an admixture that contains not more than 0.01% chloride by mass of cement.

Superplasticizer means Types F and G admixtures according to ASTM C 494.

Type A means a water reducing admixture that reduces the quantity of mixing water required to produce concrete of a given consistency.

Type B means a retarding admixture that retards the setting of concrete.

Type C means an accelerating admixture that accelerates the setting and early strength development of concrete.

Type D means a water reducing and retarding admixture that reduces the quantity of mixing water required to produce concrete of a given consistency and retards the setting of concrete.

Type E means a water reducing and accelerating admixture that reduces the quantity of mixing water required to produce concrete of a given consistency and accelerates the setting and early strength development of concrete.

Type F means a superplasticizing admixture that reduces the quantity of mixing water required to produce concrete of a given consistency by 12% or greater.

Type G means a superplasticizing and retarding admixture that reduces the quantity of mixing water required to produce concrete of a given consistency by 12% or greater and retards the setting of concrete.

Type S Admixture means a specific performance admixture that provides desired performance characteristics, other than reducing water content or changing the time of setting of concrete or both, without any adverse effects on fresh, hardened, and durability properties of concrete.

1303.04 DESIGN AND SUBMISSION REQUIREMENTS

1303.04.01 Submission Requirements

1303.04.01.01 Admixtures

The supplier shall submit documentation verifying that each admixture used on the Contract is included on the ministry's DSM.

1303.05 MATERIALS

All admixtures shall be in liquid form.

All admixtures shall be non-chloride, with the exception of admixtures used in fast-track full-depth repairs to concrete pavements or concrete base.

Admixtures shall be according to LS-422, LS-423, and LS-424.

In addition, required performance characteristics of each Type S chemical admixture shall be demonstrated on Owner approved field trials prior to use in the work.

Admixtures shall be sampled and tested as specified in the Contract Documents.

Relative density and pH of air entraining admixtures, and non-volatile content and relative density of chemical and superplasticizing admixtures shall be according to the product data shown on the DSM, within the following tolerances:

a) Relative density:

- i. Where relative density is 1.050 or less, the tolerance shall be ± 0.005 .
- ii. Where relative density is greater than 1.050, the tolerance shall be calculated according to the following formula:

$$\text{Tolerance} = (\text{relative density of acceptance sample} - 1.000) / 10$$

b) Non-volatile content $\pm 2.5\%$.

c) pH ± 1.5 .

Appendix 1303-A, November 2014
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



MATERIAL SPECIFICATION FOR CONCRETE - MATERIALS AND PRODUCTION

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1350-A	Commentary
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1350.01 SCOPE

This specification covers the requirements for materials and methods for proportioning, mixing, transporting, field testing, acceptance, and payment adjustments of concrete material, including provisions for referee testing of compressive strength, air void system parameters, and rapid chloride permeability of high performance concrete and silica fume overlays.

1350.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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

1350.01.02

Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

1350.02

REFERENCES

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

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

Ontario Provincial Standard Specifications, Material

OPSS 1002	Aggregates - Concrete
OPSS 1301	Cementing Materials
OPSS 1302	Water
OPSS 1303	Air Entraining and Chemical Admixtures for Concrete

Ontario Ministry of Transportation Publications

Designated Sources for Materials (DSM)

Laboratory Testing Manual:

LS-100	Method of Rounding-off Data and Other Numbers
LS-101	Method for Calculation of Per Cent Within Limits
LS-407	Method of Test for Compressive Strength of Moulded Cylinders
LS-413	Method of Test for Non-Volatile Content of Chemical Admixtures, Latex Admixtures and Curing Compounds
LS-414	Method of Test for Relative Density of Chemical Admixtures, Air Entraining Admixtures, Latex Admixtures and Curing Compounds
LS-415	Method of Test for pH of Aqueous Solutions by Glass Electrode
LS-426	Method of Testing Compressive Strength of High Performance Concrete Cylinders
LS-431	Method of Test for Microscopical Determination of Air Void System Parameters in Hardened Concrete, for Conformance Testing
LS-432	Method of Test for Microscopical Determination of Air Void System Parameters in Hardened Concrete

- LS-433 Method of Test for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration
 LS-435 Method of Test for Linear Shrinkage of Concrete

MTO Forms:

- PH-CC-322 Concrete Construction Report
 PH-CC-340 Field Sample Data Sheet - Concrete
 PH-CC-433A Concrete Mix Design Submission Form A
 PH-CC-433B Concrete Mix Design Submission Form B
 PH-CC-434 Sample Letter to Contractor - Concrete Mix Design

CSA Standards

- A23.2-1C Sampling Plastic Concrete*
 A23.2-3C Making and Curing Concrete Compression and Flexural Test Specimens*
 A23.2-4C Air Content of Plastic Concrete by the Pressure Method*
 A23.2-5C Slump and Slump Flow of Concrete*
 A23.2-6C Density, Yield, and Cementing Materials Factor of Plastic Concrete*
 A23.2-14C Obtaining and Testing Drilled Cores for Compressive Strength Testing*
 A23.2-17C Temperature of Freshly Mixed Hydraulic Cement Concrete*
 A23.2-1D Moulds for Forming Concrete Test Cylinders Vertically*
 A3004-B6 Physical Test Methods for Cementitious Materials for Use in Concrete and Masonry **
 A3001 Cementitious Materials for Use in Concrete**
 * [Part of A23.1-09/A23.2-09 - Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete]
 ** [Part of A3000-08 - Cementitious Materials Compendium]

1350.03 DEFINITIONS

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

High Performance Concrete (HPC) means concrete with a minimum specified 28-Day compressive strength of at least 50 MPa that includes silica fume and may include other supplementary cementing materials, and having specified rapid chloride permeability at 28 to 32 Days of 1,000 coulombs or less.

High Strength Concrete means concrete with a minimum specified 28-Day compressive strength of 40 MPa or greater.

Stationary Mixer means a non-mobile mixer installed at a plant for the purpose of mixing concrete.

Steel Reinforcement means all types of steel reinforcement for concrete, including reinforcing steel bars, stainless steel reinforcing bars, splice bars, welded steel wire fabric, and prestressing strands and bars.

Tremie Concrete means a concrete mix specifically designed to be placed under water by means of a tremie.

1350.04 DESIGN AND SUBMISSION REQUIREMENTS

1350.04.01 Design Requirements

1350.04.01.01 General

The concrete mix shall be designed to provide adequate strength and durability for the intended use and to meet the requirements as specified in the Contract Documents.

1350.04.01.01.01 Use of Admixtures

Water reducer Type A or D according to OPSS 1303 shall be used in all concrete, except in applications where plant addition of superplasticizer is permitted, in which case water reducer may be used at the Contractor's option.

Retarding of concrete set shall be provided when specified in the Contract Documents. If no retarding of set is specified, retarders may be used at the Contractor's option to delay setting of concrete for a maximum of 3 hours. Longer periods of set retardation shall be used only when specified in the Contract Documents.

Accelerators shall only be used when specified in the Contract Documents.

Superplasticizers shall be used in HPC and concrete in expansion joint end dams as specified in the Contract Documents. Superplasticizers may be used in concrete patches, refacing, and silica fume overlays at the Contractor's option. In all other applications, superplasticizer shall be used only when approved by the Owner.

In applications where rapid chloride permeability is an acceptance requirement, including high performance concrete and silica fume overlays, superplasticizer may be added at the plant. In all other applications where superplasticizer is to be used it shall be added at the site.

1350.04.02 Submission Requirements

1350.04.02.01 Mix Design

1350.04.02.01.01 General

A complete mix design submission shall be provided for concrete of each specified compressive strength that is to be placed in the work, for each of the following:

- a) Cast-in-place concrete.
- b) Slipformed concrete.
- c) Mixes with different sources of materials.
- d) Mixes with different admixtures.
- e) Precast concrete.
- f) Special purpose or unique mixes.

The Contractor shall provide a complete mix design submission for each specific concrete mix prior to the placement of that mix in the work. A complete mix design submission consists of the following:

- a) A completed MTO form PH-CC-433A (Form A).
- b) A completed MTO form PH-CC-433B (Form B).
- c) Mix design-supporting documentation.

Form A and Form B shall identify all materials to be used in the concrete. No material shall be used in the concrete without the knowledge of the Owner.

If the same mix design (i.e., same materials and sources in the same proportions) is to be supplied by multiple plants, submission of separate mix designs and separate supporting documentation is not required.

The mix shall not be placed until the Contract Administrator provides written confirmation that Form A and the mix design supporting information meet the requirements as specified in the Contract Documents. Within 4 Business Days following the delivery of all required documentation by the Contractor, the Contract Administrator shall provide the Contractor with a completed MTO form PH-CC-434 indicating the above confirmation or advising the Contractor of any requirements that have not been met.

1350.04.02.01.02 Changes to Mix Design Submission

The following adjustments to the submitted mix design may be made without having to submit a new mix design or supporting data:

- a) Total cementing material content: $\pm 5\%$ of quantity stated on Form B.
- b) Supplementary cementing materials: $+0/-5\%$ of quantity stated on Form B.
- c) Admixtures: Variation within range of dosage stated on Form B.
- d) Water: Variation within range stated on Form B.

Removal of a material from the mix or addition of retarding admixture Type B or D according to OPSS 1303 requires submission of a new mix design, but does not require submission of supporting test data.

A new mix design, including supporting documentation, shall be provided prior to placing concrete, if the Contractor proposes to change the mix in any of the following ways:

- a) Changing sources of materials used in the concrete.
- b) Substituting a material or product for another from the same source.
- c) Adding any material to the concrete that was not on the original mix design, except retarding admixture Type B or D according to OPSS 1303.
- d) Adjusting the quantities of the stated materials in the concrete outside of the ranges provided above.

The submission process for new or modified mix designs is the same as for the original mix design, except that when supporting documentation is not required, the confirmation by the Contract Administrator shall be provided within 1 Business Day.

1350.04.02.01.03 Submission of Form A

At least 7 Business Days prior to the placement of concrete, the Contractor shall submit an accurately completed Form A to the Contract Administrator.

The Contractor shall assign a unique number to each mix design submitted, consisting of the following:

- a) 8-digit Contract number, followed by
- b) 2 digits indicating the specified compressive strength of concrete, followed by
- c) 2 digits indicating the number of the submission for that Contract (e.g., 01 for the first mix design of a specified strength, 02 for the second, and so on) followed, if applicable, by

- d) 1 digit indicating the number of revisions of a mix design submitted previously (e.g., 1 for first revision, 2 for second revision, and so on).

1350.04.02.01.04 Submission of Form B

Prior to the placement of concrete of a specified mix design, the Contractor shall ensure that for each Form A submitted, a corresponding Form B is accurately completed by the concrete supplier and submitted directly to the Head, Concrete Section.

The Form B shall bear the mix design number assigned by the Contractor to the corresponding Form A.

1350.04.02.01.05 Mix Design Supporting Documentation

Form A shall be accompanied by all material quality test data and other information for the mix design and for component materials required by the Contract Documents. All required supporting test data and certificates shall be less than 12 months old at the time the concrete mix design is submitted.

Supporting documentation shall include the following:

- a) A currently valid Certificate of Ready Mixed Concrete Production Facilities as issued by the Ready Mixed Concrete Association of Ontario (RMCAO) for any plant to be used on the Contract.
- b) The range of concrete production rates required for the work.
- c) A certificate or letter verifying the compatibility of the admixtures to be used in the concrete, if admixtures are supplied from different manufacturers.
- d) Water test results, if water other than municipal drinking water is used, demonstrating compliance with the requirements as specified in the Contract Documents.
- e) A certificate verifying the cement is free from early stiffening tendencies when tested according to CAN/CSA A3004-B6, if non-agitating trucks are used.
- f) Any other requirements specified elsewhere in the Contract Documents.

Documentation applicable to multiple mix designs need only be submitted once for a Contract.

1350.04.02.02 Certification of Ready Mixed Concrete Production Facilities

For multi-year Contracts, the Contractor shall submit annually for all plants supplying concrete to the work, verification that the plant continues to hold a valid Certificate of Ready Mixed Concrete Production Facilities, as issued by the RMCAO.

1350.05 MATERIALS

1350.05.01 Cementing Materials

Cementing materials shall be according to OPSS 1301 and CAN/CSA A3001, except:

- a) For all concrete other than silica fume overlays and HPC, Portland cement shall be used. A portion of it may be replaced by supplementary cementing material; however, silica fume or blended cement containing silica fume shall not be used.

- b) For silica fume overlays and HPC, blended hydraulic cement containing silica fume shall be used. A portion of it may be replaced by Portland cement Type GU or supplementary cementing materials or both.

Supplementary cementing material shall be ground granulated blast furnace slag or fly ash or a combination of the two materials and shall be restricted to the following proportions by mass of the total cementing material:

- a) Slag up to 25%.
- b) Fly ash up to 10%, except for silica fume overlays and HPC where up to 25% is permitted.
- c) A mixture of slag and fly ash up to 25%, except the amount of fly ash shall not exceed 10% by mass of the total cementing materials, in concrete other than silica fume overlays and HPC.

For tremie concrete, the minimum cementing material content shall be 415 kg per cubic metre of concrete.

1350.05.02 Aggregates

Aggregates shall be according to OPSS 1002.

1350.05.03 Water

Water used for production shall be according to OPSS 1302.

1350.05.04 Admixtures for Concrete

Air entraining, chemical, and superplasticizing admixtures for concrete shall be according to OPSS 1303.

1350.05.05 Concrete

The Contractor shall identify target slump and air values for all plastic concrete.

The plastic concrete shall meet the following requirements:

- a) Concrete shall be free of lumps and segregation and shall have consistent air content and slump throughout each load.
- b) Plastic air content shall meet the requirements as shown in Table 1.
- c) Slump shall meet the requirements of Table 1. The maximum allowable slump, including tolerance, shall be 100 mm, except for tremie concrete, which shall be 180 mm.

When superplasticizer is to be added to the concrete according to the Use of Admixtures clause, the following shall apply:

- i. For superplasticizers added at the plant, the Contractor shall identify target slump for the concrete after the addition of superplasticizer. The tolerance on measurement of concrete slump after addition of superplasticizer shall be ± 30 mm and the maximum slump including tolerance shall not exceed 230 mm.

- ii. For superplasticizers added at the site, the Contractor shall identify target slumps for the concrete both prior to and after the addition of superplasticizer. The tolerance on measurement of concrete slump prior to the addition of superplasticizer shall be ± 20 mm and the maximum slump including tolerance shall not exceed 100 mm. The tolerance on measurement of concrete slump after addition of superplasticizer shall be ± 30 mm and the maximum slump, including tolerance, shall not exceed 230 mm.
- d) The concrete temperature at the time of discharge from the truck shall be at or between 10 and 28 °C, with the exception of HPC and silica fume overlays, which shall be at or between 10 and 25 °C.

The hardened concrete shall meet the following requirements:

- a) Concrete compressive strength shall be as specified in the Contract Documents.
- b) Rapid chloride permeability of HPC and silica fume overlays at 28 to 32 Days shall be less than or equal to 1,000 coulombs.
- c) Air void system parameters as determined on the hardened concrete shall meet the following requirements:
 - i. Each core shall have a minimum air content of 3.0 %.
 - ii. Each core shall have a maximum spacing factor of 0.230 mm, except for HPC and silica fume overlays for which each core shall have a maximum spacing factor of 0.250 mm.

1350.06 EQUIPMENT

1350.06.01 Batching Plant

The batching plant and equipment shall be certified by the RMCAO prior to producing concrete for the work, including concrete for any trial batches, and shall meet the requirements for certification throughout the production of concrete.

1350.06.02 Delivery Equipment

Delivery equipment shall be truck mixers, agitator trucks, or non-agitating equipment. Use of non-agitating equipment shall be restricted to delivery for placement of concrete base or concrete pavement.

Truck mixers shall consist of concrete mixers mounted on a truck or other vehicle used for the complete mixing of concrete ingredients after they have been batched at the plant. All truck mixers shall be certified by RMCAO and shall display valid certification stickers.

Agitator trucks shall consist of drums or containers mounted on trucks or other vehicles in which completely mixed concrete is kept sufficiently agitated during delivery to prevent segregation.

Non-agitating equipment shall consist of containers mounted on trucks for delivering completely mixed concrete. The body of the container shall be smooth, watertight, made of steel, and equipped with gates that permit control of the discharge of the concrete.

1350.07 PRODUCTION

1350.07.01 General

Concrete shall be produced at a batching plant. Use of mobile mixers is not permitted. A back-up plant shall be identified for all post-tensioned deck placements.

When multiple plants supply concrete for the same component, all plants, including primary and back-up, shall produce the same mix design using the same aggregates, cementing materials, and admixtures.

The supplementary cementing material shall be weighed separately from the cement, except when the cement and supplementary cementing materials are supplied in blended form.

The entire contents of the mixer shall be discharged and the mixer completely emptied of wash water prior to loading of a new concrete batch. When a truck mixer is used for complete mixing, it shall not be loaded beyond its maximum mixing capacity.

Cementing materials shall not be added by bags or sacks or from a storage facility remote from the ready mix plant.

1350.07.02 Temperature Control

Any method of heating aggregates shall be such as to produce uniform conditions, without local hot spots.

Frozen lumps of aggregate shall not be added to the concrete.

When ice is used as part of mixing water, the ice shall be measured by mass and shall be completely melted by the time concrete mixing is completed.

1350.07.03 Mixing Time and Mixing Rate

The minimum mixing time for concrete shall be as recommended by the equipment manufacturer or the minimum time required to produce concrete meeting the requirements of this specification, whichever is greater.

When a stationary mixer is used for partial mixing of concrete prior to transferring to a truck mixer, the mixing time shall be no more than is required to intermingle the ingredients. After transfer to a truck mixer, further mixing at the designated mixing speed shall be carried out.

After completion of mixing, the truck mixer drum shall be rotated at the designed agitating speed until discharge of concrete commences.

1350.07.04 Delivery

1350.07.04.01 General

Concrete that is transported in non-agitating equipment shall be covered. Concrete delivered by means of agitator trucks or truck mixers shall be transported after completion of mixing.

1350.07.04.02 Discharge Time

When concrete is transported to the site by means of agitating or mixing equipment, discharge of the concrete shall be completed within 1.5 hours after introduction of the mixing water to the cement and aggregates, except when the air temperature exceeds 28 °C and the concrete temperature exceeds 25 °C, the concrete shall be discharged within 1 hour after the introduction of the mixing water.

When concrete is transported by means of non-agitating equipment, discharge shall be completed within 30 minutes after introduction of the mixing water to the cement and aggregates.

Use of retarders does not change the specified concrete discharge time.

1350.07.04.03 Delivery Ticket

Each load shall be accompanied by a delivery ticket. The following information shall be printed on each ticket at the plant using an automated printing device:

- a) Name and location of plant.
- b) Date, including year, month, and day.
- c) Contract number.
- d) Truck number.
- e) Time of batching concrete. Where an electronic ticketing system is not used, time shall be stamped by a time clock within 5 minutes of batching.
- f) Mix design number assigned by the Contractor or the supplier's unique mix design number verified to correspond to the mix design number assigned by the Contractor.
- g) Specified minimum 28-Day compressive strength of concrete.

In addition, the Contractor shall record in writing on the delivery ticket: the amount of any material added after batching; rejection of a load or part thereof, if applicable; time truck arrived at the job site; and the time the truck finished discharging.

1350.07.05 Material Sampling and Testing

1350.07.05.01 Contractor Sampling for Quality Control Purposes

The Contractor may obtain samples of plastic concrete for quality control purposes. The Contractor shall not carry out sampling or destructive testing of hardened concrete in the work for quality control purposes without obtaining the written permission of the Owner in advance. The Owner's denial of permission shall not relieve the Contractor of responsibility for the quality of concrete placed or to be placed in the work.

1350.07.05.02 Sampling of Water, Admixtures, and Cementing Materials

The Contractor shall obtain samples of all cementing materials, admixtures, and water (when other than municipal drinking water is used) according to the frequencies as shown in Table 8, for testing by the Owner.

The Contractor shall deliver samples of admixtures and water to the Regional Quality Assurance laboratory.

The Contractor shall deliver samples of cementing materials to:

Head, Concrete Section
Ontario Ministry of Transportation
Room 15, Building C
1201 Wilson Avenue,
Downsview, ON M3M 1J8

Samples of admixtures and water shall be protected from freezing and high temperatures. Cementing materials samples shall be protected from moisture.

1350.07.05.03 Testing of Plastic Concrete

Field sampling and testing of concrete shall be performed by a person holding either of the following certifications:

- a) CCIL Certified Concrete Testing Technician, or
- b) ACI Concrete Field Testing Technician, Grade 1.

This person shall have a valid original card issued by the certifying agency in their possession at all times.

Samples for determining acceptance of concrete for air and slump shall be grab samples taken according to CSA A23.2-1C after approximately 10% of the load has been discharged. The discharge shall be stopped and no additional concrete shall be discharged or placed into the work until samples have been tested and found acceptable. If the test results indicate that the concrete does not meet the specified requirements and adjustments specified in the Acceptance and Field Adjustments of Plastic Concrete clause and cannot produce acceptable concrete, the remainder of the load shall be rejected.

Temperature shall be measured according to CSA A23.2-17C. Slump shall be measured according to CSA A23.2-5C. Air content shall be measured according to CSA A23.2-4C. The air meter shall be calibrated at least once a year according to CSA A23.2-4C and a copy of the calibration certificate shall be with the air meter and available for review when requested by the Contract Administrator.

1350.07.05.04 Frequency of Testing Slump, Air Content, and Temperature

For all concrete, quality control testing consisting of slump, air content, and temperature determinations shall be carried out on each load or batch of concrete until satisfactory control is established. Satisfactory control shall be established each Day. It is established when concrete from 5 consecutive loads or batches is within the specified requirements without field adjustments as defined in the Acceptance and Field Adjustments of Plastic Concrete clause. If any field adjustments are required, testing on each load shall be continued until 5 consecutive loads or batches meet the requirements with no field adjustment. After satisfactory control has been established, testing shall be carried out on every third load. If testing indicates that a load does not meet the requirements, testing shall resume on each load until satisfactory control is established.

If multiple plants supply concrete, satisfactory control shall be established for each plant.

In addition to the above, air content, slump, and temperature tests shall be carried out whenever compressive test cylinders are cast.

1350.07.05.05 Acceptance and Field Adjustments of Plastic Concrete

The Contractor shall be responsible for all quality control inspection and testing required to ensure that plastic concrete included in the work is according to the submitted mix design and meets the specified requirements for air content, slump, temperature, delivery time, and uniformity.

Slump of concrete shall be measured prior to and after the addition of superplasticizer. When superplasticizer is permitted to be added at the plant according to the Use of Admixtures clause, the slump shall be measured after the addition of superplasticizer. Air content shall be measured after any addition of superplasticizer.

For non-superplasticized concrete when the measured slump is higher than that specified, the Contractor shall be permitted to immediately retest the slump. When the measured slump is higher than that specified, the plastic concrete shall be rejected and shall not be placed in the work. When superplasticizer is added on site and the measured slump prior to addition of superplasticizer is within specified limits, but exceeds the upper limit after the addition of superplasticizer and there is time available within the discharge time limit specified, the Contractor shall be permitted to wait and re-test the slump.

When the measured plastic air content exceeds the upper test limit and there is time available within the discharge time limit specified, the Contractor shall be permitted to rotate the load at agitation speed and re-test the air content. The use of additives to reduce the air content shall not be permitted.

When a truck mixer is used, the following field adjustments may be carried out prior to acceptance of the load:

1. When the measured air content is low, air-entraining admixture may be added.
2. When the measured or estimated slump is low, the following adjustments may be made:
 - a) For concrete mixes that do not include superplasticizer, water may be added:
 - i. Prior to discharge of concrete from the truck has started, or
 - ii. When the measured slump of concrete is lower than the maximum targeted range.
 - b) For concrete mixes with site-added superplasticizer:
 - i. Water may be added prior to superplasticizer is added at the site. Water additions may be done prior to discharge of concrete from the truck has started or when the measured slump of concrete is lower than the maximum targeted range,
 - ii. No water shall be added after the addition of a superplasticizer. Additional doses of superplasticizer may be added.
 - c) For concrete mixes with plant added superplasticizer:
 - i. No water shall be added.
 - ii. Superplasticizer may be added.

No field adjustments shall be carried out after concrete has been accepted, with the exception of superplasticized concrete. For superplasticized concrete, addition of a superplasticizer to increase the slump to assist in placing shall be permitted.

When any material is added to the concrete, the load of concrete shall be mixed for 30 revolutions or more at the designated mixing speed to ensure that the concrete is uniformly mixed. The load shall be re-tested for acceptance.

1350.07.05.06 Visual Acceptance of Plastic Concrete

The Contractor shall visually inspect plastic concrete during discharge to identify the presence of any segregation or lumps.

If any segregation is identified, the Contractor shall immediately reject the entire load of concrete.

Any visible lumps present in the concrete shall be removed prior to concrete is placed in the work. If more than 3 visible lumps are present in a load of concrete, the remainder of the load shall be immediately rejected and no further concrete from that truckload shall be placed in the work.

If more than three truckloads during the day's work are observed to contain more than 3 lumps per truck, concrete placement shall be stopped at the end of the Day or at the end of the placement of the specific structure component, whichever comes first.

No further concrete shall be placed until all of the following occur:

- a) The Contractor has provided an explanation of the reasons for the lumps and identified the steps that shall be taken to eliminate the reoccurrence of lumps in future work.
- b) A trial batch has been carried out in the presence of the Contract Administrator and the Contract Administrator has verified that the concrete is free of lumps.
- c) The Contract Administrator has granted written approval for placement to proceed.

1350.07.05.07 Within-Batch Uniformity of Plastic Concrete

When required by the Contract Administrator, determination of the within-batch uniformity of the plastic concrete shall be carried out by testing air content, slump, and density according to CSA A23.2-4C, 5C, and 6C, respectively. The Contractor shall be granted 24 hours notice when density testing is required as part of within-batch uniformity determination. No advance notice shall be granted for carrying out the slump and air portion of the uniformity testing.

Tests shall be carried out on samples of concrete obtained when approximately 10%, 50%, and 90% of the batch has been discharged while the mixer is being emptied at normal operating rate. The minimum size of sample shall be 30 litres. Between samples, the mixer shall not be allowed to turn in the mixing direction.

The acceptance and rejection limits for uniformity shall be as shown in Table 2. When the result of each test is equal to or less than the acceptance limit, the concrete is uniform. When the result of any single test is greater than the rejection limit, the concrete is considered to be non-uniform.

If the result of any single test exceeds the acceptance limit and is not greater than the rejection limit, all tests shall be made on the next consecutive batch or load delivered by that mixing equipment.

If, after testing one additional batch or load, the test result is greater than the acceptance limit, the concrete is non-uniform.

When the concrete is non-uniform and the mixing equipment is a stationary mixer, no more concrete shall be produced in it until within batch uniformity has been demonstrated. If the unit is a truck mixer, the truck mixer shall not be used again.

1350.07.05.08 Submission of Plastic Concrete Test Results

After each Day's work, the Contractor shall submit to the Contract Administrator a copy of the delivery ticket for each load of concrete and a daily summary. The daily summary shall include air contents, slumps prior to and after any additions, concrete temperature, and all adjustments made to each load of concrete, including volume of any water or superplasticizer added, and shall identify rejected material.

1350.07.05.09 Compressive Strength

1350.07.05.09.01 General

Prior to placing concrete, the Contractor shall provide an estimate of concrete volumes for each minimum specified 28-Day compressive strength. The Contract Administrator shall identify the method of acceptance to be used for each. Acceptance method A shall be used when the quantity of concrete of a specified minimum strength is 100 m³ or more. Acceptance method B shall be used for concrete in expansion joints, tremie concrete, or when the quantity of concrete of a specified minimum strength is less than 100 m³.

1350.07.05.09.02 Acceptance Method A

The Contract Administrator shall determine the lot and subplot size after discussion with the Contractor and prior to any concrete is placed. Each lot shall contain concrete of one specified minimum 28-Day strength. There shall be only one lot of each specified strength of concrete; however, if the quantity of concrete of one specified strength is greater than 5,000 m³, the Contract Administrator shall consider requests to divide the concrete into two lots based on placement in separate structures or in different construction seasons.

Each lot shall be divided into sublots of approximately 10 m³ to a maximum of 100 m³. Sublot sizes shall be established based on the estimated concrete quantity such that each lot contains a minimum of 10 sublots. One set of acceptance and one set of referee cylinders shall be made from each subplot. The loads of concrete to be sampled shall be selected by the Contract Administrator on a random basis.

In addition to acceptance cylinders cast on a random basis, the Contractor shall also cast test cylinders as required by the Contract Administrator. The results from these cylinders shall be used for assessment of structural adequacy, for information purposes, or for other uses by the Owner.

1350.07.05.09.03 Acceptance Method B

One set of acceptance and referee cylinders, each shall be cast for every 20 m³ of concrete placed or one set per day, whichever is more frequent.

1350.07.05.09.04 Test Cylinders

The Contractor shall cast, cure, and transport cylinders for compressive strength testing by the Owner.

Every time a set of acceptance cylinders is cast, a second set of cylinders shall be cast for referee testing purposes, unless otherwise specified in the Contract Documents.

Concrete test cylinders for compressive strength testing for acceptance and for referee testing purposes, where required, shall be cast, cured, and transported according to CSA A23.2-3C. Referee cylinders shall be cured and transported to the Regional Quality Assurance Laboratory, along with the acceptance cylinders. A set of cylinders for concrete made with aggregate of nominal maximum size larger than 19 mm shall consist of two 150 mm diameter x 300 mm long cylinders. For all other concrete, a set of cylinders shall consist of three 100 mm diameter x 200 mm long cylinders.

Concrete test cylinders for early strength determination shall be cast, cured, and transported as specified in the Contract Documents.

No referee cylinders shall be cast when cylinders are prepared for determination of early strength or are requested by the Owner, for information purposes.

All concrete test cylinders shall be cast in moulds. The moulds shall be single use moulds according to CSA A23.2-1D and made of plastic with a lid. The lids shall be chemically and physically compatible with the concrete and shall provide watertight closure for the moulds.

Test information shall be recorded on MTO form PH-CC 322, a copy of which shall be submitted with each set of the concrete cylinders.

The Contractor shall continuously record and monitor temperature immediately adjacent to the cylinders during the field-curing period. The maximum time interval for recording the temperature shall be every 15 minutes.

1350.07.05.09.05 Submission of Cylinder Curing Records

The Contractor shall submit cylinder curing temperature records to the Contract Administrator at the completion of the field-curing period.

1350.07.05.10 Air Void System Parameters

Cores for evaluation of air void system parameters shall be required for the categories of concrete shown in Table 3.

The Contractor shall remove cores from the hardened concrete for testing by the Owner. Cores shall be taken at random locations specified by the Contract Administrator. All cores shall be removed when the concrete is between 7 to 10 Days of age, and cores from bridge decks shall be removed prior to application of any waterproofing membrane.

The lot sizes, core size, and number of cores shall be as shown in Table 3. When two cores are required for a lot, the lot shall be divided into two, and one core shall be removed at a random location within each half of the lot. For concrete barriers and barrier walls on structures, the cores shall be removed from the lower sloped portion of the wall at the designated locations. For parapet walls, the cores shall be removed from the lower one-third of the wall at the designated locations. If the total quantity of a component is less than shown in Table 3, one core per stage shall be removed and tested. Steel reinforcement and other embedded material shall be avoided when possible while coring and the Contractor shall use a covermeter to establish reinforcement location, prior to coring.

For concrete patches and refacing where the total area of patches or refacing on a structure is less than 20 m², no cores shall be required, but one 100 x 200 mm cylinder shall be cast and tested.

The Contract number, lot number, and exact location of each individual core shall be marked legibly on the core with durable ink. The cores shall be delivered to the Regional Quality Assurance laboratory with a transmittal form and Form A of the concrete mix design for the component.

1350.07.05.11 Rapid Chloride Permeability

Cores for evaluation of rapid chloride permeability shall be required for HPC and silica fume overlays as shown in Table 4. Cores for evaluation of rapid chloride permeability may also be required for other concrete as specified in the Contract Documents.

The Contractor shall remove cores from the hardened concrete for testing by the Owner.

One core shall be removed at the random location specified by the Contract Administrator and the second core shall be removed at a location no more than 1 m from the location of the first core. Cores shall not contain steel reinforcement or other embedded material. All cores shall be removed when the concrete is between 7 to 10 Days of age and cores from bridge decks shall be removed prior to application of any waterproofing membrane.

The lot sizes, core sizes, and number of cores shall be as shown in Table 4. If the total quantity of a component is less than shown in the Table 4, the minimum number of cores specified in Table 4 shall be removed.

Each core shall be placed in a plastic bag, sealed to prevent loss of moisture, and delivered to the Regional Quality Assurance laboratory within 24 hours of coring with a transmittal form and Form A of the concrete mix design for the component.

1350.07.06 Filling of Core Holes

The Contractor shall fill each core hole immediately after coring with a proprietary patching material from the ministry's DSM. The patching material shall be comparable to the surrounding concrete in terms of strength and permeability. The patching material shall be mixed, handled, and cured according to the manufacturer's instructions. Immediately prior to filling, the inside surface of each core hole shall be cleaned of the paste left from the coring operation by nylon brushing and all free water shall be removed. The patch shall be finished flush with the surface of the surrounding concrete. All excess material shall be removed from the surface of the concrete.

1350.08 QUALITY ASSURANCE

1350.08.01 Acceptance of Concrete Compressive Strength

1350.08.01.01 General

Lots for compressive strength shall be as identified in the Acceptance Method A or Acceptance Method B clause, as applicable.

Compressive strength shall be determined according to LS-407 and LS-426.

The compressive strength result of a subplot shall be the average of the set of 3 acceptance cylinders made from the subplot, rounded to one decimal place, except for concrete made with aggregate of nominal maximum size larger than 19 mm where the subplot result shall be the average of 2 cylinders.

The individual test results shall be forwarded to the Contractor, as they become available. The Contractor shall forward individual test results and monthly summaries to the concrete supplier.

When any individual strength test result falls below the specified minimum 28-Day strength by more than 4.0 MPa, the Contract Administrator may require the Contractor to take and test 100 mm diameter concrete cores to determine whether individual sections of concrete are structurally adequate and whether remedial work or removal is required. When required, cores shall be removed in groups of 3 at locations specified by the Contract Administrator. Cores shall be removed, moisture conditioned, and tested for compressive strength according to CSA A23.2-14C.

Where required, determination of structural adequacy is independent of and in addition to any payment reduction. Core results shall not replace cylinder results in any bonus or penalty calculations. Where extensive design calculation is required in order to confirm structural adequacy, the Contractor shall reimburse the Owner for all costs incurred up to a maximum of \$2,000.00 per occurrence.

1350.08.01.02 Acceptance Method A

Acceptance of concrete compressive strength for each lot shall be based on the mean and standard deviation of the compressive strength results of all sublots contained in the lot.

The mean and standard deviation of the results and forecast potential bonus or penalty, if any, shall be submitted to the Contractor at monthly intervals.

The Contract Administrator shall calculate the percent within limits (PWL) according to LS 101, using the specified compressive strength as the lower limit.

When the lot PWL is greater than 95%, the Contractor shall receive a bonus, in $\$/m^3$, as calculated by the following:

$$\text{Bonus} = \text{PWL} - 95$$

When the lot PWL is greater than or equal to 90% and less than or equal to 95%, there shall be no bonus or penalty due to concrete compressive strength.

When the lot PWL is less than 90% and greater than or equal to 50%, the Contractor shall be assessed a penalty, in $\$/m^3$, as calculated by the following:

$$\text{Penalty} = 90 - \text{PWL}$$

When the lot PWL is less than 50%, the lot is unacceptable and is subject to removal and replacement. The Contractor may submit an alternative in writing for the Owner's consideration for unacceptable lots. If the Contract Administrator determines that an unacceptable lot may remain in the work, it shall be subject to the calculated penalty.

For the purpose of penalty or bonus, the quantity of concrete in each lot shall be calculated by the Contract Administrator as the sum of the following:

- a) The payment quantity for items paid by unit price per cubic metre of concrete.
- b) The theoretical quantity as specified in the Contract Documents for items paid by lump sum, provided the actual quantity is within $\pm 3\%$ of the theoretical quantity.
- c) The quantity of concrete in each lot shall be calculated from the quantities specified in the Contract Drawings for items, where these quantities are listed.
- d) The quantity based on the neat lines called for in the Contract Drawings, where none of the above methods are applicable.

1350.08.01.03 Acceptance Method B

Concrete compressive strength shall be considered acceptable when it meets all of the following:

- a) The average of all groups of 3 consecutive compressive strength tests shall be equal to or greater than the specified strength.
- b) No individual strength test shall be more than 4.0 MPa below the specified strength.

Unacceptable concrete shall be subject to removal and replacement.

The Contractor may submit an alternative in writing for the Owner's consideration for unacceptable concrete.

1350.08.01.04 Referee Testing Based on Duplicate Cylinders

The referee testing process for concrete compressive strength is based on duplicate cylinders cast at the same time as the acceptance cylinders.

Referee testing of compressive strength for a subplot may only be invoked by the Contractor within 5 Business Days of receiving the test results for that subplot.

The referee laboratory shall be designated by the Owner based on the applicable roster. Referee test results shall be forwarded to the Contractor, as they become available.

If the difference between the referee test result and the acceptance test result is less than the confirmation value, the acceptance test result is then confirmed and the acceptance test result shall be used in the determination of acceptance and payment for the concrete. If the difference between the referee test result and the acceptance test result is greater than the confirmation value, the acceptance test result is then not confirmed and the acceptance test result shall be disregarded and not used in the determination of acceptance and payment. The confirmation value for confirming the acceptance test result shall be the greater of 10% of the specified strength or 10% of the strength of the acceptance cylinders, expressed to one decimal place.

If the referee test result is more than 4.0 MPa below the specified strength, the result shall be reviewed to determine if structural adequacy is in question and, if so, the relevant provisions of this specification shall be followed.

When acceptance results are eliminated from the analysis as a result of referee process, the concrete shall be assessed based on the available strength results for the lot.

If acceptance test results from multiple sublots are eliminated such that there are fewer than 4 acceptance test results available for the lot, Acceptance Method B shall be used for acceptance of the concrete.

1350.08.01.04.01 Referee Testing Cost

The cost of compressive strength referee testing shall be as specified in the Contract Documents.

When the referee result confirms the acceptance test result, the Contractor shall be charged the cost of compressive strength referee testing. When the referee result does not confirm the acceptance test result, the Owner shall bear the cost.

1350.08.02 Acceptance of Air Void System in Hardened Concrete

1350.08.02.01 General

The lots for air void system shall be as shown in Table 3.

One half of each core shall be tested to determine the acceptability of concrete. The core shall be tested according to LS-432. The other half of each core shall be retained by the Owner for audit purposes.

Individual test results shall be forwarded to the Contractor, as they become available.

1350.08.02.02 Basis of Acceptance

For a lot to be considered acceptable, each core shall have air content of 3.0% or more and spacing factor of 0.230 mm or less in all concrete, except for silica fume overlays and HPC where the spacing factor shall be 0.250 mm or less. Acceptable lots shall be subject to full payment or bonus payment.

An unacceptable lot is a lot represented by one or two cores that fail to meet the air void system parameters. Unacceptable lots shall be removed and replaced at the Contractor's expense, except where the Owner permits the work to remain in place. The replacement lots shall be evaluated for acceptance on the same basis as the original lot. When the Owner permits the work to remain in place, it shall be subject to the calculated penalty and shall not be eligible for bonus.

For the purpose of calculating bonus or penalty, the Contract Administrator shall round-off spacing factor test data to two decimal places and air content test data to one decimal place according to LS-100 and shall determine the quantity of concrete in lots using the dimensions as specified in the Contract Documents.

When two cores are tested per lot, the bonus payment for an acceptable lot shall be calculated by averaging bonus values corresponding to individual core results. When one core is tested per lot, the bonus payment for an acceptable lot shall be the bonus value corresponding to the core.

Bonus payment for a lot represented by 2 cores shall be calculated according to the following:

$$B = (B1 + B2)/2$$

Where: B = bonus in \$/m³ of concrete in the lot
B1 and B2 = bonus for cores 1 and 2 in \$/m³ of concrete in the lot from Table 5

Bonus for acceptable lot = lot quantity (m³) x B

Payment for unacceptable lots shall be calculated by averaging the pay factors corresponding to individual core results. Where one core in an unacceptable lot meets the specified requirements for air void system, the core shall be assigned a pay factor of 100%. When only one core is tested per lot, the payment for an unacceptable lot shall be the pay factors corresponding to the individual core result.

Payment for unacceptable lot represented by two cores shall be calculated according to the following:

$$P = (P1 + P2)/2$$

Where: P = pay factor for the lot (%)
P1 and P2 = pay factor for cores 1 and 2 in % as shown in Table 6 or 7, as applicable

Payment reduction for a lot = lot quantity/tender quantity x tender lump sum price x ((100-P)/100)

Where: Lot quantity and tender quantity are in cubic metres

1350.08.02.03 Referee Testing

Referee testing of air void system parameters may only be invoked by the Contractor within 5 Business Days of receiving the test result.

When referee testing is invoked, all core samples representing a lot shall be referee tested and the acceptance test results discarded. The lot referee test results shall replace the acceptance test result in the acceptance requirements of this specification.

Referee testing shall be carried out on the same half of the core sample that was tested for acceptance.

Cores shall be tested according to LS-431. Referee test results shall be forwarded to the Contractor, as they become available.

1350.08.02.03.01 Referee Testing Cost

The cost of air void system referee testing shall be as specified in the Contract Documents.

When the referee results indicate that the refereed lot is acceptable, the Owner shall bear the cost. When the referee results indicate that the refereed lot is not acceptable, the Contractor shall be charged the cost of the air void system referee testing.

1350.08.03 Acceptance of Rapid Chloride Permeability

1350.08.03.01 General

The lots for rapid chloride permeability shall be as shown in Table 4.

Cores shall be tested according to LS-433. Acceptance testing shall be carried out at 28 to 32 Days. For HPC, two 50 mm long samples shall be cut from one of the cores representing a lot and tested to determine the acceptance of the lot. The other core shall be retained for referee testing.

For silica fume overlays, one 50 mm sample shall be cut from each of 2 cores. Two samples for the lot shall be tested to determine the acceptance of the lot. The remaining 2 cores shall be retained for referee testing.

Individual test results shall be forwarded to the Contractor, as they become available.

1350.08.03.02 Basis of Acceptance

Acceptance of rapid chloride permeability shall be based on the average of results obtained on cores representing a lot. Lots with an average value of rapid chloride permeability exceeding 1,000 coulombs and less than or equal to 2,000 coulombs shall be accepted with a price reduction. Lots with rapid chloride permeability value exceeding 2,000 coulombs shall be considered unacceptable. Unacceptable concrete shall be removed and replaced at the Contractor's expense.

For the purpose of calculating penalty, the Contract Administrator shall determine the quantity of concrete in the lots using the dimensions as specified in the Contract Documents.

The payment reduction shall be calculated and applied as follows:

$$Pa = (C-1000)/5$$

Where: Pa = payment reduction in \$/m³
C = average rapid chloride permeability of a lot

Payment reduction per lot = lot quantity (m³) x Pa

1350.08.03.03 Referee Testing

Referee testing of rapid chloride permeability may only be invoked by the Contractor within 5 Business Days of receipt of the acceptance test result.

For HPC, referee testing shall be carried out on two 50 mm samples obtained from the reserved core representing the lot for which referee testing was invoked and the results shall be averaged to obtain the test result for the lot. For silica fume overlay, referee testing shall be carried out on two 50 mm samples cut from the two reserved cores representing the lot for which referee testing was invoked and the results shall be averaged to obtain the test result for the lot.

Cores shall be tested according to LS-433.

Referee test results shall be forwarded to the Contractor, as they become available.

When the referee result is greater than the acceptance test result or no more than 200 Coulombs below the acceptance test result, the acceptance test result is then confirmed and shall remain valid. When the referee test result for the lot is more than 200 Coulombs below the acceptance test result, the acceptance test result is then not confirmed and the referee test result shall replace the acceptance test result in the acceptance requirements of this specification.

1350.08.03.03.01 Referee Testing Cost

The cost of referee testing shall be as specified in the Contract Documents.

When the referee result confirms the acceptance test result, the Contractor shall be responsible for the cost of rapid chloride permeability referee testing. When the referee result does not confirm the acceptance test result, the Owner shall bear the cost.

1350.08.04 Acceptance of Water, Admixtures, and Cementing Materials

1350.08.04.01 General

Concrete made with admixtures, water, or cementing materials that do not meet the specified requirements is unacceptable and may be subject to financial penalty or removal if there is potential for the short-term or long-term performance of the concrete to be adversely affected.

1350.08.04.02 Admixtures

Air entraining admixtures shall be tested by the Owner for pH and relative density. Chemical and superplasticizing admixtures shall be tested by the Owner for relative density and non-volatile content. Testing shall be according to LS-413, LS-414, and LS-415, as applicable.

One 750 ml admixture sample shall be used for acceptance testing. The other 750 ml admixture sample shall be reserved for referee testing.

Individual test results shall be forwarded to the Contractor, as they become available. Admixture represented by sample test results that fail to fall within the specified tolerances for pH, relative density, or non-volatile content shall be deemed unacceptable and shall not be used for making concrete.

Referee testing of admixtures may only be invoked by the Contractor within 5 Business Days of receiving the test results. Referee testing shall be carried out on the reserved referee sample.

The referee laboratory shall be designated by the Owner based on the applicable roster. Referee samples shall be transported from the Regional Quality Assurance laboratory to the Referee Laboratory by the ministry, and testing shall be carried out according to LS-413, LS-414, and LS-415, as applicable.

Referee test results shall be forwarded to the Contractor, as they become available.

The referee test results shall replace the original results.

The cost of referee testing shall be as specified in the Contract Documents.

When the referee results indicate that the refereed sample is acceptable, the Owner shall bear the cost. When the referee results indicate that the refereed sample is not acceptable, the Contractor shall be charged the cost of the admixture referee testing.

1350.08.04.03 Water Other than Municipal Drinking Water

Samples of water, other than municipal water, shall be tested by the Owner according to OPSS 1302.

One 1-litre water sample shall be used for acceptance testing. The other 1-litre water sample shall be reserved for referee testing.

Individual test results shall be forwarded to the Contractor, as they become available.

Water that fails the requirements of OPSS 1302 shall be deemed unacceptable and the source of water represented by the failed samples shall not be used for making of concrete.

Referee testing of water may only be invoked by the Contractor within 5 Business Days of receiving the test results. Referee testing shall be carried out on the reserved referee sample.

The referee laboratory shall be designated by the Owner based upon the applicable roster. Referee samples shall be transported from the Regional Quality Assurance laboratory to the Referee Laboratory by the ministry, and testing shall be carried out according to OPSS 1302.

Referee test results shall be forwarded to the Contractor, as they become available.

The referee test results shall replace the original result.

The cost of referee testing shall be as specified in the Contract Documents.

When the referee results indicate that the refereed sample is acceptable, the Owner shall bear the cost. When the referee results indicate that the refereed sample is not acceptable, the Contractor shall be charged the cost of the water referee testing.

1350.08.04.04 Cementing Materials

Cementing materials shall be tested by the Owner for fineness, soundness by autoclave, initial time of set, compressive strength, and slag activity index or pozzolanic strength activity index, as applicable, according to CSA A 3000.

One 10-kilogram sample shall be taken and divided into two 5-kilogram samples. One 5-kilogram sample shall be used for acceptance testing. The second 5-kilogram sample shall be reserved for referee testing.

Individual test results shall be forwarded to the Contractor, as they become available.

Cementing materials that do not comply with the requirements of OPSS 1301 and CAN/CSA A3001 shall not be used for making of concrete.

Referee testing of cementing materials may only be invoked by the Contractor within 5 Business Days of receiving the test results. Referee testing shall be carried out on the reserved referee sample.

Referee testing shall be carried out according to CSA A 3000 by the Owner's laboratory or an independent laboratory acceptable to the Contractor and the ministry in the presence of the Contractor or his designate.

Referee results shall be reported to the Contractor, as they are available.

The referee test results shall replace the original result.

The cost of referee testing shall be as specified in the Contract Documents.

When the referee results indicate that the refereed sample is acceptable, the Owner shall bear the cost. When the referee results indicate that the refereed sample is not acceptable, the Contractor shall be charged the cost of the cementing material referee testing.

TABLE 1
Slump and Air Content of Plastic Concrete

Component	Slump mm (Note 1)	Air Content in Plastic Concrete %
Cast-In-Place, Slipformed Concrete Barriers	Target slump ± 10	Target air ± 1.5
Tremie Concrete	Target slump ± 30	When required 5.0 ± 1.5
All Other Concrete	Target slump ± 20	Target air ± 1.5
Note: 1. When the use of superplasticizer is permitted, requirements shall be as specified in the Concrete clause.		

TABLE 2
Determination of Within-Batch Uniformity of the Concrete

Test	Range Between Highest and Lowest Values of 3 Test Samples	
	Acceptable If Equal to or Less Than	Rejectable If More Than
Density, kg/m^3	32	50
Air Content in Plastic Concrete, %	0.7	1.0
Slump, mm	30	50

TABLE 3
Cores for Air Void System Determination

Category	Lot Size	Core Size	Number of Cores Per Lot
Sidewalk on Structure and Curb on Structure	500 lineal metres per stage.	100 mm diameter and 200 mm long.	2
Median on Structure	500 lineal metres per stage.		
Parapet or Barrier Wall on Structure	500 lineal metres per structure per stage.		
Toe Wall	500 lineal metres per stage.		
Bridge Deck-Thin Slab Deck	500 m ² per stage.		
Bridge Deck-Post-Tensioned Deck	300 m ² per stage.		
Abutment, Wingwall, Cast-In-Place Retaining Wall	1 abutment, wingwall, cast-in-place retaining wall or a stage thereof.		
Pier	1 pier. (Note 1)		
Arches and Spandrels	Between piers or between pier and abutment.		
Culvert	1,000 m ² of floor area of cast-in-place concrete culvert. (Note 2)		
	All cast-in-place concrete associated with a precast culvert.		
Approach Slab	500 m ² per stage.		
Sidewalk and Curb With Gutter	500 lineal metres. (Note 3)	100 mm diameter and a minimum of 125 mm long.	2
Concrete Barrier	Cast-in-place, slipformed: 1,000 lineal metres. (Note 3)	100 mm diameter and 200 mm long.	2
	Cast-in-place, formed, including transitions: 250 lineal metres. (Note 3)		
Concrete Patches and Refacing	Approximately equal in size and not greater than 100 m ² for each individual structure.	150 mm diameter and 100 mm long.	1
Overlays	300 m ² per placement per individual structure.	150 mm diameter and 100 mm long.	1
Notes: 1. A pier consists of columns and a pier cap. 2. The total floor area of a component shall be added together and then divided into lots of specified size. Where a culvert has no floor, the area of the upper surface shall be used as the basis of determining lots. 3. The total length of a component shall be added together and then divided into lots of specified size.			

TABLE 4
Cores for Rapid Chloride Permeability Determination

Category	Lot Size	Core Size	Number of Cores Per Lot
Sidewalk on Structure and Curb on Structure	500 lineal metres per stage.	100 mm diameter and a minimum 125 mm long.	2
Median on Structure	500 lineal metres per stage.		
Parapet or Barrier Wall on Structure	500 lineal metres per stage.		
Bridge Deck	500 m ² per stage.		
Abutment, Wingwall, Cast-In-Place Retaining Wall	1 abutment, wingwall, cast-in-place retaining wall or a stage thereof.		
Pier	1 pier. (Note 1)		
Arches and Spandrels	Between piers or between pier and abutment.		
Overlays	300 m ² per placement for each individual structure.	100 mm diameter and 70 mm long. (Note 2)	4
Notes: 1. A pier consists of columns and a pier cap. 2. Where overlay thickness is less than 70 mm, the Contractor shall make cylinders for testing of rapid chloride permeability.			

TABLE 5
Bonuses for Air Void System Parameters in All Hardened Concrete
 $\$/\text{m}^3$

Spacing Factor, mm	Air Content, %																			
	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8
<0.100	0	1	2	3	4	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5
0.100	0	1	2	3	4	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5
0.110	0	1	2	3	4	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5
0.120	0	1	2	3	4	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5
0.130	0	1	2	3	4	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5
0.140	0	1	2	3	4	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5
0.150	0	1	2	3	4	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5
0.160	0	1	2	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
0.170	0	1	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
0.180	0	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
0.190	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0.200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Notes:

- A. For silica fume overlays and HPC, when a core has an air content of 3% or higher and a spacing factor of 0.250 mm or lower, but its air void system parameters are outside the range shown in Table 5, it shall be assigned a value of 0 $\$/\text{m}^3$ for the purpose of calculating a bonus.
- B. For all other concrete, when a core has an air content of 3% or higher and a spacing factor of 0.230 mm or lower, but its air void system parameters are outside the range shown in Table 5, it shall be assigned a value of 0 $\$/\text{m}^3$ for the purpose of calculating a bonus.

TABLE 6
Pay Factor for Air Void System Parameters of Hardened Concrete for Concrete Other Than Silica Fume Overlays and HPC
Pay Factor in % of Tender Item Price Per Lot

Air Content, %																						
	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	>2.9	
Spacing Factor, mm	<0.100	52	55	57	59	62	64	67	69	71	74	76	79	81	83	86	88	90	93	95	100	
	0.100	52	55	57	59	62	64	67	69	71	74	76	79	81	83	86	88	90	93	95	100	
	0.110	52	55	57	59	62	64	67	69	71	74	76	79	81	83	86	88	90	93	95	100	
	0.120	52	55	57	59	62	64	67	69	71	74	76	79	81	83	86	88	90	93	95	100	
	0.130	52	55	57	59	62	64	67	69	71	74	76	79	81	83	86	88	90	93	95	100	
	0.140	52	55	57	59	62	64	67	69	71	74	76	79	81	83	86	88	90	93	95	100	
	0.150	52	55	57	59	62	64	67	69	71	74	76	79	81	83	86	88	90	93	95	100	
	0.160	52	55	57	59	62	64	67	69	71	74	76	79	81	83	86	88	90	93	95	100	
	0.170	52	55	57	59	62	64	67	69	71	74	76	79	81	83	86	88	90	93	95	100	
	0.180	52	55	57	59	62	64	67	69	71	74	76	79	81	83	86	88	90	93	95	100	
	0.190	52	55	57	59	62	64	67	69	71	74	76	79	81	83	86	88	90	93	95	100	
	0.200	52	55	57	59	62	64	67	69	71	74	76	79	81	83	86	88	90	93	95	100	
	0.210	52	55	57	59	62	64	67	69	71	74	76	79	81	83	86	88	90	93	95	100	
	0.220	52	55	57	59	62	64	67	69	71	74	76	79	81	83	86	88	90	93	95	100	
	0.230	52	55	57	59	62	64	67	69	71	74	76	79	81	83	86	88	90	93	95	100	
	0.240	50	52	55	57	59	62	64	67	69	71	74	76	79	81	83	86	88	90	93	95	95
	0.250	48	50	52	55	57	59	62	64	67	69	71	74	76	79	81	83	86	88	90	93	95
	0.260	45	48	50	52	55	57	59	62	64	67	69	71	74	76	79	81	83	86	88	90	93
	0.270	43	45	48	50	52	55	57	59	62	64	67	69	71	74	76	79	81	83	86	88	90
	0.280	40	43	45	48	50	52	55	57	59	62	64	67	69	71	74	76	79	81	83	86	88
	0.290	38	40	43	45	48	50	52	55	57	59	62	64	67	69	71	74	76	79	81	83	86
	0.300	36	38	40	43	45	48	50	52	55	57	59	62	64	67	69	71	74	76	79	81	83
	0.310	33	36	38	40	43	45	48	50	52	55	57	59	62	64	67	69	71	74	76	79	81
0.320	31	33	36	38	40	43	45	48	50	52	55	57	59	62	64	67	69	71	74	76	79	
0.330	29	31	33	36	38	40	43	45	48	50	52	55	57	59	62	64	67	69	71	74	76	
0.340	26	29	31	33	36	38	40	43	45	48	50	52	55	57	59	62	64	67	69	71	74	
0.350	24	26	29	31	33	36	38	40	43	45	48	50	52	55	57	59	62	64	67	69	71	
0.360	21	24	26	29	31	33	36	38	40	43	45	48	50	52	55	57	59	62	64	67	69	
0.370	19	21	24	26	29	31	33	36	38	40	43	45	48	50	52	55	57	59	62	64	67	
0.380	17	19	21	24	26	29	31	33	36	38	40	43	45	48	50	52	55	57	59	62	64	
0.390	14	17	19	21	24	26	29	31	33	36	38	40	43	45	48	50	52	55	57	59	62	
0.400	12	14	17	19	21	24	26	29	31	33	36	38	40	43	45	48	50	52	55	57	59	
0.410	9	12	14	17	19	21	24	26	29	31	33	36	38	40	43	45	48	50	52	55	57	
0.420	7	9	12	14	17	19	21	24	26	29	31	33	36	38	40	43	45	48	50	52	55	
0.430	5	7	9	12	14	17	19	21	24	26	29	31	33	36	38	40	43	45	48	50	52	
0.440	2	5	7	9	12	14	17	19	21	24	26	29	31	33	36	38	40	43	45	48	50	
0.450	0	2	5	7	9	12	14	17	19	21	24	26	29	31	33	36	38	40	43	45	48	
>0.450	0	0	2	5	7	9	12	14	17	19	21	24	26	29	31	33	36	38	40	43	45	

Note:

- When a core in an unacceptable lot has an air content of 3% or higher and a spacing factor of 0.230 mm or lower, the core shall be assigned a value of 100% for the purpose of calculating a penalty.
- Thick line between 0.230 and 0.240 mm spacing factor indicates maximum acceptable spacing factor.

TABLE 8
Admixtures, Water, and Cementing Materials - Minimum
Frequencies for Sampling and Testing

Material	Use or Type of Construction	Minimum Sampling Frequency (Note 1)	Minimum Sample Size (Note 2)
Air Entraining and Chemical and Superplasticizing Admixtures	All concrete.	One sample shall be taken at the beginning of concrete placement in each calendar year, no more than 30 Days prior to concrete placement.	Two samples shall be taken. Each shall be at least 750 ml.
Water Other Than Municipal Drinking Water	All concrete.	One additional sample shall be taken during the calendar year.	Two samples shall be taken. Each shall be at least 1 litre.
Cementing Materials: Portland Cement, Ground Granulated Blast Furnace Slag, Fly Ash, and Blended Silica Fume Cement	Concrete pavement and base.	One sample per Contract or one sample per each 10, 000 m³ of concrete, whichever is more frequent.	10 kg of each cementing material used.
	Precast components.	One sample per calendar year.	
	All other concrete.	One sample per Contract or one sample per each 5,000 m³ of concrete, whichever is more frequent.	

Notes:

1. Additional samples shall be taken every time there is a change in material source.

2. Admixture and water samples shall be contained in a 1 litre bottle of a suitable plastic with a lid. Cementing material samples shall be contained in a canvas bag with plastic insert, accompanied by MTO form PH-CC-340.

Appendix 1350-A, November 2014
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here



MATERIAL SPECIFICATION FOR STEEL REINFORCEMENT FOR CONCRETE

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APPENDICES

1440-A	Commentary
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1440.01	SCOPE
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This specification covers the requirements for all steel reinforcement used in concrete work.

1440.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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

1440.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

1440.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 905 Steel Reinforcement for Concrete

Ontario Ministry of Transportation Publications

Designated Sources for Materials (DSM)
Structural Manual

CSA Standards

G30.18-09 Carbon Steel Bars for Concrete Reinforcement
G40.21-04 (R2009) Structural Quality Steels
S6-06 Canadian Highway Bridge Design Code

ASTM International

A 82/A 82M-07 Steel Wire, Plain, for Concrete Reinforcement
A 185/A 185-07 Steel Welded Wire Reinforcement, Plain, for Concrete
A 276-10 Stainless Steel Bars and Shapes
A 416/A 416M-12a Steel Strand, Uncoated Seven-Wire for Prestressed Concrete
A 421/A 421M-10 Uncoated Stress-Relieved Steel Wire for Prestressed Concrete
A 496/A 496M-07 Steel Wire, Deformed, for Concrete Reinforcement
A 497/A 497M-07 Steel Welded Wire Reinforcement, Deformed, for Concrete

A 722/A 722M-12 Uncoated High-Strength Steel Bars for Prestressing Concrete
A 955M/A 955M-12e1 Deformed and Plain Stainless Steel Bars for Concrete Reinforcement

International Organization for Standardization/International Electrotechnical Commission

ISO/IEC 17025:1999 General Requirements for the Competence of the Testing and Calibration Laboratories

Others

Reinforcing Steel Institute of Canada - Reinforcing Steel Manual of Standard Practice - 2004

1440.03 DEFINITIONS

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

Heat means a single operation of melting of steel, also called a melt.

Lot means a quantity of steel that can be identified. For each size designation of prestressing steel strand, a lot shall be reels or coils produced from one heat. For each nominal diameter of prestressing steel bar and for each size designation of reinforcing steel bar, a lot shall be all the supplied bars from one heat.

Prestressing Steel means as defined in OPSS 905.

Prestressing Steel Bar means a high strength alloy steel bar having a nominal diameter greater than 9 mm.

Reinforcing Steel Bars means as defined in OPSS 905.

Spacer means a rolled steel shape punched to form hooks that are bent over the spiral to maintain a specified pitch.

Spiral means continuously wound reinforcing steel in the form of a cylindrical helix.

Splice Bar means as defined in OPSS 905.

Stainless Steel Reinforcing Bars means as defined in OPSS 905.

Steel Reinforcement means as defined in OPSS 905.

Strand means as defined in OPSS 905.

1440.04 DESIGN AND SUBMISSION REQUIREMENTS

1440.04.01 Submission Requirements

1440.04.01.01 Mill Certificates for Reinforcing Steel Bars, Stainless Steel Reinforcing Bars, Splice Bars, and Stainless Steel Splice Bars

Two copies of the mill certificates for each lot shall be submitted to the Contract Administrator prior to shipment of reinforcing steel bars, stainless steel reinforcing bars, splice bars, and stainless steel splice bars. The certificates shall show that the material is as specified in the Contract Documents.

1440.04.02**Mill Certificates and Stress-Strain Curves for Prestressing Steel**

Two copies of the mill certificates and stress-strain curves for each lot shall be submitted to the Contract Administrator prior to shipment of prestressing steel. The certificates shall show that the material is as specified in the Contract Documents.

When mill test certificates originate from a mill outside Canada or the United States of America, the Contractor shall have the information on the mill test certificate verified by testing by a Canadian laboratory. This laboratory shall be certified by an organization accredited by the Standards Council of Canada to comply with the requirements of ISO/IEC DIS 17025 for the specific tests or type of tests required by the material standard specified on the mill test certificate. The mill test certificates shall be stamped with the name of the Canadian laboratory and appropriate wording stating that the material is in conformance with the specified Contract requirements. The stamp shall include the appropriate material specification number, testing date (i.e., yyyy-mm-dd), and the signature of an authorized officer of the Canadian laboratory.

1440.05**MATERIALS****1440.05.01****Reinforcing Steel Bars, Splice Bars, Tie Bars, Dowel Bars, Spirals, and Spacers**

Reinforcing steel bars shall be according to CAN/CSA G30.18.

All reinforcing steel bars shall be Grade 400W according to CSA G30.18.

Plain steel wire for spirals shall be according to ASTM A 82. Deformed steel bars for spirals shall be according to CSA G30.18 type W. Steel spacers according to CAN/CSA G40.21, Grade 350 G shall be provided with the spirals.

1440.05.02**Stainless Steel Reinforcing Bars, Stainless Steel Splice Bars, Tie Bars, Dowel Bars, Spirals, Spacers, and Stainless Steel Mechanical Connectors**

Stainless steel reinforcing bars and spirals shall be according to ASTM A 276 and ASTM A955M, minimum Grade 420.

Nominal dimensions, unit masses, and deformation requirements for metric bar sizes shall be according to CAN/CSA G30.18. Stainless spirals shall be provided with stainless spacers in conformance with ASTM A 276.

Stainless steel reinforcing bars, stainless steel spirals, stainless steel spiral spacers, and mechanical connectors shall be of a stainless steel type shown in Table 1.

Imperial and soft-converted metric bar size substitutions for metric bar sizes shall be permitted on a one-for-one basis without adjustment as shown in Table 2.

Other Imperial and soft-converted metric stainless steel reinforcing bar sizes may be substituted for metric bar sizes, subject to the following:

- a) The area of substituted steel reinforcement for the concrete component per linear metre or per gross cross-section area, as applicable, shall not be less than that shown for the concrete component on the Contract Drawings; and,
- b) The spacing of substituted steel reinforcement for the concrete component shall be according to CAN/CSA-S6 and the Structural Manual, Division 1.

Nominal cross-sectional areas of metric and imperial bar sizes used for determining substitutions shall be according to ASTM A 955M and CAN/CSA G30.18, respectively.

1440.05.03 Deformed Steel Wire

Deformed steel wire shall be according to ASTM A 496.

1440.05.04 Welded Smooth Steel Wire Fabric

Welded smooth steel wire fabric shall be according to ASTM A 185.

1440.05.05 Welded Deformed Steel Wire Fabric

Welded deformed steel wire fabric shall be according to ASTM A 497M.

1440.05.06 Prestressing Steel

Prestressing steel strand shall be weldless, low relaxation grade according to ASTM A 416M. Prestressing steel strand shall be certified by its manufacturer to bond to concrete of normal strength and consistency.

Prestressing steel wire shall be according to ASTM A 421M.

Prestressing steel bars shall be according to ASTM A 722M. The bars shall not be welded.

1440.07 PRODUCTION

1440.07.01 Manufacture of Reinforcing Steel Bars

The manufacture of reinforcing steel bars shall be by a manufacturer listed under "Mill" in the Designated Sources for Materials listing for Reinforcing Steel, Uncoated, Fabricators and Mills.

1440.07.02 Manufacture of Stainless Steel Reinforcing Bars

The manufacture of stainless steel reinforcing bars shall be by a manufacturer listed under "Mills" in the Designated Sources for Materials listing for Reinforcing Steel, Stainless, Mills and Fabricators.

1440.07.03 Fabrication of Reinforcing Steel Bar, Stainless Steel Reinforcing Bar, Splice Bar, and Stainless Steel Splice Bars

Bars shall be cold bent at the fabricator's shop.

The standard fabricating tolerances for all bars, straight or bent, shall be according to the Reinforcing Steel Manual of Standard Practice of the Reinforcing Steel Institute of Canada.

Fabrication of stainless steel reinforcing bars shall be so that the bar surfaces are not contaminated with deposits of iron or non-stainless steels, and the bar is not damaged by straightening from coil.

Fabrication of stainless steel reinforcing bars shall be by a fabricator listed under "Fabricators" in the Designated Sources for Materials listing for Reinforcing Steel, Stainless, Mills and Fabricators.

1440.07.04 Identification

1440.07.04.01 Prestressing Steel

All steel strand from each manufactured reel used and all high strength alloy bars used shall be assigned an individual lot number and shall be tagged with the lot number.

1440.07.04.02 Reinforcing Steel Bars, Stainless Steel Reinforcing Bars, Splice Bars, and Stainless Steel Splice Bars

All bars shall be shipped in bundles.

Each lot of reinforcing steel bars, stainless steel reinforcing bars, splice bars, and stainless steel splice bars shall be assigned an individual lot number and shall be tagged with the lot number.

In addition, tags for stainless steel reinforcing bars shall identify the manufacturer, stainless steel type and grade, and bar mark number, including stainless designation.

1440.08 QUALITY ASSURANCE

1440.08.01 Inspection and Testing

The Owner reserves the right to carry out inspections and tests at such times as the Owner may consider necessary to ensure that the materials supplied are according to this specification.

Materials failing to comply with the requirements of this specification shall be rejected.

The Owner's representative shall be permitted free entry to the manufacturing and fabrication plants, as well as the finished product storage and loading areas for inspection purposes.

TABLE 1
Type of Stainless Steel

Common or Trade Name	AISI Type	UNS Designation
Type 316 LN	316 LN	S31653
Type 2205 Duplex	2205	S31803

Note:

- A. Condition/Finish: reinforcing stainless steel bars and shapes shall be hot rolled and pickled, or hot rolled and descaled to the required mechanical properties and dimensions.

TABLE 2
Size Conversions

Metric Bar Size	Imperial Bar Size	Bar Designation No.
15M	# 5	16
25M	# 8	25
35M	# 11	36

Appendix 1440-A, November 2014
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



MATERIAL SPECIFICATION FOR STANDARD HIGHWAY FENCE COMPONENTS

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1540.09	OWNER PURCHASE OF MATERIAL - Not Used

APPENDICES

1540-A	Commentary
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1540.01 SCOPE

This specification covers the requirements for highway fence components and hardware.

1540.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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

1540.01.02 Appendices Significance and Use

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

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

1540.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Material

OPSS 1601 Wood, Preservation Treatment, and Shop Fabrication

Canadian General Standards Board (CGSB)

138.2-96 Steel Framework for Chain-Link Fence

ASTM International

A 116-11 Metallic-Coated, Steel-Woven Wire Fence Fabric
A 641/A 641M-09a Zinc-Coated (Galvanized) Carbon Steel Wire
A 702-89 (2006) Steel Fence Posts and Assemblies, Hot Wrought

Others

NLGA Standard Grading Rules for Canadian Lumber (2003)

1540.03 DEFINITIONS

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

Chain and Hook means hardware to hold the gate in place when closed.

Hinge Bolt means hardware that attaches to the gatepost and fits into the hinge clip to permit the gate to swing.

Hinge Clip means hardware that attaches to the gate frame and functions with the hinge bolt.

Sweep means the deviation of a wooden brace from straightness.

1540.05 MATERIALS

1540.05.01 Fence Fabric

The fence fabric shall be one type as shown in Table 1.

Locks or fastening at the intersections of the line and stay wires of the woven fence fabric shall prevent longitudinal and vertical slipping.

Fence fabric shall be galvanized prior to fabrication to provide a minimum weight of metallic coating according to ASTM A 641, Class 3.

1540.05.02 Wooden Posts

Wooden posts shall be according to OPSS 1601.

Wooden terminal posts shall have a minimum diameter of 200 mm. Wooden line posts shall have a minimum diameter of 150 mm. The maximum diameter of the large end of any wooden post shall be 330 mm.

1540.05.03 Steel Posts

Steel line posts shall be T-rail posts.

T-rail posts and angle iron posts shall be galvanized and according to ASTM A 702.

T-rail posts shall be 2.4 m long and punched so that the fence fabric can be secured to the broad face of the post. Each post shall be supplied with nine steel wire ties for securing the fence fabric.

1540.05.04 Steel Wire Ties

Steel wire ties shall be galvanized and according to ASTM A 702.

1540.05.05 Diagonal Wooden Braces

Diagonal wooden braces shall be round or sawn Eastern White Cedar, Jack Pine, Red Pine, or Southern Yellow Pine according to OPSS 1601. Round braces shall be a minimum diameter of 110 mm and maximum diameter of 165 mm. Sawn braces shall be a minimum 100 x 100 mm and in sound condition according to NLGA Standard Grading Rules for Canadian Lumber, Utility Light Framing. Diagonal wooden braces shall have a maximum sweep of 25 mm.

1540.05.06 Diagonal Brace Wire

Diagonal brace wire shall consist of four strands of 3.5 mm diameter, galvanized, soft steel.

When installing fence fabric with design number 949-12-12.5, the diagonal brace wire shall consist of four strands of 2.51 mm diameter, Class 3, high tensile wire.

1540.05.07 Staples

Staples for wooden posts shall be 4.0 mm diameter, galvanized, with a minimum driving length of 45 mm.

1540.05.08 Gates

Gates shall be constructed from 43 mm outside diameter galvanized steel pipe for the frame and 32 mm outside diameter galvanized steel pipe for the braces according to the requirements for galvanized standard-weight pipe, CAN/CGSB 138.2. All joints shall be electrically welded and coated with a zinc rich paint.

All required hardware and galvanizing of such parts shall be according to CAN/CGSB 138.2.

1540.05.09 Mechanical Splicing Units and Crimp Sleeves

Mechanical splice units or crimping sleeves shall provide a maximum load carrying capacity that meets or exceeds the minimum breaking strength of the fence fabric line wires. For 3.50 mm and 3.76 mm diameter line wire, the minimum breaking strength of the splice shall be 4,590 N.

For 2.51 mm diameter line wire, the minimum breaking strength of the splice shall be 5,990 N.

1540.07 PRODUCTION

1540.07.01 Gates

Gates shall be supplied completely assembled, including the fence fabric. The fabric and other components used on the gates shall match the adjacent fence.

All gates shall be supplied with galvanized chain and hook, hinge bolts, and hinge clips.

TABLE 1
Fence Fabric

Fence Fabric Design Number	Number of Horizontal Wires	Minimum Height mm	Wire Diameter mm	Stay Wire Spacing mm	Standard
949-12-9	9	1219	3.76	305	ASTM A 116
949-12-9.75	9	1219	3.50	305	ASTM A 641
949-12-12.5	9	1219	2.51	305	ASTM A 116

Appendix 1540-A, November 2014
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



MATERIAL SPECIFICATION FOR WOOD, PRESERVATIVE TREATMENT, AND SHOP FABRICATION

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1601.07	PRODUCTION
1601.08	QUALITY ASSURANCE
1601.09	OWNER PURCHASE OF MATERIAL - Not Used

APPENDICES

1601-A	Commentary
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1601.01 SCOPE

This specification covers the requirements for wood used in permanent and temporary structures and posts for signs, highway fence, and guide rail.

1601.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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

1601.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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1601.02 REFERENCES

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

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

CSA Standards

O56-M79 (R2006)	Round Wood Piles (Metric Version)
O80 Series-97 (R2002)	Wood Preservation
O122-06	Structural Glued-Laminated Timber
O141-05	Softwood Lumber
O177-06	Qualification Code for Manufacturers of Structural Glued-Laminated Timber

American Wood-Preservers Association (AWPA)

P1/P13-06	Creosote Preservative
P5-06	Waterborne Preservatives

Others

National Lumber Grades Authority (NLGA):
Standard Grading Rules for Canadian Lumber, 2005

1601.03

DEFINITIONS

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

Check means separation of the wood along the grain, the greater part of which occurs across the rings of annual growth. When the depth of a check exceeds half the thickness of the member, it shall be deemed a split.

Decay means a disintegration of the wood substance due to the action of wood-destroying fungi that causes the wood to become unsound. Also known as dote or rot.

Dressed Wood means wood that is surfaced by a planing machine to attain a standard of smoothness and uniformity of size.

Glued-Laminated Wood means a structural wood member produced by gluing together a number of wood pieces according to CSA O122.

Grade means the designation of the size or quality of a piece of wood according to the NLGA Standard Grading Rules for Canadian Lumber.

New Wood means wood that is free from deterioration such as that caused by decay, chemical or insect attack, or physical damage and has not been remanufactured since the time of its original grading.

Preservative Treatment means a pressure process that impregnates wood with toxic agents to prevent decay and insect attack.

Shake means a lengthwise separation of the wood that occurs between or through the rings of annual growth.

Short Crook means a localized deviation from straightness that is more than half the mean diameter of the crooked section within any section five feet or less in length.

Species means the tree source from which the wood was taken.

Split means a lengthwise separation of the wood due to the tearing apart of the wood cells that usually extends from surface to surface of a wooden pile.

Sweep means the deviation of a post from straightness.

Used Wood means wood other than that defined as new wood.

Wane means bark or lack of wood from any cause on the edge or corner of a piece of lumber.

Wood means that generic term covering all wood including glued-laminated members.

1601.05

MATERIALS

1601.05.01

General

All wood in permanent structures shall be new and shall be according to the grade, species, size, and surface finish as specified in the Contract Documents. All sizes of sawn wood shall be dressed sizes.

1601.05.02 Wood for Highway Fence, Cable Guide Rail, and Delineator Posts

Round wooden posts for highway fence, cable guide rail, and delineators shall be Eastern White Cedar, Jack Pine, Red Pine, or Southern Yellow Pine. Allowable defects shall be according to CAN3/CSA O56M, except that the posts shall be free from loose or unsound knots, short crooks, reverse sweep, shakes, decay, and checks that exceed 6 mm in width. Posts having a sweep exceeding 2% of the length of the post shall be rejected.

1601.05.03 Wood for Steel Beam Guide Rail and Sign Posts

Wooden posts and wooden offset blocks for steel beam guide rail shall be Jack Pine, Red Pine, or Southern Yellow Pine.

Wooden posts for signs shall be Jack Pine, Red Pine, Western Red Cedar, Lodgepole, or Ponderosa Pine.

Except for maximum allowable wane, posts and blocks for steel beam guide rail and posts for signs shall be No. 1 Grade - Structural Posts and Timbers graded according to the NLGA Standard Grading Rules for Canadian Lumber.

Wane on blocks and on the portion of posts to be set above ground shall not exceed a total width of 25 mm on any one face. Wane on the lower 1.2 m or on the portion of posts to be set below ground shall not exceed a total width of 60 mm on any one face. The total width of wane on any face shall be determined by deducting the portion of the face that is entirely free from wane from the minimum permissible dimension as specified in the Contract Documents.

1601.05.04 Round Wooden Piles

Wooden piles shall be cleaned and peeled and according to CAN3/CSA O56M.

1601.05.05 Structural Glued-Laminated Wood

Structural glued-laminated wood shall be according to CSA O122 and shall be produced by a manufacturer certified according to CSA O177.

1601.05.06 Preservatives

Preservatives shall be according to CSA O80 Series and shall be selected from the following:

- a) Creosote shall be according to AWWA P1.
- b) Pentachlorophenol in Type A hydrocarbon solvent. The mixture shall be not less than 5% pentachlorophenol and petroleum solvent.
- c) Chromated Copper Arsenate (CCA) shall be according to AWWA P5, Type A, B, or C.
- d) Ammoniacal Copper Arsenate (ACA) shall be according to AWWA P5.
- e) Alkaline Copper Quaternary (ACQ) shall be according to AWWA P5.

1601.05.07 Painting of Preservative Treated Wood

Only waterborne preservatives CCA or ACA shall be permitted for use on wood that is to be painted.

1601.05.08 Marking of Wood for Identification

All wood shall be marked using a grade stamp of an association or independent grading agency according to CAN/CSA O141.

1601.05.09 Marking of Wood for Identification of Preservative Treatment

All wood with preservative treatment shall be marked using a certification mark authorized by the Canadian Wood Preservers Bureau (CWPB).

1601.05.10 Certificates of Compliance

1601.05.10.01 Identification of Wood

When the grade stamp is obscured or is nonexistent, the following certificates shall be provided by the fabricator:

- a) Verification of compliance with grade and species by an agency approved by the Canadian Lumber Standards Accreditation Board (CLSAB).
- b) Verification that all structural glued-laminated wood has been produced by a certified manufacturer.

1601.05.10.02 Preservative Treatment

When the certification mark is obscured or is nonexistent, a certificate shall be provided by the fabricator verifying that the material was treated at a plant authorized by the CWPB.

1601.05.11 Used Wood

Used wood shall not be used as posts for delineator, steel beam guide rail, or cable guide rail installations.

Used wood shall be permitted for use in temporary structures, provided that the wood is of known history and the grade and species are identifiable. The wood shall be the stress level for new wood of the same grade and species, provided that the previous use has not damaged the wood in such a way that the grade requirements are no longer met. Where wood has been damaged, has deteriorated due to decay or to chemical or insect attack, or its planned use is in a structure to which the public has access, the wood shall not be used, unless it is regraded by a grading agency approved by CLSAB.

1601.07 PRODUCTION

1601.07.01 Preservative Treatment

Preservative treatment shall be according to CSA O80 Series.

All wood for permanent applications shall be pressure preservative treated except Eastern White Cedar for cable guide rail posts, guide posts, delineator posts, and highway fence posts and Western Red Cedar for sign posts.

All wood, except cedar posts, in temporary structures with an intended service life exceeding one year shall be pressure preservative treated.

Wood treated using oil borne preservatives shall be subjected to a vacuum expansion bath at a treatment plant according to CSA O80 Series to produce a material that is free of excessive surface oil. Wood treated using water borne preservatives shall have an average moisture content not exceeding 25% at 25 mm depth below the surface prior to preservative treatment.

1601.07.02 Shop Fabrication

Cutting, framing, drilling, and grooving of wood shall be performed prior to preservative treatment.

1601.07.03 Handling, Storage and Care of Wood

Handling and storage of wood shall be according to CSA O80 Series.

Wood shall be kept free of dirt and stored in a location that will not create an excessive increase in temperature through the green house effect resulting in rapid drying of the material. Wood shall be stored in a manner that will prevent ponding or trapping of excess moisture between surfaces where it cannot dry readily.

When oil treatment is used, the wood shall be given three coats of creosote oil to repair all cuts, abrasions, and holes made after the initial pressure preservative treatment. Each coat shall be dry before the next coat is applied.

Repair of cuts, abrasions, and holes in material treated with water-borne preservatives shall be according to CSA O80 Series.

1601.07.04 Quality Control - Wood Preservation

The wood preserving plant shall use quality control procedures according to CSA O80 Series.

1601.07.05 Tolerances

1601.07.05.01 Dimensions

The following tolerances shall apply:

Diameter of round wooden posts for highway fence, cable guide rail, and delineator posts	± 10 mm
Diameter of other round wooden posts	± 6 mm
Dressed cross-sectional dimensions	± 2 mm
Length	± 10 mm

1601.07.05.02 Splits and Checks

Splits and checks in all treated wood shall not exceed the following limits:

Cedar and Treated Posts

- a) The width of splits and checks at the surface shall not exceed 10 mm, regardless of their length or depth.
- b) The depth of splits or checks shall not exceed the depth of 40% of the post diameter or thickness, regardless of their length or width.

Other Treated Wood

- a) The width of splits and checks at the surface shall not exceed 6 mm.
- b) Splits shall not exceed in length any of the following:
 - i. Twice the member thickness.
 - ii. One and one half times the member width.
 - iii. One quarter of the member length.

1601.08 QUALITY ASSURANCE

1601.08.01 Inspection

The quality of all materials and finished products shall be subject to inspection and approval by the Owner. The manufacturer shall afford the Owner all reasonable facilities and access to ensure that the wood products furnished are according to this specification.

Appendix 1601-A, November 2014
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



**MATERIAL SPECIFICATION FOR
PAINT COATING SYSTEMS FOR STRUCTURAL STEEL**

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1704.01 SCOPE

This specification covers the material requirements of paint coating systems for structural steel. It also covers the procedure to be followed for initial approval and subsequent acceptance testing of paint coatings and paint coating systems.

1704.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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

1704.01.02

Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

1704.02

REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 911 Coating Structural Steel Systems

ASTM International

A 123/A123M-12	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
B 117-11	Standard Practice for Operating Salt Spray (Fog) Apparatus
D 523-14	Standard Test Method for Specular Gloss
D 562-10	Standard Test Method for Consistency of Paints Measuring Krebs Unit (KU) Viscosity Using the Stormer-Type Viscometer
D 609-00 (2012)	Standard Practice for Preparation of Cold-Rolled Steel Panels for Testing Paint, Varnish, Conversion Coatings, and Related Coating Products
D 610-08 (2012)	Standard Test Method for Evaluating Degree of Rusting on Painted Steel Surfaces
D 660-93 (2011)	Standard Test Method for Evaluating Degree of Checking of Exterior Paints
D 661-93 (2011)	Standard Test Method for Evaluating Degree of Cracking of Exterior Paints
D 714-02 (2009)	Standard Test Method for Evaluating Degree of Blistering of Paints
D 772-86(2011)	Standard Test Method for Evaluating Degree of Flaking (Scaling) of Exterior Paints
D 1210-05 (2010)	Standard Test Method for Fineness of Dispersion of Pigment-Vehicle Systems by Hegman-Type Gage
D 1475-13	Standard test Method for Density of Liquid Coatings, Inks, and Related Products
D1640 -03(2009)	Standard Test Methods for Drying, Curing, or Film Formation of Organic Coatings at Room Temperature

D 1654-08	Standard test method for Evaluation of Painted or Coated Specimens subjected to Corrosive environment
D 2369-10e1	Standard Test Method for Volatile Content of Coatings
D 2371-85(2010)	Standard Test Method for Pigment Content of Solvent-Reducible Paints
D 2621-87(2011)	Standard Test Method for Infrared Identification of Vehicle Solids From Solvent-Reducible Paints
D 3271-87(2012)	Standard Practice for Direct Injection of Solvent-Reducible Paints Into a Gas Chromatograph for Solvent Analysis
D 3723-05(2011)	Standard Test Method for Pigment Content of Water-Emulsion Paints by Low-Temperature Ashing
D 3960-05(2013)	Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paint and Related Coatings
D 4214-07	Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films
D 4400-99(2012)e1	Standard Test Method for Sag Resistance of Paints Using a Multinotch Applicator
D 4451-02(2008)	Standard Test Method for Pigment Content of Paints by Low-Temperature Ashing
D 4541-09e1	Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
D 4587-11	Standard Practice for Fluorescent UV-Condensation Exposures of Paint and Related Coatings
D 5894-10	Standard Practice for Cyclic Salt Fog/UV Exposure of Painted Metal, (Alternating Exposures in a Fog/Dry Cabinet and a UV/Condensation Cabinet)
D 6386-10	Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting
E 1347-06 (2011)	Standard Test Method for Color and Color-Difference Measurement by Tristimulus (Filter) Colorimetry

ASTM International Manual Series: MNL 17

Paint and Coating Testing Manual, 15th Edition, 2012

The Society for Protective Coatings (SSPC)

Good Painting Practice, SSPC Painting Manual, Volume 1, 4th Edition, 2002

SP 3-82 (2004) Power Tool Cleaning

VIS 1-02 Visual Standard for Abrasive Blast Cleaned Steel

VIS 3-93(2004) Visual Standard for Power and Hand Tool Cleaned Steel

SSPC and National Association of Corrosion Engineers (NACE) Joint Publications

SP 5 / NACE No. 1, Jan 2007 White Metal Blast Cleaning

SP 10 / NACE No. 2, September 2000 Near-White Blast Cleaning

SSPC, American Welding Society (AWS) and NACE Joint Publications

SSPC-CS 23.00 / AWS C2.23M/NACE No.12-2003 Application of Thermal Spray Coatings (metalizing) of Aluminum, Zinc, and Their Alloys and Composites for Corrosion Protection of Steel

Others

U.S. General Services Administration:
Federal Standard 595C Colors, 2008

1704.03 DEFINITIONS

For the purpose of this specification, the definitions in the SSPC, Good Painting Practice Manual Volume 1, 4th Edition; and the following definitions apply:

Coating System means as defined in OPSS 911.

Low Volatile Organic Coating Material means coating material that contains not more than 340 g/L of volatile organic compounds (VOC) when tested according to ASTM D 3960.

Marginally Prepared Surface means a steel surface prepared by power tool cleaning according to SSPC-SP 3.

Paint Coating means as defined in OPSS 911.

Paint Coating System means as defined in OPSS 911.

Pot Life means the length of time a multi-component material is usable after all the components are mixed in the recommended portions.

Seal Coat means as defined in OPSS 911.

Structural Steel means as defined in OPSS 911.

Target Value means the value of various properties listed in OPSF 1704-1 submitted by the supplier with the initial submission of material samples for coating system approval.

1704.04 DESIGN AND SUBMISSION REQUIREMENTS

1704.04.01 Submissions Requirements

1704.04.01.01 Paint Coatings and Paint Coating System Approval

The supplier shall provide samples and a completed OPSF 1704-1 for each component of the paint coating system for approval and material acceptance testing. The sample shall be accompanied by the manufacturer's instructions for use; material safety data sheets; and material information, including documentation on laboratory and field tests carried out to establish the pot life; physical characteristics; and chemical composition as shown in OPSF 1704-1.

1704.05 MATERIALS

1704.05.01 Coating Material

1704.05.01.01 General

The requirements of the paint coating shall be according to the following:

- a) The concentration of lead in the dry film of each coating shall not exceed 0.01% or 100 ppm.
- b) The components shall be homogenous, well-dispersed to a uniform consistency and, when mixed according to manufacturer's instructions, shall be suitable for application by spray equipment.
- c) Each paint coating shall be a low VOC material.
- d) Zinc-rich touch up paint shall contain not less than 87% of zinc by mass of non-volatile matter.

- e) The paint coating system for marginally prepared surfaces shall be suitable for application over existing coatings of alkyd, vinyl, and currently approved low VOC paint coating systems.

1704.05.01.02 Colour

The prime coat shall be of such a colour as to assist the applicator in distinguishing between primed areas and the uncoated cleaned steel or other prepared surfaces.

Each coat shall be formulated to show a distinct colour difference. With the exception of coal tar epoxies, the colour of the finish coat shall be equivalent to 10045 brown for Atmospheric Corrosion Resistant steel, and a colour equivalent to 16307 grey for all other steels, both according to Federal Standard 595C Colors.

1704.05.01.03 Application Requirements

When applied according to the manufacturer's instructions and to the manufacturer's specified thickness, the paint coating shall show good levelling with no runs, sags, or mud cracks. Applied coatings shall have no pin-holes, holidays, bubbles, or craters.

Each coat shall be capable of application by spray, brush, or roller for a temperature range of 5 to 35 °C, without thinning.

After the components have been combined, multiple component paint coating shall have a minimum pot life of 3 hours at 25 °C.

1704.05.01.03.01 Two-Coat Zinc Rich Rapid Deployment Coating System

In order to qualify as a primer for a rapid deployment coating system, zinc rich coating material shall cure or dry sufficiently to be top coated within 3 hours at 15 °C when applied at a wet film thickness required for a DFT of 100 µm.

The coatings to be used as the top coat material shall cure or dry to touch within 4 hours when applied at a wet film thickness required for a DFT of 125 µm.

1704.05.01.04 Performance Requirements

1704.05.01.04.01 General

The entire coating system shall be tested on test panels for adhesion, weathering resistance, and corrosion resistance performance. Testing shall be as shown in Table 1.

1704.05.01.04.02 Accelerated Weathering

After 5,000 hours of exposure, the coating system on the test panel for abrasive blast cleaned surfaces shall exhibit none of the characteristics of the paint failure as described in the Coating Failures chapter of the SSPC Good Painting Practice Manual, except for characteristics noted below. Chalk rating shall be 7 or higher, and the colour difference shall not exceed 6 units.

After 2,500 hours of exposure, the coating system on the test panel for marginally prepared surfaces shall exhibit none of the characteristics of the paint failure as described in the Coating Failures chapter of the SSPC Good Painting Practice Manual, except for characteristics noted below. Chalk rating shall be 7 or higher and the colour difference shall not exceed 6 units.

After 5,000 hours of exposure, the coating system on the galvanized test panel shall exhibit none of the characteristics of the paint failure as described in the Coating Failures chapter of the SSPC Good Painting Practice Manual, except for characteristics noted below. Chalk rating shall be 7 or higher and the colour difference shall not exceed 6 units.

After 5,000 hours of exposure, the coating system on the metallized test panel shall exhibit none of the characteristics of the paint failure as described in the chapter "Causes and Prevention of Paint Failure" in SSPC Vol. 1. Chalking shall be 7 or higher, and the colour difference shall not exceed 6 units when measured as shown in Table 1.

1704.05.01.04.03 Cyclic Corrosion Resistance Testing

After 12 cycles of exposure, the coating system on the test panel for abrasive blast cleaned surfaces shall exhibit none of the characteristics of the paint failure as described in the Coating Failures chapter of the SSPC Good Painting Practice Manual, except for characteristics noted below. There shall not be any corrosion, except along the score lines. The average value of the rust creepage of all the scored panels tested shall not be more than 4 mm. However, the rust creepage on any individual panel may exceed 4.0 mm, but shall be below 5.0 mm. Chalk rating shall be 7 or higher and the colour difference shall not exceed 6 units.

After 6 cycles of exposure, the coating system on the test panel for marginally prepared surfaces shall exhibit none of the characteristics of the paint failure as described in the Coating Failures chapter of the SSPC Good Painting Practice Manual, except for characteristics noted below. There shall not be any corrosion, except along the score lines. The average value of the rust creepage of all the scored panels tested shall not be more than 4 mm. However, the rust creepage on any individual panel may exceed 4.0 mm, but shall be below 5.0 mm. Chalk rating shall be 7 or higher and the colour difference shall not exceed 6 units.

After 12 cycles of exposure, the coating system on the galvanized test panel shall exhibit none of the characteristics of the paint failure as described in the Coating Failures chapter of the SSPC Good Painting Practice Manual, except for characteristics noted below. There shall not be any corrosion, except along the score lines. The average value of the rust creepage of all the scored panels tested shall not be more than 4 mm. However, the rust creepage on any individual panel may exceed 4.0 mm, but shall be below 5.0 mm. Chalk rating shall be 7 or higher and the colour difference shall not exceed 6 units.

After 12 cycles of exposure, the seal coatings on the metallized test panel shall exhibit none of the characteristics of the paint failure as described in the chapter "Causes and Prevention of Paint Failure" in SSPC Vol. 1. There shall not be any corrosion, except along the score lines where the total width of rust creepage shall not be more than 1.0 mm. Chalking shall be 7 or higher and the colour difference shall not exceed 6 units when measured as shown in Table 1.

1704.05.01.04.04 Salt Spray Resistance Testing

Salt spray resistance testing of zinc-rich touch up paint coated test panels shall be conducted according to ASTM B117 for 720 hours. There shall not be any corrosion, except along the score lines where the total width of rust creepage shall not be more than 1.00mm.

1704.05.01.05 Recoat Time

At an ambient temperature of 23 °C and a relative humidity of 80%, a paint coating shall dry or cure sufficiently to receive the next coat satisfactorily within 16 hours of application. It shall remain recoatable for a minimum of 30 Days.

1704.07 PRODUCTION

1704.07.01 Quality Control

1704.07.01.01 Physical Tests and Paint Coating Composition

The results for physical tests and paint coating composition of production batches shall be within the tolerances as shown in Table 2, when the results of testing are compared to the respective test results of the sample submitted for the coating system approval.

1704.07.01.02 Chemical Analysis

When the product from production batches of paint coatings is analyzed for chemical composition, the test results shall not vary by more than:

- a) $\pm$ 5% from the value of the original submission, if the amount of ingredient is greater than 50% by weight of the product.
- b) $\pm$ 10% from the value of the original submission, if the amount of the ingredient is from 5 to 50% by weight of the product.

1704.07.01.03 Infrared Analysis

The infrared spectrum of the product or any product fraction of production batches of paint coatings shall match the corresponding spectrum from the sample submitted for coating system approval.

1704.07.01.04 Gas Chromatogram of Volatiles

The gas chromatogram of production batches of paint coatings shall show the identical volatile components present in the same proportions as in the sample submitted for coating system approval.

1704.07.01.05 Colour Difference

Colour difference of production batches of paint coatings shall be within the tolerances as shown in Table 2. The reference colour for the finish coat shall be the appropriate colour specified in the Material section. For all other coats, the reference colour shall be the colour of the sample submitted for paint coating system approval.

1704.07.02 Packaging and Delivery

The paint shall be delivered in the manufacturer's originally sealed containers.

Containers shall be leak-free and constructed so that the contents can be thoroughly and completely mixed. They shall be provided with triple-tight lids. Containers 4 litres or larger shall have wire bail handles.

Each container and shipping case shall be marked to show the following information:

- a) Identification of the paint coating system.
- b) The contents of container (i.e., prime coat, second coat, third coat, or fourth coat).
- c) The colour and colour code.
- d) The manufacturer's name and address.

- e) The quantity of the contents in litres.
- f) The date of filling the container (i.e., yyyy-mm-dd).
- g) The manufacturer's code and coating batch numbers.

The markings shall be permanent and the coating batch number shall be prominently displayed.

1704.07.02.01 Certificate of Compliance

A certificate of compliance from the manufacturer indicating that the physical properties and chemical composition of the material supplied complies with the requirements of this specification shall be included with each shipment of paint.

1704.08 QUALITY ASSURANCE

1704.08.01 Test Panels

1704.08.01.01 Testing General

For the following tests, the number of panels specified below shall be made for the paint coating system being evaluated and the panels for the approved paint coating system to be used for reference purposes during paint coating operations.

1704.08.01.02 Weathering Resistance and Corrosion Resistance Testing

1704.08.01.02.01 Panel Preparation

1704.08.01.02.01.01 Abrasive Blast Cleaned Surfaces

Panels shall be cold-rolled carbon steel according to ASTM D 609, measuring 75 x 150 x 2.6 mm with rounded edges. Panels shall be blast cleaned to the requirements of SP 10/NACE NO. 2. The pictorial standards as shown in SSPC-VIS 1 shall be used to check conformance of the panel preparation in conjunction with SP 10/NACE NO. 2. The height of the surface profile shall be a minimum of 25 µm and a maximum of 75 µm.

1704.08.01.02.01.02 Marginally Prepared Surfaces

The panels shall be prepared as specified in the Abrasive Blast Cleaned Surfaces clause and then be subjected to 72 hours of salt spray according to ASTM B 117, after which, the rusted panels shall be power-tool cleaned to SSPC SP 3 condition by power wire brush. The pictorial standards as shown in SSPC-VIS 3 shall be used to check conformance of the panel preparation in conjunction with SSPC SP3.

1704.08.01.02.01.03 Paint Coating on Galvanized Surfaces

As the first step, cold-rolled carbon steel panels, measuring 75 x 150 x 5 mm with rounded edges shall be hot dip galvanized according to ASTM A123/A123M. Galvanized panel surfaces shall then be prepared according to ASTM D 6386. Thick edges due to excess zinc run-off, high spots, and rough edges shall be removed by power tools. Surface preparation shall be performed by sweep blasting to roughen the surface using an abrasive of a hardness that does not damage the galvanized coating.

1704.08.01.02.01.04 Seal Coating on Metallized Surfaces

As the first step, cold-rolled carbon steel panels measuring 75 mm x 150 mm x 2.6 mm, and shall be blast cleaned to the requirements of SP5/NACE NO. 1. The height of the surface profile shall be a minimum of 50 µm and a maximum of 75 µm. The blast cleaned panels shall then be coated on both surfaces and the edges with 85% zinc / 15% aluminum alloy by thermal metal spraying according to SSPC-CS 23.00 / AWS C2.23M/NACE No.12. The dry film thickness of the metallized coating shall be between 75 µm and 110 µm. The metallized panels shall be vacuum sealed or stored in a vacuum desiccator to prevent oxidation until the seal coat material is ready to be spray applied.

1704.08.01.02.02 Paint Coating and Seal Coating Application

The paint coating system shall be spray applied on both faces of the prepared test panels according to the manufacturer's recommendations and to the manufacturer's recommended thickness. When the painted faces are hard dry, the edges of the panels shall be covered with the same coating applied by brush. After the final coat, the panels shall be dried and cured for 7 Days prior to any further handling.

The coating on the panels intended for scoring shall be scored according to ASTM D1654.

1704.08.01.02.03 Test Method for Accelerated Weathering

Test panels shall be prepared and coated as specified in the Panel Preparation clause and the Paint Coating and Seal Coating Application clause.

Seven unscored panels shall be prepared for each cleaning requirement for each coating system. One panel from each set shall be set aside as reference for comparison purposes. The other panels from each set shall undergo exposure testing as shown in Table 1. Evaluation shall be done at 500 hour intervals of exposure to the maximum of 5,000 hours for coating systems on abrasive blast cleaned surfaces and galvanized surfaces, seal coating on metallized surfaces, and 2,500 hours for coatings on marginally prepared surfaces.

1704.08.01.02.04 Test Method for Cyclic Corrosion Resistance of Coatings

Test panels shall be prepared, coated, and scored as specified in the Panel Preparation clause and the Paint Coating and Seal Coating Application clause.

Eleven panels shall be prepared for each cleaning requirement for each coating system. One panel from each set shall be set aside as reference for comparison purposes. The other panels, 5 unscored and 5 scored from each set, shall undergo exposure testing as shown in Table 1. Evaluation shall be done after each cycle of exposure. At the completion of testing, the coating between the score lines on the bottom half of the scored panels shall be stripped and the mean rust creepage in millimetres for each panel shall be determined according to ASTM D 1654. The average rust creepage shall be calculated from the mean rust creepage values of the individual panels of the respective paint system.

1704.08.02 Coating System Approval

1704.08.02.01 General

Approval shall only be given for a complete paint coating system and for paint coating to be used as a seal coat for thermal spray metal coating.

Testing shall be performed by the Owner or by an independent laboratory chosen by the Owner.

When an independent laboratory is used, the paint manufacturer shall arrange for testing by the independent laboratory. The independent laboratory shall obtain samples of the approved paint coating and paint coating system to be used for comparison purposes from the Owner.

1704.08.02.02 Testing by Owner

When testing is carried out by the Owner for initial approval, the supplier shall be notified of the sample size, date, labelling, and other details regarding submission of samples, including cost.

1704.08.02.03 Testing for Coating System Approval and Approval of Subsequent Batches

The initial submission shall be evaluated for approval based on the requirements specified in the Materials section, using the testing methods as shown in Tables 1 and 2, and the data submitted on the completed OPSF 1704-1.

For comparison, an approved system from the Owner's list of approved coatings shall be subjected to the tests for accelerated weathering and cyclic corrosion resistance concurrently with the system under evaluation. Where possible, coatings of the same generic type shall be used for comparison.

When the testing is done by the approved independent laboratory, the Owner shall review the test results and may repeat any of the tests.

Subsequent batches of material shall be tested for acceptance as specified in the Quality Assurance section.

1704.08.02.05 Acceptance or Rejection

1704.08.02.05.01 Initial Approval

Approval shall only be given to paint coatings and paint coating systems satisfying the requirements of the Materials section.

1704.08.03 Sampling at Work Site

Samples of material for quality assurance testing shall be taken by the Owner from material delivered to the work site.

1704.08.03.01 Acceptance or Rejection on Site

Testing shall be done by the Owner according to the methods as shown in Table 2.

Acceptance shall be based on the testing requirements and allowable tolerances as shown in Table 2, when compared to the results of the testing conducted by the Owner on the initially approved material.

Failure to conform to the requirements of the Material section and the tolerances as shown in Table 2, changes made in the formulation after approval, inability to maintain production quality, and unsatisfactory field performance of paint coatings or paint coating systems shall be a cause for rejection.

TABLE 1
Performance Tests for Paint Coating Systems

Type of Test	ASTM Method	Requirements
Pull-Off Adhesion	D 4541	2.75 MPa minimum
Accelerated Weathering using Fluorescent UV - Condensation Light- and Water-Exposure Apparatus for evaluation of: Paint coating system on abrasive blast cleaned test panels Paint coating systems on hot dip galvanized test panels Seal coating on metallized test panels Paint coating system on marginally prepared test panels	D 4587 Test Condition D	Exposed to: 5,000 hours maximum 5,000 hours maximum 5,000 hours maximum 2,500 hours maximum
Cyclic Corrosion Resistance Testing by Alternating Exposures in a UV/Condensation Cabinet and a Salt Fog/Dry Cabinet for evaluation of: Paint coating system on abrasive blast cleaned test panels Paint coating systems on hot dip galvanized test panels Seal coating on metallized test panels Paint coating system on marginally prepared test panels	D 5894	Exposed to: 12 cycles maximum (Note 1) 12 cycles maximum (Note 1) 12 cycles maximum (Note 1) 6 cycles maximum (Note 1)
Evaluation of Test Panels After Accelerated Weathering Test / Cyclic Corrosion Resistance Test for: Gloss Colour Difference (ΔE) Chalking Checking Cracking Flaking Blistering Rusting Rust Creepage	D 523 E 1347 D 4214 D 660 D 661 D 772 D 714 D 610 D 1654	Test Method for Accelerated Weathering and the Test Method for Cyclic Corrosion Resistance of Coatings clauses (Note 2)
Notes: 1. One cycle represents a total exposure of 336 hours which comprises 168 hours or 1 week of exposure of test panels in the fluorescent UV condensation cabinet, followed by 168 hours of exposure of the test panels in the cyclic salt fog or dry exposure cabinet. 2. Clauses in this specification.		

TABLE 2
Test Methods for Physical Testing and Compositional Analysis of Paint Coatings
and Acceptance Criteria for Field Samples and Production Batches

	ASTM	Acceptance Criteria (Note 1)	
		Tolerance (Note 2)	Others
Physical Tests on Mixed Coating:			
Density	D 1475	5%	-
Consistency, Krieb Units (KU)	D 562	± 10 or 25% (Note 3)	-
Dry Time:			
To Touch	D1640	$\pm 30\%$	-
Hard Dry	D1640	$\pm 30\%$	-
Hiding Power Determination Using Pfund Black and White Cryptometer	Paint and Coating Testing Manual	± 1.5 (Note 4)	-
Skimming	-	-	-
Fineness of Grind, Hegman Units (HU)	D 1210	± 2	-
Sag Resistance	D 4400	$\pm 20\%$	-
Coating Composition:			
Pigment Content by % mass	D 4451, D 2371, D 3723	$\pm 5\%$	-
Vehicle Solids Content by % mass @ 24 hours	-	$\pm 5\%$	-
Volatile Content by % mass @ 2 hours and 24 hours	D 2369	$\pm 5\%$	-
Pigment Composition by Chemical and Instrumental Analysis	-	-	Chemical Analysis clause (Note 5)
VOC Content	D 3960	$\pm 10\%$ but the total not exceeding 340 g/L (Note 6)	-
Vehicle Solids Identification by Infrared Analysis	D 2621	-	Infrared Analysis clause (Note 5)
Determination of Paint Volatiles Composition by Gas Chromatography	D 3271	-	Gas Chromatogram of Volatiles clause (Note 5)
Determination of Thinner Composition by Gas Chromatography	D 3271	-	Gas Chromatogram of Volatiles clause (Note 5)
Tests on Cured Paint Coating:			
Gloss	D 523	$\pm 30\%$	-
Colour Difference (ΔE)	E 1347	± 4 units	-
IR Fingerprinting	Paint and Coating Testing Manual	-	Infrared Analysis clause (Note 5)
Notes:			
1. Acceptance criteria for field samples and production batches. 2. Allowable tolerance for field samples or production batches based on the Owner's test results for the initially approved paint coating material. 3. Whichever is less. 4. Pfund black and white cryptometer, wedge #3.5. 5. Clause in this specification. 6. VOC content of Zinc -rich touch up paint shall not exceed 500g/L.			

PAINT COATING DATA FORM

A. MANUFACTURER INFORMATION

Name:
Address:
Telephone:
Fax:
Email:

B. SAMPLE IDENTIFICATION

Manufacturer's Code No.:	Coating Batch No.:
Colour of Coating:	Production Date:

C. TEST DATA OF MIXED COATING

	Test Method	Manufacturer's Test Results
Density, kg/L	ASTM D 1475	
VOC, g/L	ASTM D 3960	
Viscosity, KU	ASTM D 562	
Pot Life, hours @ 25 °C	Manufacturer's Procedure	
Sag Resistance, mm	ASTM D 4400	
Dry Time, hours @ 25 °C		
To touch	ASTM D1640	
Hard dry	ASTM D1640	

D. COMPOSITION OF MIXED COATING

	Test Method	% by Mass
Pigment and Fillers	ASTM D 2371, D 4451, D 3723	
Non Volatile	-	
Volatile	ASTM D 2369	

E. COMPOSITION OF PIGMENTS AND FILLERS IN EACH COMPONENT % BY MASS - List % lead to three decimal places

	Component A	%	Component B	%	Component C	%
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

F. PAINT VOLATILE COMPOSITION BY GAS CHROMATOGRAPHY - Attach chromatogram with peaks identified

	Chemical Name	%
1		
2		
3		
4		
5		

G. COMPOSITION OF THINNER BY GAS CHROMATOGRAPHY - Attach chromatogram with peaks identified

	Chemical Name	%
1		
2		
3		
4		
5		

H. VEHICLE SOLIDS IDENTIFICATION by Infrared Analysis - Attach spectrum with major peaks identified

I. MIXING RATIO OF COMPONENTS A, B, and C by weight _____

J. IR FINGERPRINT OF MIXED, CURED COATING - Attach Spectrum with major peaks identified

OPSF 1704-1

Appendix 1704-A, November 2014
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



MATERIAL SPECIFICATION FOR CIRCULAR AND ELLIPTICAL CONCRETE PIPE

TABLE OF CONTENTS

1820.01	SCOPE
1820.02	REFERENCES
1820.03	DEFINITIONS - Not Used
1820.04	DESIGN AND SUBMISSION REQUIREMENTS
1820.05	MATERIALS
1820.06	EQUIPMENT - Not Used
1820.07	PRODUCTION
1820.08	QUALITY ASSURANCE - Not Used
1820.09	OWNER PURCHASE OF MATERIAL

APPENDICES

1820-A	Commentary
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1820.01 SCOPE

This specification covers the requirements for reinforced and non-reinforced non-pressure circular concrete pipe with rubber gasket joints, and for non-gasketed reinforced elliptical concrete pipe.

1820.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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

1820.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

1820.02 REFERENCES

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

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

CSA Standards

A257.1-09	Non-Reinforced Circular Concrete Culvert, Storm Drain, Sewer Pipe, and Fittings [Part of A257 Series-09, Standards for Concrete Pipe and Manhole Sections]
A257.2-09	Reinforced Circular Concrete Culvert, Storm Drain, Sewer Pipe, and Fittings [Part of A257 Series-09, Standards for Concrete Pipe and Manhole Sections]
A257.3-09	Joints for Circular Concrete Sewer and Culvert Pipe, Manhole Sections, and Fittings Using Rubber Gaskets [Part of A257 Series-09, Standards for Concrete Pipe and Manhole Sections]
A3000-08	Cementitious Materials Compendium

ASTM International

C 507M-11	Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe (Metric)
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Plant Prequalification Program Publication

Prequalification Requirements for Precast Concrete Drainage Products

1820.04 DESIGN AND SUBMISSION REQUIREMENTS

1820.04.01 Design Requirements

1820.04.01.01 Concrete Pipe

Non-reinforced circular concrete pipe shall be according to CAN/CSA A257.1.

Reinforced circular concrete pipe shall be according to CAN/CSA A257.2.

Reinforced elliptical concrete pipe shall be according to ASTM C 507M.

1820.04.01.02 Joints and Gaskets

Joints and gaskets for circular concrete pipe shall be according to CAN/CSA A257.3.

Joints for elliptical concrete pipe shall be according to ASTM C 507M, and according to the requirements outlined in the publication, Prequalification Requirements for Precast Concrete Drainage Products.

Elliptical concrete pipe produced with non-gasketed joints shall be used for storm pipe sewers only.

1820.04.01.03 Jacking Pipe

Jacking pipe shall be according to CAN/CSA A257.2 with a minimum class of 65-D and a minimum concrete strength of 40MPa.

1820.04.01.04 Elliptical Reinforcing

Elliptical reinforcing for circular concrete pipe is not permitted for pipes up to and including 900 mm nominal internal diameter.

1820.04.01.05 Lift Holes and Anchors

Lift holes are not permitted for pipes. Lift anchors are not permitted for pipes up to and including 900 mm nominal internal diameter.

1820.05 MATERIALS

1820.05.01 Cement

Cement shall be Portland cement or a commercial blend of Portland cement and blast-furnace slag or fly ash, or both. Ground granulated blast-furnace slag or fly ash may also be added separately to Portland cement. Whether added separately or in the form of blended cement, ground granulated blast-furnace slag shall constitute not more than 70% by mass of the total cementing materials and fly ash shall constitute not more than 40% by mass of the total cementing materials. The total amount of supplementary cementing materials in the cement for concrete pipe shall not exceed 70% by mass of the total cementing materials.

Portland cement, blended cement, ground granulated blast-furnace slag, and fly ash shall be according to CAN/CSA A3000.

1820.07 PRODUCTION

1820.07.01 General

A manufacturer producing circular concrete pipe or elliptical concrete pipe or both shall possess a current Prequalification Certificate, issued under the Plant Prequalification Program as outlined in the publication, Prequalification Requirements for Precast Concrete Drainage Products.

1820.07.02 Markings

Markings for circular concrete pipe shall be according to CAN/CSA A257.2.

Markings for elliptical concrete pipe shall be according to ASTM C 507M.

In addition, all pipe shall be marked with the Prequalification Stamp shown in Figure 1 and as outlined in the publication, Prequalification Requirements for Precast Concrete Drainage Products.



Figure 1
Prequalification Stamp

Appendix 1820-A, November 2014
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



NOTICE TO USERS OF OPSS.PROV 1841

CONSTRUCTION SPECIFICATION FOR NON-PRESSURE POLYVINYL CHLORIDE PIPE PRODUCTS

OPSS.PROV 1841 has been replaced by OPSS 1841
located in

OPS Volume 2,
Municipal and Provincial Common
General and Construction Specifications

**USE OF EITHER OF THE SPECIFICATIONS IS AS SPECIFIED
IN THE CONTRACT DOCUMENTS**



MATERIAL SPECIFICATION FOR IMPRESSED CURRENT CATHODIC PROTECTION SYSTEM FOR BRIDGE STRUCTURES

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2301.07	PRODUCTION
2301.08	QUALITY ASSURANCE
2301.09	OWNER PURCHASE OF MATERIAL - Not Used

APPENDICES

2301-A	Commentary
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2301.01 SCOPE

This specification covers the material requirements for impressed current cathodic protection systems for highway bridge structures.

2301.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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

2301.01.02 Appendices Significance and Use

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

Appendices are developed for the Owner's use only.

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

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

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

2301.02 REFERENCES

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

Ontario Provincial Standard Specifications, Construction

OPSS 603	Installation of Ducts
OPSS 609	Grounding
OPSS 935	Impressed Current Cathodic Protection System for Bridge Structures

Ontario Provincial Standard Specifications, Material

OPSS 1350	Concrete - Materials and Production
OPSS 2410	Extra Low Voltage Cables

CSA Standards

C22.2 No. 0.4-M1982 (R1993)	Bonding and Grounding of Electrical Equipment, Protective Grounding
C22.2 No. 5.1-M91	Molded Case Circuit Breakers
C22.2 No. 38-95	Thermosetting Insulated Wires and Cables
C22.2 No. 41-M1987 (R1993)	Grounding and Bonding Equipment
C22.2 No. 56-77 (R1992)	Flexible Metal Conduit and Liquid Tight Flexible Metal Conduit
C22.2 No. 65-93	Wire Connectors
C22.2 No. 85-M89	Rigid PVC Boxes and Fittings
C22.2 No. 158-1987 (R1995)	Terminal Blocks
C233.1-87 (R1995)	Gapless Oxide Surge Arrester for Alternating Current Systems
C57-1966 (R1994)	Electrical Power Connectors for Use in Overhead Line Conductors

ASTM International

B 265-95	Titanium and Titanium Alloy Strip, Sheet and Plate
A 666-94	Specification for Austenitic Stainless Steel, Sheet, Strip, Plate and Flat Bar for Structural Applications

Others

Ontario Traffic Signal Control Equipment Specification (OTSCES)
Ontario Electrical Safety Code

2301.03 DEFINITIONS

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

Constant Current means an operating mode in a rectifier in which the current is set at a fixed level and the voltage varies according to the anode-to-concrete resistance.

Constant Voltage means an operating mode in a rectifier in which the voltage is set at a fixed level and the current varies according to the anode-to-concrete resistance.

Equipment Assembly means a cabinet containing the assembled and wired cathodic protection control and monitoring equipment.

Spacer Grid means a grid of cross-laid glass fibre reinforced polymer bars (GFRP) used to isolate the anode mesh and distribution bars from the reinforcing steel in order to prevent contact and subsequent shorts.

Instant-Off means as defined in OPSS 935.

Interruption means switching on and off the rectifier output.

Rectifier means a device used to convert alternating current to direct current. In a cathodic protection system, the rectifier is used to regulate the voltage and current output to each zone.

Remote Monitoring and Control Unit (RMU) means a device used to control the operating parameters of a rectifier, collect and transfer operating data of the rectifier and embedded instrumentation to a remote computer, and performs depolarization tests.

Zone means as defined in OPSS 935.

2301.04 DESIGN AND SUBMISSION REQUIREMENTS

2301.04.01 Design Requirements

2301.04.01.01 Cathodic Protection Rectifier

2301.04.01.01.01 General

A rectifier shall be provided for each zone as specified in the Contract Documents. Each rectifier circuit shall be individually controlled and shall be capable of operating in constant current or constant voltage.

Each rectifier circuit shall be able to operate separately. Adjustment of the output of any rectifier circuit shall not affect the preset output of any other rectifier circuit.

The rectifier shall not exceed 970 mm high x 450 mm wide x 320 mm deep. The rectifier shall be enclosed with access openings for the display, control, and external terminal blocks. The rectifier shall be equipped for mounting on a rack in the cathodic protection cabinet.

2301.04.01.01.02 AC Input

The rectifier shall operate on a nominal line voltage of 120 Volts AC, 60 Hz. The rectifier shall be equipped with a 3-wire cord with a 3 prong plug for AC power supply. The rectifier shall accept an AC voltage input range of 95 to 135 VAC.

2301.04.01.01.03 DC Output

The DC output of each rectifier circuit shall have two modes of operation; constant current or constant voltage. The circuit shall provide a visual indication of the mode of operation. The rated DC output of the rectifier circuit shall be 25 volts, 2 amperes. Each rectifier circuit shall be capable of operating from 0 to 100% of the rated amperage and voltage output. The output of each circuit shall be filtered with full wave rectification and shall be electrically isolated from the line input. The output ripple shall not exceed 5% of output voltage when measured at the rated output voltage and current.

Each rectifier circuit shall be equipped with a 0.1 ohm current shunt, precise to 1%, and connected in series with the rectifier output circuitry. The wattage shall be compatible with the rectifier output.

2301.04.01.01.04 DC Panel Meters

Each rectifier circuit shall have a digital DC panel meter for measuring voltage and current.

The meter shall have an accuracy of $\pm 0.5\%$. The operating temperature of the meter shall be from -30 to +60 °C. The input impedance shall be at least 10 Mega ohms.

2301.04.01.01.05 Interruption Capability

The rectifier shall be designed with devices to allow manual interruption and remote electronic interruption for the purpose of instant-off measurements and depolarization testing.

A secondary switch for manual interruption shall be incorporated into the wiring and supplied on the cathodic protection terminal block assembly.

2301.04.01.01.06 Remote Monitoring and Control of Output Current, Voltage and Potential

The rectifier shall be designed with devices so that the output current and voltage of each rectifier circuit can be monitored and the output current and voltage controlled remotely from zero to full rated DC output, with infinite resolution.

2301.04.01.01.07 Operating Temperature and Humidity

The rectifier shall be capable of operating when the ambient temperature is between -30 to +60 °C and the relative humidity is between 10 to 100%. The rectifier shall shutdown automatically on thermal fault above +60 °C and shall be capable of restarting automatically on cooling.

2301.04.01.01.08 Protection Devices

Each rectifier circuit shall be designed with an in-line breaker or other means to protect against overloads and short circuits.

2301.04.01.01.09 Lightning and Surge Protection

The rectifier shall be designed with lightning and voltage surge protection for the AC input and the DC output according to CAN/CSA-C233.1.

2301.04.01.02 Cathodic Protection Remote Monitoring and Control Unit

2301.04.01.02.01 Operational Requirements

The remote monitoring and control unit (RMU) shall be capable of monitoring the "on", "off", and "instant-off" readings of the embedded instrumentation, and the output voltage and current of the rectifier for each zone. The RMU shall be capable of controlling the output current and voltage and be capable of performing depolarization tests.

2301.04.01.02.02 Physical Requirements

The RMU shall not exceed 200 mm high x 450 mm wide x 500 mm deep. The RMU shall be enclosed with stainless steel panels, with access openings for the display, control, and external terminal blocks. The RMU shall be equipped for mounting on a rack in the cathodic protection cabinet.

2301.04.01.02.03 Hardware Requirements

2301.04.01.02.03.01 General

The RMU shall be equipped with a real time clock, a modem, and operating software.

The RMU shall operate on a nominal line voltage of 120 Volts AC, 60 Hz. The RMU shall be equipped with a 3-wire cord with a 3 prong plug for AC power supply. The RMU shall accept an AC voltage input range of 95 to 135 VAC.

The RMU shall be capable of measuring a minimum of 16 analog input parameters for each zone as specified in the Contract Documents.

A switch shall be provided on the front panel of the RMU to bypass the remote control of the current and voltage to allow on-site adjustment of the DC output.

The RMU shall be designed with a current limiting device that can be manually adjusted so that malfunction of the RMU will not result in excessive rectifier current output.

The RMU shall be equipped with a device that will automatically reset the RMU if the program does not operate properly.

2301.04.01.02.03.02 Interrupter

An on/off interrupt device shall be provided for conducting depolarization tests for each zone. The interrupt device shall be capable of opening the circuit within 50 milliseconds after the interrupt signal is given. The output current interrupt signal shall not interfere with normal operation of the rectifier when the RMU malfunctions.

2301.04.01.02.03.03 Communication

The RMU shall be equipped with two RS232 ports for local accessing the system running parameters. All functions provided by the RMU software including the downloading of the stored data shall be available through these ports.

The communication shall be performed via one RS232 port using a wireless data modem. The RMU shall be capable of connecting directly to a portable computer in the field via the other RS232 port. The cable for connecting the RMU and the portable computer shall be supplied with the RMU and the connections shall be made via two part plug-in connectors.

The RMU shall communicate to the remote rectifier system using a wireless data communication system using the following networking technologies: HSPA+ with fallback to HSUPA; HSDPA; UMTS; EDGE; GPRS; or EV-DO, revision A, with fallback to CDMA EV-DO, revision 0, CDMA1xRTT, comprising of an RS232 Serial Port HOST interface. A transparent point to point or point to multipoint link should be implemented between the RMU and the remote system, containing RS232 links as communication input/output terminals.

2301.04.01.02.03.04 Data Storage

The program shall operate so that recorded data is preserved in the event of a power failure to the unit.

The RMU shall have a minimum of 32 GB battery backed data storage.

2301.04.01.02.03.05 Real-Time Clock

The RMU shall be designed with a real time clock to time stamp recorded data, to indicate occurrence of and duration of, and power failures to the unit. The clock shall have a minimum resolution of one second and shall compensate for leap years and days of the month.

2301.04.01.02.03.06 Operating Temperature and Humidity

The RMU shall operate when the ambient temperature is between -30 to +60 °C and relative humidity is in the range of 10 to 100%. The RMU shall shutdown automatically on thermal fault when the ambient temperature is above +60 °C and shall restart automatically on cooling.

2301.04.01.02.03.07 Protection Devices

The RMU circuit shall be protected against current overloading and short circuit using an inline fuse or other means.

2301.04.01.02.03.08 Lightning and Surge Protection

The RMU shall have lightning and surge protection according to CAN/CSA-C233.1 for the AC input and DC output.

2301.04.01.02.03.09 System Operating Indicator

The RMU shall be designed with a system operating indicator located on the front panel.

2301.04.01.02.04 Software Requirements

2301.04.01.02.04.01 General

The software program shall be manually driven and shall include a help menu.

The RMU software shall be compatible with Microsoft Windows 7 Professional for desktop and laptop computer applications.

2301.04.01.02.04.02 Screen Display at Connection

The software shall present the user with a request for a password upon connection of the RMU either by a portable computer via one of the RS232 ports or a remote computer via a modem.

Two password security levels shall be provided:

- a) The OPERATOR password shall be alpha numeric with a minimum of 4 characters and a maximum of 12. The operator function shall be designed to permit the user to monitor the cathodic protection system, perform depolarization testing, and permit the user to change the parameters in the program.

When a password is entered, the program shall display a message to acknowledge the entered password as correct or not. The user shall have three opportunities to enter the correct password.

If the entered password is still incorrect after three attempts, the program shall terminate further communications for 30 minutes.

- b) The MONITOR password shall be alpha numeric with a minimum of 4 characters and a maximum of 12.

The monitor function shall be designed to permit the user to monitor the cathodic protection system and perform depolarization testing, but shall not permit the user to alter any parameters in the program.

2301.04.01.02.04.03 Screen Display with OPERATOR Password

When the OPERATOR password is entered, the OPERATOR menu shall be displayed on the screen providing the options as shown in Table 1.

2301.04.01.02.04.04 Screen Display with Monitor Password

When the MONITOR password is entered, a MONITOR menu providing the options as shown in Table 2 shall be displayed on the screen.

The options specified are selected options from the OPERATOR menu as shown in Table 1.

2301.04.01.03 Cathodic Protection Terminal Block Assembly

The design shall be according to CSA C22.2 No. 158.

The rail shall be designed to accommodate two terminal block zone assemblies.

2301.05 MATERIALS

2301.05.01 General

All electrical materials, equipment, components, or completed assemblies of components shall be approved according to the Ontario Electrical Safety Code.

2301.05.02 Cathodic Protection Equipment Assembly

2301.05.02.01 Fan and Thermostat

The fan and thermostat shall be according to the OSTCES.

2301.05.02.02 Wireless Modem Antenna

The wireless modem antenna shall be a 1/4 wave rod, weatherproof and waterproof, and shall be supplied ready for installation as a unit.

2301.05.02.03 Wire Connections

All wire connectors shall be according to CSA C22.2 No. 65.

2301.05.02.04 Grounding and Bonding Equipment

All equipment used for grounding and bonding shall be according to CSA C22.2 No. 0.4 and No. 41.

2301.05.02.05 Thermoset Wires and Cables

All interconnecting cables shall be according to CSA C22.2 No. 38, shall be at least 19 strand copper, type RWU90 cross link, -40 °C. The AC wiring shall be #14 AWG. The wires in the cables connecting the remote monitoring unit, the rectifier, and the terminal block assembly shall be #22 AWG.

The wire for the rectifier output DC current shall be #12 AWG. The bonding wire to the ground bar shall be No. 6 AWG.

2301.05.02.06 Lightning and Surge Protection

Lightning arresters shall be according to CAN/CSA-C233.1 and meet low voltage applications therein. The protection device shall be rated at a minimum of 650V.

AC surge and lightning protection shall be installed inside the 401C cathodic protection cabinet. The protection shall be used on the AC input side of both the rectifiers and RMU.

DC surge and lightning protection shall be installed inside the 401C cathodic protection cabinet. The protection shall be used on the DC power output side for rectifiers.

The AC and DC surge and lightning protection shall be supplied as specified in the Contract Documents.

2301.05.02.07 Fasteners

All fasteners shall be Type 304 stainless steel according to ASTM A666.

2301.05.02.08 Cable Separation

AC, DC and signal wires shall be shielded electrically from each other to prevent electrical interference.

2301.05.03 Cathodic Protection Cabinet

The cathodic protection cabinet shall be Model 401C according to the OTSCES.

The pedestal and all other associated components shall be according to the OTSCES.

2301.05.04 Cathodic Protection Rectifier

The rectifier shall be supplied by sources as specified in the Contract Documents.

The rectifier and RMU shall be fully compatible in operation. The rectifier and the RMU shall be supplied by the same supplier.

2301.05.04.01 Thermoset Wires and Cables

Wire shall be according to CSA C22.2 No. 38.

2301.05.05 Cathodic Protection Remote Monitoring and Control Unit

The RMU shall be supplied by sources as specified in the Contract Documents.

The rectifier and RMU shall be fully compatible in operation. The rectifier and the RMU shall be supplied by the same supplier.

2301.05.05.01 Wiring

All wiring used in the RMU shall be PVC insulated with a temperature range of -40 to +60 °C at 150V. Cables providing AC power to the RMU shall be according to CSA C22.2 No. 38.

2301.05.06 Cathodic Protection Terminal Block Assembly

The cathodic protection terminal block assembly, including fasteners, shall be manufactured from corrosion resistant materials so that exposure to moisture will not impair the effectiveness of the assembly. The assembly shall be mounted on a DIN rail according to the requirements for mounting on an OTSCES rack.

Each terminal block zone assembly shall have a design specific number of terminal points as shown in Table 3.

Each terminal point shall be capable of accommodating all wire sizes from #6 AWG to #14 AWG.

Terminals 1 to 4, anodes, shall be interconnected with a jumper.

Terminals 5 to 8, cathode structure (CS), shall be interconnected with a jumper.

The assembly shall be equipped with a simple 15 ampere on/off switch, single pole, double throw switch manufactured according to CSA C22.2 No. 5.1 to provide a secondary manual interrupt for the rectifier.

Electrical materials shall be according to CSA C22.2 No. 158.

Extra low voltage cable shall be according to CSA C22.2 No. 38 and shall be at least 7 strand type RWU90 cross link, -40°C.

2301.05.07 Cathodic Protection AC Power Distribution Assembly

The AC power distribution assembly, including the enclosure, circuit breakers, wire connectors, grounding and bonding equipment and thermoset wires shall be supplied as per the OTSCES.

2301.05.08 Identification Marking

The identification marking for the cabinet, rectifier and remote monitoring, and control unit shall be weather resistant on a corrosion resistant metal plate.

2301.05.09 Extra Low Voltage Cables for Cathodic Protection

All extra low voltage cable shall be according to OPSS 2410 or shall be type RWU90, cross link, -40°C, minimum 7-strand copper according to CSA C22.2 No. 38.

2301.05.09.01 Anode Bus Cables

The anode bus cable from the junction box to the control panel of the cathodic protection cabinet shall be extra low voltage cable #6 AWG with black insulation, without splicing.

2301.05.09.02 Cathode Connection Cables

The cathode CS bus cable from the junction box to the rectifier of the cathodic protection cabinet shall be extra low voltage cable #6 AWG with white insulation, without splicing.

The cathode CM extension cable from the junction box to the control panel of the cathodic protection cabinet shall be extra low voltage cable #10 AWG with red insulation, without splicing.

2301.05.09.03 Reference Cell Cables

2301.05.09.03.01 Graphite Reference Cell Cables

The reference cell extension cable from the junction box to the control panel of the cathodic protection cabinet shall be extra low voltage cable #10 AWG with green insulation, without splicing.

2301.05.09.03.02 Silver-Silver Chloride Reference Cell Cables

The reference cell extension cable from the junction box to the control panel of the cathodic protection cabinet shall be extra low voltage cable #10 AWG with blue insulation, without splicing.

2301.05.09.04 Grounding Materials

The ground wire, ground electrodes, and connectors shall be according to OPSS 609.

2301.05.09.05 Connectors

The cable connectors shall be according to CSA C22.2 No. 65 and CSA C57.

2301.05.10 Rigid Ducts and Junction Boxes for Cathodic Protection

2301.05.10.01 Ducts and Fittings

The ducts and fittings shall be rigid RE/PVC watertight and shall be according to OPSS 603.

The flexible liquid tight ducts and fittings shall be according to CSA C22.2 No. 56.

2301.05.10.02 Junction Boxes

The junction boxes shall be rigid PVC as specified in the Contract Documents and according to CAN/CSA C22.2 No. 85.

The boxes shall be supplied with predrilled holes for connectors and two 6 mm diameter drain holes. The drain holes shall be located with a minimum separation of 250 mm at the lowest point in the box where water may collect.

2301.05.11 Anode Mesh

The anode mesh material shall be high purity titanium Grade 1, according to ASTM B265, and coated with a mixed metal oxide catalyst. The diamond dimensions for the anode mesh shall be 80 x 40 mm maximum. The anode mesh shall be supplied in minimum widths of 1 m and as specified in the Contract Documents.

2301.05.11.01 Distribution Bars

The distribution bars shall be titanium Grade 1, according to ASTM B265. The bars shall be 12 mm wide x 1 mm thick and shall be supplied in lengths at least 3 m long.

The surfaces of the bar shall be free of oxides, grease, and other contaminants.

The bars shall be supplied as specified in the Contract Documents.

2301.05.11.02 Anode Mesh Fasteners

The fasteners shall be fabricated from nylon 6/6 grade plastic suitable for long term embedment in concrete, shall be resistant to acid, and shall be capable of securing the mesh anodes in place on concrete surfaces.

The portion of the fastener embedded in the concrete shall be no larger than 8 mm diameter and no more than 33 mm in length.

The fasteners shall be supplied as specified in the Contract Documents.

2301.05.11.03 Spacer Grid

The spacer grid shall consist of 12 mm glass fibre reinforcing polymer bars (GFRP) in each direction with a bar spacing of not more than 200 mm.

2301.05.12 Reference Cells

2301.05.12.01 Graphite Reference Cell

Graphite reference cells shall be 40 x 40 x 150 mm graphite bars, grade SR-45 or equivalent.

Cables for graphite reference cells shall be extra low voltage cables according to OPSS 2410 or shall be #10 AWG RWU90 with green insulation, type RWU90, cross link, -40°C, and minimum 7-strand copper according to CSA C22.2 No. 38.

The 40 x 40 x 150 mm graphite reference cell shall be fitted with a length of extra low voltage cable #10 AWG RWU90 with green insulation. The extra low voltage cable shall be sufficiently long to extend from the point of embedment to the splice in the junction box, without splicing.

The extra low voltage cable shall be securely attached to the graphite bar by means of a threaded brass connector. The cable shall be soldered in a hole in the centre of the brass connector. The brass connector shall be fitted into a drilled and tapped hole in the graphite bar. The brass connector shall be recessed at least 15 mm and shall have side clearances of 15 mm. After soldering, the recess shall be filled to fully seal out water from soldered area. The supplier shall install the cable prior to delivery of the reference cells to the site. The resistance between the end of the cable and the end of the graphite block shall not exceed 1 ohm.

The graphite reference cells shall be supplied as specified in the Contract Documents.

2301.05.12.02 Silver-Silver Chloride Reference Cell

Cables for silver-silver chloride reference cells shall be extra low voltage cables according to OPSS 2410 or shall be #10 AWG with blue insulation, type RWU90, cross link, -40°C, and minimum 7-strand copper according to CSA C22.2 No. 38.

The silver-silver chloride reference cell shall be fitted with a length of extra low voltage cable #10 AWG with blue insulation. The extra low voltage cable shall be sufficiently long to extend from the point of embedment to the splice in the junction box, without splicing.

The silver-silver chloride reference cells shall be supplied as specified in the Contract Documents.

2301.05.13 Cathode Connections

Cables for cathode connections shall be extra low voltage cables according to OPSS 2410 or shall be type RWU90, cross link, -40°C, and minimum 7 strand copper according to CSA C22.2 No. 38.

The cathode CS cable from the point of connection of the reinforcing steel to the junction box shall be extra low voltage #10 AWG RWU90 with white insulation, without splicing.

The cathode CM cable from the point of connection of the reinforcing steel to the junction box shall be extra low voltage #10 AWG RWU90 with red insulation, without splicing.

2301.05.14 Silicone Seal

The silicone seal shall be suitable for electrical applications and burial in concrete.

2301.05.15 Heat Shrink Tubing and Splice Kits

The heat shrink tubing and splice kit shall fully insulate and seal out water from the connection area of the splice and shall be suitable for burial applications.

Heat shrink tubing and splice kits shall be supplied as specified in the Contract Documents.

2301.05.16 Heat Shrink Tape

The heat shrink tape shall fully insulate and seal out water from the connection area of the splice.

2301.05.17 Epoxy

The epoxy shall be non-conductive low viscosity type and suitable for burial in concrete.

Epoxy shall be supplied as specified in the Contract Documents.

2301.05.18 Thermite Weld

Cathode connections to the reinforcing steel shall be made by thermite weld.

2301.05.19 Thread Locking Compound

The thread locking compound shall be a removable anaerobic setting liquid compound that when used in metal to metal contact positively locks and seals the threaded fastener to prevent corrosion and loosening.

2301.07 PRODUCTION

2301.07.01 Cathodic Protection System Equipment Assembly

Assembly of the cathodic protection system shall consist of the following equipment:

- a) Cathodic protection cabinet.
- b) Cathodic protection remote monitoring and control unit.
- c) Cathodic protection rectifier.
- d) Cathodic protection terminal assembly.
- e) Cathodic protection AC power distribution assembly.
- f) Fan with thermostat.
- g) Wireless modem.

The cathodic protection remote monitoring and control unit equipment shall be installed and wired in the cathodic protection cabinet according to the details on the Working Drawings and according to OPSS 935.

The wireless modem antenna shall be installed according to the antenna manufacturer's requirements.

All connections to ground shall extend to the ground bar.

All cables shall be bundled and held in place with nylon cable ties or shall be installed in wiring ducts or raceways.

2301.07.02 Identification Marking

Each of the following cathodic protection system components shall have identification markings showing the manufacturer's name or trade mark; serial number, if available; and the date of manufacture permanently attached with adhesive to the assembly in a highly visible location.

- a) Cathodic protection cabinet.
- b) Cathodic protection rectifier
- c) Cathodic protection remote monitoring and control unit.

Each completed cathodic protection equipment assembly shall have identification marking showing the date, name and site number of the structure, and the assembler's name. The marking shall be weather resistant placed on a corrosion resistant plate permanently attached with adhesive to the inside of the door in a highly visible location.

The terminal block and each rectifier shall be labeled to show their respective zones.

2301.07.03 Quality Control

2301.07.03.01 Cathodic Protection Equipment Assembly

The entire assembly shall be tested using dummy loads prior to shipment to ensure that all components of the assembly are in good working order.

A representative of the supplier of the cathodic protection equipment assembly shall be on site for support and troubleshooting during testing of the installed cathodic protection system

2301.07.03.02 Cathodic Protection Rectifier

The following pre-installation inspection and testing shall be performed:

The rectifier shall be fully tested at low, high, and nominal line voltage. The AC input voltage, current, watts, and the output voltage, current, and efficiency shall be recorded at each input voltage. All rectifier circuits shall be individually tested to ensure that each circuit meets the requirements of this specification.

Each control card shall be subjected to a continuous 180 hour burn-in test. Initially, power shall be applied to each card for 72 hours at an ambient temperature of +60 °C. Power shall be removed and the card cooled for 18 hours in an environment at -30 °C. Power shall be reapplied for 18 hours at -30 °C. The card shall remain energized for 72 hours during which time the ambient temperature shall be +60 °C. The control card shall be tested immediately after removal from the final high temperature cycle. Control cards failing the test shall be replaced and the 180 hour burn-in procedure repeated.

The 180 hour burn-in test required for the entire rectifier operating unit, including control cards, shall be carried out at a testing facility that is certified to International Standards Organization (ISO) 9001.

2301.07.04.03 Cathodic Protection Remote Monitoring and Control Unit

The following pre-installation inspection and testing shall be performed:

The RMU shall be fully tested at low, high, and nominal line voltage.

Each circuit card shall be subjected to a continuous 180 hour burn-in test. Initially, power shall be applied to each card for 72 hours at an ambient temperature of +60 °C. Power shall be removed and the card cooled for 18 hours in an environment at -30 °C. Power shall be reapplied for 18 hours at -30 °C. The card shall remain energized for 72 hours during which time the ambient temperature shall be +60 °C. The card shall be tested immediately after removal from the final high temperature cycle. Circuit cards failing the test shall be replaced and the 180 hour burn-in procedure repeated on the new card.

The 180 hour burn-in test required for the entire RMU operating unit, including control cards, shall be carried out at a testing facility that is certified to ISO 9001.

2301.08**QUALITY ASSURANCE****2301.08.01****Inspection**

All work is subject to an inspection by the Owner's representative prior to shipment.

The Owner's representative shall have free access to the place of manufacture of the assembly while work on the unit is being performed for the purpose of inspecting the work and examining plant records and certificates, materials being used, process of fabrication, and to make any tests as may be considered necessary.

TABLE 1
Operator Menu Options

Option	Explanation
DATE	The DATE option shall display the present date in the form of yyyy/mm/dd (year/month/day). Provision shall be made to permit the OPERATOR to change the date.
TIME	The TIME option shall display the present time in form of hh:mm:ss (hour:minute:second). Provision shall be made to permit the OPERATOR to change the time.
DOCUMENTATION	The DOCUMENTATION option shall provide for the display at least 10 lines of site information as last set by the OPERATOR and shall permit the OPERATOR to change information.
READ	The READ option shall be designed to measure the values of the parameters of applied voltages, applied currents, and reference potentials in all the zones of the cathodic protection system and to display specific zones and all zones when requested by the user. Measurements shall be taken when the power to the rectifier is in the "on" or "off" state. Provisions shall be made for the number of zones specified with 16 channels one for each parameter per zone. The parameters required to be input shall be specified and shall be entered by the supplier. Each parameter shall be labelled and its corresponding unit displayed. The range and resolution required is as follows: Output current - 0 to 10 A with 10 mA resolution Output voltage - 0 to 30 V with 10 mV resolution Reference cell potential - ± 3 V with 1 mV resolution

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Option	Explanation
INSTANT-OFF	The INSTANT-OFF reading option shall be designed to simultaneously measure the instant-off readings of the output voltages, output current, reference cell potentials, and voltage probes in all the zones when the rectifier current is interrupted and display them for a specific zone or all zones. Provision shall be made to permit the OPERATOR to change the "off" time when the instant-off readings of the parameters are taken. The off time shall be measured in increments of 50 milliseconds, starting at 250 milliseconds. Each parameter shall be labelled appropriately and its unit displayed. The range and resolution required shall be as follows: Output current - 0 to 10 A with 10 mA resolution Output voltage - 0 to 30 V with 10 mV resolution Reference cell potential ± 3 V with 1 mV resolution The rectifier shall automatically switch on again after the "instant-off" readings are recorded.
DEPOLARIZATION	The DEPOLARIZATION option shall be designed to perform a depolarization test. Provision shall be made to allow the OPERATOR to change the test duration and sampling rate of the depolarization test. The test duration shall be entered in hours 01 to 999 with a resolution of one hour. The sampling rate shall be shown in minutes 01 to 120 with a resolution of one minute. The values to be measured and stored for the test shall be: - i the value of each parameter before turning the rectifier off. - ii the "instant-off" value using the "off" period from the INSTANT-OFF option. - iii the depolarized value of each parameter at the end of the test. The shift between the "instant-off" and the depolarized readings of all parameters shall be calculated at the end of the test. If a depolarization test is in progress, the message "Depolarization Test is in Progress" and the time remaining in the test shall be displayed. Provision shall be made to permit the user to terminate the test in progress.
MODE	The MODE option shall be designed to enable the OPERATOR to switch between the current and voltage control of the rectifier.

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Option	Explanation
CURRENT ADJUSTMENT	The CURRENT ADJUSTMENT option shall be designed to make provision for the OPERATOR to adjust the current output level for each zone when the rectifier is operated in the current control mode. The output voltage shall be adjusted until the output current meets the set level.
VOLTAGE ADJUSTMENT	Adjust output voltage when the rectifier is operated in the voltage control mode.
PASSWORD CHANGE	The PASSWORD CHANGE option shall be designed to permit the OPERATOR to change the passwords for the MONITOR and OPERATOR levels. The passwords shall consist of alphabet A to Z or numbers 0 to 9 in any combination with a maximum of 12 characters.
PARAMETER CHANGE	The PARAMETER CHANGE option shall be designed to make provisions for the OPERATOR to modify the description and unit of any one parameter in each zone. The description shall consist of up to 20 characters.
TRENDING FREQUENCY CHANGE	The TRENDING FREQUENCY CHANGE option shall be designed to permit the OPERATOR to adjust the trending frequency. The trending frequency change shall be entered in increments of one minute from 1 to 180 minutes to control the amount of data stored in the trend and its resolution.
DOWNLOAD	The DOWNLOAD option shall be designed to permit the OPERATOR to download data from the RMU to the remote computer.
REPORT	The REPORT option shall be designed to provide a summary report showing the site information for the cathodic protection system as listed in the Documentation option, the "on" and "instant-off" values of the parameters, the depolarized readings at the end of the test, and the potential shift between the "instant-off" and the depolarized readings for each zone. Provision shall be made to permit the user to view the report on screen or to print a report at the users option.
BYE	The BYE option shall be designed to display the status of the rectifier indicating whether the rectifier is in the "on" or "off" state and the status of the depolarization test, and when the end of the session is confirmed shall terminate the communication.

TABLE 2
Monitor Menu Options

Option	Explanation
DATE	Display present date.
TIME	Display present time.
DOCUMENTATION	The DOCUMENTATION option shall display the information last set by the OPERATOR.
READ	Measure and display parameters in a specific zone or in all the zones when the power to the rectifier is "on" or "off."
INSTANT-OFF READING	The rectifier shall be automatically switched on after the instant-off readings are recorded. The "off" time shall be that last set by the OPERATOR.
DEPOLARIZATION	The test duration and sampling rate displayed for the depolarization test shall be those last set by the OPERATOR.
REPORT	Produce summary report of depolarization test.
BYE	Terminate communication.

TABLE 3
Cathodic Protection Terminal Block Assembly Terminal Points

	Terminal	Terminal Colour	Lettering	Extra Low Voltage Cable Size AWG
1	Anode	Black	A1	#6
2	Anode	Black	A2	#6
3	Anode	Black	A3	#6
4	Anode	Black	A4	#6
5	Cathode	White	CS1	#6
6	Cathode	White	CS2	#6
7	Cathode	White	CS3	#6
8	Cathode	White	CS4	#6
9	Cathode	Red	CM1	#10
10	Cathode	Red	CM2	#10
11	Cathode	Red	CM3	#10
12	Cathode	Red	CM4	#10
13	Graphite Reference Cell	Green	R1	#10
14	Graphite Reference Cell	Green	R2	#10
15	Graphite Reference Cell	Green	R3	#10
16	Silver-Silver Chloride Reference Cell	Blue	R4	#10

Appendix 2301-A, November 2014
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.

