

Ontario Provincial Standards for Roads and Public Works



- Volume 8 -

MUNICIPAL-ORIENTED

MATERIAL SPECIFICATIONS



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Association

MANUAL REVISION RECORD

Municipal-Oriented

Volume 8 – 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	NOV 2008	Included in new manuals	27		
2	APR 2010	Included in new manuals	28		
3	NOV 2012	Included in new manuals	29		
4	APRIL 2013	Included in new manuals	30		
5	NOV 2013	Included in new manuals	31		
6	NOV 2014	Included in new manuals	32		
7	APR 2015	Included in new manuals	33		
8	NOV 2015	Included in new manuals	34		
9	NOV 2016	Included in new manuals	35		
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REVISION INFORMATION SHEET

ONTARIO PROVINCIAL STANDARDS FOR ROADS AND PUBLIC WORKS

VOLUME 8 MUNICIPAL-ORIENTED MATERIAL SPECIFICATIONS

MANUAL REVISION #9

NOVEMBER 2016

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for use of Ontario Provincial Standards; therefore, manual holders are cautioned about immediately discarding superseded and cancelled standards.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.
(www.publications.serviceontario.ca)

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 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 8

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

Standard Specifications Volume 8

Superseded/Cancelled (Remove)		Revised/New (Insert)		Remarks
OPSS.MUNI	Dated	OPSS.MUNI	Dated	
1101	Nov 2013	1101	Nov 2016	“MATERIAL SPECIFICATION FOR PERFORMANCE GRADED CEMENT” See Summary of Revisions.
		1102	Nov 2016	“MATERIAL SPECIFICATION FOR LIQUID ASPHALT USED IN SPRAYING, SEALING AND PRIMING APPLICATIONS” See Summary of Revisions.
		1103	Nov 2016	“MATERIAL SPECIFICATION FOR EMULSIFIED ASPHALT” See Summary of Revisions.
		1152	Nov 2016	“MATERIAL SPECIFICATION FOR SC-800 PATCHING MATERIAL” See Summary of Revisions.
		1153	Nov 2016	“MATERIAL SPECIFICATION FOR EMULSIFIED ASPHALT PATCHING MATERIAL” See Summary of Revisions.
		1202	Nov 2016	“MATERIAL SPECIFICATION FOR BEARINGS - ELASTOMERIC PLAIN AND STEEL LAMINATED” The MUNI implemented in November 2016 replaces OPSS 1202 COMMON, November 2008 with no content changes.
		1203	Nov 2016	“MATERIAL SPECIFICATION FOR BEARINGS - ROTATIONAL AND SLIDING SURFACE” The MUNI implemented in November 2016 replaces OPSS 1203 COMMON, November 2008 with no content changes.

Superseded/Cancelled (Remove)		Revised/New (Insert)		Remarks
OPSS.MUNI	Dated	OPSS.MUNI	Dated	
		1359	Nov 2016	“MATERIAL SPECIFICATION FOR UNSHRINKABLE FILL” See Summary of Revisions.
1440	Nov 2014	1440	Nov 2016	“MATERIAL SPECIFICATION FOR STEEL REINFORCEMENT FOR CONCRETE ” See Summary of Revisions.
		1504	Nov 2016	“MATERIAL SPECIFICATION FOR STEEL BEAM GUIDE RAIL” Section 1504.02 References; CSA G40.20/G40.21, CSA G164, CSA W59, and ASTM A 307 updated.
		1505	Nov 2016	“MATERIAL SPECIFICATION FOR CHANNEL COMPONENTS FOR STEEL BEAM GUIDE RAIL” Section 1505.02 References, CSA S136 and ASTM A 307 updated.
1540	Nov 2014	1540	Nov 2016	“MATERIAL SPECIFICATION FOR STANDARD HIGHWAY FENCE COMPONENTS” See Summary of Revisions.
		2422	Nov 2016	“MATERIAL SPECIFICATION FOR HEAVY CLASS STEEL AND SECTIONAL POLES, BASE MOUNTED” See Summary of Revisions.
		2434	Nov 2016	“MATERIAL SPECIFICATION FOR HIGH PRESSURE SODIUM LUMINAIRES FOR UNDERPASS LIGHTING” See Summary of Revisions.

Superseded/Cancelled (Remove)		Revised/New (Insert)		Remarks
OPSS.MUNI	Dated	OPSS.MUNI	Dated	
		2453	Nov 2016	“MATERIAL SPECIFICATION FOR SECTIONAL STEEL POLES” See Summary of Revisions.
		2471	Nov 2016	“MATERIAL SPECIFICATION FOR SECTIONAL STEEL HIGH MAST LIGHTING POLES” See Summary of Revisions.
		2474	Nov 2016	“MATERIAL SPECIFICATION FOR ANCHORAGE ASSEMBLY - HIGH MAST LIGHTING POLE” See Summary of Revisions.

SUMMARY OF REVISIONS TO OPSS.MUNI 1101

MATERIAL SPECIFICATION FOR PERFORMANCE GRADED ASPHALT CEMENT

- 1101.02, REFERENCES, Added new LS, AASHTO, and ASTM references.
- 1101.03, DEFINITIONS, Rewritten.
- 1101.04, DESIGN AND SUBMISSION REQUIREMENTS, Updated.
- 1101.05, MATERIALS, Rewritten.
- 1101.08, QUALITY ASSURANCE, Rewritten.
- Table 1, Added.
- Appendix 1101-A, Updated.
- Table A-1, Updated.
- Table A-3, Added.
- Appendix 1101-B, Added.
- Table B-1, Added.

SUMMARY OF REVISIONS TO OPSS.MUNI 1102

MATERIAL SPECIFICATION FOR LIQUID ASPHALT USED IN SPRAYING, SEALING, AND PRIMING APPLICATIONS

- Section 1102.02.01, Specification Significance and Use, Updated for MUNI use.
- Section 1102.01.02, Appendices Significance and Use, Updated for MUNI use.
- Section 1102.02, References, Updated for MUNI use.
- Appendix, Updated for MUNI use.

SUMMARY OF REVISIONS TO OPSS.MUNI 1103

MATERIAL SPECIFICATION FOR EMULSIFIED ASPHALT

- Section 1103.02.01, Specification Significance and Use, Updated for MUNI use.
- Section 1103.01.02, Appendices Significance and Use, Updated for MUNI use.
- Section 1103.02, References, Updated for MUNI use.
- Appendix, Updated for MUNI use.

SUMMARY OF REVISIONS TO OPSS 1359

MATERIAL SPECIFICATION FOR UNSHRINKABLE BACKFILL

- Title, Updated to remove "...And Hot In-Place Recycling with Integral Overlay".
- Section 1359.02.01, Specification Significance and Use, Updated for MUNI use.
- Section 1359.01.02, Appendices Significance and Use, Updated for MUNI use.
- Section 1359.02, References, Updated for MUNI use, and MTO Publications added.
- Section 1359.03, Definitions, RCM definition added.
- Section 1359.04.01, Submission Requirements, Reworded to remove the term "contractor" and make it implied.
- Section 1359.05.03, Aggregates, New paragraph added.
- Section 1359.05.03.01, Use of Recycled Concrete Material, New section added.
- Section 1359.05.03.02, Grading, New section added.
- Section 1359.06.01, Mixing Equipment, Updated.
- Section 1359.06.02, Transport Equipment, Updated.
- Table 1, Added.
- Appendix, Updated to ensure correct numbering of the referenced sections.

SUMMARY OF REVISIONS TO OPSS.MUNI 1440

MATERIAL SPECIFICATION FOR STEEL REINFORCEMENT FOR CONCRETE

It is recommended that users read the entire specification to become familiar with the differences. Below is a summary of the revisions:

- Section 1440.02, References, rewritten.
- Section 1440.03, Definitions, rewritten, added, or deleted.
- Section 1440.04, Design and Submission Requirements, rewritten.
- Section 1440.05, Materials, rewritten.
- Section 1440.07, Production, rewritten.
- Section 1440.08, Quality Assurance, rewritten.

SUMMARY OF REVISIONS TO OPSS.MUNI 1152

MATERIAL SPECIFICATION FOR SC-800 PATCHING MATERIAL

- Section 1152.02.01, Specification Significance and Use, Updated for MUNI use.
- Section 1152.01.02, Appendices Significance and Use, Updated for MUNI use.
- Section 1152.02, References, Updated for MUNI use.
- Appendix, Updated for MUNI use.

SUMMARY OF REVISIONS TO OPSS.MUNI 1153

MATERIAL SPECIFICATION FOR EMULSIFIED ASPHALT PATCHING MATERIAL

- Section 1153.02.01, Specification Significance and Use, Updated for MUNI use.
- Section 1153.01.02, Appendices Significance and Use, Updated for MUNI use.
- Section 1153.02, References, Updated for MUNI use.
- Appendix, Updated for MUNI use.

SUMMARY OF REVISIONS TO OPSS.MUNI 1540

MATERIAL SPECIFICATION FOR STANDARD HIGHWAY FENCE COMPONENTS

- Subsection 1540.05.06 Diagonal Brace Wire, new 2nd paragraph added.
- Subsection 1540.05.09 Mechanical Splicing Units and Crimp Sleeves, new 2nd paragraph added.
- Existing section 1540.09 Owner Purchase of Material, deleted.
- Table 1, fence fabric specifications revised.
- Appendix 1540, Related Ontario Provincial Standards Drawings; OPSD 971.103 added.

SUMMARY OF REVISIONS TO OPSS.MUNI 2422

MATERIAL SPECIFICATION FOR HEAVY CLASS STEEL AND SECTIONAL STEEL POLES, BASE MOUNTED

- Section 2422.02 References, CSA G40.20/G40.21, CSA S6, CSA W59, and AASHTO LTS updated.
- Subsection 2422.04.01 Design Requirements, fatigue requirements revised.
- Clause 2422.04.01.01, wind loading requirements revised.
- Clause 2422.04.02.01, last paragraph, calculations added.

SUMMARY OF REVISIONS TO OPSS.MUNI 2434

MATERIAL SPECIFICATION FOR HIGH PRESSURE SODIUM LUMINAIRES FOR UNDERPASS LIGHTING

- Section 2434.02 References; CSA C22.2 No. 89 updated; and CSA C863, ANSI C136.31, ASTM B 117, ASTM D 1654, IEC 60598, and IEC 62262 added.
- New section 2434.04 Design and Submission Requirements, added.
- Existing subsection 2434.05.01, moved to 2434.04.01.02 and revised.
- Existing clause 2434.05.01.02, moved to 2434.04.01.02 and revised.
- Existing clause 2434.05.01.03, moved to 2434.04.01.03 and revised.
- Existing subsection 2434.05.02 Marking, renumbered to 2434.05.01 and revised.
- New section 2434.07 Production, added.
- Subsection 2434.08.01 Inspection, revised.
- Existing subsection 2434.09.01 Technical Information to be Provided in Quotations, deleted.
- Existing subsection 2434.09.02 Packaging and Shipment, renumbered to 2434.09.01 and revised.
- Existing subsection 2434.09.03 Measurement and Payment, renumbered to 2434.09.02 and revised.
- Existing Table 1, deleted.
- Appendix, Designer Action/Considerations and Related Ontario Provincial Standard Drawings, added.

SUMMARY OF REVISIONS TO OPSS.MUNI 2453

MATERIAL SPECIFICATION FOR SECTIONAL STEEL POLES

- Section 2453.02 References, CSA G40.21, CSA S6, CSA W59, and ASTM A 123 updated.
- Clause 2453.04.01.01, wind loading requirements revised.
- Clause 2453.04.01.02, ice loading requirements revised.

SUMMARY OF REVISIONS TO OPSS.MUNI 2471

MATERIAL SPECIFICATION FOR SECTIONAL STEEL HIGH MAST LIGHTING POLES

- Section 2471.02 References, CSA G40.20/G40.21, CSA S6, CSA W47.1, CSA W59, CSA W178.1, CSA W178.2, ASTM A 500, CGSB 48.9712, AASHTO LTS, ISO/IEC 17025, and Federal Standards 595 updated.
- Subsection 2471.07.05 Identification Nameplates, a) to g) deleted.
- Appendix 2471, Related Ontario Provincial Standard Drawings; OPSD 2450.010, 2450.020, OPSD 2452.010, and OPSD 2452.020 deleted.

SUMMARY OF REVISIONS TO OPSS.MUNI 2474

MATERIAL SPECIFICATION FOR ANCHORAGE ASSEMBLY – HIGH MAST LIGHTING POLE

- Section 2474.02 References; CSA G40.20/G40.21, CSA G164, CSA W59, CSA W178.2, CGSB 48.9712, ASTM A 153, ASTM A 449, and ASTM A 563 updated.
- Existing section 2474.03 Definitions, deleted.
- Existing subsection 2474.04.01; renumbered to 2474.04.01.01, renamed, and revised.
- Subsection 2474.08.02 Inspection, revised.
- Appendix, Related Ontario Provincial Standard Drawings; OPSD 2456.010 deleted.



DATE	SPEC. NO. OPSS.MUNI	TITLE
DIVISION 10 - AGGREGATES		
NOV 2013	1002	Aggregates - Concrete
NOV 2013	1003	Aggregates - Hot Mix Asphalt
NOV 2013	1004	Aggregates - Miscellaneous
NOV 2013	1006	Aggregates - Surface Treatment
NOV 2013	1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
DIVISION 11 - BITUMENS		
NOV 2016	1101	Performance Graded Asphalt Cement
NOV 2016	1102	Liquid Asphalt Used In Spraying, Sealing and Priming Applications
NOV 2016	1103	Emulsified Asphalt
NOV 2006	1151	Super pave and Stone Mastic Asphalt Mixtures
NOV 2016	1152	SC-800 Patching Material
NOV 2016	1153	Emulsified Asphalt Patching Material
DIVISION 12 - SEALS, BEARINGS, WATERSTOPS		
NOV 2016	1202	Bearings – Elastomeric Plain And Steel Laminated
NOV 2016	1203	Bearings –Rotational and Sliding Surface
APR 2015	1205	Clay Seal
NOV 2014	1210	Deck Joint Assemblies
DIVISION 13 - CEMENT AND CONCRETE		
NOV 2014	1303	Admixtures for Concrete
NOV 2014	1350	Concrete - Materials and Production
NOV 2016	1359	Unshrinkable Backfill
DIVISION 14 - METAL		
NOV 2016	1440	Steel Reinforcement for Concrete
DIVISION 15 - SAFETY RELATED		
NOV 2016	1504	Steel Beam Guide Rail



DATE	SPEC. NO. OPSS.MUNI	TITLE
NOV 2016	1505	Channel Components For Steel Beam Guide Rail
NOV 2016	1540	Standard Highway Fence Components
DIVISION 16 - WOOD AND PLASTICS		
NOV 2014	1601	Wood, Preservative Treatment, and Shop Fabrication
DIVISION 17 - COATINGS		
NOV 2014	1704	Paint Coating Systems for Structural Steel
DIVISION 18 - PIPES AND ASSOCIATED DRAINAGE ITEMS		
NOV 2014	1820	Circular and Elliptical Concrete Pipe
NOV 2015	1841	Notice to Users of OPSS.MUNI 1841 (Non-Pressure Polyvinyl Chloride Pipe Products)
DIVISION 19 - ENVIRONMENTAL		
CURRENTLY NO SPECIFICATIONS		
DIVISION 20 - SIGNS AND SIGN SUPPORT		
CURRENTLY NO SPECIFICATIONS		
DIVISION 21 - CLOTHING, CLOTH, AND THE LIKE		
CURRENTLY NO SPECIFICATIONS		
DIVISION 22 - UNASSIGNED		
CURRENTLY NO SPECIFICATIONS		
DIVISION 23 - MISCELLANEOUS		
CURRENTLY NO SPECIFICATIONS		
DIVISION 24 - ELECTRICAL		
NOV 2016	2422	Heavy Class Steel and Sectional Poles, Base Mounted
NOV 2016	2434	High Pressure Sodium Luminaires For Underpass Lighting
NOV 2016	2453	Sectional Steel Poles
NOV 2016	2471	Sectional Steel High Mast Lighting Poles
NOV 2016	2474	Anchorage Assembly – High Mast Lighting Pole



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DATE	SPEC. NO. OPSS.MUNI	TITLE

DIVISION 25 - CHEMICALS

CURRENTLY NO SPECIFICATIONS



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

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

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

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

Ontario Provincial Standard Specifications, Material

OPSS 1001 Aggregates - General

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 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-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	Insoluble Residue of Carbonate Aggregates
LS-614	Freezing and Thawing of Coarse Aggregate
LS-616	Petrographic Examination 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-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

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 at 38 °C) *
 - A23.2-23A Test Method for the Resistance of Fine Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus *
 - A23.2-24A Test Method 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 Degree of Alkali-Reactivity of Aggregates and to Identify 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/Test Methods and Standard Practices for Concrete]

ASTM International

- C 87/C 87M-10 Standard Test Method for 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) Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing

1002.03 DEFINITIONS

For the purposes 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.

CCIL means the Canadian Council of Independent Laboratories.

Duplicate Samples means two samples taken at the same time and location – one to be used for Quality Assurance and the other for Referee Testing.

Manufactured Sand means sand produced by the crushing and further processing, i.e., washing, grading, classifying of quarried rock, boulders, cobbles, or gravel from which the natural fine aggregate has been removed. Natural sand may be added to optimize properties.

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.

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.

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

Self-Consolidating Concrete means a highly flowable and 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).

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

1002.05 MATERIALS

1002.05.01 General

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

Aggregates may be sands, gravel, quarried rock, or air-cooled blast furnace slag provided the source is of such a nature and extent as to ensure acceptable processed aggregates of a consistent gradation and quality.

Steel slag shall not be used in hydraulic cement concrete.

Air-cooled blast furnace slag shall not be used as aggregate in concrete pavements.

When a change in the character of the aggregates occurs or when the performance of the aggregates is found to be unsatisfactory, use of those aggregates shall be discontinued until the Contractor can prove to the satisfaction of the Contract Administrator that the source remains acceptable or can be made acceptable.

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, or demonstrated past field performance in hydraulic cement concrete. In the case of acceptance based on field performance, the structure shall have been in the same environment and application as 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.

Demonstration of field performance shall be done according to CSA 23.2-27A - Attachment 2, 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 pavement 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 Gradation Requirements

Except as noted below, fine aggregates shall meet the gradation requirements shown in Table 1.

When mix design changes or other criteria require the use of a gradation other than as specified in Table 1, the required gradation shall be submitted to the Contract Administrator for review.

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 Gradation Requirements

1002.05.03.01.01 General

Coarse aggregate gradation requirements shown in Table 3 and Table 4 represent the allowable limits.

1002.05.03.01.02 Concrete Structures, Sidewalks, Curb and Gutter

The nominal maximum aggregate size shall be 19.0 mm, or as specified in the Contract Documents. Gradation of the coarse aggregate shall be within the limits shown in Table 3. It is acceptable to stockpile aggregates in individual size fractions and blend them in the mix so as to meet the gradation limits.

1002.05.03.01.03 Concrete Pavement and Concrete Base

The gradation of the coarse aggregates used in concrete pavement and concrete base shall meet the requirements for 37.5 mm and 19 mm aggregate shown in Table 4. Aggregates shall be stockpiled as individual size fractions and blended in the mix so as to meet the combined gradation 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, the 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 mm ± 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 Ministry of Transportation's 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 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 in the concrete freezing and thawing test according to ASTM C 666, Procedure A.

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

- a) The concrete for the test shall be proportioned to the combined gradation shown in Table 4, with 325 kg/m³ of Type GU hydraulic cement, a plastic air content of 6.5% ± 1.5%, and a slump of 50 mm ± 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 hours ± 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. The bench within the quarry from which the aggregate is selected for testing shall be identified by the Contractor. Approval of aggregate for concrete pavement 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, 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's 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

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.

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 gradations 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 immediately removed from the stockpile.

Aggregates shall be retained in stockpiles for at least 24 hours before use. Suitable stockpile locations are at the construction site, the site of batching of the concrete, the concrete source, or any other location acceptable to the Contract Administrator.

1002.08 QUALITY ASSURANCE

1002.08.01 General

QA testing may be carried out by the Owner for the purposes of ensuring that the aggregates used in the work are according to the requirements of this specification. Individual test results may 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 indicated in the Contract Documents.

1002.08.02 Laboratory Requirements

The Contract Administrator shall designate the QA laboratories.

An acceptable laboratory conducting tests for physical properties shall be one that holds a current Type D certificate from CCIL for the applicable test methods and also participates in the annual MTO Proficiency Sample Testing Program for the specific tests except for LS-616 and LS-620.

An acceptable laboratory conducting tests for gradation according to LS-602 and materials finer than 75 µm by washing of the aggregates according to LS-601 shall be one that holds a current Type C certificate from CCIL.

Testing shall be conducted by qualified laboratory staff that holds a current certificate from CCIL in aggregate testing.

Equivalent alternate laboratory and technician certifications or laboratory proficiency testing programs may be used to demonstrate similar requirements, provided that they are acceptable to the Contract Administrator.

1002.08.03 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, then the Contractor shall be charged for the cost of the testing using LS-614, administrative charges, and additional sampling, if required.

1002.08.04 Special Gradation 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 gradation 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.

1002.08.05 Sampling

Sampling shall be according to CSA A23.2-1A and LS-625.

Duplicate samples shall be taken and sealed by the Contractor in the presence of the Contract Administrator from stockpiles at the concrete plant, or in the absence of a stockpile at the plant, from stockpiles at the aggregate source that contain a minimum quantity of 500 tonnes of each aggregate for each concrete mix unless otherwise directed by the Contract Administrator.

The mass of each sample shall meet the requirements shown in Table 6. When more than 30 kg is required, the total sample shall be recombined by the QA laboratory prior to testing. In the event that the Contractor is unavailable to take the sample, no further materials shall be placed in the work until the duplicate samples have been taken.

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 on both the inside and outside of the sample container.

1002.08.06 Testing and Retention of Samples

When the Contract Administrator elects to carry out QA testing, one of the duplicate samples shall be randomly selected for testing by the QA laboratory and the remaining sealed sample shall be retained by the QA laboratory for possible referee testing.

1002.08.07 Acceptance

QA test results shall be used for acceptance purposes, except when referee testing has been carried out.

When QA test results show that the aggregates meet the requirements of this specification, the aggregates shall be accepted.

When QA test results show that the aggregates do not meet the requirements of this specification, the Contract Administrator shall notify the Contractor that the material represented by the test results shall not be accepted. This notification shall take place in writing within 3 Business Days of receipt of the non-conforming data. The Contractor has the option of either removing the aggregates from the Work or invoking referee testing. The Contractor may request a reduced price in lieu of removal for aggregates that fail to meet the requirements of this specification. Irrespective of the negotiation of a reduced price payment, the warranty provisions of the Contract Documents shall apply.

1002.08.08 Referee Testing

When QA test results do not meet the requirements of this specification, the Contractor has the option of invoking referee testing of the test result that fails to meet the requirements. The Contractor shall notify the Contract Administrator of the selected option in writing within 2 Business Days following written notification of unacceptable material.

The Contract Administrator shall select a referee testing laboratory acceptable to the Contractor within 3 Business Days following the Contractor's notification to invoke referee testing. Referee test samples shall be delivered to the referee testing laboratory from the QA laboratory by the Contract Administrator. The sealed sample shall be opened in the presence of the Contractor and the Contract Administrator.

Referee testing shall be carried out in the presence of the Contract Administrator. When applicable, the referee laboratory shall also test a control aggregate sample for each test method required. The Contractor may observe the testing at no cost to the Owner.

The Contractor and Owner may send a maximum of two representatives each to observe the referee testing. The Contract Administrator shall notify the Owner and Contractor a minimum of 3 Business Days in advance of the date of referee testing. Provided that such notice was given, referee testing shall be carried out regardless of the absence of one or more observers.

Observers shall follow the referee laboratory protocols for access to the premises and testing equipment and shall not unnecessarily impede the progress of the testing. Observers shall be permitted to validate sample identification and view sample condition. Subject to safety requirements, test method and equipment limitations, they shall also be permitted to observe test procedures, take notes, view equipment readings, and review completed work sheets while in attendance.

Comments on the non-conformity of the test methods shall be made and corrected at the time of testing.

Referee test results shall be binding on both the Owner and the Contractor.

When a referee test result shows that the aggregates do not meet the requirements of this specification, the aggregates represented by the test result, including aggregates in existing stockpiles or in the Work, shall not be accepted. The Contractor shall remove the aggregates from the Work at no cost to the Owner. The Contractor may request a reduced price in lieu of removal of the aggregates that fail to meet the requirements of this specification. Irrespective of the negotiation of a reduced price payment, the warranty provisions of the Contract Documents shall apply.

When referee test results show that the aggregates meet the requirements of this specification, the aggregates represented by the sample shall be accepted.

The Owner shall be responsible for the cost of referee testing, provided that the referee test results show that the aggregates meet the applicable specifications. Otherwise, the Contractor shall be responsible for the cost.

TABLE 1
Gradation Requirements (LS-602) for Fine Aggregate (Note 1)

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 aggregate 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 Aggregate

Laboratory Test Name	MTO or CSA Lab Test Number	Acceptance Limit
Organic Impurities, Maximum organic plate number (Note 1)	LS-610	3
Micro-Deval Abrasion, % maximum loss	LS-619 or CSA A23.2-23A	20
Accelerated Mortar Bar Expansion, % maximum at 14 Days (Notes 2 and 3)	LS-620 or CSA A23.2-25A	0.150
Concrete Prism Expansion, % maximum at 1 year (Notes 2 and 4)	CSA A23.2-14A	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 C87 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 Ministry of Transportation's 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 that is intended to be used.		

TABLE 3
Gradation Requirements (LS-602) for Coarse Aggregate
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
Gradation Requirements (LS-602) for Coarse Aggregate
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 Requirements for Coarse Aggregates for Concrete

MTO or CSA Laboratory Test	MTO or CSA Laboratory Test Number	Acceptance Requirements (Note 1)	
		Pavement	Structures, Sidewalk, Curb and Gutter, and Concrete Base
Wash Pass 75 µm Sieve, Guideline A, % maximum - for gravel - for crushed rock	LS-601 (Guideline A)	1.0 2.0	1.0 2.0
Absorption, % maximum	LS-604 or CSA A23.2-12A	2.0	2.0 (Note 2)
Flat and Elongated Particles, % maximum	LS-608	20	20
Petrographic Number, Concrete, maximum	LS-609	125	140
Unconfined Freeze-Thaw, % maximum loss, (Note 3)	LS-614 or CSA A23.2-24A	6	6
Micro-Deval Abrasion, % maximum loss	LS-618 or CSA A23.2-29A	14	17 (Note 2)
Accelerated Mortar Bar Expansion, % maximum at 14 Days (Notes 2 and 5)	LS-620 or CSA A23.2-25A	0.150 (Note 6)	0.150 (Note 6)
Concrete Prism Expansion, % maximum at one year (Notes 4 and 7)	CSA A23.2-14A	0.040	0.040
Potential Alkali-Carbonate Reactivity of Quarried Carbonate Rock (Note 8)	CSA A23.2-26A	Chemical Composition Must Plot in the Non-Expansive Field of Fig. 1 of Test Method	
Alternative Requirement to Unconfined Freeze-Thaw Loss (LS-614)			
Magnesium Sulphate Soundness, 5 Cycles, % maximum loss (Note 3)	LS-606	12	12
Notes:			
1. Where 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 meets the alternative requirements for LS-606, magnesium sulphate soundness. 4. The need for data to demonstrate compliance with this requirement will be waived by the Contract Administrator if the source is on the current Ministry of Transportation's 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 on as coarse aggregate on the ASL. 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 1 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 of Field Samples (Note 1) kg
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 container shall be used.	

Appendix 1002-A, November 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

The designer should determine if the following is required and, if so, specify it in the Contract Documents:

- The nominal maximum size of aggregate if other than 19.0 mm is required. (1002.05.03.01.02)
- If the quality assurance sampling and testing frequencies provided in Appendix 1002-B are to be used, Appendix 1002-B needs to be invoked by reference in the Contract Documents.
- If the payment reduction in lieu of aggregate removal provided in Appendix 1002-C is to be used, Appendix 1002-C needs to be invoked by reference in the Contract Documents.
- If the test data forms in Appendices 1002-D and 1002-E are to be used for submission purposes, Appendices 1002-D and 1002-E need to be invoked by reference in the Contract Documents.

The designer should be aware that quality assurance (QA) testing for purposes of ensuring material used in the Work meets the requirements of OPSS 1002 is not mandatory, unless specifically included in the Contract Documents. The designer should determine the need for QA testing based on the size and complexity of the work and specify the required frequency of QA sampling and testing (1002.08.01). Appendix B provides recommended QA sampling and testing frequencies.

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

Related Ontario Provincial Standard Drawings

No information provided here.

Appendix 1002-B, November 2013**FOR USE IN MUNICIPAL CONTRACTS, WHEN REFERENCED IN THE CONTRACT DOCUMENTS**

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

Supplementary Requirements for Quality Assurance Sampling and Testing Frequencies

OPSS.MUNI 1002 Aggregates - Concrete, is amended as follows:

1002.08 QUALITY ASSURANCE**1002.08.01 General**

The first paragraph of subsection 1002.08.01 is deleted in its entirety and replaced with the following:

QA sampling and testing shall be carried out by the Owner for the purposes of ensuring that the aggregates used in the work are according to the requirements of the Contract Documents. QA sampling and testing shall be carried out at the frequency specified in Table B-1. Individual test results may be forwarded to the Contractor as they become available.

Table B-1 is added.

TABLE B-1
Sampling and Testing Frequency for Physical Property and Gradation Requirements

Concrete Production Per Mix Design, m³	Minimum Frequency Each Aggregate Type per Each Concrete Type
$\leq 5,000$	One sample.
$> 5,000$ (Note 1)	One sample per 5,000 m ³ .
Note: 1. When the concrete production per mix design is: a) Less than one-half the quantity required for a sample, then that quantity shall be added to the quantity representing the previous sample. b) Greater than or equal to one-half the quantity required for a sample, then that quantity shall require its own sample.	

Appendix 1002-C, November 2013

FOR USE IN MUNICIPAL CONTRACTS, WHEN REFERENCED IN THE CONTRACT DOCUMENTS

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

Supplementary Requirements for a Price Reduction In Lieu of Removal of Aggregates

OPSS.MUNI 1002 Aggregates - Concrete, is amended as follows:

When a tested sample of aggregates shows that the aggregates do not meet the requirements of this specification, the aggregates represented by the test result, including material in existing stockpiles or in the Work, shall not be accepted. The Contractor may request a reduced price in lieu of removal provided the applicable test results:

- a) Do not exceed the requirement for LS-614, or LS-606 if it has replaced LS-614, by more than 25% of the specified value.
- b) Do not exceed the 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.

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

Appendix 1002-D, November 2013**FOR USE IN MUNICIPAL CONTRACTS, WHEN REFERENCED IN THE CONTRACT DOCUMENTS**

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

**OPSS 1002- CONCRETE AGGREGATE TEST DATA
FINE AGGREGATE**

Contract No.:	Contractor:	Contract Location:	
Testing Laboratory:		Telephone No.:	Fax No.:
Sampled By (Print Name):		Date Sampled (YY/MM/DD):	

Fineness Modulus:	Aggregate Inventory Number(AIN):		Gradation (Attach grading or control chart):	
Source Name/Location:	Sieve Size:	Gradation Requirement: 0-3% natural sand 0-6% manufactured sand	Sample Results:	Meets Requirements (Y/N):
	% pass 75 µm			

Laboratory Test and Number	Requirement	Concrete ASL (√)	Test Results		
			Reference Material	Sample	Meets Requirements (Y/N)
Organic Impurities, Maximum organic plate number, LS-610	3 (Notes 1 and Note 5)				
Micro-Deval Abrasion, % maximum loss, LS-619 or CSA A23.2-23A	20				
Accelerated Mortar Bar Expansion, % maximum at 14 Days, LS-620 or CSA A23.2-25A, (Note 2)	0.150 (Note 3)				
Concrete Prism Expansion, % maximum at 1 year, CSA A23.2-14A, (Note 2)	0.040 (Note 4)				
Structural Strength, minimum at 7 Days, ASTM C 87, (Note 5)	≥ 95% strength of mortar washed in NaOH				

I hereby certify that testing has been carried out by a properly qualified/certified test technician:

Issued by: _____
PRINT NAME TESTING LABORATORY REPRESENTATIVE SIGNATURE DATE

Received by: _____
PRINT NAME CONTRACT ADMINISTRATOR REPRESENTATIVE SIGNATURE DATE

Copies to: ☐ Contract Administrator ☐ Contractor

Appendix 1002-D

Note:

1. A fine aggregate producing a darker colour than standard colour No. 3 shall be considered to have failed the requirement for LS-610.
2. Compliance with this requirement is waived, 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 23.2-14A are met.
4. An aggregate only has to meet this requirement if it fails the requirements of CSA A23.3-25A. Test data shall have been obtained within the past 18 months from an aggregate sample taken from the same source and processed in the same manner as the material intended for use.
5. This test is only required if the aggregate has failed LS-610. An aggregate that has failed the requirements for LS-610 may be accepted if comparative mortar specimens prepared according to ASTM C 87 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 the 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%.

Appendix 1002-E, November 2013
FOR USE IN MUNICIPAL CONTRACTS, WHEN REFERENCED IN THE CONTRACT DOCUMENTS

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

**OPSS 1002- CONCRETE AGGREGATE TEST DATA
COARSE AGGREGATE**

Contract No.:	Contractor:	Contract Location:	
Testing Laboratory:		Telephone No.:	Fax No.:
Sampled By (Print Name):		Date Sampled (YY/MM/DD):	
Nominal Maximum Size (mm):	Aggregate Inventory Number(AIN):	Gradation (Attach grading or control chart):	
Source Name/Location:		Meets Requirements (Y/N):	

Laboratory Test and Number	Requirement (Note 1)		Concrete ASL (✓)	Test Results		
	Pavement	Structures, Sidewalks, Curb and Gutter, Concrete Base		Reference Material	Sample	Meets Requirements (Y/N)
Salt Scaling, maximum loss @ 50 cycles, LS-412 (Notes 2, 3, and 4))	0.80 kg/m ²					
Wash Pass 75 µm Sieve , Guideline A, % maximum, LS-601	1.0 (gravel) 2.0 (crushed rock)					
Absorption, % maximum LS-604 or CSA A23.3-12A	2.0 (Note 5)					
Flat and Elongated Particles, % maximum, LS-608	20					
Petrographic Number, Concrete, Maximum, LS-609	125 (Attach PN report)	140 (Attach PN report)				
Unconfined Freeze-Thaw, % maximum loss, LS-614 or CSA A23.2-24A, (Note 6)	6					
Micro-Deval Abrasion, % maximum loss, LS 618 or CSA A23.2-29A	14	17 (Note 7)				
Accelerated Mortar Bar Expansion, % maximum at 14 Days, LS-620 or CSA A23.2-25A, (Notes 3 and 8)	0.150 (Notes 9 and 10)					
Concrete Prism Expansion, % maximum at 1 year, CSA A23.2-14A, (Notes 3, 8, and 11)	0.040					
Potential Alkali-Carbonate Reactivity, Carbonate Rock, CSA A23.2-26A, (Note 12)	Chemical composition must plot in the non-expansive field of Fig. 1			Attach data	Attach graph	
Concrete Freeze-Thaw, ASTM C 666, Procedure A (Notes 3 and 13)	Average Δ length ≤ ± 0.350% Average FTF ≥90% of FTF @ 14 Days					
Alternative Requirement to Unconfined Freeze-Thaw (LS-614 or CSA A 23.2-12A)						
Magnesium Sulphate Soundness, % maximum loss, LS-606, (Note 6)	12					

Appendix 1002-E

I hereby certify that testing has been carried out by a properly qualified/certified test technician:

Issued by:

PRINT NAME	TESTING LABORATORY REPRESENTATIVE SIGNATURE	DATE

Received by:

PRINT NAME	CONTRACT ADMINISTRATOR REPRESENTATIVE SIGNATURE	DATE

Copies to: ☐ Contract Administrator ☐ Contractor

Notes:

1. Where a concrete surface is exposed to vehicular traffic, the physical requirements for "Pavement" shall apply to the aggregate used.
2. This test only needs to be done at the time of first use of a source for concrete aggregate.
3. Compliance with this requirement is waived if the aggregate source is on the MTO regional Aggregate Source List for Structural Concrete - Fine and Coarse Aggregates, or the MTO regional Aggregate Source List for Concrete Base/Pavement Coarse Aggregates.
4. Coarse aggregate composed of more than 80% siliceous aggregates, as determined by petrographic examination (LS-609), shall be tested, 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. The concrete shall be proportioned with 355 kg/m³ of Type GU hydraulic cement, shall have a plastic air content of 7.0 ± 1.5% and a slump of 80 ± 20 mm.
5. For air-cooled blast-furnace slag aggregate, the allowable maximum value for absorption shall conform to the Owner's requirements for slag aggregate.
6. Compliance with the unconfined freeze-thaw test, LS-614 or CSA A23.2-24A is waived if the aggregate meets the alternative requirement for magnesium sulphate soundness loss, LS-606.
7. For air-cooled blast-furnace slag aggregate, the allowable maximum value for Micro-Deval shall be 21% for structures.
8. If the aggregate is potentially expansive due to alkali-carbonate reaction as determined by CSA A23.2-26A, the aggregate must meet the requirement of CSA A23.2-14A, even though it may be shown as a coarse aggregate on the MTO regional Aggregate Sources List for Structural Concrete Fine and Coarse Aggregates or the Aggregate Sources List for Concrete Base/Pavement Coarse Aggregates.
9. 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.
10. An aggregate that fails this requirement may be accepted provided the requirement for CSA A23.2- 14A is met.
11. An aggregate needs to meet this requirement only if it fails the requirements of either CSA A23.2-25A or CSA A23.2-26A. If this test is conducted for an aggregate deemed potentially expansive according to CSA A23.2-26A, then a 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. 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
12. This requirement only applies to aggregates 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.
13. The following apply to this test:
 - a) Coarse aggregates from limestone and dolostone bedrock quarries for concrete pavement and concrete base shall be tested, except for aggregate produced from the Oxford, Gull River or Bobcaygeon Formations.
 - b) The fine aggregate shall be either the fine aggregate intended for use or a fine aggregate from the same geographic area as the coarse aggregate.
 - c) The bench within the quarry from which the aggregate is selected for testing shall be defined. Acceptance shall only apply to the bench of the quarry from which the selected aggregate was taken. Aggregate processed from other benches within the same quarry will require further testing prior to use.
 - d) The concrete for the test shall be proportioned to the combined grading shown in Table 4, of OPSS 1002, with 325 kg/m³ of Type GU hydraulic cement, a plastic air content of 6.5 ± 1.5%, and a slump of 50 ± 20 mm.
 - e) Procedure A shall be modified so that each freeze cycle takes 10.5 ± 1 hours; and the test shall be conducted for 350 cycles.



MATERIAL SPECIFICATION FOR AGGREGATES - HOT MIX ASPHALT

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

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

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

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

Ontario Provincial Standard Specifications, Material

OPSS 1001 Aggregates - General

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:

LS-312	Fractionation of Unextracted Reclaimed Asphalt Pavement (RAP) and Hot Mix Aggregate for Testing or Incorporation in Other Test Samples
LS-601	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-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	Insoluble Residue of Carbonate Aggregates
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-625	Guidelines for Sampling of Aggregate Materials
LS-629	Uncompacted Void Content of Fine Aggregate
LS-703/704	Liquid Limit, Plastic Limit and Plasticity Index of Soils

ASTM International

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

American Association of State Highway and Transportation Officials (AASHTO)

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

1003.03 DEFINITIONS

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

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.

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

CCIL means the Canadian Council of Independent Laboratories.

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

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

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.

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

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 a material's resistance to weathering or degradation or both.

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

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

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

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

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

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

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

1003.05 MATERIALS

1003.05.01 General

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

Aggregates may be sands, gravels, quarried rock, or the aggregate portion of RST, or the aggregate portion of RAP, provided the source is of such a nature and extent as to ensure acceptable processed aggregates of a consistent gradation and quality.

Steel slag, air-cooled blast furnace slag, nickel slag, and copper slag are not acceptable for use in HMA.

RAP containing steel slag is not permitted.

RST containing asbestos is not permitted. Post consumer shingle material is not permitted.

If one or more of the aggregates to be used in the mix requires an anti-stripping agent, then all aggregates shall be treated with the same anti-stripping agent.

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 requirements of this specification.

When a change in the character of the aggregate occurs or when the performance of the aggregate is found to be unsatisfactory, use of those aggregates shall be discontinued until the Contractor can prove to the satisfaction of the Contract Administrator that the source remains acceptable or can be made acceptable.

For HL1,

- a) Coarse aggregate shall be produced by crushing bedrock or gravel.
- b) Coarse aggregate shall be supplied from sources named on the MTO pre-qualified products list.

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

For Superpave 12.5 FC2 and DFC,

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

For HDBC,

- a) Coarse aggregates shall be produced by crushing either bedrock material, gravel, cobble, or boulder material retained on the 50.0 mm sieve.
- b) Fine aggregates shall be produced by crushing either bedrock material, gravel, cobble, or boulder material retained on the 9.5 mm sieve.
- c) If necessary, coarse and fine aggregates shall be processed to meet the HMA requirements specified in the Contract Documents, including washing and classification.

For SMA,

- a) Coarse and fine aggregates shall be produced from crushed bedrock material supplied from sources shown in Table 1.
- b) Coarse and fine aggregates shall be obtained from the same source.
- c) Aggregate derived from RST may be from a source different than the rest of the aggregates for the SMA.

Irrespective of compliance or non-compliance with the physical requirements, aggregates may be accepted or rejected on the basis of documented field performance. The pavement with which satisfactory field performance is demonstrated shall have been in a similar environment and application to that in which the aggregate is proposed for use and shall be at least 10 years old. A petrographic study shall be conducted to demonstrate that the aggregate in the original pavement is the same as that under consideration. Field performance shall be determined by the Owner.

Blending of aggregates shall be permitted at the hot mix plant.

1003.05.02 Fine Aggregate

1003.05.02.01 Gradation Requirements

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

1003.05.02.02 Physical Property Requirements

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

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

1003.05.02.03 Consensus Property Requirements

For Superpave HMA, the fine aggregate portion of the combined HMA aggregate, including aggregate derived from RAP or RST or both which has been fractionated and proportioned according to LS-312 and the mix design, shall meet the consensus property requirements of AASHTO T 176 and LS-629 shown in Table 3 for the traffic category specified in the Contract Documents. However, for AASHTO T 176 only, the combine fine aggregate portion shall exclude any fine aggregate that is derived from RAP or RST or both.

1003.05.03 Coarse Aggregate

1003.05.03.01 Gradation Requirements

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

1003.05.03.02 Physical Property Requirements

Coarse Aggregates for use in HMA binder and leveling courses shall meet the physical property requirements shown in Table 4.

Coarse aggregates for use in HMA surface courses shall meet the physical property requirements shown in Table 5.

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

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

When the Contractor elects to sample blended coarse aggregates from the cold feed to show conformance with this specification, the blended coarse aggregate shall also meet the above requirements.

1003.05.03.03 Consensus Property Requirements

For Superpave HMA, the coarse aggregate portion of the combined HMA aggregate, including any coarse aggregate derived from RAP, which has been fractionated and proportioned according to LS-312 and the mix design, shall meet the consensus property requirements shown in Table 3 for the traffic category specified in the Contract Documents.

1003.05.04 Filler

Filler shall consist of mineral filler, hydrated lime, Portland cement, or other material as designated 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 Tables 4 and 5 for Superpave mixes. Mineral filler shall be sufficiently dry so as to flow freely, free from agglomerations, non-plastic according to LS-703/704, and meet the following gradation requirements according to LS-601 and LS-602:

- a) 100% passing 600 µm sieve.
- b) Not less than 70% passing 75 µm sieve.
- c) Not more than 20% passing 20 µm sieve, SMA only.

1003.07 PRODUCTION

1003.07.01 Aggregate Processing, Handling, and Stockpiling

Processed aggregates shall be separated into fine and coarse aggregates and stockpiled separately.

Aggregates separated during processing, aggregate secured from different sources, and aggregates from the same source but of different gradations shall be placed in individual stockpiles. 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 that have become mixed with each other shall not be used and shall be immediately removed from the stockpile.

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

QA testing may be carried out by the Owner for the purposes of ensuring that the aggregates used in the work are according to the requirements of this specification. Individual test results may 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 materials, test data from each source and product shall be managed independently.

The Contractor shall elect to either:

- a) Have QA sampling and testing done on a stockpile basis, when each aggregate stockpile shall meet the physical requirements; or
- b) Have QA sampling and testing of the material after the cold feed bins, but before the material is mixed with liquid asphalt cement, when the combined fine aggregates and the combined coarse aggregates shall meet the physical requirements.

If the Contractor elects to use process b) above, and one or more components do not by themselves meet this specification, the Contractor shall notify the Contract Administrator and provide a production process satisfactory to the Contract Administrator.

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

The Owner shall be responsible for all costs associated with testing for QA purposes, unless otherwise specified in the Contract Documents.

1003.08.02 Laboratory Requirements

The Contract Administrator shall designate the QA laboratories.

An acceptable laboratory conducting tests for physical and consensus properties shall be one that holds a current Type D certificate from CCIL for the applicable test methods and also participates in the annual MTO Proficiency Sample Testing Program for the specific tests, when applicable.

An acceptable laboratory for testing gradation according to LS-602, percent crushed particles according to LS-607, and materials finer than 75 μm by washing of the aggregates according to LS-601 shall be one that holds a current Type C certificate from CCIL.

Testing shall be conducted by qualified laboratory staff that holds a current certificate from CCIL in aggregate testing.

Equal alternate laboratory and technician certifications or laboratory proficiency testing programs may be used to demonstrate similar requirements, provided that they are acceptable to the Contract Administrator.

1003.08.03 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 be charged for the cost of the testing using LS-614, administrative charges, and additional sampling, if required.

1003.08.04 Blending Method

The Contractor may select to have QA acceptance of the total combined aggregate conducted according to the blending method. The Contractor shall provide appropriate facilities and equipment for QA sampling otherwise this option shall not be available. To select this method, the Contractor shall notify the Contract Administrator in writing along with a description of the sampling facilities and equipment, prior to paving.

1003.08.05 Sampling

Sampling shall be conducted by the Contractor according to LS-625.

Duplicate samples shall be taken and sealed by the Contractor in the presence of the Contract Administrator from stockpiles at the hot mix plant or from after the cold feed at the plant, but before the addition of liquid asphalt cement. The place of sampling shall be determined by the Contractor.

Duplicate samples taken from stockpiles at the hot mix plant shall be from stockpiles that contain a minimum quantity of 500 tonnes of each aggregate for each HMA.

Duplicate samples taken from after the cold feed during production of the HMA shall be taken at a time determined by the Contract Administrator.

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

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

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.

1003.08.06 Testing and Retention of Samples

When the Contract Administrator elects to carry out QA testing, one of the duplicate samples shall be randomly selected for testing by the QA laboratory and the remaining sealed sample shall be retained by the QA laboratory for possible referee testing.

Samples taken from the stockpiles shall be treated as individual samples.

Samples taken from after the cold feed shall be separated on the 4.75 mm sieve and the fine aggregate portion and the coarse aggregate portion tested as the fine or the coarse aggregate of the mix, even though a combination of aggregates may have been used in forming the fine or coarse aggregate.

1003.08.07 Acceptance

QA test results shall be used for acceptance purposes, except when referee testing has been carried out.

When QA test results show that the aggregates meet the requirements of this specification, the aggregates shall be accepted.

When QA test results show that the aggregates do not meet the requirements of this specification, the Contract Administrator shall notify the Contractor that the aggregates represented by the test results shall not be accepted. This notification shall take place in writing within 3 Business Days of receipt of the non-conforming data. The Contractor has the option of either removing the material from the work or invoking referee testing. The Contractor may request a reduced price in lieu of removal for aggregates that fail to meet the requirements of this specification. Irrespective of a reduced price payment, the warranty provisions of the Contract Documents shall apply.

1003.08.08**Referee Testing**

When QA test results do not meet the requirements of this specification, the Contractor has the option of invoking referee testing of the test result that fails to meet the requirements. The Contractor shall notify the Contract Administrator of the selected option in writing within 2 Business Days following written notification of unacceptable material.

The Contract Administrator shall select a referee testing laboratory acceptable to the Contractor, within 3 Business Days following the Contractor's notification to invoke referee testing. Referee test samples shall be delivered to the referee testing laboratory from the QA laboratory by the Contract Administrator. The sealed sample shall be opened in the presence of the Contractor and the Contract Administrator.

Referee testing shall be carried out in the presence of the Contract Administrator. When applicable, the referee testing laboratory shall also test a control aggregate sample for each test method required. The Contractor may observe the testing at no cost to the Owner.

The Contractor and Owner may send a maximum of two representatives each to observe the referee testing. The Contract Administrator shall notify the Owner and Contractor a minimum of 3 Business Days in advance of the date of referee testing. Provided that such notice was given, referee testing shall be carried out regardless of the absence of one or more observers.

Observers shall follow the referee laboratory protocols for access to the premises and testing equipment and shall not unnecessarily impede the progress of the testing. Observers shall be permitted to validate sample identification and view sample condition. Subject to safety requirements, test method and equipment limitations, they shall also be permitted to observe test procedures, take notes, view equipment readings, and review completed work sheets while in attendance.

Comments on the non-conformity of the test methods shall be made and corrected at the time of testing.

Referee test results shall be binding on both the Owner and the Contractor.

When a referee test result shows that the aggregates do not meet the requirements of this specification, the material represented by the test result, including materials in existing stockpiles or in the Work, shall not be accepted. The Contractor shall remove the material from the Work at no cost to the Owner. The Contractor may request a reduced price in lieu of removal of the aggregates that fail to meet the requirements of this specification. Irrespective of the negotiation of a reduced price payment, the warranty provisions of the Contract Documents shall apply.

When a referee test result shows that the aggregates meet the requirements of this specification, the aggregates represented by the sample shall be accepted.

The Owner shall be responsible for the cost of referee testing, provided that the referee test results show that the aggregates meet the applicable specifications. Otherwise, the Contractor shall be responsible for the cost.

TABLE 1
SMA – Coarse and Fine Aggregate Sources

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

TABLE 2
Physical Property Requirements for Fine Aggregates

Laboratory Test	MTO Test No.	Surface Course				Binder Course
		SMA 9.5, SMA 12.5, DFC, and Superpave 12.5 FC2	HL 1, HL 3, HL 3HS, HL 3F, and Superpave 4.75 and 12.5 FC1	HL 2, HL 4	Superpave 9.5 and 12.5	HL 2, HL 4, HL 4F, HL 8, HDBC, MDBC, SMA 19.0, and Superpave 4.75, 19.0, and 25.0
Acid Insoluble Residue, minimum % (material retained on 2.36 mm sieve only)	LS-613	--	--	--	60 (Note 1)	--
Micro-Deval Abrasion, % maximum loss, (Note 2)	LS-619	15	20	25	25	25
Plasticity Index, maximum	LS-703/704	0	0	0	0	0

Notes:

- The requirements listed below are only applicable to surface courses placed in the area to the north and west of a boundary defined by the north shore of Lake Superior, the north shore of the St. Mary's River, the south shore of St. Joseph Island, the north shore of Lake Huron easterly to the north and east shore of Georgian Bay (excluding Manitoulin Island), along the Severn River to Washago and a line easterly passing through Norland, Burnt River, Burleigh Falls, Madoc, and hence easterly along Highway 7 to Perth and northerly to Calabogie and easterly to Arnprior and the Ottawa River:
 - When a fine aggregate for use in a surface course mix is obtained from a gravel pit or quarry source which contains carbonate rock type (e.g., limestone and dolostone) then blending with aggregate from non-carbonate rock types shall be required to increase the soluble residue content to meet the minimum 60% requirement. The method of blending shall be uniform and shall be subject to approval by the Owner.
 - 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.
- When the blending method has been selected, this requirement applies to the total fine aggregate blend. In addition, when the blending method has been selected, the Micro-Deval Abrasion loss for each individual fine aggregate in stockpile, prior to blending, shall not exceed 35%.

TABLE 3
Consensus Property Requirements for Superpave Aggregates (Including RAP or RST or Both)

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

Notes:

1. The Ontario Traffic Category shall be as specified in the Contract Documents.
2. 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.
3. Denotes the depth of the top of lift below final pavement surface. If less than 25% of a layer is within 100 mm of the surface, the layer may be considered to be below 100 mm.
4. 85/80 denotes that 85% of the coarse aggregate has one fractured face and 80% has two or more fractured faces.
5. An uncompacted void content of 43% is acceptable provided that the selected mix satisfies the mix volumetrics specified in OPSS 1151.

TABLE 4
Physical Property Requirements for Coarse Aggregates – Binder Course

Laboratory Test	MTO Test No.	Superpave 4.75, 9.5, 19.0, 25.0	HL4, HL8	HDBC, SMA 19.0	MDBC
Wash Pass 75 µm sieve, % maximum loss (Note 1)	LS-601 Guideline B	1.3	1.3	1.3	1.3
Absorption, % maximum	LS-604	2.0	2.0	2.0	2.0
Percent Crushed Particles, % minimum	LS-607	--	60	--	95
Flat and Elongated Particles, % maximum at 4:1	LS-608	20 (Note 2)	20	15	15
Unconfined Freeze-Thaw, % maximum loss (Note 3)	LS-614	15	15	15	15
Particles with 2 Faces Crushed, % minimum (Note 4)	LS-617	--	--	95	80 (Note 5)
Micro-Deval Abrasion, % maximum loss	LS-618	21	21	21	21
Alternative Requirement for Unconfined Freeze-Thaw Loss, LS-614					
Magnesium Sulphate Soundness, % maximum loss	LS-606	15	15	15	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. For Ontario Traffic Categories D and E, Superpave 19.0 shall be 15% maximum. 3. This requirement shall be waived by the Owner when the aggregate meets the alternative magnesium sulphate soundness requirements, LS-606. 4. This only applies to HDBC and MDBC coarse aggregate crushed from gravel sources. 5. The maximum allowable amount of uncrushed particles is 5%, MDBC only.					

TABLE 5
Physical Property Requirements for Coarse Aggregates – Surface Course

Laboratory Test	MTO Test No.	HL1	Superpave 12.5 FC1	HL1, DFC, SMA 9.5 and 12.5, Superpave 12.5 FC1 and 12.5 FC2			Superpave 4.75, 9.5, and 12.5	HL 3 HL 3F HL 3HS	HL4 HL 4F
		Gravel	Gravel	Quarry Rock					
				Dolomitic Sandstone	Traprock, Diabase, and Andesite	Meta-Arkose, Meta-Gabbro, and Gneiss			
Wash Pass 75 µm sieve, % maximum loss	LS-601 Guideline B	1.0	1.0	1.0	1.0	1.0	1.3 (Note 1)	1.3 (Note 1)	1.3 (Note 1)
Absorption, % maximum	LS-604	1.0	1.0	1.0	1.0	1.0	2.0	1.75	2.0
Percent Crushed Particles, % minimum	LS-607	--	--	--	--	--	--	60	60
Flat and Elongated Particles, % maximum at 4:1	LS-608	15	15	15	15	15	20	20	20
Petrographic Number (HL), maximum	LS-609	120	120	145	120	145	(Note 2)	--	--
Petrographic Examination, non-carbonate of retained 4.75 mm, % minimum	LS- 609	--	--	--	--	--	--	60 (Note 2)	60 (Note 2)
Insoluble Residue retained 75 µm sieve, % minimum	LS-613	--	--	45	--	--	--	--	--
Unconfined Freeze-Thaw, % maximum loss	LS-614	6	6	7	6	6	6 (Note 3)	6 (Note 3)	6 (Note3)
Particles with 2 Faces Crushed, % minimum	LS-617	80	--	--	--	--	--	--	--
Micro-Deval Abrasion, % maximum loss	LS-618	10	10	15	10	15	17	17	17
Alternative Requirement for Unconfined Freeze-Thaw Loss, LS-614									
Magnesium Sulphate Soundness, % maximum loss	LS-606	--	--	--	--	--	12	12	12
Notes:									
1. When quarried rock is used as a source of coarse aggregates, a maximum of 2.0% passing the 75 µm sieve shall be permitted.									
2. The requirements listed below are only applicable to surface courses placed in the area to the north and west of a boundary defined by the north shore of Lake Superior, the north shore of the St. Mary's River, the south shore of St. Joseph Island, the north shore of Lake Huron easterly to the north and east shore of Georgian Bay (excluding Manitoulin Island), along the Severn River to Washago and a line easterly passing through Norland, Burnt River, Burleigh Falls, Madoc, and hence easterly along Highway 7 to Perth and northerly to Calabogie and easterly to Arnprior and the Ottawa River:									
a) When the coarse aggregate for use in a surface course mix is obtained from a gravel pit or quarry source 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 minimum acid insoluble residue of 60%. The method of blending shall be uniform and shall 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.									
3. This requirement shall be waived by the Owner when the aggregate meets the alternative magnesium soundness requirements, LS-606.									

TABLE 6
Field Sample Size

Material	Minimum Mass of Field Sample (Note 1) kg
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
Hot Mix Asphalt	25
Filler/Baghouse Fines	2
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, November 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

The designer should be aware that OPSS 1003 includes the introduction of Superpave mixes and new physical test methods.

The designer should specify the following in the Contract Documents:

- Hot mix asphalt (HMA) type requirements. (1003.05.01)
- Storage and delivery requirements for quality assurance (QA) samples. (1003.08.02)
- Ontario traffic category using the following table as a guideline (1003.05.02.03, 1003.05.03.03, Table 3):

Superpave and SMA Design Traffic Categories by ESALs

Ontario Traffic Category	20-Year Design ESALs (Note 1)	Typical Applications
A	Less than 0.3 million	Low volume roads, parking lots, driveways, and residential roads.
B	0.3 to 3 million	Minor collector roads.
C	3 to 10 million	Major collector and minor arterial roads.
D	10 to 30 million	Major arterial roads and transit routes.
E	Greater than 30 million	Freeways, major arterial roads with heavy truck traffic, and special applications such as truck and bus climbing lanes or stopping areas.
Note: 1. Equivalent Single Axle Load (ESAL) for the projected traffic level expected in the design lane over a 20-year period, regardless of the actual design life of the pavement.		

The designer should determine if the following is required and, if so, specify it in the Contract Documents:

- If the grading requirements provided in Appendix 1003-B are to be used, Appendix 1003-B needs to be invoked by reference in the Contract Documents.
- If the sampling and testing frequencies provided in Appendix 1003-C are to be used for QA purposes, Appendix 1003-C needs to be invoked by reference in the Contract Documents.
- If the payment reduction in lieu of aggregate removal provided in Appendix 1003-D is to be used, Appendix 1003-D needs to be invoked by reference in the Contract Documents.

Appendix 1003-A

- If the forms in Appendices 1003-E, 1003-F, and 1003-G are to be used for submission purposes, Appendices 1003-3, 1003-F, and 1003-G need to be invoked by reference in the Contract Documents.

The designer should be aware that fine and coarse aggregate gradations are not given in this specification. For quality control (QC) of any specific operation, the Contractor should develop an average gradation for the particular source and production facilities and control the gradation within reasonable tolerances from this average in such a way as to ensure a suitable HMA meeting the requirements of the Contract Documents. For the information of aggregate suppliers and others, the gradation requirements for fine and coarse aggregate are included in Appendix 1003-B.

The designer should be aware that quality assurance (QA) testing for purposes of ensuring material used in the Work meets the requirements of OPSS 1003 is not mandatory, unless specifically included in the Contract Documents. The designer should determine the need for QA testing based on the size and complexity of the work and specify the required frequency of QA sampling and testing (1003.08.01). Appendix 1003-C provides recommended QA sampling and testing frequencies.

The designer should be aware that in cases of high traffic volumes and high frictional demand, the use of HL1 and DFC or SMA, Superpave 12.5 FC1 and 12.5 FC2 aggregates may be necessary to give adequate frictional properties. In this case, the designer should provide a list of prequalified aggregate sources for SMA, DFC, Superpave 12.5 FC2 coarse and fine aggregates, and HL1 and Superpave 12.5 FC1 coarse aggregate. (1003.05.01)

Although this specification does not include testing for frictional properties, prequalified aggregate sources that have met specific friction property criteria may be found listed on the MTO pre-qualified products list: Designated Sources for Materials (DSM) #3.05.25 Asphalt - Aggregates, Coarse for Superpave 12.5 FC1, Superpave 12.5 FC2, SMA, HL1, DFC, and OFC; and Aggregates, Fine for Superpave 12.5 FC2, SMA, DFC, and OFC.

The designer should be aware that the use of steel slag is prohibited because of deleterious expansion associated with the hydration of lime (CaO) and periclase (MgO) within the slag. Nickel and copper slags are prohibited because of performance concerns.

The designer should be aware that blending to improve the physical properties of aggregates is not permitted by OPSS 1001, except to increase the percentage of crushed particles or decrease the percentage of flat and elongated particles. In this specification, blending of aggregates shall be permitted at the hot mix plant, provided it takes place at the cold feed and it is possible to take a sample of the blended aggregate. This permits the use of small amounts of material such as coarse crusher screenings that do not normally meet the specification, provided that the overall physical properties of the aggregate mix meet the specification. The Contractor may elect to either have quality assurance (QA) testing done on a stockpile basis, in which case each aggregate stockpile shall meet the physical requirements, or have QA testing done of the material after the cold feed bins, but before the material is mixed with asphalt cement.

The specification requires that coarse and fine aggregates for SMA be from the same aggregate source.

The designer should be aware of any additional referee testing laboratory requirements, including time lines, selection criteria, or roster for referee laboratories and include them in the Contract Documents.

The designer should be aware that the requirement for a minimum of 60% non-carbonate aggregate outlined in Table 2 and Table 5, in certain parts of the province is based on the following considerations: Carbonate aggregates due to their low resistance to abrasion polish easily under traffic, and depending on traffic volume may result in pavements with relatively differing frictional properties. In areas of the province with a predominant type of rock, siliceous or carbonate, it has been found that it is best to give consistent frictional properties to pavement surfaces.

Appendix 1003-A

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

Related Ontario Provincial Standard Drawings

No information provided here.

Appendix 1003-B, November 2013**FOR USE IN MUNICIPAL CONTRACTS, WHEN REFERENCED IN THE CONTRACT DOCUMENTS**

Note: This is a non-mandatory Additional Information Appendix intended to provide supplementary requirements for the OPS specification in a municipal contract, when the appendix is invoked by the Owner. It is written in mandatory language to permit invoking it by reference in the Contract Documents.

OPSS.MUNI 1003 is modified by the addition of the following gradation requirements for fine and coarse aggregates:

TABLE B-1
OPSS 1003 - Gradation for Fine Aggregate, LS-602

MTO Sieve Designation	Percent Passing by Mass				
	DFC	HL 1 and HL 3	HL 2	HL 4, HL 8, and MDBC	HDBC
9.5 mm	100	100	100	100	100
4.75 mm	85 - 100	90 - 100	85 - 100	85 - 100	95 - 100
2.36 mm	65 - 95	70 - 100	70 - 90	60 - 100	80 - 100
1.18 mm	48 - 80	50 - 90	50 - 75	34 - 90	50 - 90
600 µm	25-60	30 - 70	30 - 55	17 - 70	28 - 70
300 µm	10 - 35	15 - 40	15 - 35	9 - 40	10 - 40
150 µm	5 - 15	5 - 15	5 - 15	3 - 15	0 - 15
75 µm	0 - 6	0 - 5	3 - 8	0 - 7	0 - 5
Note: A. The difference between the amount retained between any two consecutive sieves, excluding the 75 µm sieve shall not be less than 5%.					

TABLE B-2
OPSS 1003 - Gradation for Coarse Aggregate, LS-602

MTO Sieve Designation	Percent Passing by Mass		
	HL 1, DFC, and HL 3	HL 4	HL 8, MDBC, and HDBC
26.5 mm	-	-	100
19.0 mm	-	100	90 - 100
16.0 mm	100	96 - 100	65 - 90
13.2 mm	96 - 100	67 - 86	-
9.5 mm	50 - 73	29 - 52	20 - 55
6.7 mm	-	-	-
4.75 mm	0 - 10	0 - 10	0 - 10

Appendix 1003-C, November 2013
FOR USE IN MUNICIPAL CONTRACTS, WHEN REFERENCED IN THE CONTRACT DOCUMENTS

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

Supplementary Requirements for Quality Assurance Sampling and Testing Frequencies

OPSS.MUNI 1003, Aggregates – Hot Mix Asphalt, is amended as follows:

1003.08 Quality Assurance

1003.08.01 General

The first paragraph of subsection 1003.08.01 is deleted in its entirety and replaced with the following:

QA sampling and testing shall be carried out by the Owner for the purposes of ensuring that the aggregates used in the work are according to the requirements of the Contract Documents. QA sampling and testing shall be carried out at the frequency specified in Table C-1. Individual test results may be forwarded to the Contractor as they become available.

Table C-1 is added.

TABLE C-1
Sampling and Testing Frequency for Physical and Consensus Properties, Note 1

HMA Production per HMA Type, t	Minimum Frequency Each Aggregate Type Per Each HMA Type
$\leq 10,000$	One sample.
$> 10,000$ (Note 2)	One sample per 10,000 tonnes.
Note: - Sampling and testing for consensus properties is applicable to Superpave HMA aggregates only. - When the quantity of material is: - Less than one-half the quantity required for a sample, then that quantity shall be added to the quantity representing the previous sample. - Greater than or equal to one-half the quantity required for a sample, then that quantity shall require its own sample.	

Appendix 1003-D, November 2013
FOR USE IN MUNICIPAL CONTRACTS, WHEN REFERENCED IN THE CONTRACT DOCUMENTS

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

Supplementary Requirements for a Price Reduction In Lieu of Removal of Aggregates

When a tested sample of aggregates shows that the aggregates do not meet the requirements of this specification, the aggregates represented by the test result, including material in existing stockpiles or in the Work, shall not be accepted. The Contractor may request a reduced price in lieu of removal provided the applicable test results:

- a) Do not exceed the requirement for LS-614, or LS-606 if it has replaced 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.

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

Appendix 1003-E, November 2013

FOR USE IN MUNICIPAL CONTRACTS, WHEN REFERENCED IN THE CONTRACT DOCUMENTS

Note: This is a non-mandatory Additional Information Appendix intended to provide supplementary requirements for the OPS specification in a municipal contract, when the appendix is invoked by the Owner. It is written in mandatory language to permit invoking it by reference in the Contract Documents.

OPSS 1003 - HOT MIX AGGREGATE TEST DATA PHYSICAL PROPERTIES - FINE AGGREGATE

Contract No.:	Contractor:	Contract Location:	
Testing Laboratory:		Telephone No.:	Fax No.:
Sampled By (Print Name):		Date Sampled (YY/MM/DD):	
Mix Type:		Sample Type: Stockpile [] Cold Feed (Blended FA) []	

Source Name/Location:	Aggregate Inventory Number (AIN):	Pit (P) or Quarry (Q):	% of Mix:
Source Name/Location:	Aggregate Inventory Number (AIN):	Pit (P) or Quarry (Q):	% of Mix:
Source Name/Location:	Aggregate Inventory Number (AIN):	Pit (P) or Quarry (Q):	% of Mix:

Note: All sources of fine aggregates used in blend should be included in the table given above.

Laboratory Test and Number	Requirement					Reference Material Results	Sample Test Results	Meets Requirement (Y/N)
	Surface Course				Binder Course			
	SMA 9.5 and 12.5, DFC, Superpave 12.5 FC2	HL 1, HL 3, HL 3HS, Superpave 4.75 and 12.5 FC1	HL 2, HL 4	Superpave 9.5 and 12.5	HL 2, HL 4, HL 4F, HL 8, HDBC, MDBC, SMA 19.0, Superpave 4.75, 19.0, and 25.0			
Acid Insoluble Residue, Minimum % retained on 2.36 mm sieve, LS-613	--	--	--	60 (Note 1)	--			
Micro-Deval Abrasion, % maximum loss, LS-619 (Note 2)	15	20	25	25	25			
Plasticity Index, Maximum, LS-703/704	0							

I hereby certify that testing has been carried out by a properly qualified/certified test technician:

Issued by: _____
PRINT NAME TESTING LABORATORY REPRESENTATIVE SIGNATURE DATE

Received by: _____
PRINT NAME CONTRACT ADMINISTRATOR REPRESENTATIVE SIGNATURE DATE

Copies to: ☐ Contract Administrator ☐ Contractor

Appendix 1003-E

Notes:

1. The requirements listed below are only applicable to surface courses placed in the area to the north and west of a boundary defined by the north shore of Lake Superior, the north shore of the St. Mary's River, the south shore of St. Joseph Island, the north shore of Lake Huron easterly to the north and east shore of Georgian Bay (excluding Manitoulin Island), along the Severn River to Washago and a line easterly passing through Norland, Burnt River, Burleigh Falls, Madoc, and hence easterly along Highway 7 to Perth and northerly to Calabogie and easterly to Arnprior and the Ottawa River:
 - a) When a fine aggregate for use in a surface course mix is obtained from a gravel pit or quarry source which contains carbonate rock type (e.g., limestone and dolostone) then blending with aggregate from non-carbonate rock types shall be required to increase the soluble residue content to meet the minimum 60% requirement. The method of blending shall be uniform and shall be subject to approval by the Owner.
 - b) When the fine aggregate for use in a surface course mix is obtained from a non-carbonate gravel or quarry source, blending with carbonate rock types is not permitted.
2. For blended aggregates sampled from the cold feed, the Micro-Deval Abrasion loss for each individual fine aggregate in stockpile, prior to blending, shall not exceed 35 percent.

Appendix 1003-F, November 2013

FOR USE IN MUNICIPAL CONTRACTS, WHEN REFERENCED IN THE CONTRACT DOCUMENTS

Note: This is a non-mandatory Additional Information Appendix intended to provide supplementary requirements for the OPS specification in a municipal contract, when the appendix is invoked by the Owner. It is written in mandatory language to permit invoking it by reference in the Contract Documents.

OPSS 1003 - HOT MIX AGGREGATE TEST DATA PHYSICAL PROPERTIES – COARSE AGGREGATE

Contract No.:	Contractor:	Contract Location:	
Testing Laboratory:		Telephone No.:	Fax No.:
Sampled By (Print Name):		Date Sampled (YY/MM/DD):	
Mix Type:	Source Name/Location:	Aggregate Inventory Number (AIN):	

HL1, DFC, SMA 9.5 and 12.5, Superpave 12.5 FC1 and 12.5 FC2									
Laboratory Test and Number	Requirements					Rock Type (Note 1)	Test Results		
	Gravel (G)		Quarry Rock				Reference Material	Sample	Meets Requirements (Y/N)
	HL 1	Superpave 12.5 FC1	Dolomitic Sandstone (D)	Traprock, Diabase, and Andesite (T)	Meta-Arkose, Meta-Gabbro, Gneiss, Granite (M)				
Wash Pass 75 µm sieve, % maximum loss, LS-601, Guideline B	1.0	1.0	1.0	1.0	1.0				
Absorption, % maximum, LS-604	1.0	1.0	1.0	1.0	1.0				
Flat and Elongated Particles, % maximum at 4:1, LS-608	15	15	15	15	15				
Petrographic Number (HL), Maximum, LS-609	120	120	145	120	145				
Insoluble Residue retained 75 µm sieve, % minimum, LS-613			45						
Unconfined Freeze-Thaw, % maximum loss, LS-614	6	6	7	6	6				
Particles with 2 Faces Crushed, % minimum, LS-617	80								
Micro-Deval Abrasion, % maximum loss, LS-618	10	10	15	10	15				

Superpave 4.75, 9.5, 12.5, 19.0, and 25.0, HL 3, HL 3F, HL 3HS, HL 4, HL 4F, HL 8, SMA 19.0, HDBC, MDBC									
Laboratory Test and Number	Requirements							Test Results	
	Surface Course			Binder Course				Reference Material	Sample Test Results
	Superpave 4.75, 9.5, and 12.5	HL 3, HL 3F, HL 3HS	Results	Superpave 4.75, 9.5, 12.5, 19.0, and 25.0	HL 4, HL 8	SMA 19.0, HDBC	MDBC		
Wash Pass 75 µm sieve, % maximum loss, LS-601-Guideline B, (Note 2)	1.3	1.3	1.3	1.3	1.3	1.3	1.3		
Absorption, % maximum, LS-604	2.0	1.75	2.0	2.0	2.0	2.0	2.0		
Percent Crushed Particles, % minimum, LS-607	--	60	60	--	60	--	95		
Flat and Elongated Particles, % maximum at 4:1, LS-608	20	20	20	20 (Note 3)	20	15	15		
Petrographic Number (HL), maximum, LS-609	Note 4	--	--	--	--	--	--		
Petrographic Examination, non-carbonate of retained 4.75 mm, % minimum, LS-609	--	60 (Note 4)	60 (Note 4)	--	--	--	--		
Unconfined Freeze-Thaw, % maximum loss, LS-614 (Note 5)	6	6	6	15	15	15	15		
Particles with 2 Faces Crushed, % minimum, LS-617 (Note 6)	--	--	--	--	--	95	80 (Note 7)		
Micro-Deval Abrasion, % maximum loss, LS-618	17	17	17	21	21	21	21		
Alternative Requirement for Unconfined Freeze-Thaw Loss, LS-614									
Magnesium Sulphate Soundness, % maximum loss, LS-606	12	12	12	15	15	15	15		

Appendix 1003-F

I hereby certify that testing has been carried out by a properly qualified/certified test technician:

Issued by: _____
PRINT NAME TESTING LABORATORY REPRESENTATIVE SIGNATURE DATE

Received by: _____
PRINT NAME CONTRACT ADMINISTRATOR REPRESENTATIVE SIGNATURE DATE

Copies to: ☐ Contract Administrator ☐ Contractor

Notes:

1. Enter the type of rock or material used in the mix as follows:
G – gravel
D – dolomitic sandstone
T – traprock, diabase, andesite
M – meta-arkose, meta-gabbro, gneiss, granite
2. When quarried rock is used as a source of coarse aggregates, a maximum of 2% passing the 75 µm sieve shall be permitted.
3. For Ontario Traffic Categories D and E, Superpave 19.0 shall be 15% maximum.
4. The requirements listed below are only applicable to surface course placed in the area to the north and west of a boundary defined by the north shore of Lake Superior, the north shore of the St. Mary's River, the south shore of St. Joseph Island, the north shore of Lake Huron easterly to the north and east shore of Georgian Bay (excluding Manitoulin Island), along the Severn River to Washago and a line easterly passing through Norland, Burnt River, Burleigh Falls, Madoc, and hence easterly along Highway 7 to Perth and northerly to Calabogie and easterly to Arnprior and the Ottawa River.
 - a) When the coarse aggregate for use in surface course mix is obtained from a gravel pit or quarry source containing more than 40% carbonate rock type (e.g., limestone and dolostone) then blending with aggregate of non-carbonate rock types shall be required to increase the minimum non-rock carbonate rock type content of the coarse aggregate to 60%, as determined by petrographic examination, LS-609. The method of blending shall be uniform and shall be subject to approval by the Owner. 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 course mix is obtained from a non-carbonate source, blending with carbonate rock types shall not be permitted.
5. This requirement shall be waived by the Owner when the aggregate meets the alternative magnesium sulphate soundness requirement, LS-606.
6. This only applies to coarse aggregate crushed from gravel sources.
7. The maximum allowable amount of uncrushed particles is 5%.

Appendix 1003-G, November 2013

FOR USE IN MUNICIPAL CONTRACTS, WHEN REFERENCED IN THE CONTRACT DOCUMENTS

Note: This is a non-mandatory Additional Information Appendix intended to provide supplementary requirements for the OPS specification in a municipal contract, when the appendix is invoked by the Owner. It is written in mandatory language to permit invoking it by reference in the Contract Documents.

OPSS 1003 - HOT MIX AGGREGATE TEST DATA SUPERPAVE CONSENSUS PROPERTY REQUIREMENTS

Contract No.:	Contractor:	Contract Location:	
Testing Laboratory:		Telephone No.:	Fax No.:
Sampled By (Print Name):		Date Sampled (YY/MM/DD):	
Superpave Mix Type: 4.75 [] 9.5 [] 12.5 [] 12.5 FC1 [] 12.5 FC2 [] 19.0 [] 25 []			Sample Type (Stockpile, Belt, etc.):

FINE AGGREGATES								
Source Name/Location:			Aggregate Inventory Number (AIN):			Pit (P) or Quarry (Q):		% of Mix:
Source Name/Location:			Aggregate Inventory Number (AIN):			Pit (P) or Quarry (Q):		% of Mix:
Source Name/Location:			Aggregate Inventory Number (AIN):			Pit (P) or Quarry (Q):		% of Mix:
Laboratory Test and Number		Requirement					Test Result	
		Traffic Category (Note 1)					Sample Test Result	Meets Requirement (Y/N)
		A	B	C	D	E		
Uncompacted Void Content, % minimum, LS-629	≤ 100 mm (Note 2)	--	40	45 (Note 3)	45 (Note 3)	45 (Note 3)		
	> 100 mm (Note 2)	--	40	40	40	45 (Note 3)		
Sand Equivalent Method 1, % minimum, AASHTO T 176 (Note 4)		40	40	45	45	50		

COARSE AGGREGATES								
Source Name/Location:			Aggregate Inventory Number (AIN):			Pit (P) or Quarry (Q):		% of Mix:
Source Name/Location:			Aggregate Inventory Number (AIN):			Pit (P) or Quarry (Q):		% of Mix:
Source Name/Location:			Aggregate Inventory Number (AIN):			Pit (P) or Quarry (Q):		% of Mix:
Laboratory Test and Number		Requirement					Test Result	
		Traffic Category (Note 1)					Sample Test Result	Meets Requirement (Y/N)
Fractured Particles in Coarse Aggregate, % minimum, ASTM D 5821 (Note 5)	≤ 100 mm (Note 2)	55/-	75/-	85/80	95/90	100/100		
	> 100 mm (Note 2)	-/-	50/-	60/-	80/75	100/100		
Flat and Elongated Particles (5:1), % maximum, ASTM D 4791		--	10					

Appendix 1003-G

I hereby certify that testing has been carried out by a properly qualified/certified test technician:

Issued by: _____
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Received by: _____
PRINT NAME CONTRACT ADMINISTRATOR REPRESENTATIVE SIGNATURE DATE

Copies to: ☐ Contract Administrator ☐ Contractor

Notes:

1. The Ontario Traffic Category shall be as specified in the Contract Documents.
2. Denotes the depth of the top 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. A minimum uncompacted void content of 43% is acceptable provided that the selected mix satisfies the mix volumetrics specified in the Contract Documents.
4. 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.
5. 85/80 denotes that 85% of the coarse aggregate has one fractured face and 80% has two or more fractured faces.



MATERIAL SPECIFICATION FOR AGGREGATES - MISCELLANEOUS

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1004.01 SCOPE

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

1004.01.01 Specification Significance and Use

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

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

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

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

Ontario Provincial Standard Specifications, Material

OPSS 1001 Aggregates - General
OPSS 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 Percent Crushed Particles in Processed Coarse Aggregate
LS-608 Percent Flat and Elongated Particles in Coarse Aggregate
LS-610 Organic Impurities in Concrete Sands
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-703/704 Liquid Limit, Plastic Limit, and Plasticity Index of Soils

ASTM International

C 87/C 87M-10 Standard Test Method for 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

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

CCIL means the Canadian Council of Independent Laboratories.

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

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

Deleterious Material means materials that include, but not limited to, the following: wood, clay brick, clay tile, plastic, gypsum, gypsum plaster, wallboard, roots, and all other organic material.

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 hydraulic 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 an aggregate'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 requirements specified in the Contract Documents

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.

Statistical Control means when all sources of assignable variation have been removed, the variability of the process is confined to probability variation alone,

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

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

Aggregates shall be produced from 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 a change in the character of the aggregate occurs or when the performance of aggregate that meets the requirements of this specification is found to be unsatisfactory, use of the aggregate shall be discontinued until the Contractor can prove to the satisfaction of the Contract Administrator that the source remains acceptable or can be made acceptable.

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 subject to the approval of the Contract Administrator other inert materials with similar characteristics, or combinations thereof, having hard, strong, durable particles. The sand shall be free from a coating of any deleterious material and free from other deleterious substances.

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

1004.05.05.01 General

Rip-rap, rock protection, and gabion stone 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.

1004.05.05.02 Rip-Rap and Gabion Stone

Rip-rap R-10 and R-50 classifications and gabion stone G-3 and G-10 classifications shall meet the physical property requirements shown in Table 7 and gradation requirements shown in Table 8.

1004.05.05.03 Rock Protection

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 immediately removed from the stockpile.

Once a stockpile has been produced, sampled, and tested, no further material may be added to the stockpile. Stockpiles produced, sampled, and tested under the procedure for control chart method may continue to have material added, provided that sampling and testing show that the material in the stockpile is in accordance to this specification and that the process remains in statistical control.

1004.08 QUALITY ASSURANCE

1004.08.01 General

QA testing may be carried out by the Owner for the purposes of ensuring that the aggregates used in the work are according to the requirements of this specification. Individual test results may 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.

The Owner shall be responsible for all costs associated with testing for QA purposes, unless otherwise indicated in the Contract Documents.

1004.08.02 Laboratory Requirements

The Contract Administrator shall designate all QA laboratories.

An acceptable laboratory conducting tests for physical properties shall be one that holds a current Type D certificate from CCIL for the applicable test methods and also participates in the annual MTO Proficiency Sample Testing Program for the specific tests, when applicable.

An acceptable laboratory conducting tests for gradation according to LS-602, materials finer than 75 µm by washing of the aggregates according to LS-601, and percent crushed particles according to LS-607 shall be one that holds a current Type C certificate from CCIL.

Testing shall be conducted by qualified laboratory staff that holds a current certificate from CCIL in aggregate testing.

Equivalent alternate laboratory and technician certifications or laboratory proficiency testing programs may be used to demonstrate similar requirements, provided that they are acceptable to the Contract Administrator.

1004.08.03 Sampling

Sampling shall be according to LS-625.

Duplicate samples shall be taken and sealed by the Contractor in the presence of the Contract Administrator at the time and location determined by the Contract Administrator. When material contains blended or reclaimed aggregates or both, QA sampling shall be performed on the final blended product.

The mass of each sample shall meet the requirements of Table 13. When more than 30 kg is required, the total sample shall be recombined by the QA laboratory prior to testing.

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

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 on the inside and outside of the sample container.

1004.08.04 Testing and Retention of Samples

When the Contract Administrator elects to carry out QA testing, one of the duplicate samples shall be randomly selected for testing by the QA laboratory and the remaining sealed sample shall be retained by the QA laboratory for possible referee testing.

1004.08.05 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.

1004.08.06 Acceptance

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

When QA test results show that the material meets the requirements of this specification, the aggregates shall be accepted.

When QA test results show that the material does not meet the requirements of this specification, the Contract Administrator shall notify the Contractor that material represented by the test results shall not be accepted. This notification shall take place in writing within 3 Business Days of receipt of the non-conforming data. The Contractor has the option of either removing the material from the work or invoking referee testing. The Contractor may request a reduced price in lieu of removal for aggregates that fail to meet the requirements of this specification. Irrespective of the negotiation of a reduced price payment, the warranty provisions of the Contract Documents shall apply.

1004.08.07 Referee Testing

When QA test results do not meet the requirements of this specification, the Contractor has the option of invoking referee testing of the test result that fails to meet the requirements. The Contractor shall notify the Contract Administrator of the selected option in writing within 2 Business Days following written notification of unacceptable material.

The Contract Administrator shall select a referee testing laboratory acceptable to the Contractor within 3 Business Days following the Contractor's notification to invoke referee testing.

Referee test samples shall be delivered to the referee testing laboratory from the QA laboratory by the Contract Administrator. The sealed sample shall be opened in the presence of the Contractor and the Contract Administrator. If referee materials are not available, the Contractor shall be responsible for obtaining and submitting new samples to the referee laboratory from a location to be decided by the Contract Administrator. The Contract Administrator shall be present to witness the sampling.

Referee testing shall be carried out in the presence of the Contract Administrator. When applicable, the referee testing laboratory shall also test a control aggregate sample for each test method required. The Contractor may observe the testing at no cost to the Owner.

The Contractor and the Owner may send a maximum of two representatives each to observe the referee testing. The Contract Administrator shall notify the Owner and the Contractor a minimum of 3 Business Days in advance of the date of referee testing. Provided that such notice was given, referee testing shall be carried out regardless of the absence of one or more observers.

Observers shall follow the referee laboratory protocols for access to the premises and testing equipment and shall not unnecessarily impede the progress of testing. Observers shall be permitted to validate sample identification and view sample condition. Subject to safety requirements, test method and equipment limitation, the shall also be permitted to observe test procedures, take notes, view equipment readings, and review completed work sheets while in attendance.

Comments on the non-conformity of the test methods shall be made and corrected at the time of testing.

Referee test results shall be binding on both the Owner and the Contractor.

When a referee test result shows that the aggregates do not meet the requirements of this specification, the aggregates represented by the test result, including aggregates in existing stockpiles or in the Work, shall not be accepted. The Contractor shall remove the aggregates from the Work at no cost to the Owner. The Contractor may request a reduced price in lieu of removal of the aggregates that fail to meet the requirements of this specification. Irrespective of the negotiation of a reduced price payment, the warranty provisions of the Contract Documents shall apply.

When a referee test result shows that the aggregates meet the requirements of this specification, the aggregates represented by the sample shall be accepted.

The Owner shall be responsible for the cost of referee testing, provided that the referee test results show that the aggregates meet the applicable specifications. Otherwise, the Contractor shall be responsible for the cost.

TABLE 1
Physical Property Requirements for Clear Stone

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

Laboratory Test	MTO Test Number	Granular Sheeting
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
Plasticity Index, maximum	LS-703/704	0
Notes: 1. For materials north of the French/Mattawa Rivers only: For materials with > 4.0% passing the 75 µm sieve, 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 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

Laboratory Test	Test Number	Requirement
Organic Impurities, Organic Plate Number	LS-610	3 (Note 1)
Mortar Strength Test	ASTM C 87/C 87M	(Note 2)
Notes: 1. When the fine aggregate is subjected to this test, it shall not produce a colour darker than the standard solution or Organic Plate Number 3. A fine aggregate failing this test may be approved if it meets the requirements of the mortar strength test according to ASTM C 87/C 87M. 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

Laboratory Test	Test Number	Rip-Rap	Gabion Stone	Rock Protection
Specific Gravity, minimum	ASTM D 6473 (Note 1)	2.50	2.50	2.5
Absorption, % maximum		2.0	2.0	2.0
Flat and Elongated Particles, % maximum	LS-608 (Note 2)	15	15	15
Micro-Deval Abrasion, Coarse Aggregate, Grading A % maximum loss	LS-618 (Note 3)	25	25	25

Notes:

1. These requirements shall be based on the average test results for at least five 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 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 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 mm (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	500	-	-	-	-	100
75	305	-	-	-	100	Well-graded
50	265	-	-	-	70 - 90	
25	210	-	-	-	40 - 55	
15	180	-	100	100	-	
10	155	-	90 - 100	70 - 90	-	
5	125	100	-	40 - 55	-	
3	105	90 - 100	-	-	-	0-10
2.5	100	-	0 - 5	-	0 - 15	-
0.5	60	0 - 5	-	0 - 15	-	-
Notes: 1. Masses are based on approximate size of an equivalent cube with a specific gravity of 2.65 and are provided for estimating purposes only. 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 when 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 piece determined using an average of three rectilinear measurements of the piece shall be allowed in lieu of weighing.						

TABLE 9
Physical Property Requirements for Truck Arrester Bed Aggregate

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

MTO 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, to be confirmed by visual inspection of the stockpile. A. 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
Sample Size Requirements

Aggregate Type	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
Rip Rap / 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 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

The designer should be aware that OPSS 1004 includes the introduction of physical test methods.

The designer may consider the use of reclaimed materials as an alternate aggregate source material. If so, the designer should specify this requirement in the Contract Documents. (1004.05.01)

The designer should be aware that quality assurance (QA) testing for purposes of ensuring material used in the Work meets the requirements of OPSS 1004 is not mandatory, unless specifically included in the Contract Documents. The designer should determine the need for QA testing based on the size and complexity of the work and specify the required frequency of QA sampling and testing (1006.08.01). Appendix 1004-B provides recommended QA sampling and testing frequencies. The designer should determine if the sampling and testing frequencies provided in Appendix 1004-B are to be used for QA purposes. If so, they need to be invoked by reference in the Contract Documents.

The designer should ensure that the need for stability of 53 mm clear stone is considered. When required, the minimum percent crushed requirement should be added. (Table 1)

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

Related Ontario Provincial Standard Drawings

No information provided here.

Appendix 1004-B, November 2013**FOR USE IN MUNICIPAL CONTRACTS, WHEN REFERENCED IN THE CONTRACT DOCUMENTS**

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

Supplementary Requirements for Quality Assurance Sampling and Testing Frequencies

OPSS.MUNI 1004, Aggregates - Miscellaneous, is amended as follows:

1004.08 Quality Assurance**1004.08.01 General**

The first paragraph of subsection 1004.08.01 is deleted in its entirety and replaced with the following:

QA sampling and testing shall be carried out by the Owner for the purposes of ensuring that the aggregates used in the work are according to the requirements of the Contract Documents. QA sampling and testing shall be carried out at the frequency specified in Table B-1. Individual test results may be forwarded to the Contractor as they become available.

Table B-1 is added.

TABLE B-1
Sampling and Testing Frequencies for Physical Property and Gradation Requirements

Aggregate Type	Tender Quantity	Minimum Frequency
Clear stone	< 200 tonnes	At the Contract Administrator's discretion.
	≥ 200 tonnes and < 1,000 tonnes	One sample.
	≥ 1,000 tonnes (Note 1)	One sample per 1,000 tonnes.
Gabion Stone, (m ³ of gabion baskets)	< 100 m ³	At the Contract Administrator's discretion.
	≥ 100 m ³ and < 1,000 m ³	One sample.
	≥ 1,000 m ³ (Note 1)	One sample per 1,000 m ³ .
Granular Sheetting Rip-Rap	< 200 m ²	At the Contract Administrator's discretion.
	≥ 200 m ² and < 5,000 m ²	One sample.
	≥ 5,000 m ² (Note 1)	One sample per 5,000 m ² .
Rock Protection	< 200 m ³	At the Contract Administrator's discretion.
	≥ 200 m ³ and < 5,000 m ³	One sample.
	≥ 5,000 m ³ (Note 1)	One sample per 5,000 m ³ .
Truck Arrestor Bed	< 5,000 tonnes	One sample.
	≥ 5,000 tonnes (Note 1)	One sample per 5,000 tonnes.
Winter Sand	< 500 tonnes	At the Contract Administrator's discretion.
	≥ 500 tonnes and ≤ 5,000 tonnes	One sample.
	> 5,000 tonnes (Note 1)	One sample per 5,000 tonnes.

Notes:

1. When the tender quantity of material is:

- a) Less than one-half the quantity required for a sample, then that quantity shall be added to the quantity representing the previous sample.
- b) Greater than or equal to one-half the quantity required for a sample, then that quantity shall require its own sample.



MATERIAL SPECIFICATION FOR AGGREGATES - SURFACE TREATMENT

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

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

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

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

Ontario Provincial Standard Specifications, Material

OPSS 1001 Aggregates - General

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 Aggregates 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	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-625	Guidelines for Sampling of Aggregate Materials
LS-703/704	Liquid Limit, Plastic Limit, and Plasticity Index of Soils

1006.03

DEFINITIONS

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

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.

CCIL means the Canadian Council of Independent Laboratories.

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.

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.

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

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

Slag means 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

1006.05.01.01

General

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

Aggregates shall be produced from sands, gravels, or quarried rock.

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

At the discretion of the Owner, the physical property requirements may be waived provided the Contractor has demonstrated satisfactory field performance for a pavement that 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 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 a change in the character of the aggregate occurs or when the performance of the aggregate is found to be unsatisfactory, use of those aggregates shall be discontinued until the Contractor can prove to the satisfaction of the Contract Administrator that the source remains acceptable or can be made acceptable.

1006.05.01.02

Gradation Requirements

Aggregate shall meet the gradation requirements shown in Table 1.

1006.05.01.03 Physical Property Requirements

Aggregate shall meet the physical property requirements of Table 2.

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 placed in individual stockpiles. 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 immediately removed from the stockpile.

1006.08 QUALITY ASSURANCE

1006.08.01 General

QA testing may be carried out by the Owner for purposes of ensuring that the aggregates used in the work are according to the requirements of this specification. Individual test results may be forwarded to the Contractor as they become available.

When a hydrated lime anti-stripping agent is used and testing is required, 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.

The Owner shall be responsible for all costs associated with testing for QA purposes, unless otherwise specified in the Contract Documents.

1006.08.02 Laboratory Requirements

The Contract Administrator shall designate all QA laboratories.

An acceptable laboratory conducting aggregate tests for physical properties shall be one that holds a current Type D certificate from CCIL for the applicable test methods and also participates in the annual MTO Proficiency Sample Testing Program for the specific tests, when applicable.

An acceptable laboratory conducting tests for gradation according to LS-602, materials finer than 75 µm by washing of the aggregates according to LS-601, and percent crushed particles according to LS-607 shall be one that holds a current Type C certificate from CCIL.

Testing shall be conducted by qualified laboratory staff that holds a current certificate from CCIL in aggregate testing.

Equivalent alternate laboratory and technician certifications or laboratory proficiency testing programs may be used to demonstrate similar requirements provided that they are acceptable to the Contract Administrator.

1006.08.03 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 be charged for the cost of the testing using LS-614, administrative charges, and additional sampling, if required.

1006.08.04 Sampling

Sampling shall be according to LS-625.

Duplicate samples shall be randomly obtained from the stockpile and sealed by the Contractor in the presence of the Contract Administrator. 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.

The mass of each sample shall meet the requirements shown in Table 3. Each bag or container shall hold not more than 30 kg. When more than 30 kg is required, the total sample shall be recombined by the QA laboratory prior to testing.

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

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 on both the inside and the outside of the sample container.

1006.08.05 Testing and Retention of Samples

When the Contract Administrator elects to carry out QA testing, one of the duplicate samples shall be randomly selected for testing by the QA laboratory and the remaining sealed sample shall be retained by the QA laboratory for possible referee testing.

1006.08.06 Acceptance

QA test results shall be used for acceptance purposes, except when referee testing has been carried out.

When QA test results show that the aggregates meet the requirements of this specification, the aggregates shall be accepted.

When QA test results show that the aggregates do not meet the requirements of this specification, the Contract Administrator shall notify the Contractor that the aggregates represented by the test results shall not be accepted. This notification shall take place in writing within 3 Business Days of receipt of the non-conforming data. The Contractor has the option of either removing the material from the work or invoking referee testing. The Contractor may request a reduced price in lieu of removal for aggregates that fail to meet the requirements of this specification. Irrespective of the negotiation of a reduced price payment, the warranty provisions of the Contract Documents shall apply.

When QA test results do not meet the requirements of this specification the Contractor has the option of invoking referee testing of the test result that fails to meet the requirements. The Contractor shall notify the Contract Administrator of the selected option in writing within 2 Business Days following notification of unacceptable material.

The Contract Administrator shall select a referee testing laboratory acceptable to the Contractor within 3 Business Days following the Contractor's notification to invoke referee testing. Referee test samples shall be delivered to the referee testing laboratory from the QA laboratory by the Contract Administrator. The sealed test sample shall be opened in the presence of the Contractor and the Contract Administrator.

Referee testing shall be carried out in the presence of the Contract Administrator. Where applicable, the referee testing laboratory shall also test a control aggregate sample for each test method required. The Contractor may observe the testing at no cost to the Owner.

The Contractor and Owner may send a maximum of two representatives each to observe the referee testing. The Contract Administrator shall notify the Owner and Contractor a minimum of 3 Business Days in advance of the date of referee testing. Provided that such notice was given, referee testing shall be carried out regardless of the absence of one or more observers.

Observers shall follow the referee laboratory protocols for access to the premises and testing equipment and shall not unnecessarily impede the progress of the testing. Observers shall be permitted to validate sample identification and view sample condition. Subject to safety requirements, test method and equipment limitations, they shall also be permitted to observe test procedures, take notes, view equipment readings and review completed work sheets while in attendance.

Comments on the non-conformity of the test methods shall be made and corrected at the time of testing.

Referee test results shall be binding on both the Owner and the Contractor.

When a referee test result shows that the aggregates do not meet the requirements of this specification, the aggregates represented by the test result, including aggregates in existing stockpiles or in the Work, shall be rejected. The Contractor shall remove the aggregates from the work at no cost to the Owner. The Contractor may request a reduced price in lieu of removal for aggregates that fail to meet the requirements of this specification. Irrespective of the negotiation of a reduced price payment, the warranty provisions of the Contract Documents shall apply.

When referee test results show that the aggregates meet the requirements of this specification, the aggregates represented by the sample shall be accepted.

The Owner shall be responsible for the cost of referee testing provided that the referee test results show that the aggregates meet the applicable specifications otherwise the Contractor shall be responsible for the cost.

TABLE 1
Gradation Requirements, LS-602

MTO Sieve Designation	Percent Passing by Mass					
	Class 1 (Note 1)	Class 2	Class 3 (Note 2)	Class 4	Class 5 (Note 1)	Class 6 (Note 3)
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 4	2-7	Note 4	0-7	Note 4	Note 4
Notes: 1. Class 1 and Class 5 aggregates shall be washed according to OPSS 1001. 2. Class 3 aggregate has the same gradation requirements as HL4 coarse aggregate. 3. Class 6 aggregate has the same gradation requirements as HL3 coarse aggregate. 4. Class 1, 3, 5, and 6 requirements for percent passing 75 µm are shown in Table 2.						

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 retained 4.75 mm sieve, % 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	--	--
Plasticity Index, maximum	LS-703/704	--	0	--	0	--	--
Alternative Requirement to Unconfined Freeze-Thaw Loss, LS-614							
Magnesium Sulphate Soundness (coarse aggregate), % maximum loss	LS-606	12	15	12	--	12	12
Notes: - With the exception of LS-619 and LS-703/704, 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. - When quarried rock is used as a source of coarse aggregate, a maximum of 2.0% passing the 75 µm sieve shall be permitted. - 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: - 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 of 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%. - 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. - The Owner shall waive the requirements for LS-614, provided the Contractor has submitted a written request that the coarse aggregates meet the alternative requirements for LS-606.							

TABLE 3
Sample Size

Material	Minimum Mass of Field Samples (Note 1) kg
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 1006-A, November 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

The designer should determine if the following is required and, if so, specify it in the Contract Documents:

- If the QA sampling and testing frequencies provided in Appendix 1006-B are to be used for QA purposes, Appendix 1006-B needs to be invoked by reference in the Contract Documents.
- If the payment reduction in lieu of aggregate removal provided in Appendix 1006-C is to be used, Appendix 1006-C needs to be invoked by reference in the Contract Documents.
- If the form in Appendix 1006-D is to be used for submission purposes, Appendix 1006-D needs to be invoked by reference in the Contract Documents.

The designer should be aware that quality assurance (QA) testing for purposes of ensuring material used in the Work meets the requirements of is not mandatory, unless specifically included in the Contract Documents. The designer should determine the need for QA testing based on the size and complexity of the work and specify the required frequency of QA sampling and testing. Appendix 1006-B provides recommended QA sampling and testing frequencies.

The requirement for a minimum of 60% non-carbonate aggregate, Table 2, Note 3, in certain parts of the province is based on the following considerations: Carbonate aggregates, due to their low resistance to abrasion, polish easily under traffic and, depending on traffic volume, may result in pavements with relatively differing low frictional properties. In areas of the province with a predominant type of rock, siliceous or carbonate, it has been found that it is best to give consistent frictional properties to pavement surfaces. For instance, it has been found that the use of carbonate aggregates in areas of predominantly siliceous rocks results in lower frictional values than normal for that area and a relatively higher proportion of wet weather skidding accidents in those areas paved with carbonate rocks. In areas of the predominant use of carbonate rocks it has been found that drivers appear to adjust their behaviour to the generally lower frictional properties.

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

Related Ontario Provincial Standard Drawings

No information provided here.

Appendix 1006-B, November 2013
FOR USE IN MUNICIPAL CONTRACTS, WHEN REFERENCED IN THE CONTRACT DOCUMENTS

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

Supplementary Requirements for Quality Assurance Sampling and Testing Frequencies

OPSS.MUNI 1006, Aggregates - Surface Treatment is amended as follows:

1006.08 QUALITY ASSURANCE

1006.08.01 General

The first paragraph of subsection 1006.08.01 is deleted in its entirety and replaced with the following:

QA sampling and testing shall be carried out by the Owner for the purpose of ensuring that the aggregates used in the Work are according to the requirements of the Contract Documents. QA sampling and testing carried out at the frequency specified in Table B-1. Individual test results may be forwarded to the Contractor as they become available.

Table B-1 is added.

TABLE B-1
Sampling and Testing Frequencies for Physical Property and Gradation Requirement (Note 1)

Aggregate Quantity from Each Source t	Minimum Frequency Class 1, 2, 3, 4, 5 and 6
< 500	Sampling and testing may be waived at the discretion of the Contract Administrator.
≥ 500 and ≤ 2,000	One sample for both physical properties and gradation.
> 2,000 (Note 2)	<u>Gradation</u> : One sample per 2,000 tonnes. <u>Physical Properties</u> : One sample per 20,000 tonnes.
Notes: 1. The physical property requirements may be waived at the discretion of the Owner, provided that the Contractor has demonstrated satisfactory field performance for a pavement that 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. 2. When the quantity of granular material is: a) Less than one-half the quantity required for a sample, then that quantity shall be added to the quantity representing the previous sample. b) Greater than or equal to one-half the quantity required for a sample, then that quantity shall require its own sample.	

Appendix 1006-C, November 2013
FOR USE IN MUNICIPAL CONTRACTS, WHEN REFERENCED IN THE CONTRACT DOCUMENTS

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

Supplementary Requirements for Payment Reduction In Lieu of Removal of Aggregates

OPSS.MUNI 1006, Aggregates - Surface Treatment is amended as follows:

When a tested sample of aggregates shows that the aggregates do not meet the requirements of this specification, the aggregates represented by the test result, including material in existing stockpiles or in the Work, shall not be accepted. The Contractor may request a reduced price in lieu of removal provided that the applicable test results for that sample:

- a) Do not exceed the requirement for LS-614, or LS-606 if it has replaced 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) Do not identify a plasticity index within the material, when determined according to LS-703/704, and meet the requirement for LS-602 on the 75 µm sieve.
- e) Do not exceed 10% of the specified value for any other requirement in this specification.

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

FOR USE IN MUNICIPAL CONTRACTS, WHEN REFERENCED IN THE CONTRACT DOCUMENTS

OPSS 1006 – Surface Treatment Aggregate Test Data

Contract No.:	Contractor:	Contract Location:	
Name of Testing Laboratory:		Telephone No.:	Fax No.:
Sampled by (Print Name):		Date Sampled (YY/MM/DD):	
Aggregate Class:		Quantity (tonnes) :	
Source Name/Location:		Aggregate Inventory Number (AIN) :	

Laboratory Test and Number	Requirements						Test Results		
	Class 1 (Note 1)	Class 2 (Note 1)	Class 3 (Note 1)	Class 4	Class 5 (Note 1)	Class 6 (Note 1)	Reference Material	Sample	Meets Requirements (Y/N)
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, Minimum % non-carbonate retained on 4.75 sieve, LS-609	60 (Note 3)	60 (Note 3)	60 (Note 3)	--	60 (Note 3)	60 (Note 3)			
Unconfined Freeze-Thaw, % maximum loss, LS-614 (Note 4)	6	15	6	--	6	6			
Micro-Deval Abrasion(CA), % maximum loss, LS-618	17	25	17	--	17	17			
Micro Deval Abrasion (FA), % maximum loss, LS-619	--	30	--	25	--	--			
Plasticity Index, maximum, LS-703/704	--	0	--	0	--	--			
Alternative Requirement to Unconfined Freeze-Thaw (LS-614)									
Magnesium Sulphate Soundness, % maximum loss, LS-606 (Note 4)	12	15	12	--	12	12			

Issued by:

PRINT NAME _____

TESTING LABORATORY REPRESENTATIVE SIGNATURE

DATE _____

PRINT NAME _____

CONTRACT ADMINISTRATOR REPRESENTATIVE SIGNATURE

DATE _____

☐ **Contractor**

Appendix 1006-D

Notes:

4. With the exception of LS-619 and LS-703/704, 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.
5. When quarried rock is used as a source of coarse aggregate, a maximum of 2.0% passing the 75 μ m sieve shall be permitted.
6. 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 of 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, provided the Contractor has submitted a written request that the coarse aggregates meet the alternative requirements for LS-606.



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

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1010-C	Supplementary Requirements for Payment Reduction In Lieu of Aggregate Removal
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1010-E	Coarse Aggregate Test Data Form

1010.01	SCOPE

This specification covers the material requirements for aggregates for use in base, subbase, select subgrade, granular surface, shouldering, and backfill material.

1010.01.01 Specification Significance and Use

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

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

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

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

Ontario Provincial Standard Specification, Material

OPSS 1001 Aggregates - General

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LS-601	Material Finer than 75 µm Sieve in Mineral Aggregates by Washing
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LS-607	Percent Crushed Particles in Processed Coarse Aggregate
LS-614	Freezing and Thawing of Coarse Aggregate
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LS-625	Guidelines for Sampling of Aggregate Materials
LS-630	Amount of Contamination of Coarse Aggregates
LS-702	Particle Size Analysis of Soils
LS-703/704	Liquid Limit, Plastic Limit, and Plasticity Index of Soils
LS-709	Permeability of Granular Soils

1010.03 DEFINITIONS

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

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.

CCIL means the Canadian Council of Independent Laboratories.

Ceramic means porcelain, china, and whiteware (e.g., sinks, toilets, and bidets made from clay and silica fired at a high temperature, excluding clay brick and tile) that is free of organic materials, metal, and plastic.

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

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 µm sieve when tested according to LS-601 or LS-602.

Free of Clay means the amount of material with a particle diameter less than 2 µm shall not be greater than 1% of the total sample when tested according to LS-702.

Glass means processed glass obtained from the recycling stream that is free of organic materials, metal, and plastic.

Granular A means a set of requirements for dense graded aggregates intended for use as granular base within the pavement structure, granular shouldering, and backfill.

Granular B means a set of requirements for well-graded aggregates intended for use as granular subbase within the pavement structure and granular backfill. Granular B may be Type I, Type II, or Type III.

Granular M means a set of requirements for dense graded aggregates intended for use on unpaved road surfaces and for the maintenance of unpaved shoulders.

Granular O means a set of requirements for open graded aggregates intended only for use as a free draining granular base within the pavement structure.

Granular S means a set of requirements for dense graded aggregates intended only for use as surface dressing of low volume unpaved roads with an AADT less than 200.

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

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.

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.

Reclaimed Asphalt Pavement (RAP) means processed hot mix asphalt material that is recovered by partial or full depth removal.

Reclaimed Concrete Material (RCM) means removed or processed old hydraulic cement concrete.

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

Select Subgrade Material (SSM) means a set of requirements for well-graded non-plastic aggregates used to replace poor subgrade materials and as swamp backfill.

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

1010.05 MATERIALS

1010.05.01 General

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

Aggregates shall meet the physical property requirements shown in Table 1 and the gradation requirements shown in Table 2.

When aggregates are tested according to LS-630, the total amount of wood shall not exceed 0.1% by mass, and the total amount of deleterious material and other contaminants shall not exceed a combined total of 1.0% by mass.

Glass and ceramic material shall be processed to remove all deleterious organic materials. 100% of the processed glass and ceramic material shall pass the 13.2 mm sieve.

When RCM is permitted, RCM shall not contain loose reinforcing materials.

When air-cooled blast furnace slag, nickel slag, and RAP containing steel slag aggregates are used, site-specific notification shall be given by the Contractor to the Ontario Ministry of the Environment (MOE).

When reclaimed materials are permitted, they shall be homogeneously blended.

Steel slag shall not be used.

When a change in the character of the aggregate occurs or when the performance of the aggregate is found to be unsatisfactory, use of those aggregates shall be discontinued until the Contractor can prove to the satisfaction of the Contract Administrator that the source remains acceptable or can be made acceptable.

1010.05.02 Granular A, Granular M, and Granular S

Granular A, Granular M, and Granular S shall be produced by crushing one or more of the following:

- a) Quarried bedrock.
- b) Boulders, cobbles, gravel, sand, and fines from naturally formed deposits.

- c) RAP up to 30% by mass.
- d) RCM up to 100% by mass.
- e) Air-cooled blast-furnace slag or nickel slag.
- f) Glass or ceramic materials up to a combined total of 15% by mass.

Granular A and Granular M containing RAP with steel slag aggregates shall be acceptable for unpaved gravel shoulders only.

1010.05.03 Granular B

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

1010.05.03.01 Granular B Type I and Type III

Granular B Type I and Type III may be produced from naturally formed deposits of sand, gravel, and cobbles or by crushing one or more of the following:

- a) Quarried bedrock.
- b) Air-cooled blast-furnace slag or nickel slag.
- c) RCM up to 100% by mass.
- d) RAP up to 30% by mass.
- e) Glass or ceramic materials up to 15% by mass combined.

RAP containing steel slag aggregates shall not be allowed.

1010.05.03.02 Granular B Type II

Granular B Type II shall only be produced by crushing:

- a) Quarried bedrock.
- b) Air-cooled blast furnace slag or nickel slag.

Steel slag and reclaimed materials shall not be used in the production of Granular B Type II.

1010.05.04 Granular O

Granular O shall only be produced by crushing:

- a) Quarried bedrock.
- b) Cobbles or boulders retained on the 50 mm sieve.

Steel slag and reclaimed materials shall not be used in the production of Granular O.

1010.05.05 Select Subgrade Material

Select subgrade material shall only be produced from natural deposits of non-plastic silt, sand, and gravel material. Reclaimed materials of any type shall not be used.

1010.07 PRODUCTION

1010.07.01 Aggregate Processing, Handling, and Stockpiling

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 immediately removed from the stockpile.

1010.08 QUALITY ASSURANCE

1010.08.01 General

QA testing may be carried out by the Owner for the purposes of ensuring that the aggregates used in the work are according to the requirements of 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 materials, test data from each source and product shall be managed independently.

The Owner shall be responsible for all costs associated with testing for QA purposes, unless otherwise specified in the Contract Documents.

1010.08.02 Laboratory Requirements

The Contract Administrator shall designate the QA laboratories.

An acceptable laboratory conducting tests for physical properties shall be one that holds a current Type D certificate from CCIL for the applicable test methods and also participates in the annual MTO Proficiency Sample Testing Program for the specific tests, except LS-616 and LS-709.

An acceptable laboratory conducting tests for gradation according to LS-602 and percent crushed particles according to LS-607 shall be one that holds a current Type C certificate from CCIL.

Testing shall be conducted by qualified laboratory staff that holds a current certificate from CCIL in aggregate testing.

Equivalent alternate laboratory and technician certifications or laboratory proficiency testing programs may be used to demonstrate similar requirements, provided that they are acceptable to the Contract Administrator.

1010.08.03 Sampling

Sampling shall be according to LS-625.

Duplicate samples shall be taken and sealed by the Contractor in the presence of the Contract Administrator at the time and location determined by the Contract Administrator. When materials contain blended or reclaimed aggregates or both, QA sampling shall be performed on the final blended product.

The mass of each sample shall meet the requirements shown in Table 3. When more than 30 kg is required, the total samples shall be recombined by the QA laboratory prior to testing.

In the event that the Contractor is unavailable to take the sample, no further materials shall be placed in the work until the duplicate samples been taken.

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 on both the inside and the outside of the sample container.

1010.08.04 Testing and Retention of Samples

When the Contract Administrator elects to carry out QA testing, one of the duplicate samples shall be randomly selected for testing by the QA laboratory and the remaining sealed sample shall be retained by the QA laboratory for possible referee testing.

1010.08.05 Acceptance

QA test results shall be used for acceptance purposes, except when referee testing has been carried out.

When QA test results show that the aggregates meet the requirements of this specification, the aggregates shall be accepted.

When QA test results show that the aggregates do not meet the requirements of this specification, the Contract Administrator shall notify the Contractor that aggregates represented by the test results shall not be accepted. This notification shall take place in writing within 3 Business Days of receipt of the non-conforming data. The Contractor has the option of either removing the aggregates from the work or invoking referee testing. The Contractor may request a reduced price in lieu of removal of aggregates that fail to meet the requirements of this specification. Irrespective of the negotiation of a reduced price payment, the warranty provisions of the Contract Documents shall apply.

At the discretion of the Contract Administrator, irrespective of non-compliance with the requirements of this specification, aggregates may be accepted on the basis of satisfactory field performance.

1010.08.06 Referee Testing

When QA test results do not meet the requirements of this specification, the Contractor has the option of invoking referee testing of the test result that fails to meet the requirements. The Contractor shall notify the Contract Administrator of the selected option in writing within 2 Business Days following written notification of unacceptable material.

The Contract Administrator shall select a referee laboratory acceptable to the Contractor within 3 Business Days following the Contractor's notification to invoke referee testing. Referee test samples shall be delivered to the referee testing laboratory from the QA laboratory by the Contract Administrator. The sealed sample shall be opened in the presence of the Contractor and the Contract Administrator. If referee materials are not available, the Contractor shall be responsible for obtaining and submitting new samples to the referee laboratory from a location to be decided by the Contract Administrator. The Contract Administrator shall be present to witness the sampling.

Referee testing shall be carried out in the presence of the Contract Administrator. When applicable, the referee laboratory shall also test a control aggregate sample for each test method required. The Contractor may observe the testing at no cost to the Owner.

The Contractor and Owner may send a maximum of two representatives each to observe the referee testing. The Contract Administrator shall notify the Owner and Contractor a minimum of 3 Business Days in advance of the date of referee testing. Provided that such notice was given, referee testing shall be carried out regardless of the absence of one or more observers.

Observers shall follow the referee laboratory protocols for access to the premises and testing equipment and shall not unnecessarily impede the progress of the testing. Observers shall be permitted to validate sample identification and view sample condition. Subject to safety requirements, test method and equipment limitations, they shall also be permitted to observe test procedures, take notes, view equipment readings and review completed work sheets while in attendance.

Comments on the non-conformity of the test methods shall be made and corrected at the time of testing.

Referee test results shall be binding on both the Owner and the Contractor.

When a referee test result shows that the aggregates do not meet the requirements of this specification, the aggregates represented by the test result, including aggregates in existing stockpiles or in the Work, shall not be accepted. The Contractor shall remove the aggregates from the Work at no cost to the Owner. The Contractor may request a reduced price in lieu of the removal of aggregates that fail to meet the requirements of this specification. Irrespective of the negotiation of a reduced price payment, the warranty provisions of the Contract Documents shall apply.

When a referee test result shows that the aggregates meet the requirements of this specification, the aggregates represented by the sample shall be accepted.

The Owner shall be responsible for the cost of referee testing provided that the referee test results show that the aggregates meet the applicable specifications. Otherwise, the Contractor shall be responsible for the cost.

TABLE 1
Physical Property Requirements

MTO Laboratory Test and Number	Granular O	Granular A	Granular S	Granular B Type I and Type III	Granular B Type II	Granular M	Select Subgrade Material
Percent crushed particles, % minimum, LS-607	100	60	50	--	--	60	--
Unconfined Freeze-Thaw, % maximum loss, LS-614	15	--	--	--	--	--	--
2 or more crushed faces, % minimum, LS-617	85 (Note 1)	--	--	--	--	--	--
Micro-Deval Abrasion Coarse Aggregate, % maximum loss, LS-618	21	25	25	30 (Note 2)	30	25	30 (Note 2)
Micro-Deval Abrasion, Fine Aggregate, % maximum loss, LS-619	25	30	30	35	35	30	N/A
Asphalt Coated Particles, % maximum, LS-621	0	30	30	30	0	30	0
Amount of Contamination, LS-630	(Note 3)						
Plasticity Index, maximum LS-703/704	0						
Determination of Permeability, k, LS-709	(Note 4)						
Notes:							
1. When Granular O is produced from boulders, cobbles, or gravel retained on the 50 mm sieve.							
2. The coarse aggregate Micro-Deval abrasion loss test requirements shall be waived if the material has more than 80% passing the 4.75 mm sieve.							
3. Granular A, B Type I, B Type III, or M may contain crushed glass or ceramic materials up to a combined total of 15% by mass. Granular A, B Type I, B Type III, M, O, and S shall not contain more than 1% by mass of wood, clay brick and/or gypsum and/or gypsum wall board or plaster. Granular B Type II and SSM shall not contain more than 0.1% by mass of wood.							
4. For materials north of the French and Mattawa Rivers only, the coefficient of permeability, k, shall be greater than 1.0×10^{-4} cm/s or alternatively, where past field experience has demonstrated satisfactory performance. Prior data demonstrating compliance with this requirement for k shall be acceptable, provided such testing has been done within the 5 years of the material being used and field performance has continually been shown to be satisfactory.							

TABLE 2
Gradation Requirements - Percent Passing

MTO Test	Sieve	Granular							Select Subgrade Material
		A	B (Note 1)			M	O	S	
			Type I (Note 2)	Type II	Type III (Note 2)				
Sieve Analysis, % Passing, LS-602	150 mm	N/A	100	N/A	100	N/A	N/A	N/A	100
	106 mm	N/A	N/A	100	N/A	N/A	N/A	N/A	N/A
	37.5 mm	N/A	N/A	N/A	N/A	N/A	100	N/A	N/A
	26.5 mm	100	50-100	50-100	50-100	N/A	95-100	100	50-100
	19.0 mm	85-100 (87-100, Note 3)	N/A	N/A	N/A	100	80-95	90-100	N/A
	13.2 mm	65-90 (75-95, Note 3)	N/A	N/A	N/A	75-95	60-80	75-100	N/A
	9.5 mm	50-73 (60-83, Note 3)	N/A	N/A	32-100	55-80	50-70	60-85	N/A
	4.75 mm	35-55 (40-60, Note 3)	20-100	20-55	20-90	35-55	20-45	40-60	20-100
	1.18 mm	15-40	10-100	10-40	10-60	15-40	0-15	20-40	10-100
	300 µm	5-22	2-65	5-22	2-35	5-22	N/A	11-25	5-95
	150 µm	N/A	N/A	N/A	N/A	N/A	N/A	N/A	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	9.0-15.0 (9.0-17.0, Note 4)	0-25.0

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 air-cooled blast furnace slag source.
4. When the aggregate is obtained from a quarry or an air-cooled blast furnace slag or nickel slag source.

TABLE 3
Sample Size

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

Appendix 1010-A, November 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

The designer should specify the following in the Contract Documents:

- Type of Granular B to be used. (1010.05.03)

The designer should determine if the following is required and, if so, specify it in the Contract Documents:

- If the quality assurance sampling and testing frequencies provided in Appendix 1010-B are to be used, Appendix 1010-B needs to be invoked by reference in the Contract Documents.
- If the payment reduction in lieu of aggregate removal provided in Appendix 1010-C is to be used, Appendix 1010-C needs to be invoked by reference in the Contract Documents.
- If the test data forms in Appendices 1010-D and 1010-E are to be used for submission purposes, Appendices 1010-D and 1010-E need to be invoked by reference in the Contract Documents.

The use of steel slag aggregate is prohibited.

The designer should be aware that aggregates that are wholly or partially comprised of industrial by-products and/or recycled materials such as, but not limited to, air-cooled iron blast furnace slag, nickel slag, and RAP containing steel slag aggregates, may have specific placement and approval requirements or constraints to mitigate adverse affects on the environment based on local conditions and/or municipal and MOE policy. Prior to tendering, when such Owner supplied or specified materials are to be used, the designer should provide site notification to MOE and ensure any applicable environmental placement and approval requirements and constraints are included in the Contract Documents.

RAP content is determined by LS-621, percent Asphalt Coated Particles. However, this test is limited to identifying RAP content in the coarse aggregate portion only. When RAP in fine aggregate is a concern a Petrographic Examination of the material passing the 4.75 mm sieve is recommended. (1010.05.02)

The designer should be aware that quality assurance (QA) testing for the purpose of ensuring material used in the work meet the requirements of OPSS 1010 is not mandatory unless specifically included in the Contract Documents. The designer should determine the need for QA testing based on the size and complexity of the work and specify the required frequencies of QA sampling and testing. Appendix 1010-B provides recommended QA sampling and testing frequencies.

The designer may specify a higher percent crushed requirement to improve performance in higher traffic areas.

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

Appendix 1010-A

Related Ontario Provincial Standard Drawings

No information provided here.

Appendix 1010-B, November 2013**FOR USE IN MUNICIPAL CONTRACTS, WHEN REFERENCED IN THE CONTRACT DOCUMENTS**

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

Supplementary Requirements for Quality Assurance Sampling and Testing Frequency

OPSS.MUNI 1010, Aggregates-Base, Subbase, Select Subgrade, and Backfill Material, is amended as follows:

1010.08 QUALITY ASSURANCE**1010.08.01 General**

The first paragraph of subsection 1010.08.01 is deleted in its entirety and replaced with the following:

QA sampling and testing shall be carried out by the Owner for the purposes of ensuring that the aggregates used in the work are according to the requirements of the Contract Documents. QA sampling and testing shall be carried out at the frequency specified in Table B-1. Individual test results may be forwarded to the Contractor as they become available.

Table B-1 is added.

TABLE B-1
Sampling and Testing Frequency for Physical Property Requirements

Quantity from Each Source or Process t	Granular A; Granular B - Type I, II, and III; Granular M; Granular O; and Select Subgrade Material
≤ 5,000	One sample.
> 5,000 (Note 1)	One sample per 5,000 tonnes.
Note: 1. When the quantity of material is: a) Less than one-half the quantity required for a sample, then that quantity shall be added to the quantity representing the previous sample. b) Greater than or equal to one-half the quantity required for a sample, then that quantity shall require its own sample.	

Appendix 1010-B

Table B-2 is added.

TABLE B-2
Sampling and Testing Frequency for Gradation Requirements

Quantity from Each Source or Process t	Granular A, O, and M	Granular B - Type I, II, and III, and Select Subgrade Material
< 250	At the Contract Administrator's discretion.	
≥ 250 and ≤ 1,000	One sample.	
> 1,000 (Note 1)	One sample per 1,000 tonnes.	
Note: 1. When the quantity of granular material is: a) Less than one-half the quantity required for a sample, then that quantity shall be added to the quantity representing the previous sample. b) Greater than or equal to one-half the quantity required for a sample, then that quantity shall require its own sample.		

Appendix 1010-C, November 2013

FOR USE IN MUNICIPAL CONTRACTS, WHEN REFERENCED IN THE CONTRACT DOCUMENTS

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

Supplementary Requirements for Reduced Price Payment In Lieu of Aggregate Removal

When a tested sample of aggregates shows that the aggregates do not meet the requirements of this specification, the aggregates represented by the test result, including material in existing stockpiles or in the Work, shall not be accepted. The Contractor may request a reduced price in lieu of removal provided the applicable test results:

- 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 a plasticity index within the material when determined according to LS-703/704 and the requirement for LS-602 on the 75 µm is met.
- d) Meet all other requirements of this specification.

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

Appendix 1010-D, November 2013

FOR USE IN MUNICIPAL CONTRACTS, WHEN REFERENCED IN THE CONTRACT DOCUMENTS

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

OPSS 1010 - Aggregate Test Data - Granulars Physical Properties

Contract No.:	Contractor:	Contract Location:	
Name of Testing Laboratory:		Telephone No.:	Fax No.:
Sampled by (Print Name):		Date Sampled (YY/MM/DD):	Date Tested (YY/MM/DD):
Granular Type:		Quantity (tonnes) :	
Source Name/Location:		Aggregate Inventory Number (AIN) :	

Laboratory Test and Number	Requirements								Test Results		
	A	B Type I	B Type II	B Type III	M	O	S	SSM	Reference Material	Sample	Meets Requirements (Y/N)
Crushed Particles, % minimum, LS-607	60	--	100	--	60	100	50	--			
Unconfined Freeze-Thaw, % maximum loss, LS-614	--	--	--	--	--	15	--	--			
2 or more Crushed Faces, % minimum, LS-617	--	--	--	--	--	85 (Note 1)	--	--			
Micro-Deval Abrasion, Coarse Aggregate % maximum loss, LS-618	25	30 (Note 2)	30	30 (Note 2)	25	21	25	30 (Note 2)			
Micro-Deval Abrasion, Fine Aggregate % maximum loss, LS-619	30	35	35	35	30	25	30	--			
Asphalt Coated Particles, % maximum, LS-621	30	30	0	30	30	0	30	0			
Amount of Contamination, LS-630	(Note 3)										
Plasticity Index, maximum, LS-703/704	0										
Determination of Permeability, k, LS-709	(Note 4)										
Notes:											
1. When Granular O is produced from boulders, cobbles, or gravel retained on the 50 mm sieve.											
2. 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.											
3. Granular A, B Type I, B Type III, or M may contain up to 15 percent by mass crushed glass or ceramic materials. Granular A, B Type III, M, O, and S shall not contain more than 1.0 percent by mass of wood, clay brick and/or gypsum and/or gypsum wall board or plaster. Granular B Type II and SSM shall not contain more than 0.1 percent by mass of wood.											
4. For materials north of the French/Mattawa Rivers only, the coefficient of permeability, k, shall be greater than 1.0 x 10 ⁻⁴ cm/s or 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.											

I hereby certify that testing has been carried out by a properly qualified/certified test technician:

Issued by: _____
 PRINT NAME TESTING LABORATORY REPRESENTATIVE SIGNATURE DATE

Received by: _____
 PRINT NAME CONTRACT ADMINISTRATOR REPRESENTATIVE SIGNATURE DATE

Copies to: Contract Administrator Contractor

Appendix 1010-E, November 2013

FOR USE IN MUNICIPAL CONTRACTS, WHEN REFERENCED IN THE CONTRACT DOCUMENTS

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

OPSS 1010 - AGGREGATE TEST DATA - GRANULARS GRADATION REQUIREMENTS, LS-602

Contract No.:	Contractor:	Contract Location:	
Name of Testing Laboratory:		Telephone No.:	Fax No.:
Sampled by (Print Name):		Date Sampled (YY/MM/DD):	Date Tested (YY/MM/DD):
Granular Type:		Quantity (tonnes) :	
Source Name/Location:		Aggregate Inventory Number (AIN) :	

Sieve Size	Gradation Requirement, % Passing								Test Result	
	A	B (Note 1)			M	O	S	SSM	Sample	Meets Requirements (Y/N)
		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	50-100	50-100	50-100	--	95-100	100	50-100		
19.0 mm	85-100 (87-100, Note 3)	--	--	--	100	80-95	90-100	--		
13.2 mm	65-90 (75-95, Note 3)	--	--	--	75-95	60-80	75-100	--		
905 mm	50-73 (60-73, Note 3)	--	--	32-100	55-80	50-70	60-85	--		
4.75 mm	35-55 (40-60, Note 3)	20-100	20-55	20-90	35-55	20-45	40-60	20-100		
1.18 mm	15-40	10-100	10-40	10-60	15-40	0-15	20-40	10-100		
300 µm	2-55	2-65	5-22	2-35	5-22	--	11-25	5-95		
150 µm	--	--	--	--	--	--	--	2-65		
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	9.0-15.0 (9.0-17.0, Note 4)	0-25.0		

Notes:

- When Granular B is used for granular backfill for pipe subdrains, 100% of the material shall pass the 37.5 mm sieve.
- When RAP is blended with Granular B Type I or Type III, 100 percent of the RAP shall pass the 75 mm sieve. Conditions in Note 1 supersede in this requirement.
- When the aggregate is obtained from an iron blast furnace slag source.
- When the aggregate is obtained from a quarry or blast furnace slag or nickel slag source.

I hereby certify that testing has been carried out by a properly qualified/certified test technician:

Issued by: _____
PRINT NAME TESTING LABORATORY REPRESENTATIVE SIGNATURE DATE

Received by: _____
PRINT NAME CONTRACT ADMINISTRATOR REPRESENTATIVE SIGNATURE DATE

Copies to: Contract Administrator Contractor



MATERIAL SPECIFICATION FOR PERFORMANCE GRADED ASPHALT CEMENT

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1101.01	SCOPE

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

1101.01.01 Specification Significance and Use

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

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

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 310 Hot Mix Asphalt

Ontario Ministry of Transportation Publications

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

ASTM International

D 3665-12	Standard Practice for Random Sampling of Construction Materials
D 7343-12	Standard Practice for Optimization, Sample Handling, Calibration, and Validation of X-ray Fluorescence Spectrometry Methods for Elemental Analysis of Petroleum Products and Lubricants

American Association of State Highway and Transportation Officials (AASHTO)

M 320-10	Standard Specification for Performance Graded Asphalt Binder
M 332-14	Standard Specification for Performance-Graded Asphalt Binder Using Multiple Stress Creep Recovery (MSCR) Test
R 29-14	Grading or Verifying the Performance Grade of an Asphalt Binder

T 40-02 (2012) Sampling Bituminous Materials
T 350-14 Standard Method of Test for Multiple Stress Creep Recovery (MSCR) Test 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.

CTOD means Critical Crack Tip Opening Displacement as defined in LS-299.

Hot Mix Asphalt (HMA) means as defined in OPSS 310.

Independent Laboratory means a third party laboratory that is not owned or corporately affiliated with the laboratory that prepared the mix design or with the Contractor.

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 of PGAC specified in the Contract Documents where the PGAC grade specified is PGAC XX-YY.

Performance Graded Asphalt Cement (PGAC) means an asphalt binder that is produced from petroleum residue, either with or without the addition of non-particulate modifiers and meets the requirements of AASHTO M 320 or M 332.

PGAC XX-YY means PGAC with XX being the high temperature performance grade and -YY being the low temperature performance grade, as specified elsewhere in the Contract Documents, and meets the requirements of AASHTO M 320.

PGAC XXS-YY means PGAC graded using Multiple Stress Creep Recovery (MSCR) test for standard traffic level, as specified in the Contract Documents, and meets the requirements of AASHTO M 332.

PGAC XXH-YY means PGAC graded using Multiple Stress Creep Recovery (MSCR) test for high traffic level, as specified elsewhere in the Contract Documents, and meets the requirements of AASHTO M 332.

PGAC XXV-YY means PGAC graded using Multiple Stress Creep Recovery (MSCR) test for very high traffic level, as specified in the Contract Documents, and meets the requirements of AASHTO M 332.

PGAC XXE-YY means PGAC graded using Multiple Stress Creep Recovery (MSCR) test for extreme traffic level, as specified in the Contract Documents, and meets the requirements of AASHTO M 332.

Recompaction Temperature means the temperature to which plant produced mix is to 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) Documentation of construction, storage and handling requirements, including the material safety data sheet, recompaction temperature, mix discharge temperature, and recommended extraction procedure.
- d) When the asphalt cement contains any zinc oxide or iron carboxylates or a combination, added as a Hydrogen Sulfide (H₂S) scavengers, they must be declared.
- 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.

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. Silicone oils are allowed as anti-foaming agents at less than five parts per million. Zinc oxide and iron carboxylates may be used as hydrogen sulfide (H₂S) scavengers..

PGAC shall not contain more than 0.3% polyphosphoric acid (PPA) or 0.3% elemental sulfur (S) in addition to the typical sulfur that is naturally presence in the asphalt cement, and these shall only be used as catalysts for the purpose of modification with epoxy(E)-type or styrene-butadiene (SB)-type polymer modifiers. PGAC shall not contain any orthophosphoric acid.

PGAC shall not be air blown or catalytically oxidized in any manner. PGAC shall not contain any air blown or catalytically oxidized residues.

The asphalt cement shall not contain any of the following additives added for PGAC modification: atactic polypropylene; carbon black; polyisobutylene; polyisoprene; natural rubber; alkaline bases; insoluble particulates or fibres; salts of iron, copper, manganese and/or cobalt; silicates; styrene-butadiene rubber (random copolymer latex); synthetic waxes (paraffin waxes, naphthenic waxes); synthetic and saturated oils (including but not limited to the following: vegetable oils or modified vegetable oils; (paraffin oils, polyalphaolefins (PAO), lube oils, and re-refined lube oils.); waste oils (including but not limited to the following: cracked residues, re-refined high vacuum distillate oils; tall oils, vacuum tower asphalt extenders; waste cooking oils, waste engine oils, waste engine oil residues). Asphalt cement supplier shall declare in writing that they have not added the PGAC additives listed above.

If modifiers or additives other than styrene-butadiene (e.g., SB diblock, SBS triblock, SBS radial, SBS high vinyl, SB tapered, etc.) or epoxy-type (e.g. reactive elastomeric terpolymers) polymers are used for the modification of neat asphalt cement, pre-approval from the Owner is required.

Organic bases may be contained in the PGAC provided they are used as anti-stripping or warm mix additives or both. If any of the above additives are present in anti-stripping and/or warm mix asphalt additives, they shall be declared at the time of mix submission.

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

PGAC shall be shipped, used, and handled at all times in accordance with the manufacturer's specifications.

1101.07 PRODUCTION

1101.07.01 Sampling and Testing

Sampling shall be as described 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 determined by the Owner based on QA test results conducted by the Owner's designated laboratory, unless superseded by referee test results, according to the requirements of the Contract Documents.

The Contractor shall be provided with test results from the tests that are completed.

The Owner shall be responsible for all costs associated with testing for QA purposes, unless otherwise specified in the Contract Documents.

The Owner may conduct elemental testing according to ASTM D7343 or other tests to determine if the asphalt cement meets the material requirements as specified in the Materials section.

1101.08.01.01 Laboratory Requirements

The laboratory conducting PGAC testing shall have participated in the most recent AASHTO Materials Reference Laboratory proficiency sample correlation program for PGAC and the most recent MTO correlation for all PGAC testing to be carried out. All QA and referee labs shall be CCIL certified for the tests required.

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:

- a) It was not added at the supplier depot to a PGAC containing polyphosphoric acid (PPA); and that
- b) When production begins the Contractor submits to the Contract Administrator complete AASHTO M 320 test results rounded to the nearest 0.5 °C for the following:
 - i. Asphalt cement with anti-stripping additive at the percentage identified in the mix design.
 - ii. Asphalt cement without the anti-stripping additive.

1101.08.03 Sampling

The Contract Administrator shall determine the frequency of sampling and testing for each grade of PGAC based on the HMA tender quantity. The Contract Administrator shall determine the quantity and location of HMA to be represented by each PGAC sample. When only one sample is taken on the job, the sample shall be deemed to represent all HMA placed on the Contract with that PGAC grade. All 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 according to 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 reviewed in advance. The QA, referee, and other required samples for possible Owner testing shall be taken at the same time.

PGAC shall be sampled when notified by the Contract Administrator.
Sample quantity, labelling and delivery requirements shall be according to Table 2. Samples shall be delivered in a condition suitable for testing.

1101.08.03.01 Switching Performance Grade or Source of Supply

The Contract Administrator shall be advised in writing whenever there is a change in performance grade or source of supply.

1101.08.04 Quality Assurance Testing

When the Contract Administrator elects to carry out QA testing, one of the samples shall be randomly selected for testing by the QA laboratory and the remaining sealed sample shall be retained by the QA laboratory for possible referee testing.

Test results for samples that do not comply with the performance grading requirements shall be categorized as 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 design maximum pavement temperature or lower than the design minimum pavement temperature is not considered a deviation.

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

Rejectable: Not complying with the above.

When a sample 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.

The Owner may conduct elemental testing according to ASTM D7343 or other tests to determine if the asphalt cement meets the material requirements as specified in the Materials section.

1101.08.05 Disposition of HMA Produced with PGAC Not Conforming with the Requirements of the Contract Documents

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. 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:

Borderline: The HMA shall be accepted at full payment.

Rejectable: The HMA shall not be accepted into the Work. The Contract Administrator shall notify the Contractor in writing within 3 Business Days of receipt of the non-conforming data. The Contractor has the option of either removing the HMA from the Work and replacing it with acceptable HMA or invoking referee testing. The Contractor may request a reduced price in- lieu of removal of the HMA. Irrespective of the negotiation of a reduced price payment, the warranty provisions of the Contract Documents shall apply.

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.

1101.08.06 Referee Testing

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

The Contract Administrator shall select a referee testing laboratory acceptable to the Owner within 3 Business Days following the Contractor's written notification to invoke referee testing. Referee test samples shall be delivered to the referee testing laboratory from the QA laboratory by the Contract Administrator.

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 PGAC to determine whether the product conforms to the Contract Documents and the disposition of the HMA represented by the sample tested.

Referee testing shall be carried out in the presence of the Owner's designate. The Contractor may observe the testing at no cost to the Owner.

The Contractor and the Owner may send a maximum of two representatives each to observe the referee testing. The Contract Administrator shall notify the Owner and Contractor a minimum of 3 Business Days in advance of the date of referee testing. Provided that such notice was given, referee testing shall be carried out regardless of the absence of one or more observers.

Observers shall follow the referee laboratory protocols for access to the premises and testing equipment and shall not unnecessarily impede the progress of the testing. Observers shall be permitted to validate sample identification and view sample condition. Subject to safety requirements, test method and equipment limitations, they shall also be permitted to observe test procedures, take notes, view equipment readings, and review completed work sheets while in attendance. The taking of photographs and videos shall not be permitted.

Concerns with sample condition or sample identification shall be made known to all observers prior to commencement of the referee testing. Comments on deviations from the applicable test method shall be made at the time of referee testing. Unresolved concerns shall be specific in nature and submitted in writing to the referee laboratory's designated representative and the other observers present, at the time of testing.

Referee test results shall be binding on both the Owner and the Contractor.

When referee test results show that the PGAC is rejectable, the HMA represented by the test results shall not be accepted. The Contractor shall remove the HMA from the Work at no cost to the Owner. The Contractor may request a reduced price in-lieu of removal of HMA produced with PGAC with rejectable test results. Irrespective of the negotiation of a reduced price payment, the warranty provisions of the Contract Documents shall apply.

The Owner shall be responsible for the cost of referee testing, provided that the referee test results confirm total conformance of the PGAC sample to the Contract Documents. Otherwise, the Contractor shall be responsible for the cost.

Table 1
Additional Asphalt Cement Testing Requirements and Acceptance Criteria for All PG Grades

PGAC Grade	Property and Attributes (Unit)		Test Method	Results Reported Rounded to the Nearest	Acceptance Criteria	Rejectable
All PGAC Grades	Ash Content, % by mass of residue (%)	PG XX-28	LS-227	0.1	≤ 0.6	> 0.6
		PG XX-34			≤ 0.6	> 0.6
		PG XX-40			≤ 0.6	> 0.6
All PGAC Grades Except PG 58-28 and PG 52-34	Low temperature limiting grade (LTLG) (°C)		LS-308	0.5	$\leq (-YY + 3)$	$> (-YY + 3)$
	Grade Loss (°C)		LS-308	0.5	≤ 6.0	> 6.0
	Non-recoverable creep compliance at 3.2 kPa ($J_{nr-3.2}$) (kPa ⁻¹)		AASHTO T 350 For testing temperature see Note 1	0.01	≤ 4.5	> 4.5
	Average percent recovery at 3.2 kPa ($R_{3.2}$) (%)			0.1	$\geq$ the lesser of $[(29.371) (J_{nr-3.2})^{-0.2633}]$ or 50	$<$ the lesser of $[(29.371) (J_{nr-3.2})^{-0.2633} - 10]$ or 50
	CTOD, δ_t (mm)	PG XX-28	LS-299	0.1	≥ 8.0	< 8.0
		PG XX-34			≥ 12.0	< 12.0
		PG XX-40			≥ 16.0	< 16.0
Notes: 1. The testing temperature shall be 52°C for PGAC Zone 1 and 58°C for PGAC Zones 2 and 3.						

TABLE 2
Sampling Requirements

Samples	Minimum Sample Quantity	Labelling	Delivery
QA	2 litres (Note 1)	Label shall include: • Contract number. • Date (i.e., yyyy-mm-dd) and time of sampling • Performance grade of the asphalt cement. • Supplier's name.	• Samples shall be delivered as specified in the Contract Documents. • Samples shall be delivered at the same time.
Referee	2 litres (Note 1)		
Notes: 1. 2 litres shall be provided in 2 suitable one litre containers or a container able to hold a minimum of 2 litres.			

Appendix 1101-A, November 2016 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

The designer should be aware that OPSS 1101 has been revised to reflect the adoption of performance grading of asphalt cements in Ontario and additional testing to further characterize properties of the asphalt cement.

The designer should be aware that in this specification asphalt binder means asphalt cement. The former term is used in the AASHTO references cited, while the latter continues to be used in OPS specifications.

The designer should be aware that for the purpose of PGAC grade designation, Ontario has been divided into three zones as follows:

Zone 1: The area north of the boundary formed by the French River, Lake Nipissing, and the Mattawa River.

Zone 2: The area south of Zone 1, and north of a line from Honey Harbour, to Longford, Taylor Corners, Cavan, Campbellford, and Mallorytown.

Zone 3: The area south of Zone 2.

For design purposes, the designer shall ensure:

- a) Towns located along a zone boundary line are to be included in the zone south of the boundary line.
- b) Projects located within 10 km of zone boundary lines may be included in either zone at the discretion of the designer so that they may be considered within one zone only.

Appendix Table A-1 provides the basic performance grades for each Ontario zone. Recycling ratios in excess of 15% should be addressed on a Contract specific basis.

The designer is advised to use LTPP-Bind (Version 3.1 or later) to confirm the cold temperature grade of PGAC. A percent reliability of greater than 90% is recommended for low volume and residential roads and greater than 95% is recommended for highways and major projects according to NCHRP Report 673. OHMPA is recommending selecting a grade based on 98% reliability.

The designer shall consider the following when selecting PGAC grades:

- a) The location of the Contract (i.e., the geographical zone in which it is located) percent reliability appropriate for facility and work being carried out, noting that some discretion is allowed.
- b) The type of hot mix, new versus recycled hot mix.
- c) Upgrades for heavy commercial traffic, frequent starts and stops, and vehicle speeds. The designer may bump the high temperature grade according to Appendix Table A-2, or when invoking Appendix B, use MSCR graded PGAC according to Appendix Table A-3.

The designer shall include delivery instructions for the asphalt cement samples elsewhere in the Contract Documents.

The designer may include Appendix B to require Multiple Stress Creep Recovery (MSCR) graded PGAC in lieu of bumping the high temperature grade. Appendix B uses the AASHTO M 332 standard which encompasses the MSCR grading system for asphalt cement. It is intended to replace the PG system for grading asphalt cement described in AASHTO M 320. AASHTO M 332 uses the MSCR test to determine the high temperature rutting properties and elastic response of the binder.

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

Note: When the Owner is concerned about testing variability they may request that the lab conducting quality assurance testing participate in MTO's PGAC correlation and may on request ask the laboratory to provide their correlation ranking. MTO typically requires a ranking of 4 or better for their QA labs. Municipalities may contact MTO Bituminous Section for a list of labs appropriate for carrying out PGAC referee testing.

Related Ontario Provincial Standard Drawings

No information provided here.

**Appendix Table A-1
OPSS 1101 - Grade Selection for Ontario**

	PGAC Zones		
	Zone 1	Zone 2	Zone 3
New Hot Mix or up to 15% RAP by Mass	52 - 34	58 - 34	58 - 28

**Appendix Table A-2
OPSS 1101 - Guidelines for the Adjustment of PGAC High Temperature Grade
Based on Roadway Classification and Traffic Conditions**

Highway Type	Increase from Standard	Optional Additional Grade Increase (Note 1)
Urban Freeway	2 Grades	N/A
Rural Freeway Urban Arterial	1 Grade	1 Grade
Rural Arterial Urban Collector	Consider increasing by 1 grade if heavy truck traffic is greater than 20% of AADT	1 Grade
Rural Collector Rural Local Urban/Suburban Collector	No Change	1 or 2 Grades
Notes: A. Upgrading of the high temperature grade is recommended for use in both surface and top binder courses, i.e., top 80 to 100 mm of hot mix. B. Alternatively, Multiple Stress Creep Recovery (MSCR) graded PGAC acceptance criteria, according to Appendix B and Appendix Table A-3, can be used. 1. Consideration should be given to an increase in the high temperature grade for roadways which experience a high percentage of heavy truck or bus traffic at slow operating speeds, frequent stops and starts, and historical concerns with instability rutting.		

Appendix Table A-3
OPSS 1101 - Guidelines for the Selection of PGAC Graded Using Multiple
Stress Creep Recovery (MSCR) Test When Invoking Appendix “B” Based on
Roadway Classification and Traffic Conditions

Highway Type	Recommended PGAC Grade Using MSCR Test	Optional Grade Increase (Note 1)
Urban Freeway	XXV-YY	N/A
Rural Freeway Urban Arterial	XXH-YY	XXV-YY
Rural Arterial Urban Collector	Consider specifying XXH-YY if heavy truck traffic is greater than 20% of AADT	XXV-YY
Rural Collector Rural Local Urban/Suburban Collector	XXS-YY	XXH-YY or XXV-YY
Toll Plaza Port Facility Dedicated Transitways Truck Marshaling Yards (standing traffic)	XXE-YY	N/A
Notes: A. It is recommended that Multiple Stress Creep Recovery (MSCR) graded PGAC is used in both surface and top binder courses, i.e., top 80 to 100 mm of hot mix. 1. Consideration should be given to an increase in the high temperature traffic level for roadways which experience a high percentage of heavy truck or bus traffic at slow operating speeds, frequent stops and starts, and historical concerns with instability rutting.		

Appendix 1101-B, November 2016

FOR USE IN MUNICIPAL CONTRACTS, WHEN REFERENCED IN THE CONTRACT DOCUMENTS

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

Additional Requirements for Performance Graded Asphalt Cement Further Graded for Traffic Loading Using Multiple Stress Creep Recovery Testing

AASHTO M332 replaces AASHTO M320, unless superceded by requirements in Appendix B Table 1 below.

OPSS.MUNI 1101 Performance Graded Asphalt Cement, is amended as follows:

1101.04 DESIGN AND SUBMISSION REQUIREMENTS

1101.04.01 Submission Requirements

1101.04.01.01 PGAC Test Documentation

Point d) of clause 1101.04.01.01 of OPSS 1101 is deleted in its entirety and replaced with the following:

- d) 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 M332 for the PGAC grade specified.

1101.05 MATERIALS

The first paragraph in Section 1101.05 of OPSS 1101 is deleted in its entirety and replaced with the following:

PGAC shall be according to AASHTO M 332 with the exception of percent difference in non-recoverable creep compliance between 0.1 kPa and 3.2 kPa (J_{nrdiff}) requirements, for the performance grades specified in the Contract Documents.

1101.08 QUALITY ASSURANCE

1101.08.02 Anti-Stripping Additive

Subsection 1101.08.02 of OPSS 1101 is deleted in its entirety and replaced with the following:

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:

- a) It was not added at the supplier depot to a PGAC containing polyphosphoric acid (PPA); and that

b) When production begins the Contractor submits to the Contract Administrator complete AASHTO M 332 and Table 1 test results for the following:

i) Asphalt cement with anti-stripping additive at the percentage identified in the mix design.

ii) Asphalt cement without the anti-stripping additive.

Table 1 is deleted in its entirety and replaced with the following:

Appendix B Table -1
Additional Asphalt Cement Testing Requirements and Acceptance Criteria for All PG Grades

	Property and Attributes (Unit)		Test Method	Results Reported Rounded to the Nearest	Acceptance Criteria	Rejectable
All PGAC Grades	Ash Content, % by mass of residue (%)	for -YY = -28	LS-227	0.1	≤ 0.6	> 0.6
		for -YY = -34			≤ 0.6	> 0.6
		for -YY = -40			≤ 0.6	> 0.6
	Non-recoverable creep compliance at 3.2 kPa ($J_{nr3.2}$) (kPa^{-1}) when PGAC XXS-YY is specified		AASHTO T 350 testing conducted at high temperature grade of the PGAC (Note 1)	0.01	≤ 4.5	> 4.5
	Non-recoverable creep compliance at 3.2 kPa ($J_{nr3.2}$) (kPa^{-1}) when PGAC XXH-YY is specified			0.01	≤ 2.0	> 2.0
	Non-recoverable creep compliance at 3.2 kPa ($J_{nr3.2}$) (kPa^{-1}) when PGAC XXV-YY is specified			0.01	≤ 1.0	> 1.0
Non-recoverable creep compliance at 3.2 kPa ($J_{nr3.2}$) (kPa^{-1}) when PGAC XXE-YY is specified		0.01		≤ 0.55	> 0.55	
Average percent recovery at 3.2 kPa ($R_{3.2}$) (%)		0.1		$\geq$ the lesser of $[(29.371) (J_{nr-3.2})^{0.2633}]$ or 50	$<$ the lesser of $[(29.371) (J_{nr-3.2})^{0.2633} - 10]$ or 50	
All H, V and E Grades	Percent difference in non-recoverable creep compliance between 0.1 kPa and 3.2 kPa, $J_{nr\text{diff}}$ (%)		0.1	N/A Testing carried out for information purpose		
	All PGAC Grades Excluding PG 58S-28 and PG 52S-34	CTOD, δ_t (mm)	for -YY = -28	LS-299	0.1	≥ 8.0
for -YY = -34			≥ 12.0			< 12.0
for -YY = -40			≥ 16.0			< 16.0
	Low temperature limiting grade (LTLG) ($^{\circ}\text{C}$)		LS-308	0.5	$\leq (-YY + 3)$	$> (-YY + 3)$
	Grade Loss ($^{\circ}\text{C}$)		LS-308	0.5	≤ 6.0	> 6.0
Notes: 1. For example, the testing temperature for PG58V-28 is 58 $^{\circ}\text{C}$ and for 52H-34 it is 52 $^{\circ}\text{C}$.						



**MATERIAL SPECIFICATION FOR
LIQUID ASPHALT USED IN SPRAYING,
SEALING, AND PRIMING APPLICATIONS**

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APPENDICES

1102-A	Commentary

1102.01 SCOPE

This specification covers the requirements for different types and grades of liquid asphalt for use in highway construction and maintenance.

1102.01.01 Specification Significance and Use

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

Use of this specification or any other specification shall be as specified in the Contract Documents.

1102.01.02 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.

1102.02 REFERENCES

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

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

Ministry of Transportation Publications

MTO Laboratory Testing Manual:

LS-200	Penetration of Bituminous Materials
LS-201	Flash Point by Cleveland Open Cup
LS-202	Kinematic Viscosity of Asphalt
LS-204	Solubility of Bituminous Materials
LS-205	Ductility of Bituminous Materials

ASTM International

D 36-14e1	Softening Point of Bitumen (Ring-and-Ball Apparatus)
D 140-15	Sampling Bituminous Materials
D 243-08	Residue of Specified Penetration
D 402-14	Distillation of Cut-back Asphaltic (Bituminous) Products
D 3143-13	Flash Point of Cut-back Asphalt with Tag Open-Cup Apparatus

1102.03 DEFINITIONS

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

Liquid Asphalt means an asphalt cement mixed with volatile materials to increase the flow qualities of the asphalt cement.

1102.05 MATERIALS

1102.05.01 General

Liquid asphalt shall be of the type and grade specified in the Contract Documents and shall be supplied from a source approved by the Owner.

Under no circumstances shall the source of supply or the product be changed or partial or total supply allocated to another supplier without the prior approval of the Owner.

1102.05.02 Physical Requirements

Liquid asphalt shall be according to Tables 1, 2, 3, and 4.

1102.05.03 Shipment

The material shall be shipped in clean containers. Containers which are being reused shall be inspected, and cleaned, if required, prior to loading to ensure there is no contamination.

When shipment is by tank truck or railway tank car, the material shall arrive at the destination at a temperature at least 5 °C higher than the minimum spraying/mixing temperature specified in Table 5 and not more than the maximum temperature specified in Table 5.

1102.08 QUALITY ASSURANCE

1102.08.01 Compliance

Liquid asphalt shall be according to Tables 1, 2, 3, and 4 for the particular grade and type when tested according to the test methods designated in the tables.

1102.08.02 Inspection

The Owner may inspect shipping containers for cleanliness at any time.

1102.08.03 Sampling

Representative samples of material being supplied shall be taken, if specified in the Contract Documents, according to ASTM D 140 from either the supplier's plant or any shipment in the presence of the Contract Administrator. Samples taken prior to delivery shall be at no extra cost to the Owner.

1102.08.04 Testing

Samples may be tested by the Owner according to the tests listed in material requirements tables.

1102.08.05**Rejection**

Failure of any sample to conform to any of the material requirements shall be cause for rejection of the material. Rejected materials shall be replaced at no extra cost to the Owner.

1102.09**OWNER PURCHASE OF MATERIAL**

Liquid asphalt shall be measured by mass in tonnes as specified in the purchasing order. The tare of the hauling vehicle shall be determined for each load.

Payment at the price specified in the purchasing order shall be for the supply of the liquid asphalt delivered to the destination on the date and time specified.

The cost of all testing, except that performed in the Owner's laboratory, shall be included in the price.

TABLE 1
Rapid Curing Liquid Asphalts

Grade	RC-30		RC-70		RC-250		RC-800		RC-3000		Test Method
Requirements	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Tests on Liquid Asphalt											
Flash Point (Tag Open Cup), °C	--	--	--	--	27	--	27	--	27	--	ASTM D 3143
Kinematic Viscosity (at 60 °C), mm ² /s	30	60	70	140	250	500	800	1600	3000	6000	LS-202
Distillation Test Distillate (% of total distillate to 360 °C)											ASTM D 402
to 190 °C	15	--	10	--	--	--	--	--	--	--	
to 225 °C	55	--	50	--	35	--	15	--	--	--	
to 260 °C	75	--	70	--	60	--	45	--	25	--	
to 316 °C	90	--	85	--	80	--	75	--	70	--	
Residue from Distillation to 360 °C, Volume, % by Difference	50	--	55	--	65	--	75	--	80	--	
Tests on Residue from Distillation											
Penetration (at 25 °C, 100 g, 5 s), 0.1 mm	80	120	80	120	80	120	80	120	80	120	LS-200
Ductility (at 25 °C, 5 cm/min), cm (Note 1)	100	--	100	--	100	--	100	--	100	--	LS-205
Solubility, % by mass (Note 2)	99.5	--	99.5	--	99.5	--	99.5	--	99.5	--	LS-204
Notes:											
1. If the ductility at 25 °C is less than 100, the material is acceptable if the ductility at 15 °C is more than 100.											
2. Using trichloroethylene as solvent.											

TABLE 2
Medium Curing Liquid Asphalts

Grade	MC-30		MC-70		MC-250		MC-800		MC-3000		Test Method
Requirements	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Tests on Liquid Asphalt											
Flash Point (Tag Open Cup), °C	38	--	38	--	65	--	65	--	65	--	ASTM D 3143
Kinematic Viscosity (at 60 °C), mm ² /s	30	60	70	140	250	500	800	1600	3000	6000	LS-202
Distillation Test Distillate (% of total distillate to 360 °C)											ASTM D 402
to 225 °C	--	25	--	20	--	10	--	--	--	--	
to 260 °C	40	70	20	60	15	55	--	35	--	15	
to 316 °C	75	93	65	90	60	87	45	80	15	75	
Residue from Distillation to 360 °C, Volume, % by Difference	50	--	55	--	67	--	75	--	80	--	
Tests on Residue from Distillation											
Penetration (at 25 °C, 100 g, 5 s), 0.1 mm	120	250	120	250	120	250	120	250	120	250	LS-200
Ductility (at 25 °C, 5 m/min), cm (Note 1)	100	--	100	--	100	--	100	--	100	--	LS-205
Solubility, % by mass (Note 2)	99.5	--	99.5	--	99.5	--	99.5	--	99.5	--	LS-204
Notes:											
1. If the ductility at 25 °C is less than 100, the material is acceptable if the ductility at 15 °C is more than 100.											
2. Using trichloroethylene as solvent.											

TABLE 3
Slow Curing Liquid Asphalts

Grade	SC-70		SC-250		SC-800		SC-3000		Test Method
Requirements	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Tests on Liquid Asphalt									
Flash Point (Cleveland Open Cup), °C.	65	--	80	--	90	--	105	--	LS-201
Kinematic Viscosity (at 60 °C), mm ² /s	70	140	250	500	800	1600	3000	6000	LS-202
Distillation Test Distillate (% of total Distillate to 360 °C)	10	30	4	20	2	12	--	5	ASTM D 402
Tests on Residue from Distillation									
Kinematic Viscosity (at 60 °C), mm ² /s	4	70	8	100	20	160	40	350	LS-202
Solubility, % by mass (Note 1)	99.5	--	99.5	--	99.5	--	99.5	--	LS-204
Asphalt Residue of Specified Penetration and Test									
Residue of 100 Penetration, %	50	--	60	--	70	--	80	--	ASTM D 243
Ductility of 100 Penetration Residue (at 25 °C, 5 cm/min), cm (Note 2)	100	--	100	--	100	--	100	--	LS-205
Notes:									
1. Using trichloroethylene as solvent.									
2. If the ductility at 25 °C is less than 100, the material is acceptable if the ductility at 15 °C is more than 100.									

TABLE 4
MTO Primer and Mixed In Place (M.I.P.)

Grade	MTO Primer		M.I.P.		Test Method
Requirements	Min.	Max.	Min.	Max.	
Tests on Liquid Asphalt					
Flash Point (Tag Open Cup), °C.	--	--	27	--	ASTM D 3143
Kinematic Viscosity (at 60 °C), mm ² /s	20	35	120	180	LS-202
Distillation Test Distillate (% of total distillate to 360 °C), to 190 °C to 225 °C to 260 °C to 316 °C	20 40 70 85	80 -- -- --	10 20 40 --	-- -- -- --	ASTM D 402
Residue from Distillation to 360 °C Volume, % by Difference	50	--	80	--	
Tests on Residue					
Penetration (at 25 °C, 100 g, 5 s), 0.1 mm	80	200	--	--	LS-200
Ductility (at 25 °C, 5 cm/min), cm (Note 1)	100	--	--	--	LS-205
Softening point, °C	--	--	21	32	ASTM D 36
Solubility, % by mass (Note 2)	99.5	--	99.5	--	LS-204
Notes:					
1. If the ductility at 25 °C is less than 100, the material is acceptable if the ductility at 15 °C is more than 100.					
2. Using trichloroethylene as solvent.					

TABLE 5
Temperature Range of Liquid Asphalts for Spraying and Mixing

Grade	Temperature, °C			
	Spraying		Mixing	
	Min.	Max.	Min.	Max.
RC-30, MC-30	30	45	25	45
RC-70, MC-70, SC-70	60	70	55	70
RC-250, MC-250, SC-250	75	90	70	90
RC-800, MC-800, SC-800	90	105	80	105
RC-3000, MC-3000, SC-3000	115	130	110	130
MTO Primer	30	45	--	--
Mixed in Place	--	--	80	105

**Appendix 1102-A, Commentary for OPSS.MUNI 1102, November 2016
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

The designer should specify the following in the Contract Documents:

- Type and grade of liquid asphalt. (1102.05.01)
- Requirements for quality assurance sampling. (1102.08.03)

Typically the types of liquid asphalt listed in this specification are used for priming of granular base, granular sealing, in cold recycled mix, and in asphalt patching material.

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

Related Ontario Provincial Standard Drawings

None



MATERIAL SPECIFICATION FOR EMULSIFIED ASPHALT

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1103-A	Commentary

1103.01 SCOPE

This specification covers the requirements for different types and grades of emulsified asphalt suitable for both roadway construction and as a straw mulch adhesive.

1103.01.01 Specification Significance and Use

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

Use of this specification or any other specification shall be as specified in the Contract Documents.

1103.01.02

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.

1103.02

REFERENCES

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

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

Ontario Provincial Standard Specifications, Material

OPSS 1153 Emulsified Asphalt Patching Material

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:

LS-200	Penetration of Bituminous Materials
LS-204	Solubility of Bituminous Materials in Trichloroethylene
LS-205	Ductility of Bituminous Materials
LS-207	Float of Bituminous Materials
LS-208	Elastic Recovery by Durometer
LS-216	Determination of Residue by Distillation of Emulsified Asphalts
LS-217	Determination of Oil Portion of Distillate in Emulsified Asphalt Primers
LS-218	Particle Charge of Emulsified Asphalt and Emulsified Asphalt Primers
LS-219	Viscosity of Emulsified Asphalts
LS-220	Demulsibility of Emulsified Asphalts
LS-221	Settlement and Storage Stability of Emulsified Asphalt

LS-222	Cement Mixing of Emulsified Asphalts
LS-223	Sieve Test for Emulsified Asphalts
LS-224	Coating for Emulsified Asphalts
LS-226	Test for High Float Emulsified Asphalt

ASTM International

D 140/D 140M -15	Standard Practice for Sampling Bituminous Materials
D 1310-14	Standard Test Method for Flash Point and Fire Point of Liquids by Tag Open-Cup Apparatus
D 2939-03	Test Methods for Emulsified Bitumens Used As Protective Coating
D 6930-10	Standard Test Method for Settlement and Storage Stability of Emulsified Asphalts

1103.03 DEFINITIONS

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

Emulsified Asphalt means an asphalt cement mixed with water to increase the flow qualities of the asphalt cement.

1103.05 MATERIALS

1103.05.01 General

Emulsified asphalt shall be of the type and grade specified in the Contract Documents and shall be supplied from a source approved by the Owner. Under no circumstances shall the source of supply or the product be changed, or partial or total supply allocated to another supplier without prior written approval of the Owner.

1103.05.02 Physical Requirements

Emulsified asphalts shall consist of suitable paving asphalts dispersed in water and shall meet the requirements specified in Tables 1, 2, 3, 8, and 9 and Figure 1. The addition of polymers or other additives after the manufacture of an emulsified asphalt shall not be permitted.

Emulsified asphalts and polymer-modified emulsified asphalts shall be homogeneous after mixing and show no signs of separation within 14 Days of delivery.

1103.05.03 Straw Mulch Adhesive

Emulsified asphalt used as a straw mulch adhesive shall be a specially refined petroleum asphalt emulsified in water, of fluid consistency designed for cold spray applications, containing neither petroleum solvents nor other components toxic to plant life, and shall be according to Table 1.

1103.05.04 Shipping

The material shall be shipped in clean containers. Containers that are being reused shall be inspected and cleaned, if required, prior to loading to ensure there is no contamination.

When shipping is by tank truck or railway tank car, the material shall arrive at the destination at a temperature at least 5 °C higher than the minimum spraying temperature specified in Table 4 and not more than the maximum spraying temperature specified in Table 4.

1103.08 QUALITY ASSURANCE

1103.08.01 Compliance

Emulsified asphalts shall be according to Tables 1, 2, 3, 8, and 9 and Figure 1 for the particular type and grade when tested according to the test methods designated in the tables.

1103.08.02 Inspection

The Owner may inspect shipping containers for cleanliness at any time.

1103.08.03 Sampling

Representative samples of material being supplied may be taken, if specified in the Contract Documents, according to ASTM D 140 from either the supplier's plant or any shipment in the presence of the Contract Administrator. Sample material taken prior to delivery shall be at no extra cost to the Owner.

1103.08.04 Testing

Samples may be tested by the Owner according to the tests listed in material requirement tables.

1103.08.05 Rejection

Failure of any sample to conform to any of the material requirements shall be cause for rejection of the material. Rejected materials shall be replaced at no extra cost to the Owner.

1103.09 OWNER PURCHASE OF MATERIAL

Asphalt emulsion shall be measured by mass in tonnes as specified in the purchasing order. The tare of the hauling vehicle shall be determined for each load.

Payment at the price specified in the purchasing order shall be for the supply of the emulsified asphalt delivered to the destination on the date and time specified.

The cost of all testing, except that performed in the Owner's laboratory, shall be included in the price.

TABLE 1
Anionic Emulsified Asphalts

Requirements	Type	Rapid Setting				Medium Setting				Slow Setting						Test Method
	Grade	RS-1		RS-2		MS-1		MS-2		SS-1		SS-1H		Straw Mulch Adhesive		
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Tests on Emulsion																
Viscosity, Saybolt Furol Seconds : at 25 °C at 50 °C	20 --	100 --	-- 75	-- 300	20 --	60 --	-- 35	-- 400	20 --	60 --	20 --	60 --	17 --	40 --	LS-219	
Residue by Distillation, % by Mass	55	--	60	--	55	--	65	--	55	--	55	--	55	--	LS-216	
Settlement, %, 5 Days 7 Days	-- --	3 --	-- --	3 --	-- --	3 --	-- --	3 --	-- --	5 --	-- --	5 --	-- --	5 --	LS-221	
Demulsibility, % 35 ml, 0.02 N CaCl ₂ 50 ml, 0.1 N CaCl ₂	60 --	-- --	60 --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- 2.0	LS-220	
Oil Portion of Distillate, % by Volume/Mass	--	--	--	--	--	--	--	10	--	--	--	--	--	--	LS-217	
Sieve Text, % by Mass	--	0.1	--	0.1	--	0.1	--	0.1	--	0.1	--	0.1	--	0.1	LS-223	
Cement Mixing Test, % by Mass	--	--	--	--	--	--	--	--	--	2.0	--	2.0	--	--	LS-222	
Particle Charge	NEGATIVE OR NEUTRAL														LS-218	
Coating Ability and Water Resistance, %, Note 1	--	--	--	--	80	--	80	--	80	--	80	--	--	--	LS-224	
Fire Resistance	--	--	--	--	--	--	--	--	--	--	--	--	PASS		Note 2	
Tests on Residue																
Penetration (at 25 °C, 100 g, 5 s), 0.1 mm	100	200	100	200	100	200	100	250	100	200	40	100	100	200	LS-200	
Ductility (at 25 °C, 5 cm/min), cm	60	--	60	--	40	--	40	--	40	--	40	--	40	--	LS-205	
Solubility in Trichloroethylene, % by Mass	97.5	--	97.5	--	97.5	--	97.5	--	97.5	--	97.5	--	97.5	--	LS-204	
Notes:																
1. This requirement does not apply for tack coat or joint painting emulsified asphalts.																
2. There shall be no flash or flare-up when the flame of a bunsen burner is held in contact with the surface of the material, as received, for a period of 10 seconds.																

TABLE 2
Cationic Emulsified Asphalts

Requirements	Type	Rapid Setting				Medium Setting				Slow Setting				Slurry Seal		Test Method
	Grade	CRS-1		CRS-2		CMS-2		CMS-2H		CSS-1		CSS-1H		CSS-H		
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Tests on Emulsion																
Viscosity, Saybolt Furol Seconds : at 25 °C at 50 °C	-- 50	-- 150	-- 100	-- 400	-- 50	-- 400	-- 50	-- 400	20 --	100 --	20 --	100 --	20 --	100 --	LS-219	
Residue by Distillation, % by Mass	62	--	67	--	65	--	65	--	57	--	57	--	57	--	LS-216	
Settlement, %, 5 Days	--	5	--	5	--	5	--	5	--	5	--	5	--	5	LS-221	
Demulsibility, % 35 ml, 0.8% Dioctyl Sodium Sulfosuccinate Solution	40	--	40	--	--	--	--	--	--	--	--	--	--	--	LS-220	
Oil Portion of Distillate, % by Volume/Mass	--	3	--	3	--	10	--	10	--	5	--	5	--	--	LS-217	
Sieve Text, % by Mass	--	0.1	--	0.1	--	0.1	--	0.1	--	0.1	--	0.1	--	0.1	LS-223	
Cement Mixing Test, % by Mass	--	--	--	--	--	--	--	--	--	2.0	--	2.0	--	--	LS-222	
Particle Charge	POSITIVE															LS-218
Coating Ability and Water Resistance, %	--	--	--	--	80	--	80	--	80	--	80	--	--	--	LS-224	
Tests on Residue																
Penetration (at 25 °C, 100 g, 5 s), 0.1 mm	100	250	100	250	100	250	40	125	100	250	40	125	40	125	LS-200	
Ductility (at 25 °C, 5 cm/min), cm	60	--	60	--	60	--	40	--	60	--	40	--	40	--	LS-205	
Solubility in Trichloroethylene, % by Mass	97.5	--	97.5	--	97.5	--	97.5	--	97.5	--	97.5	--	97.5	--	LS-204	

TABLE 3
High Float Emulsified Asphalts

Requirements	Type	High Float														Test Method
	Grade	HFRS-2		HFMS-2(ON)		HF-100S		HF-150S		HF-250S		HF-150M		HF-1000M		
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Tests on Emulsion																
Viscosity, Saybolt Furol Seconds at 50 °C	75	400	50	300	35	150	35	150	35	150	50	--	50	--	LS-219	
Residue by Distillation, % by Mass	63	--	62	--	62	--	62	--	62	--	62	--	65	--	LS-226 LS-216	
Demulsibility, % 35 ml 0.02 N CaCl ₂ 50 ml 0.10 N CaCl ₂ 50 ml 0.02 N CaCl ₂	60 -- --	-- -- --	-- -- 40	-- -- --	-- 75 --	-- -- --	-- 75 --	-- -- --	-- -- --	-- -- --	-- -- --	-- -- --	-- -- --	-- -- --	LS-220	
Oil Portion of Distillate, % by Volume/Mass	--	--	0.5	3	0.5	4	0.5	4	1	6	1	6	1	7	LS-217	
Sieve Text, % by Mass	--	0.10	--	0.10	--	0.10	--	0.10	--	0.10	--	0.10	--	0.10	LS-223	
Particle Charge	--		Negative		--		--		--		--		--		LS-218	
Coating Ability and Water Resistance, %	--		90	--	90	--	90	--	90	--	Note 1		Note 1		LS-224	
Storage Stability Test, 24 h, % by Mass	--	1.0	--	1.5	--	1.5	--	1.5	--	1.5	--	1.5	--	1.5	ASTM D 6930	
Tests on Residue																
Penetration (at 25 °C, 100 g, 5 s), 0.1 mm	100	200	90	200	100	175	150	250	250	500	150	--	--	--	LS-226 LS-200	
Ductility (at 25 °C, 5 cm/min), cm	40	--	--	--	--	--	--	--	--	--	--	--	--	--	LS-205	
Solubility in Trichloroethylene, % by Mass	97.5	--	97.5	--	97.5	--	97.5	--	97.5	--	97.5	--	97.5	--	LS-204	
Float Test at 60 °C, s	1200	--	1200	--	1200	--	1200	--	1200	--	1200	--	1200	--	LS-226 LS-207	
Apparent Viscosity (at 60 °C), Pa·s	--	--	--	--	Requirements outlined on Figure 1							10	80 (Note 2)	2	8 (Note 2)	LS-226
Notes:																
1. Follow LS-224, except that the mixture of aggregate and emulsified asphalt shall be mixed vigorously for 5 min. then allowed to stand for 3 hours after which the mixture shall be capable of being mixed an additional 1 min. The mixture shall then be rinsed twice with approximately its own volume of tap water, without showing appreciable loss of bituminous film. After the second mixing the aggregate shall be at least 90% coated.																
2. Viscosity limits (at 60 °C at 1.0 s ⁻¹) shown for mixing grades are tentative. Supplier to advise purchaser before delivery, if limits cannot be met.																

TABLE 4
Temperature for Spraying and Mixing Emulsified Asphalts, °C

Grade	Spraying		Mixing	
	Minimum	Maximum	Minimum	Maximum
RS-1, RS-1P	30 (Note 1) 20 (Note 2)	70 70	-- --	-- --
RS-2, RS-2P	60 (Note 1)	80	--	--
MS-1	--	--	30	70
MS-2	--	--	30	70
SS-1	20	70	20	70
SS-1H	20	70	20	70
HFRS-2	60	80	--	--
HFMS-2(ON), HFMS-2P(ON)	60	80	--	--
HF-100S, HF-100SP	60	80	--	--
HF-150S, HF-150SP	60	80	--	--
HF-250S	60	80	--	--
HF-150M, HF-150MP	--	--	40	80
HF-1000M	--	--	40	75
CRS-1, CRS-1P	60	80	--	--
CRS-2, CRS-2P	60	80	--	--
CMS-2	--	--	30	70
CMS-2H	--	--	30	70
CSS-1	--	--	30	70
CSS-1H	--	--	30	70
CSS-H (Slurry)	--	--	20	35
Emulsified Asphalt Primer	Manufacturer's Requirements		--	--
Notes:				
1. For surface treatment.				
2. For other uses.				

TABLE 5
Minimum Apparent Viscosity, HF-100S

Penetration at 25 °C 0.1 mm	Minimum Apparent Viscosity at 60 °C, Pa·s at 0.5 s ⁻¹	Penetration at 25 °C 0.1 mm	Minimum Apparent Viscosity at 60 °C, Pa·s at 0.5 s ⁻¹	Penetration at 25 °C 0.1 mm	Minimum Apparent Viscosity at 60 °C, Pa·s at 0.5 s ⁻¹
75	1428	117	823	159	563
76	1405	118	815	160	559
77	1382	119	806	161	554
78	1360	120	798	162	550
79	1339	121	790	163	546
80	1318	122	782	164	542
81	1298	123	774	165	538
82	1279	124	766	166	534
83	1260	125	759	167	530
84	1241	126	751	168	526
85	1223	127	744	169	522
86	1205	128	737	170	518
87	1188	129	729	171	515
88	1172	130	723	172	511
89	1155	131	716	173	507
90	1139	132	709	174	504
91	1124	133	702	175	500
92	1109	134	696	176	496
93	1094	135	690	177	493
94	1080	136	683	178	490
95	1066	137	677	179	486
96	1052	138	671	180	483
97	1038	139	665	181	480
98	1025	140	659	182	476
99	1013	141	653	183	473
100	1000	142	648	184	470
101	988	143	642	185	467
102	976	144	637	186	464
103	964	145	631	187	461
104	953	146	626	188	458
105	941	147	621	189	455
106	930	148	615	190	452
107	920	149	610	191	449
108	909	150	605	192	446
109	899	151	600	193	443
110	889	152	595	194	440
111	879	153	591	195	437
112	869	154	586	196	435
113	860	155	581	197	432
114	850	156	576	198	429
115	841	157	572	199	426
116	832	158	567	200	424

Notes:

A. This table is based on the apparent viscosity of 1000 Pa·s at 0.5 s⁻¹ at 100 penetration, and 500 Pa·s at 0.5 s⁻¹ at 175 penetration.

TABLE 6
Minimum Apparent Viscosity, HF-150S

Penetration at 25 °C 0.1 mm	Minimum Apparent Viscosity at 60 °C, Pa·s at 0.5 s⁻¹	Penetration at 25 °C 0.1 mm	Minimum Apparent Viscosity at 60 °C, Pa·s at 0.5 s⁻¹	Penetration at 25 °C 0.1 mm	Minimum Apparent Viscosity at 60 °C, Pa·s at 0.5 s⁻¹
125	164	155	136	200 - 201	109
126	163	156 - 157	135	202 - 203	108
127	162	158	134	204 - 205	107
128	161	159	133	206 - 208	106
129	160	160 - 161	132	209 - 210	105
130	158	162	131	211 - 212	104
131	157	163 - 164	130	213 - 215	103
132	156	165	129	216 - 217	102
133	155	166 - 167	128	218 - 220	101
134	154	168	127	221 - 222	100
135	153	169 - 170	126	223 - 225	99
136	152	171	125	226 - 227	98
137	151	172 - 173	124	228 - 230	97
138 - 139	150	174 - 175	123	231 - 233	96
140	149	176	122	234 - 236	95
141	148	177 - 178	121	237 - 239	94
142	147	179 - 180	120	240 - 242	93
143	146	181	119	243 - 245	92
144	145	182 - 183	118	246 - 248	91
145	144	184 - 185	117	249 - 251	90
146	143	186 - 187	116	252 - 254	89
147 - 148	142	188 - 189	115	255 - 258	88
149	141	190 - 191	114	259 - 261	87
150	140	192 - 193	113	262 - 265	86
151	139	194 - 195	112	266 - 268	85
152 - 153	138	196 - 197	111	269 - 272	84
154	137	198 - 199	110	273 - 275	83

Notes:

A. This table is based on the apparent viscosity of 140 Pa·s at 0.5 s⁻¹ at 150 penetration, and 90 Pa·s at 0.5 s⁻¹ at 250 penetration.

TABLE 7
Minimum Apparent Viscosity, HF-250S

Penetration at 25 °C 0.1 mm	Minimum Apparent Viscosity at 60 °C, Pa·s at 1.0 s⁻¹	Penetration at 25 °C 0.1 mm	Minimum Apparent Viscosity at 60 °C, Pa·s at 1.0 s⁻¹
225 - 227	57	311 - 317	37
228 - 231	56	318 - 323	36
232 - 234	55	324 - 331	35
235 - 237	54	332 - 338	34
238 - 240	53	339 - 346	33
241 - 244	52	347 - 354	32
245 - 248	51	355 - 363	31
249 - 251	50	364 - 372	30
252 - 255	49	373 - 382	29
256 - 259	48	383 - 392	28
260 - 264	47	393 - 404	27
265 - 268	46	405 - 416	26
269 - 273	45	417 - 428	25
274 - 277	44	429 - 442	24
278 - 282	43	443 - 457	23
283 - 287	42	458 - 473	22
288 - 293	41	474 - 490	21
294 - 298	40	491 - 509	20
299 - 304	39	510 - 525	19
305 - 310	38		

Notes:

A. This table is based on the apparent viscosity of 50 Pa·s at 1.0 s⁻¹ at 250 penetration, and 20 Pa·s at 1.0 s⁻¹ at 500 penetration.

TABLE 8
Polymer-Modified Emulsified Asphalts

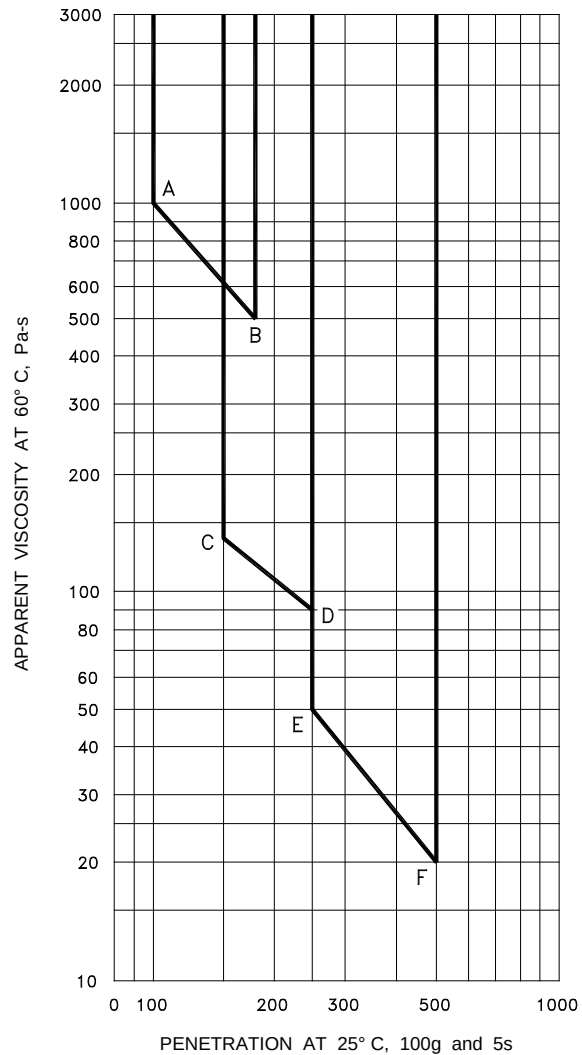
Requirements	Type	Anionic				Cationic				High Float								Test Method
	Grade	RS-1P		RS-2P		CRS-1P		CRS-2P		HFMS-2P(ON)		HF-100SP		HF-150SP		HF-150MP		
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Tests on Emulsion																		
Viscosity, Saybolt Furol Seconds: at 25 °C at 50 °C	20 --	100 --	-- 75	-- 300	-- 25	-- 150	-- 75	-- 400	-- 50	-- 300	-- 35	-- 150	-- 35	-- 150	-- 50	-- --	LS-219	
Residue by Distillation to 204.4 °C, % by Mass	55	--	60	--	62	--	65	--	62	--	62	--	62	--	62	--	LS-216 LS-226	
Settlement, 24 h, % by Mass	--	1	--	1	--	1	--	1	--	--	--	--	--	--	--	--	LS-221	
Demulsibility, % 35 ml, 0.02 N CaCl ₂ 35 ml, 0.8% Dioctyl Sodium Sulfo-Succinate Solution 50 ml 0.10 N CaCl ₂ 50 ml 0.02 N CaCl ₂	60 -- -- --	-- -- -- --	60 -- -- --	-- -- -- --	-- 40 -- --	-- -- -- --	40 -- -- --	-- -- -- --	-- -- 40 --	-- -- -- --	-- -- 75 --	-- -- -- --	-- -- 75 --	-- -- -- --	-- -- -- --	-- -- -- --	LS-220	
Oil Portion of Distillate, % by Volume/Mass	--	--	--	--	--	--	--	--	0.5	3	0.5	4	0.5	4	1	6	LS-217	
Sieve Text, % by Mass	--	0.20	--	0.20	--	0.20	--	0.20	--	0.10	--	0.10	--	0.10	--	0.10	LS-223	
Particle Charge	Negative or Neutral				Positive				Negative		--		--		--		LS-218	
Coating Ability and Water Resistance, %	--		--		--		--		90	--	90	--	90	--	Note 1		LS-224	
Storage Stability, 24 h, % by Mass	--	--	--	--	--	--	--	--	--	--	--	1.5	--	1.5	--	1.5	ASTM D 6930	
Tests on Residue																		
Penetration (at 25 °C, 100 g, 5 s), 0.1 mm	100	200	100	200	100	250	100	250	90	200	90	150	150	250	150	250	LS-200 LS-226	
Solubility in Trichloroethylene, % by Mass (Note 2)	97.5	--	97.5	--	97.5	--	97.5	--	97.5	---	97.5	--	97.5	--	97.5	--	LS-204	
Float Test at 60 °C, s	--	--	--	--	--	--	--	--	1200	--	1200	--	1200	--	1200	--	LS-226 LS-207	
Ash Content, % by Mass of Residue (Note 2)	--	1.0	--	1.0	--	1.0	--	1.0	--	1.0	--	1.0	--	1.0	--	1.0	ASTM D 2939	
Elastic Recovery (at 10 °C), %	55	--	55	--	55	--	55	--	55	--	55	--	50	--	50	--	LS-208	
Force Ductility at 800% Elongation, 5 cm/min. Pull Rate at 4 °C, kg	0.5	--	0.5	--	0.5	--	0.5	--	0.5	--	0.5	--	--	--	--	--	LS-205	
Notes:																		
1. Follow LS-224, except that the mixture of aggregate and emulsified asphalt shall be mixed vigorously for 5 min. then allowed to stand for 3 hours after which the mixture shall be capable of being mixed an additional 1 min. The mixture shall then be rinsed twice with approximately its own volume of tap water, without showing appreciable loss of bituminous film. After the second mixing the aggregate shall be at least 90% coated.																		
2. The ash content shall be determined when the manufacturer indicates that the polymer additive is not soluble in trichloroethylene.																		

TABLE 9
Emulsified Asphalt Primer

Requirements	Min.	Max.	Test Method
Viscosity, Saybolt Furol Seconds at 50 °C	35	150	LS-219
Residue by Distillation to 260 °C, % by Mass	40	--	LS-216
Oil Portion of Distillate, % by Volume/Mass	10	30	LS-217 (Note 1)
Particle Charge	Neutral		LS-218 (Note 2)
Flash Point, Tag Open Cup, °C	45	--	ASTM D 1310
Storage Stability, 24 h	No visible separation		ASTM D 6930 (Note 3)
<u>Tests on Residue</u>			
Penetration (at 25 °C, 100 g, 5 s), 0.1 mm	100	300	LS-200
Ductility (at 25 °C, 5 cm/min), cm (Note 4)	100	--	LS-205
Solubility in Trichloroethylene, % by Mass	97.5	--	LS-204
Notes:			
1. Since the total distillate exceeds 100 ml, follow LS-217 with the following modification: Prior to reaching 100 ml of distillate, carefully replace the first 100 ml graduated cylinder with a second one. After the distillation is complete, determine the volume of oil distillate in both cylinders and record the sum. Calculate the oil portion of the distillate as a percentage of the original weight of primer: $\% \text{ Oil} = \frac{\text{Total Volume of oil distillate, ml} \times 100}{200 \text{ g primer}}$			
2. Follow LS-218 with the modification that the asphalt does not deposit due to an electrical charge on either the anode (positive electrode) or the cathode (negative electrode). Equal adherence to both electrodes due to the viscous nature of the material is not considered deposition.			
3. Follow ASTM D 6930 except storage stability shall be based on visual separation of 500 ml representative sample in the glass cylinder after 24 hours.			
4. If the ductility at 25 °C is less than 100 cm, the material shall be acceptable if its ductility at 15 °C is more than 100 cm.			

Figure 1

VISCOSITY REQUIREMENTS FOR DISTILLATION RESIDUES FROM HIGH FLOAT
EMULSIFIED ASPHALT



Notes:

- A. Grade of high float emulsified asphalt: HF-100S - A, B
HF-150S - C, D
HF-250S - E, F
- B. Viscosity shall be above the extrapolated line* designated by specified letters and between penetration limits contained in vertical lines extending upwards from these points.
* See Tables 5, 6, and 7 for acceptable values.
- C. Viscosity value shall be reported at the shear rate:
0.5 s⁻¹ for grades HF-100S and HF-150S
1.0 s⁻¹ for grade HF-250S

**Appendix 1103-A, Commentary for OPSS.MUNI 1103, November 2016
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

The designer should specify the following in the Contract Documents:

- Type and grade of asphalt emulsion. (1103.05.01)
- Requirements for quality assurance sampling. (1103.08.03)

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

Related Ontario Provincial Standard Drawings

No information provided here.



**ONTARIO
PROVINCIAL
STANDARD
SPECIFICATION**

**METRIC
OPSS.MUNI 1151
NOVEMBER 2006**

**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 (HMA), recycled mixes, and mixes for miscellaneous work according to the Superpave mix design methodology.

1151.01.01 Specification Significance and Use

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

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

1151.01.02 Appendices Significance and Use

Appendices are not 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 the specification in a Contract.

1151.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Material

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

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-292	Quantitative Determination of Asphalt Cement Content by Ignition and Analysis of Remaining Aggregate From Bituminous Paving Mixtures
LS-306	Bulk Relative Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
LS-603	Resistance to Degradation of Coarse Aggregate by Abrasion and Impact in the Los Angeles Abrasion Machine
LS-604	Relative Density and Absorption of Coarse Aggregate
LS-605	Relative Density and Absorption of Fine Aggregate
LS-629	Uncompacted Void Content of Fine Aggregate

American Association of State Highway and Transportation Officials

M 320-05	Standard Specification for Performance Graded Asphalt Binder
MP 8-05	Standard Specification for Designing Stone Matrix Asphalt (SMA)
PP 28-03	Practice for Designing Superpave Volumetric Design for HMA
PP 41-02(2004)	Standard Practice for Designing Stone Matrix Asphalt (SMA)
R 35-04	Standard Practice for Superpave Volumetric Design for Hot Mix Asphalt (HMA)
T 84-00(2004)	Specific Gravity and Absorption of Fine Aggregate
T 85-91(2004)	Specific Gravity and Absorption of Coarse Aggregate
T 166-05	Bulk Specific Gravity of Compacted Asphalt Mixtures Using Saturated Surface-Dry Specimens
T 209-05	Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
T 275-91(2000)	Bulk Specific Gravity of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
T 283-03	Resistance of Compacted Bituminous Mixtures to Moisture Induced Damage
T 304-96(2004)	Uncompacted Void Content of Fine Aggregate

T 305-97(2001) Determination of Draindown Characteristics in Uncompacted Asphalt Mixtures
T 312-04 Preparing and Determining the Density of Hot Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor

ASTM International

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

Asphalt Institute Publications

Superpave Series:
SP-2 Superpave Mix Design Method

National Cooperative Highway Research Program

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

1151.03 DEFINITIONS

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

AMRL means the AASHTO Materials Reference Laboratory.

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

CCIL means the Canadian Council of Independent Laboratories.

Chip means an aggregate product, predominantly containing material passing the 6.7 mm sieve and retained on the 4.75 mm, 2.36 mm, and 1.18 mm sieves.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

1151.04 SUBMISSION AND DESIGN REQUIREMENTS

1151.04.01 Mix Requirements for Design Purposes

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

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

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

The JMF for SMA mixes shall be according to the requirements specified in AASHTO MP 8 and Tables 3 and 6.

1151.04.01.01 RAP Proportions

The use of RAP is allowed, as follows:

- a) Up to 15% by mass of RAP is permitted for Superpave 4.75, 9.5, and 12.5 surface course mixes.
- b) Up to 30% by mass of RAP is permitted for Superpave 19, 25, and 37.5 binder mixes.
- c) When 31% to 50% by mass of RAP is proposed for Superpave 19, 25, and 37.5 binder mixes, written approval by the Contract Administrator must be obtained for the mix design, including PGAC modification.
- d) Over 50% by mass of RAP is not permitted for any mix.
- e) RAP is not permitted in SMA, 12.5 FC1, and 12.5 FC2 mixes.

1151.04.02 Mix Design

1151.04.02.01 General

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

1151.04.02.02 Mix Design Method

1151.04.02.02.01 General

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

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

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

1151.04.02.02.02 Superpave Mix Design Method

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

The calculation of Voids in Mineral Aggregated (VMA) shall be based on the densities of the blended coarse and blended fine aggregate.

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

1151.04.02.02.03 Stone Mastic Asphalt Mix Design Method

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

1151.04.02.03 Mix Design Submission

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

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

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

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

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

- a) A material is eliminated.
- b) A new material is added.
- c) Changes to the material proportions have not resulted in correction of the problems with the mix.
- d) The net impact of all adjustments to the original JMF exceed any of the maximum field adjustments specified in Table 10.

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

1151.04.03 Samples for Monitoring Purposes

Representative samples of the materials to be used in the work shall be provided to the Contract Administrator at the same time that the mix design and JMF documents are submitted.

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

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

The minimum sample quantities shall be as specified in Table 11.

1151.04.04 Density of Hot Mix Aggregates

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

1151.04.05 Documents

The Contract Administrator shall be provided with a copy of the mix design and JMF documents that shall be signed, dated, and certified correct by the person accountable for the engineering and management responsibility for the laboratory that conducted the work. When the Owner has a Bituminous Mix Design Report form, the Contract Administrator shall provide it to the Contractor for submission along with other supporting documents. Information shall be provided in a legible manner. For Superpave mixes, the documentation required with the mix design submission is covered by AASHTO PP 28. The documents shall include, but are not limited to, the following information:

- a) Contract number, item number, and mix type for which the mix design and JMF were completed and a description of the usage of the mix on the Contract.
- b) All test results, mix design work sheets, and graphs.
- c) Material proportions and sources, including the Owner's Mineral Aggregate Inventory for the aggregate sources, when such information is available. The amount of RAP in percent by mass and volumetric data shall also be included.
- d) Designation of the fine aggregate and the coarse aggregate.
- e) PGAC and source and percent by mass of the required new asphalt cement.
- f) A graph of the temperature-viscosity relationship for the PGAC that is to be used in the mix.
- g) Information on additives, including source, type, percent by mass of asphalt cement, and test results according to AASHTO T 283, with specimens prepared according to AASHTO T 312.
- h) Information regarding fines that are returned to the mix, aggregate breakdown during production, and the resultant change in the aggregate gradations.
- i) Complete gradations for all coarse and fine aggregates.
- j) For Superpave mixes, excluding SMA, the volumetric properties for the mix selected in accordance with Table 5. Graphs shall be submitted for the air voids, voids in mineral aggregate, voids filled with asphalt, dust-to-asphalt ratio, bulk relative density, maximum relative density, and the gyratory curves of the mix plotted against asphalt cement content.
- k) For SMA mixes, the volumetric properties for the mix selected in accordance with Table 6. Graphs shall be reported for the air voids, voids in mineral aggregate, bulk relative density, and maximum relative density plotted against asphalt cement content.
- l) Aggregate absorptions.
- m) Bulk specific gravity and saturated surface dry density for each aggregate.
- n) Mix bulk specific gravity by AASHTO T 166. If the percent water absorbed by the specimen is found to exceed 2% by volume as described in AASHTO T 166, then the bulk specific gravity is according to AASHTO T 275, LS-306, or ASTM D 6752.
- o) Theoretical maximum specific gravity by AASHTO T 209.

- p) When RAP is permitted for use, extracted bulk relative density, percentage asphalt cement, and gradation for the RAP used in the mix.
- q) All visual observations made during the design process with particular attention and comments regarding stripping and coating for both the coarse and fine aggregates.
- r) The mixing and compaction temperature used in the mix design and the compaction temperature of the reheated mix to be employed in the testing of the production mix.
- s) The typical mix weight to produce a gyratory specimen with a height of 115 mm $\pm$ 5 mm.
- t) For SMA mixes, the draindown test results according to AASHTO T 305.

1151.04.06 Anti-Stripping Additives

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

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

Regardless of the hot mix type, the amount of anti-stripping additive either specified in the Contract Documents or determined through mix design procedure shall be a percentage of the total asphalt cement required.

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

- a) For Superpave mixes, excluding SMA, amount required to provide a minimum of 80% Tensile Strength Ratio as determined by AASHTO T 283.
- b) For SMA mixes, amount required to provide a minimum of 70% Tensile Strength Ratio as determined by AASHTO T 283.
- c) Minimum dosage requirements specified in the Contract Documents.

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

- a) For all Superpave 12.5 FC2 and SMA mixes, or other mixes consisting of more than 75% dolomitic sandstone or meta-arkose aggregates, the anti-stripping additive shall be hydrated lime (Ca(OH)_2) with a minimum dosage requirement of 1% by mass of the total dry aggregate.
- b) For all other aggregates, the anti-stripping additive may be hydrated lime or a chemical agent.

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

- a) Documentation that the hot mix shall be produced in accordance to the Contract Documents.
- b) Amount of hydrated lime to be used as determined in the mix design procedures expressed as a percentage of the specified aggregate.
- c) Complete information on how the hydrated lime is to be used and how the hydrated lime is to be incorporated into the mix.

1151.05 MATERIALS

1151.05.01 Asphalt Cement

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

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

1151.05.02 Aggregates

Aggregates shall be according to OPSS 1003.

Both the coarse and fine aggregates used for SMA shall be crushed from the same source of traprock, diabase, dolomitic sandstone, or meta-arkose. The aggregate source used shall be as specified in the Contract Documents.

1151.05.02.01 Reclaimed Asphalt Pavement

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

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

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

1151.05.03 Silicone

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

1151.05.04 Filler

Filler shall be according to OPSS 1003.

1151.05.05 Fibres

Cellulose or mineral fibres shall be used as a stabilizing additive in dosage rates of 0.3% or 0.5% by mass of the total mix respectively. Cellulose and mineral fibres shall meet the properties shown in Tables 7 and 8 respectively.

1151.06 EQUIPMENT

1151.06.01 Requirements for All Mixing Plants

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

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

1151.06.02 Truck Scales

Truck scales shall be as specified in the Contract Documents.

1151.07 PRODUCTION

1151.07.01 General

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

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

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

1151.07.02 Operational Constraints

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

The JMF shall remain in effect until the Contract Administrator receives any requested changes in writing and approves them.

1151.07.03 Handling of Materials

1151.07.03.01 Aggregate Stockpile Requirements

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

1151.07.03.02 Aggregates

1151.07.03.02.01 General

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

1151.07.03.02.02 Batch and Continuous Mixing Plants

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

1151.07.03.03 Anti-Stripping Additives

1151.07.03.03.01 Liquid Anti-Stripping Additives

Anti-stripping additive shall be handled and mixed with the asphalt cement according to the manufacturer's recommendations.

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

- a) Verification that the chemical anti-stripping additive shall remain stable in the heated asphalt cement for a minimum of 4 Days.
- b) Type and dosage of anti-stripping additive used.
- c) Time, date, and temperature when anti-stripping was added to the asphalt cement.

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

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

If a liquid anti-stripping additive is not added to the asphalt tank, a continual record of the process for adding the additive shall be provided to the Contract Administrator in addition to the above documentation each time liquid anti-stripping additive is metered into the asphalt cement.

The Contract Administrator shall be provided with an approved statement of calibration for any metering device used to add the liquid anti-stripping additive.

1151.07.03.03.02 Hydrated Lime

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

- a) Hydrated lime slurry shall be homogeneously mixed with the aggregate in a pugmill or tumble mixer, prior to entering the asphalt plant.
- b) Hydrated lime shall be homogeneously mixed with wetted aggregate in a pugmill or tumble mixer, prior to entering the asphalt plant. The wetted coarse and fine aggregate shall have a sufficient moisture content to ensure uniform and complete adhesion of lime to the aggregate.
- c) Hydrated lime shall be homogeneously mixed with the aggregate at the pit or quarry, prior to delivery of the limed aggregate to the hot mix plant.

Regardless of the mixing equipment or procedure used, the aggregate must possess a uniform and homogeneous coating of hydrated lime. Aggregate treated with hydrated lime shall be used within the same construction season it is treated. Aggregate that was treated and stored from a previous construction season may be used only if the Contract Administrator agrees to a written proposal from the Contractor. The written proposal must verify the effectiveness of the stored aggregate, indicate the sampling protocol used, and include the current test results from samples that indicate the aggregate meets the Contract requirements for retained stability.

1151.07.04 Preparation of the Mix

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

1151.08 QUALITY ASSURANCE

1151.08.01 General

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

TABLE 1
Superpave and SMA Design Traffic Categories by ESALs

Ontario Traffic Category	20-Year Design ESALs (Note 1)	Typical Applications
A	Less than 0.3 million	Low volume roads, parking lots, driveways, and residential roads.
B	0.3 to 3 million	Minor collector roads.
C	3 to 10 million	Major collector and minor arterial roads.
D	10 to 30 million	Major arterial roads and transit routes.
E	Greater than 30 million	Freeways, major arterial roads with heavy truck traffic, and special applications such as truck and bus climbing lanes or stopping areas.
Note: 1. Equivalent Single Axle Load (ESAL) for the projected traffic level expected in the design lane over a 20-year period, regardless of the actual design life of the pavement.		

TABLE 2
Superpave Aggregate Gradation Control Points

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

TABLE 3
SMA Aggregate Gradation Control Points

Hot Mix Asphalt Type	Percentage Passing by Dry Mass of Aggregates							
	Sieve Size mm							
	37.5	25	19.0	12.5	9.5	4.75	2.36	0.075
SMA 9.5	-	-	-	100	70-95	30-50	20-30	8-12
SMA 12.5	-	-	100	90-100	50-80	20-35	16-24	8-11
SMA 19.0	-	100	90-100	50-88	25-60	20-28	16-24	8-11
Note:								
A. For the SMA 9.5 mm the Upper Gradation Control Points are 21, 18, and 15 percent passing for the 1.18 mm, 0.600 mm, and 0.300 mm sieves, respectively.								

TABLE 4
Superpave Gradation Primary Control Sieve (PCS) Points

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

TABLE 5
Superpave HMA Volumetric Properties

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

Notes:

1. For Superpave 4.75 mixes, the dust-to-binder ratio shall be 0.9 to 2.0. Superpave mixes with gradations that pass beneath the PCS Control Point specified in Table 4, the dust-to-binder ratio shall be 0.8-1.6.
2. For Traffic Category A, Superpave 25.0 mixes shall have a VFA range of 67% to 80%.
3. Superpave 4.75 mixes shall have a VFA range of 75% to 78%.
Superpave 9.5 mixes shall have a VFA range of 73% to 76%.
Superpave 37.5 mixes shall have a VFA range of 64% to 75%.
4. Density testing of the coarse and fine aggregate shall be carried out in accordance with LS-604 and LS-605 respectively using the procedure for blended aggregates.

TABLE 6
SMA Hot Mix Asphalt Volumetric Properties

% Air Voids (Note 1)	Voids in Mineral Aggregate (VMA) % minimum			Voids in Coarse Aggregate (VCA) of the Compacted Mix %	Maximum Draindown at Production Temperature (Note 2) %
	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

Notes:

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

TABLE 7
Physical Requirements for Cellulose Fibres
According to AASHTO MP 8

Property	Requirement
Sieve Analysis, Method A or B:	
Method A, Alpine Sieve Analysis (Note 1)	
Fibre Length	6 mm maximum
Passing 0.150 mm sieve	70% ± 10%
Method B, Mesh Screen Analysis (Note 2)	
Fibre Length	6 mm maximum
Passing 0.850 mm sieve	85% ± 10%
0.425 mm sieve	65% ± 10%
0.106 mm sieve	30% ± 10%
Ash Content (Note 3)	18% ± 5% non-volatiles
pH (Note 4)	7.5 ± 1.0
Oil Absorption (Note 5)	5 ± 1.0, times fibre mass
Moisture Content (Note 6)	Less than 5%, by mass
Notes:	
1. Method A, Alpine Sieve Analysis - This test is performed using an Alpine Air Jet Sieve, Type 200 LS. A representative 5 gram sample of fibre is sieved for 14 minutes at a controlled vacuum of 75 kPa of water. The portion remaining on the screen is weighed. 2. Method B, Mesh Screen Analysis - This test is performed using standard 0.850, 0.425, 0.250, 0.180, 0.150, and 0.106 mm sieves, nylon brushes, and shaker. A representative 10-gram sample of fibre is sieved, using a shaker and two nylon brushes on each screen. The amount retained on each sieve is weighed and the percentage passing calculated. 3. Ash Content - A representative 2-3 gram sample of fibre is placed in a tared crucible and heated between 595 and 650 °C for not less than 2 hours. The crucible and ash are cooled in a desiccator and reweighed. 4. pH Test - 5 grams of fibre is added to 100 ml of distilled water, stirred and let sit for 30 minutes. The pH is determined with a probe calibrated with pH buffer of 7.0. 5. Absorption Test - 5 grams of fibre is accurately weighed and suspended in an excess of mineral spirits for not less than 5 minutes to ensure total saturation. It is then placed in a screen mesh strainer with an approximately 0.5 mm² opening size and shaken on a wrist action shaker for 10 minutes, approximately 32 mm motion at 240 shakes per minute. The shaken mass is then transferred without touching to a tared container and weighed. Results are reported as the amount the fibres are able to absorb, i.e., the number of times its own weight. 6. Moisture Content - 10 grams of fibre are weighed and placed in a 121 °C forced air oven for two hours. The sample is then reweighed upon removal from the oven.	

TABLE 8
Mineral Fibre Quality Requirements
According to AASHTO MP 8

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

TABLE 9
Superpave Compactive Effort

Ontario Traffic Category (Note 1)	Number of Gyration		
	N _{initial}	N _{design}	N _{max}
A	6	50	75
B and C	7	75	115
D	8	100	160
E	9	125	205
Note: 1. The traffic categories are according to Table 1.			

TABLE 10
Permitted Field Adjustment to a JMF

JMF Property	Maximum Field Adjustment (Note 1)
Percent asphalt cement content, all mixes except SMA	± 0.2
Percent asphalt cement content, SMA only	± 0.4
Percent RAP	- 5.0
Percent passing 26.5 mm, 25.0 mm, 19.0 mm, and 16.0 mm sieves	± 5.0
Percent passing 13.2 mm, 12.5 mm, and 9.5 mm sieves	± 4.0
Percent passing 4.75 mm, 2.36 mm, and 1.18 mm sieves	± 3.0
Percent passing 600 µm, 300 µm, and 150 µm sieves	No limits
Percent passing 75 µm sieve, all mixes except SMA	± 1.0
Percent passing 75 µm sieve, SMA only	± 2.0
Note: 1. The maximum field adjustment is applied against the actual JMF property value.	

TABLE 11
Minimum Sample Quantities for Mix Design Monitoring

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

Appendix 1151-A, Commentary for OPSS.MUNI 1151, November 2006

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

Designer Action/Considerations

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

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

The designer should specify the following in the Contract Documents:

- Amount of anti-stripping additive, if required, i.e., as outlined in the Ministry's Designated Sources for Materials (DSM) manual for asphalt aggregates. (1151.04.05)
- Supply and use of performance graded asphalt cement. (1151.05.01)

Appendix 1151-A

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

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

Asphalt Layer	Hot Mix Asphalt Type	Minimum Suggested Compacted Layer Thickness (Note 1) mm
Surface Course Mixes	Superpave 4.75	25
	Superpave 9.5	30 - 40
	Superpave 12.5, 12.5 FC1, and 12.5 FC2	40 - 50
	SMA 9.5	30 - 40
	SMA 12.5	40 - 50
Base Course Mixes	Superpave 19.0	50 - 80
	Superpave 25.0	60 - 100
	Superpave 37.5	100 - 150
	SMA 19.0	60 - 80
Note:		
1. The designer should be aware that the lower minimum value is for finer graded mixes and the upper minimum value is for coarser graded mixes.		

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

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

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

Related Ontario Provincial Standard Drawings

None.



MATERIAL SPECIFICATION FOR SC-800 PATCHING MATERIAL

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APPENDICES

1152-A	COMMENTARY

1152.01	SCOPE

This specification covers the requirements for the manufacturing of SC-800 patching material.

1152.01.01 Specification Significance and Use

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

Use of this specification or any other specification shall be as specified in the Contract Documents.

1152.01.02

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.

1152.02

REFERENCES

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

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

Ontario Provincial Standard Specifications, Material

OPSS 1003	Aggregates - Hot Mix Asphalt
OPSS 1102	Liquid Asphalt
OPSS 1151	Superpave and Stone Mastic Asphalt Mixtures

Ministry of Transportation Publications

MTO Laboratory Testing Manual:

LS-282	Method of Test for Quantitative Extraction of Asphalt Cement and Analysis of Extracted Aggregate from Bituminous Paving Mixtures

1152.03 DEFINITIONS

For the purpose of this specification, the following definition applies:

SC-800 Patching Material means a mixture of SC-800 liquid asphalt and mineral aggregate for patching holes, depressions, and distressed areas in existing pavements.

1152.04 DESIGN AND SUBMISSION REQUIREMENTS

1152.04.01 Design Requirements

The Contractor shall be responsible for selecting the SC-800 patching material mixture composition. The mixture composition shall meet all the requirements of this specification.

The mix shall maintain its effective properties in stockpile for a minimum period of eight months from the date of supply to the Owner.

1152.04.02 Submission Requirements

The mixture composition shall be submitted to the Owner 7 Days before the start of production. The following items shall also be included in the submission:

- a) The SC-800 supplier, facility type, and location from which the SC-800 is being supplied.
- b) Test results for the SC-800 that demonstrate compliance to the requirements of the Liquid Asphalt subsection of this specification.
- c) The aggregate supplier and location from which the aggregates are being supplied.
- d) Type of aggregate and test results for the aggregates that demonstrate compliance to the requirements of the Aggregates subsection of this specification.
- e) Percent of SC-800 in the mixture, by mass, and test results that demonstrate compliance to the requirements of the Composition of Mixture subsection of this specification.
- f) Residual asphalt content, percent by mass of SC-800 patching mixture, when tested according to LS-282, in the mixture.

1152.05 MATERIALS

1152.05.01 Liquid Asphalt

The liquid asphalt shall be SC-800 and shall be according to OPSS 1102.

1152.05.02 Aggregates

The requirements of OPSS 1003, as detailed for Superpave 12.5, shall apply to this work.

1152.05.03 Composition of Mixture

The patching mixture shall contain between 4.0 and 6.0% of SC-800 by mass. The mixture shall be according to the gradation limits specified for Superpave 12.5 in OPSS 1151.

1152.06 EQUIPMENT

Equipment shall be according to OPSS 1151.

1152.07 PRODUCTION

1152.07.01 Preparation of Liquid Asphalt

The SC-800 liquid asphalt shall be heated at the asphalt plant to a temperature of $105\text{ }^{\circ}\text{C} \pm 10\text{ }^{\circ}\text{C}$.

1152.07.02 Preparation of Mixture

The mixture shall be prepared according to OPSS 1151 except that the discharge temperature of the mixture shall be $105\text{ }^{\circ}\text{C} \pm 10\text{ }^{\circ}\text{C}$.

1152.07.03 Tolerances

The test results according to LS-282 shall indicate that the composition of the mixture meets the following tolerances with respect to the submitted mixture composition:

SC-800, Residual:	$\pm 0.3\%$
Retained 4.75 mm sieve:	$\pm 5.0\%$
Passing 75 μm sieve:	$\pm 2.0\%$

**Appendix 1152-A, Commentary for OPSS.MUNI 1152, November 2016
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

Designer should include OPSS 307, Stockpiling of Patching Materials and Patching of Asphalt Pavement, in the Contract Documents for transporting and stockpiling requirements and payment for SC-800 patching material.

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

Related Ontario Provincial Standard Drawings

No information provided here



**MATERIAL SPECIFICATION FOR
EMULSIFIED ASPHALT PATCHING MATERIAL**

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1153-A	Commentary

1153.01 SCOPE

This specification covers the requirements for the manufacturing of emulsified asphalt patching material.

1153.01.01 Specification Significance and Use

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

Use of this specification or any other specification shall be as specified in the Contract Documents.

1153.01.02

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.

1153.02

REFERENCES

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

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

Ontario Provincial Standard Specifications, Material

OPSS 1003 Aggregates - Hot Mix Asphalt
OPSS 1151 Superpave and Stone Mastic Asphalt Mixtures

Ministry of Transportation Publications

MTO Laboratory Testing Manual:

LS-282 Method of Test for Quantitative Extraction of Asphalt Cement and Analysis of Extracted Aggregate from Bituminous Paving Mixtures
LS-289 Method of Test for Workability of Cold Bituminous Patching Material by Blade Resistance Method
LS-290 Test Method for Cohesion of Cold Bituminous Patching Material by Rolling Sieve Method

1153.04 DESIGN AND SUBMISSION REQUIREMENTS

1153.04.01 Design Requirements

The Contractor shall be responsible for selecting the emulsified asphalt patching material mixture composition. The mixture composition shall meet all of the requirements of this specification.

The mix shall maintain its effective properties in stockpile for a minimum period of eight months from the date of supply to the Owner.

1153.04.02 Submission Requirements

The mixture composition shall be submitted to the Owner 7 Days before the start of the production. The following items shall also be included in the submission:

- a) Type and grade of asphalt emulsion, supplier and facility type and location from which the asphalt emulsion is being supplied.
- b) Test results for the asphalt emulsion that demonstrate compliance to the requirements of the Asphalt Emulsion subsection of this specification.
- c) The aggregate supplier and location from which the aggregates are being supplied.
- d) Type of aggregate and test results for the aggregate that demonstrate compliance to the requirements of the Aggregates and Composition of Emulsified Asphalt Patching Materials subsections of this specification.
- e) Percent of residual asphalt content, percent by mass of patching mixture, when tested according to LS-282, in the mixture demonstrating compliance to the requirements of the Composition of the Mixture subsection of this specification.

1153.05 MATERIALS

1153.05.01 Asphalt Emulsion

The asphalt emulsion type for emulsified asphalt patching material shall be selected to ensure compatibility with the aggregates to be used.

1153.05.02 Aggregates

Aggregates for emulsified asphalt patching material shall consist of a blend of coarse and fine aggregate such that not less than 85% of the portion passing a 4.75 mm sieve is natural sand.

The aggregates for emulsified asphalt patching material shall consist of clean, hard, durable particles according to the physical requirements for Superpave 12.5 as specified in OPSS 1003.

1153.05.03 Composition of Emulsified Asphalt Patching Material

The patching mixture shall contain between 3.7 to 5.5% residual asphalt content by mass. The percent residual asphalt shall be expressed as a percentage of the total mix.

Gradation of aggregates used in the patching mixture shall be according to the gradation limits specified in Table 1.

1153.06 EQUIPMENT

Equipment shall be according to OPSS 1151.

1153.07 PRODUCTION

1153.07.01 Composition of the Mixture

The mineral aggregates and asphalt emulsion shall be combined and mixed to provide a uniformly coated and homogeneous product according to Table I.

1153.07.02 Preparation of the Mixture

Emulsion temperature: 20 - 60 °C

Mix temperature as
discharged from the plant: As specified by the emulsion supplier

Mixing cycle: 40 - 60 seconds

TABLE 1
Gradation of the Mixture

MTO Sieve Designation	Percentage Passing By Mass
16.0 mm	100
13.2 mm	98 - 100
9.5 mm	85 - 100
4.75 mm	50 - 85
2.36 mm	35 - 65
1.18 mm	25 - 50
600 µm	15 - 40
300 µm	7 - 25
150 µm	2 - 13
75 µm	0 - 7

**Appendix 1153-A, Commentary for OPSS.MUNI 1153, November 2016
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

Designer should include OPSS 307, Stockpiling of Patching Materials and Patching of Asphalt Pavement, in the Contract Documents for transporting and stockpiling requirements and payment for emulsified asphalt patching material.

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

Related Ontario Provincial Standard Drawings

No information provided here



**ONTARIO
PROVINCIAL
STANDARD
SPECIFICATION**

**METRIC
OPSS.MUNI 1202
NOVEMBER 2016**
(Formerly OPSS 1202, November 2008)

Note: The MUNI implemented in November 2016 replaces OPSS 1202 COMMON, November 2008 with no content changes.

**MATERIAL SPECIFICATION FOR
BEARINGS - ELASTOMERIC PLAIN AND STEEL LAMINATED**

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1202-A	Commentary

1202.01 SCOPE

This specification covers the requirements for Materials, design, and fabrication of plain and steel-laminated elastomeric bearings for bridges.

1202.01.01 Specification Significance and Use

This specification has been developed for use in provincial- and municipal-oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by many municipalities and the Ontario Ministry of Transportation.

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

1202.01.02

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.

1202.02

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.

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

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

Ontario Ministry of Transportation Publications

Laboratory Testing Manual:

- LS-427 Method of Test for Compressive Deformation of Plain Bearings
- LS-428 Method of Test for Compressive Deformation of Laminated Bearings
- LS-429 Method of Test for Parallelism of Steel Laminates of Laminated Bearings

Structural Manual:

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

Canadian Standards Association (CSA)

- S6-06 Canadian Highway Bridge Design Code

ASTM International

D 395-03	Standard Test Methods for Rubber Property - Compression Set
D 412-06a	Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
D 429-03e1	Standard Test Methods for Rubber Property - Adhesion to Rigid Substrates
D 518-99	Standard Test Method for Rubber Deterioration - Surface Cracking
D 573-04	Standard Test Method for Rubber - Deterioration in an Air Oven
D 2240-05	Standard Test Method for Rubber Property - Durometer Hardness
D 4014-03 (2007)	Standard Specification for Plain and Steel-Laminated Elastomeric Bearings for Bridges

American Association of State Highway and Transportation Officials (AASHTO)

M251-06-UL	Plain and Laminated Elastomeric Bridge Bearings

1202.03 DEFINITIONS

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

Effective Elastomer Thickness means the sum of the thickness of all layers of elastomer, excluding outer layers of laminated bearings.

Elastomer means a compound containing virgin natural polyisoprene (natural rubber) or virgin polychloroprene (neoprene).

Engineer means a Professional Engineer licensed by the Professional Engineers of Ontario to practice in the Province of Ontario.

Laminated Bearing means a bearing composed of elastomer laminates separated by and fully bonded to steel plates.

Plain Bearing means a bearing, which consists wholly of elastomer.

Plan Dimension means the dimensions of an object, when viewed perpendicular to the top of the object.

Proposal means a Contractor's submission for which engineering design is required that provides a written:

- a) alternative to requirements specified by the Owner in the Contract Documents;
- b) course of action or undertaking by the Contractor as delegated by the Owner in the Contract Documents.

Shape Factor means the area of the loaded face of an elastomeric layer divided by the area free to bulge.

1202.04 DESIGN AND SUBMISSION REQUIREMENTS

1202.04.01 Design Requirements

1202.04.01.01 General

Elastomeric bearings shall transmit vertical loads, excluding uplift, and accommodate the rotations and translations of the structure. At serviceability limit states, the design shall be such that the bearings do not suffer damage that would affect their performance. At ultimate limit states, the strength and stability of the bearings shall be adequate to resist the factored load and accommodate movements of the structure.

1202.04.01.02 Design

The bearings shall be proportioned to function satisfactorily under the combination of the maximum and minimum factored loads and factored translations and rotations at the serviceability limit states and the ultimate limit states specified in the Contract Documents.

All steel components of the bearings including any fasteners or dowels shall be proportioned according to CAN/CSA S6 and the Structural Manual, Division 1.

1202.04.01.03 Shape Factor

The shape factors for plain and the inner layers of laminated bearings shall not be less than 1.25 or greater than 12.

1202.04.01.04 Design Bearing Pressure

The average pressure on a plain bearing at serviceability limit state loads shall not exceed the following:

- a) The value corresponding to the shape factor (S) of the bearing is calculated as $0.22S^2$, but not greater than 7.0 MPa.
- b) 4.5 MPa under permanent loads.

The average pressure on a laminated bearing shall not exceed the following values:

- a) Serviceability Limit State loads
 - i. 4.5 MPa under permanent loads.
 - ii. 7.0 MPa under all loading combinations.
- b) Ultimate Limit States
 - i. 7.0 MPa under permanent loads.
 - ii. 10.0 MPa under all loading combinations.

1202.04.01.05 Deflection

The average vertical deformation of plain and laminated bearings at serviceability limit state loads shall not exceed 7% of the effective elastomer thickness.

1202.04.01.06 Translation

Provision for translation shall be through shear deformation of the elastomer.

The shear deformation in any direction of plain and laminated bearings at serviceability limit state loads shall not exceed 50% of the effective elastomer thickness.

1202.04.01.07 Rotation

Provision for rotation shall be through vertical deformation of the elastomer without any uplift at the edge of the bearing at serviceability limit state loads.

The total vertical deformation at the edge of plain and laminated bearings due to the vertical load and rotation at serviceability limit state loads shall not exceed 14% of the effective elastomer thickness.

1202.04.01.08 Elastomer Thickness

The effective elastomer thickness for plain bearings shall be greater than or equal to 15 mm and less than or equal to 25 mm.

1202.04.01.09 Steel Thickness

The thickness of the internal steel plates for laminated bearings shall be greater than 3 mm and less than 5 mm.

1202.04.01.10 Geometric Proportions

The bearings shall have the following proportions to ensure stability:

- a) Plain Bearings
 $L > 5 T_e$ or,
 $R > 3 T_e$
- b) Laminated Bearings
 $L > 3 T_e$ or,
 $R > 2 T_e$

Where:

L = is the lesser plan dimension of a rectangular bearing
R = is the radius of a circular bearing
 T_e = effective elastomer thickness

1202.04.02 Submission Requirements

1202.04.02.01 General

The Contractor shall notify the Contract Administrator in writing of the name and address of the supplier and manufacturer of the bearings within 30 Days of the Contract award.

Proposals shall bear the seal and signature of the design and checking Engineers.

When another authority is involved, all submissions shall be made a minimum of 5 weeks prior to the commencement of work.

1202.04.02.02 Working Drawings

The Contractor shall submit 3 sets of Working Drawings for the bearings to the Contract Administrator at least 1 week prior to commencement of bearing fabrication, for information purposes only. An Engineer shall affix his or her seal and signature on the Working Drawings verifying that the drawings are consistent with the Contract Documents and sound engineering practices.

The Contractor shall have a sealed and signed copy of these drawings at the site prior to and during site installation of the bearings.

These drawings shall clearly indicate the following:

- a) Material properties.
- b) The number and thickness of internal steel plates.
- c) Compressive stiffness.
- d) Shear stiffness.
- e) Bearing alphanumeric identification.

1202.04.02.03 Manufacturer's Certification

Upon completion of fabrication and prior to installation of the bearings, the Contractor shall submit a Certificate of Compliance, signed by the manufacturer, to the Contract Administrator. The certificate shall state that the fabricated bearings are according to the Working Drawings and Contract Documents.

1202.05 MATERIALS

1202.05.01 General

Reclaimed material shall not be incorporated in the finished bearing.

1202.05.02 Steel

Internal steel plates for laminated bearings shall be rolled mild steel with a minimum yield strength of 230 MPa.

1202.05.03 Elastomers

The elastomers shall be according to the following:

- a) Virgin natural polyisoprene or virgin polychloroprene elastomer shall be the only raw polymers permitted.
- b) The physical properties of any polyisoprene and polychloroprene used shall be according to the requirements of Table 1.

1202.07 PRODUCTION

1202.07.01 Plain Bearings

Plain bearing pads shall be moulded individually, cut from moulded strips or slabs of the required thickness, or extruded and cut to length.

1202.07.02 Laminated Bearings

Laminated bearings shall be moulded under pressure as a single unit and heated in moulds that have a smooth surface finish.

Steel plates shall be according to the following:

- a) All steel plates shall be of uniform thickness.
- b) Internal steel plates shall be free from sharp edges.
- c) Steel plates shall be completely bonded on all surfaces to the elastomeric material during molding. The cover on the edges and top and bottom surfaces shall be 5 mm, except that no cover is required over pintle holes.
- d) When pintles are specified in the Contract Documents, the depth of pintle holes shall be such that the pintle engages only one steel plate through the entire thickness of the plate.

Elastomer laminates shall be of uniform thickness.

1202.07.03 Identification

Each laminated elastomeric bearing shall be marked with the date of manufacture (i.e., yyyy-mm-dd) and an individual alphanumeric identification. The latter shall consist of the designated identification letter of the supplier and source followed by the letter I for polyisoprene or C for polychloroprene and a five-digit number. Bearings shall be sequentially numbered. The characters shall be not less than 10 mm in height, stamped or engraved into two adjacent sides, with the indentations or protrusions not less than 1 mm in width and 1 mm in depth.

1202.07.04 Quality Control

1202.07.04.01 Test Specimens

All test specimens of steel laminated bearings used for compression set test ASTM D 395, Method B, shall be prepared from the representative bearing pads and may consist of a single layer or multiple layers of elastomer.

1202.07.04.02 Performance and Testing

1202.07.04.02.01 Compressive Deformation of Laminated Bearings

The bearings shall be tested according to LS-428. The increment in compressive deformation of laminated bearings shall not exceed 0.05 of the effective rubber thickness, when the bearing load is increased from an initial pressure of 1.5 MPa to a pressure of 7 MPa

1202.07.04.02.02 Compressive Deformation of Plain Bearings

Plain bearings shall be tested according to LS-427. The increment in compressive deformation of plain bearings shall not exceed 0.06 of the thickness of the bearing when the bearing load is increased from an initial pressure of 20% of the average pressure to the average pressure.

1202.07.05 Tolerances

Bearing thickness $\leq$ 40 mm	0 to + 3 mm
Bearing thickness > 40 mm	0 to + 6 mm
Bearing plan dimension	0 to + 6 mm
Thickness of individual layers of elastomer	$\pm$ 20%
Deviation from plane parallel to theoretical surface:	
Top and bottom	1 in 200
Sides	1 in 100
Steel laminates tested according to LS-429.	0.25 T _e
Cover to embedded steel	0 to + 2 mm
Pintle hole diameter	0 to + 2 mm
Position of pintle holes relative to each other	$\pm$ 2 mm

1202.09 OWNER PURCHASE OF MATERIAL

1202.09.01 Measurement and Payment

For measurement purposes, a count shall be made of the number of complete bearings delivered and accepted.

Payment at the price specified in the purchasing order shall be full compensation for the supply of complete bearings or individual components delivered to the destination on the date and time specified.

The cost of all testing, except that performed in the Owner's laboratory, shall be included in the price.

TABLE 1
Physical Requirements for Polyisoprene and Polychloroprene

Property	Test	Requirements	
		Polyisoprene	Polychloroprene
Shear modulus G_{RT} , MPa @ 20 °C (Note 1)	ASTM D 4014, Annex A1, as modified by AASHTO M251	0.80 ± 0.15	0.80 ± 0.15
Shear modulus @ - 40 °C (G_{LT}) MP (Note 1)	ASTM D 4014, Annex A1, as modified by AASHTO M251	Not more than 3 times the value at room temperature $G_{LT} \leq 3 G_{RT}$	Not more than 3 times the Value at room temperature $G_{LT} \leq 3 G_{RT}$
Tensile strength, MPa	ASTM D 412, Method A	minimum 17.0	minimum 17.0
Ultimate elongation, %	ASTM D 412, Method A	minimum 400	minimum 400
Heat resistance	ASTM D 573	70 h at 70 °C	70 h at 100 °C
Change in hardness, Shore A	ASTM D 2240	maximum + 10	maximum + 15
Change in tensile strength, %	ASTM D 412, Method A	maximum - 25	maximum - 15
Change in ultimate elongation, %	ASTM D 412, Method A	maximum - 25	maximum - 40
Compression set, %	ASTM D 395, Method B	22 h at 70 °C maximum 25	22 h at 100 °C maximum 35
Ozone	ASTM D 518, Method A 20% strain 40 ± 2 °C	25 pphm, 48 h no cracks	100 pphm 100 h no cracks
Peel bond test, N/mm	ASTM D 429, Method B	minimum 7.0	minimum 7.0
Note: 1. Shear Modulus shall be determined at ambient temperature in accordance with ASTM D 4014 Annex A1 modified as follows: the initial cycles shall be taken to a strain of 0.7 and on the last cycle the shear modulus shall be determined at 0.5 strain.			

Appendix 1202-A, November 2008
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

The designer should specify the following in the Contract Documents:

- Pintles for laminated bearings. (1202.07.01.02)
- Minimum and maximum factored loads and factored translational and rotational loads at the serviceability limit states and the ultimate limit states. (1202.04.01.02)

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

Related Ontario Provincial Standard Drawings

No information provided here.



**ONTARIO
PROVINCIAL
STANDARD
SPECIFICATION**

**METRIC
OPSS.MUNI 1203
NOVEMBER 2016**
(Formerly OPSS 1203, November 2008)

Note: The MUNI implemented in November 2016 replaces OPSS 1203 COMMON, November 2008 with no content changes.

**MATERIAL SPECIFICATION FOR
BEARINGS-ROTATIONAL AND SLIDING SURFACE**

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1203.09	OWNER PURCHASE OF MATERIAL

APPENDICES

1203-A	Commentary

1203.01 SCOPE

This specification covers the requirements for Materials, design, and fabrication of rotational and sliding surface bearings for bridges.

1203.01.01 Specification Significance and Use

This specification has been developed for use in provincial- and municipal-oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by many municipalities and the Ontario Ministry of Transportation.

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

1203.01.02

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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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.

1203.02

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.

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 911 Coating Structural Steel

Ontario Provincial Standard Specifications, Material

OPSS 1202 Bearings - Elastomeric Plain and Steel-Laminated

Ontario Ministry of Transportation Publications

Structural Manual:

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

Canadian Standards Association (CSA)

B95-1962 (R2002)	Surface Texture (Roughness, Waviness and Lay)
G40.20/40.21-04	General Requirements for Rolled or Welded Structural Quality Steel /Structural Quality Steel
G164-M92 (R2003)	Hot Dip Galvanizing of Irregularly Shaped Articles
S6-06	Canadian Highway Bridge Design Code
S157-M83 (R2001)	Strength Design in Aluminium
W48-06	Filler Metals and Allied Materials for Metal Arc Welding
W59-03	Welded Steel Construction (metal Arc Welding) (Metric Version)

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 Applications
A 325-07	Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
B 36/B 36M-06	Standard Specification for Brass Plate, Sheet, Strip, and Roller Bar
B 137-95(2004)	Standard Test Method for Measurement of Coating Mass Per Unit Area on Anodically Coated Aluminium
B 487-85(2007)	Standard Test Method for Measurement of Metal and Oxide Coating Thickness by Microscopical Examination of a Cross Section
D 395-03	Standard Test Method for Rubber Property - Compression Set
D 412-06a	Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
D 429-03e1	Standard Test Methods for Rubber Property - Adhesion to Rigid Substrates
D 638-03	Standard Test Method for Tensile Properties of Plastics
D 792-00	Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
D 2240-05	Standard Test Method for Rubber Property - Durometer Hardness
D 4894-07	Standard Specification for Polytetrafluoroethylene (PTFE) Granular Molding and Ram Extrusion Materials

American National Standards Institute (ANSI)

B4.1-1967 (R1999)	Preferred Limits and Fits for Cylindrical Parts

U.S. Military Specifications

MIL-S-8660 C	Silicone Compound

1203.03 DEFINITIONS

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

Disc Bearing means a bearing consisting of a single moulded disc of unreinforced elastomer confined by upper and lower steel bearing plates and restricted from horizontal movement by limiting rings and a centrally located shear restriction mechanism.

Elastomer means a compound containing virgin natural polyisoprene (natural rubber) for confined elastomeric bearings or polyether urethane polymer for disc bearings.

Engineer means a professional engineer licensed by the Professional Engineers of Ontario to practice in the Province of Ontario.

Plan Dimension means the dimensions of an object, when viewed perpendicular to the top of the object.

Pot Bearing means a bearing consisting of a metal piston supported by a single moulded disc of unreinforced elastomer that is confined within a metal cylinder.

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

Proposal means a Contractor's submission for which engineering design is required that provides a written:

- a) alternative to requirements specified by the Owner in the Contract Documents;
- b) course of action or undertaking by the Contractor as delegated by the Owner in the Contract Documents.

Spherical Bearing means a bearing consisting of a curved spherical metal surface in contact with and sliding on a matching curved polytetrafluoroethylene polymer (PTFE) surface.

Substructure means the abutments, piers, columns, and other components of a bridge below the bearings.

Superstructure means all parts of a bridge above the bearings.

1203.04 DESIGN AND SUBMISSION REQUIREMENTS

1203.04.01 Design Requirements

1203.04.01.01 General

The rotational bearings and sliding surfaces shall consist of components arranged so as to transmit all loads, including uplift, and accommodate the rotations and translations of the structure. At serviceability limit states, the design shall be such that the bearings shall not suffer damage that would affect their performance. At ultimate limit states, the strength and stability of the bearings shall be adequate to resist the factored loads and accommodate movements of the structure.

1203.04.01.02 Design

The bearings shall be proportioned to function satisfactorily under the critical combinations of the maximum and minimum factored loads and the factored translations and rotations at the serviceability limit states and the ultimate limit states as shown in the Contract Documents.

Bearings subject to uplift shall limit the separation of the bearing components to the value specified in the Contract Documents.

All steel components of the bearings, including fasteners, shall be proportioned according to the requirements of the CAN/CSA S6 and Structural Manual, Division 1.

Aluminium alloy components of bearing shall be proportioned according to the requirements of CAN-S157M.

The average stress in the elastomer at serviceability limit state loads shall not exceed the following values:

- a) Pot bearings 40 MPa
- b) Disc bearings 35 MPa

1203.04.01.03 Translations and Rotation

Provision for translation shall be through sliding of a stainless steel surface against a mating PTFE element.

The translational capacity in an unrestrained direction shall be as specified in the Contract Documents and the following:

- a) Longitudinal direction ± 25 mm
- b) Transverse direction ± 15 mm

Provision for rotation about any horizontal axis shall be by means of a single disc of confined elastomer for pot bearings, a single disc of polyether urethane polymer compound for disc bearings, and a spherical sliding surface of stainless steel or anodized aluminium alloy against PTFE for spherical bearings.

The rotational capacity about any horizontal axis shall be the rotation caused by ultimate limit states loads plus 1.2° .

The rotational capacity about the vertical axis through the centre of the bearing shall be $\pm 1^\circ$.

Uplift restraint devices shall not restrict rotations.

At serviceability limit states, the shift in the axial load from the centre of bearing shall not exceed the following values:

- a) 4% of the diameter of the confined elastomer for pot bearings.
- b) 10% of the diameter of the polyether urethane polymer compound for disc bearings.
- c) 10% of the plan diameter of the curved PTFE surface for spherical bearings.

Rotational bearings shall be capable of resisting the specified lateral loads in any direction in combination with the applicable vertical loads

The rotation of confined elastomeric bearings about a horizontal axis shall be limited so that the vertical strain at the perimeter of the elastomer, at serviceability limit states loads, does not exceed 0.15 of the elastomer thickness.

Brass sealing rings that are a minimum of 6 mm wide shall be provided at the perimeter of the elastomer to prevent the elastomer from extruding between the piston and the pot wall. The thickness of the brass rings shall be at least 0.2 times the width of the ring. A minimum of three layers of flat sealing rings shall be used with split ends equally positioned around the circumference of the elastomer and shall fit snugly against the surface of the inside perimeter of the pot wall. The sealing rings shall be flat and smooth on all surfaces. The upper edge of the elastomer shall be recessed to accommodate the sealing rings.

The depth of the pot wall shall be such that a minimum vertical distance of 2.5 mm remains between the top of the pot wall and the closest point of contact of the sealing rings with the pot wall upon rotating the piston an amount equal to the required rotation plus 1° .

The pot and piston surfaces in contact with the confined elastomer shall be lubricated with silicone grease. The bearing shall be sealed by a one-piece continuous preformed closed-cell compressible ring against entry of dirt, dust, and moisture between the elastomer and the pot and piston contact surfaces. Any joint in the ring shall be bonded and the strength shall be at least equal to the strength of the ring.

For disc bearings, the upper and lower plates in contact with the elastomer shall be provided with outer limiting rings to restrict the horizontal movement of the elastomer and a centrally located shear restriction mechanism.

1203.04.01.04 Sliding Surfaces

1203.04.01.04.01 General

Sliding surfaces shall allow translation or rotation by sliding of a metal surface against a mating PTFE element. For plane surfaces, the metal surface shall be stainless steel and for spherical surfaces it shall be stainless steel or anodized aluminium alloy. The metal surface shall overlap the PTFE by at least 5 mm at extremes of movement and except for guides for lateral restraint shall be positioned above the PTFE element.

1203.04.01.04.02 Polytetrafluoroethylene Polymer Element

Except when used as mating surfaces for guides for lateral restraint, the PTFE resin shall be virgin material and shall be used as unfilled sheets and shall contain spherical reservoirs for lubricant pressed into its surface. The diameter of the reservoirs shall not exceed 8 mm measured at the surface of the PTFE, and the depth shall not be less than 2 mm or more than half the thickness of the PTFE. The reservoirs shall be evenly distributed across the surface of the PTFE and shall occupy 20 to 30% of the surface.

Material used as mating surface for guides for lateral restraint shall not be dimpled or lubricated.

1203.04.01.04.03 Stainless Steel

For dimensional differences between the stainless steel and the PTFE in the direction of movement, the thickness of the stainless steel sheet shall be as follows:

Dimensional Difference Between Stainless Steel and PTFE, mm	Minimum Thickness of Stainless Steel, mm
≤ 300	1.5
> 300 and ≤ 500	2.0
> 500 and ≤ 1,500	3.0

1203.04.01.04.04 Lubrication

All PTFE surfaces except those that act as mating surfaces for guides for lateral restraint or that are subject to a contact pressure of less than 5 MPa shall be permanently lubricated with silicone grease.

1203.04.01.04.05 Thickness of Polytetrafluoroethylene Polymer and Depth of Recess

The PTFE element shall be fully bonded and recessed in a rigid backing material. The thickness of the PTFE element and the depth of recess shall be as follows:

Maximum plan dimension, mm	≤ 1,200	> 1,200
Thickness, mm	5.0	5.5
Depth of recess, mm	2.5	3.0

1203.04.01.04.06 Contact Pressure

The average contact pressure for unfilled PTFE elements based on the recessed area of the PTFE shall not exceed the following:

Limit State	Dead Load, MPa	Total Load, MPa
Serviceability	30	45
Ultimate	45	65

The maximum contact pressures at the extreme edges of flat and curved PTFE elements shall not exceed 1.2 times the values indicated above.

The average contact pressure at serviceability limit state loads for filled PTFE elements used to face mating surfaces for guides for lateral restraint shall not exceed the following:

- a) PTFE filled with up to 15% by mass of glass fibres 45 MPa.
- b) Lead filled PTFE in a bronze matrix 60 MPa.

1203.04.01.04.07 Coefficient of Friction

The coefficient of friction between stainless steel or anodized aluminium alloy sliding surfaces and lubricated virgin PTFE shall not exceed the following and shall be interpolated linearly for contact pressures within the ranges given:

Contact Pressures, MPa	Coefficient of Friction
3	0.08
7	0.07
14	0.06
≥ 21	0.04

1203.04.01.05 Guides for Lateral Restraint

The guides for lateral restraint shall be arranged to permit the required rotations about both the horizontal and vertical axis.

Translational elements with lateral restraints shall be capable of resisting either of the following lateral loads:

- a) The bearings with a capacity of 5,000 kN or less at serviceability limit state, 10% of the vertical load capacity.
- b) For bearings with a capacity over 5,000 kN at serviceability limit state, 500 kN plus 5% of the vertical load in excess of 5,000 kN.

Unless the guide bars are machined to form an integral part of the top plate, they shall be recessed not less than 5 mm into the plate to which they are attached and fastened with bolts.

The translational elements of guides for lateral restraint shall be faced with stainless steel and shall provide lateral restraint by sliding against mating surfaces faced with PTFE. Lead filled PTFE shall be at least 2 mm thick and shall be mechanically fastened and bonded to the substrate. Glass filled or virgin PTFE shall be recessed and bonded to the substrate according to the Thickness of Polytetrafluoroethylene Polymer and Depth of Recess clause.

1203.04.01.06 Top and Base Plates

The top and base plates that are permanently attached to the structure shall be provided with the bearings and shall be according to the bearing and the structure requirements.

1203.04.01.07 Fasteners and Anchorage

Fasteners used to attach the bearing to the top and base plates and the anchorage devices shall be capable of resisting either of the following the lateral loads:

- a) For bearings with a capacity of 5,000 kN or less at serviceability limit state, 10% of the vertical load capacity.
- b) For bearings with a capacity over 5,000 kN at serviceability limit state, 500 kN plus 5% of the vertical load capacity in excess of 5,000 kN.

The beneficial effect of friction shall be neglected in proportioning the fasteners and anchors.

1203.04.01.08 Deflection

The average vertical deflection at serviceability limit state loads for disc bearings shall not exceed 10% of the elastomer thickness.

1203.04.01.09 Bearing Assembly Replacement

The entire bearing assembly, except for the top plate used to attach it to the superstructure and the base plate used to anchor it to the substructure but including both contact surfaces of the sliding interface, shall be replaceable without damage to the structure and without removal of any concrete, welds, or anchorages permanently attached to the structure and without lifting the superstructure more than 5 mm. Bearings shall not be recessed into plates that are permanently attached to the structure.

1203.04.01.10 Durability

Bearings shall be designed to prevent moisture and dirt from entering the internal surfaces. The bearings shall be fabricated from materials that are durable and are protected against corrosion so as to perform the intended function.

Contact between dissimilar metals that could have corrosion potential and between the aluminium alloy and concrete shall be prevented by use of suitable insulation.

1203.04.01.11 Concrete Bearing Pressure

For bearings subject to compressive loading, the top plate and the base plate shall be proportioned to ensure the average concrete bearing pressure does not exceed 24 MPa at the ultimate limit states providing the following:

- a) Concrete on which the plate is supported has a specified nominal 28-Day compressive strength of at least 30 MPa.
- b) Edges of the plates are located a minimum of 100 mm from the edge of the concrete.
- c) The largest dimension of plate does not exceed 1,000 mm.

Alternatively, the top plate and the base plate of the bearing shall be proportioned to ensure the factored bearing resistance of concrete specified in CAN/CSA S6 and the Structural Manual, Division 1, is not exceeded.

Compressive loads in the vertical direction may be dispersed through the bearing from the edges of the elastomer or PTFE at a slope of 1.5H:1.0V providing that the dispersal lines are not interrupted by discontinuities within the bearing.

1203.04.02 Submission Requirements

1203.04.02.01 General

The Contractor shall notify the Contract Administrator in writing of the name and address of the supplier of the bearings within 30 Days of the Contract award.

Proposals shall bear the seal and signature of the design and checking Engineers.

When another authority is involved, all submissions shall be made a minimum of 5 weeks prior to the commencement of work.

1203.04.02.02 Working Drawings

The Contractor shall submit 3 sets of Working Drawings for the bearings to the Contract Administrator at least 1 week prior to commencement of bearing fabrication, for information purposes only. An Engineer shall affix his or her seal and signature on the Working Drawings verifying that the drawings are consistent with the Contract Documents and sound engineering practices.

The Working Drawings shall be according to the Contract Documents and Product Drawings.

The Working Drawings shall clearly indicate all material properties, dimensions, connection attachments, fasteners and accessories, the bearing alphanumeric identification, and the load capacity at the serviceability and ultimate limit states as follows:

- a) Maximum vertical permanent and total load.
- b) Maximum lateral load and corresponding vertical load.
- c) Maximum rotational capacity about any horizontal axis and about the vertical axis at the centre of the bearing.

The bearing supplier shall have a copy of the Working Drawings at the manufacturing plant prior to and during the bearing fabrication.

1203.04.02.03 Manufacturer's Certification

Upon completion of fabrication and prior to installation of the bearings, the Contractor shall submit to the Contract Administrator a Certificate of Compliance signed by the manufacturer. The certificate shall state that the fabricated bearings are according to the Working Drawings, Product Drawings, and Contract Documents.

1203.05 MATERIALS

1203.05.01 Steel

Mild steel components shall be according to CSA G40.20/40.21, Grade 300 W, except for components permanently attached to steel superstructures, which shall be Grade 350 A.

Stainless steel for sliding surfaces shall have a minimum corrosion resistance according to ASTM A 240M, Type 304.

Steel fasteners shall be according to ASTM A 325 and hot-dipped galvanized according to CAN/CSA G164-M. For guide bars, alternative steel fasteners and corrosion protection systems shall be as specified in the Contract Documents.

1203.05.02 Aluminium Alloy

Aluminium alloy shall be according to CAN/CSA S157-M.

1203.05.03 Brass

Brass sealing rings for confined elastomer bearings shall be according to ASTM B 36M, half-hard.

1203.05.04 Elastomers

Polyisoprene shall be according to OPSS 1202 except that the hardness may be 50 ± 5 .

Polyether urethane polymer shall be according to Table 1.

1203.05.05 Polytetrafluoroethylene Polymer

Material used in sliding surfaces shall be virgin PTFE according to ASTM D 4894. The PTFE shall be unfilled and according to Table 2.

Material used as the mating surface for guides for lateral restraint may be one of the following:

- a) Unfilled PTFE.
- b) PTFE filled with up to 25% by mass of glass fibres.
- c) Lead filled PTFE in a bronze matrix.

1203.05.06 Lubricant

Lubricant shall be silicone grease according to MIL-S-8660C.

1203.05.07 Adhesives

Adhesives for bonding PTFE to metal shall produce a bond with a minimum peel strength of 4 N/mm, when tested according to ASTM D 429, Method B. Adhesives shall not degrade in the service environment.

1203.07 PRODUCTION

1203.07.01 Welding

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

All welding shall be done with electrodes certified by the Canadian Welding Bureau to the requirements of CSA W48.

The stainless steel sheets that come in contact with PTFE shall be one piece continuously welded around the perimeter to its backing plate to prevent ingress of moisture. The weld shall be clean, uniform, and without overlaps and located outside the area in contact with PTFE.

1203.07.02 Fasteners

The threaded portion of the bolts shall be coated with silicone grease prior to installation.

1203.07.03 Anchors

The top and base plate anchorage to concrete shall be by studs approved by the Owner that are fusion welded to the plates.

1203.07.04 Machining

Metal to metal contact surfaces shall be machined or fine ground. The pots and pistons for confined elastomer bearings and the upper and lower plates with limiting rings for disc bearings shall be machined from solid metal plate or castings. The concave and convex plates for spherical bearings shall be machined from solid metal plate or castings.

There shall be no openings or discontinuities in the metal surfaces in contact with the elastomer or PTFE.

1203.07.05 Roughness of Metal Surfaces

The roughness of sliding stainless steel metallic surfaces in contact with PTFE, measured according to CSA B95, shall not be greater than 0.25 µm arithmetic average for plane surfaces and 0.50 µm arithmetic average for spherical surfaces. The roughness of anodized aluminium metallic surfaces shall not be greater than 0.40 µm arithmetic average.

The roughness of metal surfaces in contact with elastomer measured according to CSA B95 shall not be greater than 3.0 µm arithmetic average.

1203.07.06 Attachment of Polytetrafluoroethylene Polymer

Virgin or glass filled PTFE elements shall be recessed in a rigid backing material and shall be bonded over the entire area with an adhesive. The rigid backing material shall be grit blasted prior to applying the adhesive.

Lead filled PTFE shall be mechanically fastened and bonded to the backing plates.

The PTFE elements used as mating surfaces for guides for lateral restraint shall extend to within 10 mm from the ends of the backing plates.

1203.07.07 Anodizing

Aluminium alloy surfaces shall be anodized using the sulphuric acid process and shall meet the following:

Physical Property of Sealed Anodic Coating	Units	Test Method	Requirements
Thickness, t	µm	ASTM B 487	25 minimum
Mass, w	mg/cm ²	ASTM B 137	5.8 minimum
Apparent density, d	g/cm ³		2.32 minimum

The apparent density shall be determined as: $d = \frac{10 w}{t}$

1203.07.08**Corrosion Protection**

All exposed metal corners that receive corrosion protection shall have a 3 mm rounding. All exposed metal surfaces of the bearings, except stainless steel and components permanently attached to steel superstructures, shall be protected against corrosion by a low volatile organic compound coating system according to OPSS 911. The continuous weld attaching the stainless steel sheet shall be ground smooth and have the same corrosion protection as the bearing. Steel fasteners shall be galvanized or as specified in the Contract Documents.

For corrosion protection purposes, bearing components permanently attached to steel superstructures shall be considered part of the structural steel.

1203.07.09**Identification**

Each bearing shall be marked with the date of manufacture (i.e., yyyy-mm-dd) and an individual alphanumeric identification. The latter shall consist of the designated identification letter of the supplier and source followed by a sequential five digit number. The characters shall be stamped or engraved into two adjacent sides and shall be clearly legible after installation. The characters shall not be less than 10 mm in height with the indentations not less than 1 mm in width and 0.5 mm in depth.

1203.07.10**Tolerances**

The deviation from flatness of PTFE surfaces shall not exceed:

- a) 0.2 mm, when the diameter or diagonal is equal to or less than 800 mm.
- b) 0.00025 of the diameter or diagonal, when the diameter or diagonal is greater than 800 mm.

The deviation from flatness of stainless steel or aluminium alloy surfaces in contact with PTFE for plane surfaces and from the theoretical surface for spherical surfaces shall not exceed:

- a) 0.0003 LH mm for a rectangular PTFE element.
- b) 0.0006 RH mm for a circular PTFE element

where:

L = the greater plan dimension for a rectangular bearing,
R = the radius of a circular bearing, and,
H = the free height of PTFE element

For confined elastomer bearings, the tolerance of fit between the piston and the pot shall be + 0.75 to + 1.25 mm. The inside diameter of the pot cylinder shall be the same as the nominal diameter of the elastomer and shall be machined to a tolerance of:

- a) 0 to + 0.125 mm for diameters up to and including 500 mm.
- b) 0 to + 0.175 mm for diameters over 500 mm.

For disc bearings, the gap between the edge of the polyether urethane polymer disc and the inside face of the limiting ring shall be $1.25\% \pm 0.25\%$ of the diameter of the disc.

The plan dimensions of the recess for PTFE shall be the same as the nominal plan dimensions of the PTFE and shall be machined to a tolerance of 0 to + 0.2% of the diameter or diagonal.

Overall bearing plan dimension	$\pm 3 \text{ mm}$
Overall bearing height	$\pm 3 \text{ mm}$
Machined surface dimensions	$\pm 0.4 \text{ mm}$

Elastomer:

Diameter	a) 0.0 to -1.5 mm for diameters $\leq 500 \text{ mm}$ b) 0.0 to -2.0 mm for diameters $> 500 \text{ mm}$
Thickness	0.0 to + 1.0 mm

Brass rings:

Difference between internal diameter of brass ring and diameter of recess in the moulded elastomer	0 to + 0.5 mm
Difference between sum of thicknesses of brass rings and recess depth in the moulded elastomer	0 to + 0.25 mm

Recessed Guide Bars - American Standard Clearance Locational Fit Class LC3 according to ANSI B4.1.

Guides for Lateral Restraint - Gap between metal restraints surfaces and mating PTFE elements	$0.50 \text{ mm} \pm 0.25 \text{ mm}$

PTFE plan dimension 0 to - 0.2% of diameter or diagonal

PTFE thickness 0 to + 10.0% of thickness

Depth of recess for PTFE 0 to + 0.3 mm

1203.09 OWNER PURCHASE OF MATERIAL

1203.09.01 Measurement and Payment

For measurement purposes, a count shall be made of the number of complete bearings delivered and accepted.

Payment at the price specified in the purchasing order shall be full compensation for the supply of complete bearings or individual components delivered to the destination on the date and time specified.

The cost of all testing, except that performed in the Owner's laboratory, shall be included in the price.

TABLE 1
Physical Requirements for Polyether Urethane Polymer

Physical Property	ASTM Test Methods	Requirements	
		Minimum	Maximum
Hardness, Scale D	D 2240	60	64
Tensile Stress, MPa @ 100% elongation @ 200% elongation	D 412	14 26	-- --
Tensile Strength, MPa	D 412	35	--
Ultimate Elongation, %	D 412	220	--
Compression Set, % 22 h @ 70 °C	D 395	--	40

TABLE 2
Physical Requirements for Polytetrafluoroethylene Polymer

Physical Property	ASTM Test Method	Requirement
Tensile Strength, MPa	D 638	minimum 20
Elongation, %	D 638	minimum 200
Relative Density	D 792	2.16 ± 0.03

Appendix 1203-A, November 2008
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

The following shall be specified in the Contract Documents:

- Maximum and minimum factored loads, factored translations and rotations, serviceability limit states and ultimate limit states. (1203.04.01.02)
- Bearing component uplift separation. (1203.04.01.02)
- The rotational and translational capacity in an unrestrained direction or directions. (1203.04.01.03)
- Lateral loads. (1203.04.01.05)
- Guide bar alternative steel fasteners and corrosion protection systems. (1203.05.01)
- Requirements for alternative corrosion protection system to galvanizing for steel fasteners. (1203.07.08)

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

Related Ontario Provincial Standard Drawings

No information provided here.



MATERIAL SPECIFICATION FOR CLAY SEAL

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1205-A	Commentary

1205.01 SCOPE

This specification covers the requirements of clay seal material for use at the inlet side of culverts and in pipe trenches.

1205.01.01 Specification Significance and Use

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

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

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

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

Ontario Provincial Standard Specifications, Material

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

ASTM International

D 5084-10 Measurement of Hydraulic Conductivity of Saturated Porous Materials 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 and plastic soil within a wide range of water content.

Geosynthetic Clay Liner means sodium bentonite clay 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

Samples of natural clay material proposed for use in clay seal shall be submitted to the Contract Administrator for approval 3 weeks prior to use.

When clay mixture is proposed for use, a minimum 25 kg sample of the Granular A and a minimum 7 kg sample of Bentonite shall be submitted to the Contract Administrator 3 weeks prior to use.

The clay mixture shall be left to cure at various moisture contents for a minimum period of 24 hours prior to performing standard Proctor density tests and flexible wall permeability tests on samples compacted to 95% of its standard Proctor maximum dry density.

1205.05 MATERIAL

1205.05.01 General

Material used for clay seals shall lie within the hatched area shown in Figure 1 and shall be natural clay or clay mixture. Alternatively, a geosynthetic clay liner as specified in the Geosynthetic Clay Liner subsection may be used.

The coefficient of permeability as determined in the flexible wall permeameter according to ASTM D 5084 shall not exceed 1×10^{-6} cm/s.

1205.05.02 Natural Clay

Clay material for clay seal shall be according to the following:

- a) Liquid limit shall be > 40%.
- b) Plasticity index shall be > $0.73 \times (\text{Liquid Limit} - 20\%)$.

1205.05.03 Clay Mixture

Alternatively, material for clay seal may be made of the following mixture by volume:

- a) 1 part Bentonite powder
- b) 3.5 parts Granular A

The mixing of the material shall be carried out in an approved mechanical mixer.

At placement, the moisture content of the mixture shall be maintained to within $\pm 1\%$ of the optimum moisture content.

1205.05.04 Geosynthetic Clay Liner

Material specifications containing the physical, mechanical, and hydraulic properties of the geosynthetic clay liner shall be obtained from the manufacturer. The material specification shall include a manufacturer's certification and warranty. Installation shall be as per manufacturer's instructions.

1205.05.05 Granular A

Granular A shall be according to OPSS 1010.

1205.08 QUALITY ASSURANCE

1205.08.01 Sampling and Testing

Sampling requirements of clay seal material (e.g., sampling location, intervals, and lot sizes) shall be as specified in the Contract Documents.

The Contract Administrator may elect to carry out testing at the quality assurance laboratory to ensure that clay seal material used in the work conform to the requirements of this specification.

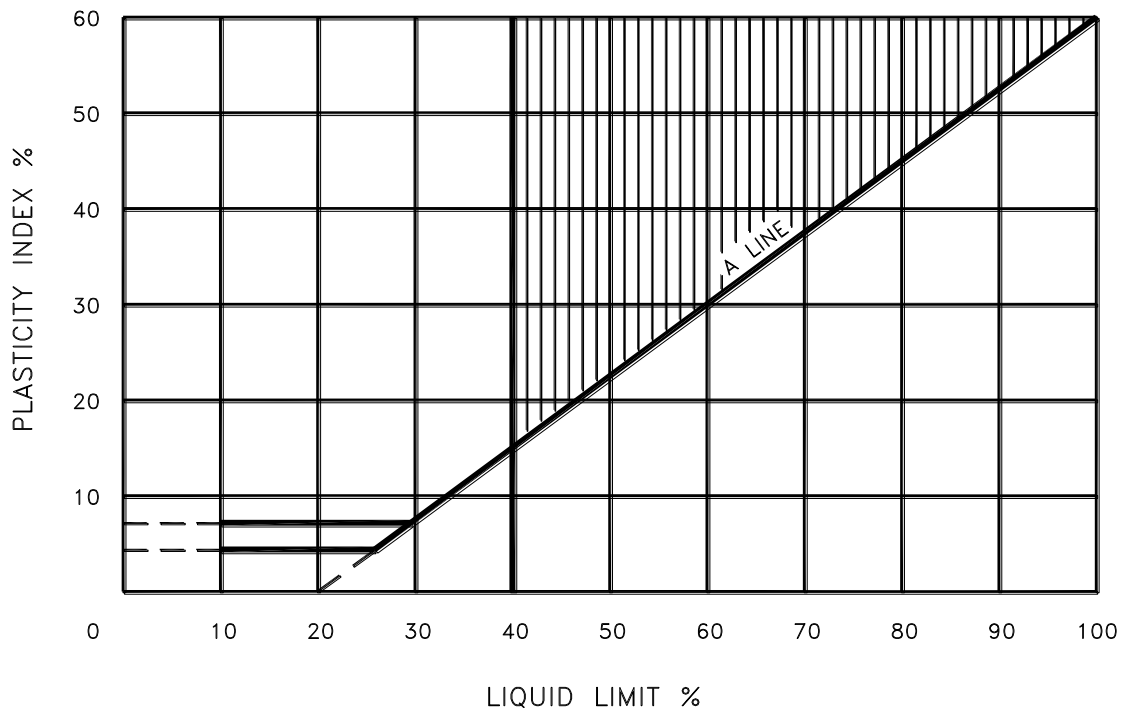


FIGURE 1
Plasticity Chart

NOTES:

- A. Figure 1, Plasticity Chart, originates from early principle soil classification developed by Arthur Casagrande and further enhanced by the Unified Soil Classification System.
- B. Figure 1 is used to distinguish between different fine grained soil types. Only highly plastic clays that fall within the limits of Figure 1 are specified as suitable clay seal materials in this specification.

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

The designer should specify the following in the Contract Documents:

- Sampling requirements of clay seal material. (1205.08.01)

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

Related Ontario Provincial Standard Drawings

OPSD 802.095 Clay Seal for Pipe Trenches



MATERIAL SPECIFICATION FOR DECK JOINT ASSEMBLIES

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APPENDICES

1210-A	Commentary

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

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

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

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

Ontario Provincial Standard Specifications, 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

1210.03 DEFINITIONS

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

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.

Engineer means a professional engineer licensed by the Professional Engineers Ontario to practice in the Province of Ontario.

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 blackout.

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.

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.

1210.04.02 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

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

Related Ontario Provincial Standard Drawings

No information provided here.



MATERIAL SPECIFICATION FOR ADMIXTURES FOR CONCRETE

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1303-A	Commentary

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

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

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

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

Ministry of Transportation Publications

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 494-04 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 an admixture that causes development of a system of microscopic air bubbles in concrete during mixing to increase its workability and resistance to freezing and thawing.

Chemical Admixture means Types A, B, C, D, and E admixtures.

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

Superplasticizer means a high range water reducing admixture such as Types F and G.

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.

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 Owner's pre-qualified products list.

1303.05 MATERIALS

Admixtures shall be non-chloride, with the exception of admixtures used for fast track full depth repairs to concrete pavements.

Admixtures shall be in liquid form.

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

1303.08 QUALITY ASSURANCE

1303.08.01 Sampling

Samples of the admixtures may be taken by the Owner from the concrete batching plant. The frequency of sampling shall be determined by the Owner.

1303.08.02 Testing

Testing for the relative density shall be according to ASTM C 494, Section 18.4.

Testing for non-volatile content shall be according to LS-413.

Testing for pH shall be according to ASTM E 70.

1303.08.03 Acceptance or Rejection

Admixture properties shall be according to the product data information submitted to the Owner at the time of material evaluation for inclusion on the Owner's pre-qualified products list.

Material represented by the sample that fails to meet the requirements of this specification shall be rejected.

Acceptance tolerances shall be $\pm 2.5\%$ for non-volatile content and ± 1.0 for pH.

Where relative density is 1.050 or less, the acceptance tolerance shall be ± 0.005 .

Where relative density is greater than 1.050, the acceptance tolerance shall be calculated according to the following formula:

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

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

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

Related Ontario Provincial Standard Drawings

No information provided here.



MATERIAL SPECIFICATION FOR CONCRETE - MATERIALS AND PRODUCTION

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APPENDICES

1350-A	Commentary

1350.01 SCOPE

This specification covers the requirements for Materials; product supply pre-qualification; and mixing, transporting, and delivering concrete.

1350.01.01 Specification Significance and Use

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

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

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 904 Concrete Structures

Ontario Provincial Standard Specifications, Material

OPSS 1001 Aggregates - General
OPSS 1002 Aggregates - Concrete
OPSS 1302 Water

CSA Standards

A23.1-09 Concrete Materials and Methods of Concrete Construction *
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 *
A23.2-8C Flexural Strength of Concrete (Using a Simple Beam with Third-Point Loading) *
A23.2-9C Compressive Strength of Cylindrical Concrete Specimens *
A23.2-10C Accelerating the Curing of Concrete Cylinders and Determining Their Compressive Strength *
A23.2-13C Splitting Tensile Strength of Cylindrical Concrete Specimens *
A283-00 (R2004) Qualification Code for Concrete Testing Laboratories
A3000-08 Cementitious Materials Compendium
* [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 157/C 157M-04	Standard Test Method for Length Change of Hardened Hydraulic-Cement, Mortar, and Concrete
C 260-01	Standard Specification for Air-Entraining Admixtures for Concrete
C 457-06	Standard Test Method for Microscopical Determination of Air Void Content and Parameters of the Air Void System in Hardened Concrete
C 494/C 494M-05a	Standard Specification for Chemical Admixtures for Concrete
C 1017/C 1017M-03	Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
C 1202-05	Standard Test Method for Electrical Indication of Concretes Ability to Resist Chloride Ion Penetration

Ready Mixed Concrete Association of Ontario Publications (RMCAO)

R1025	Certificate of Ready Mixed Concrete Production Facilities
R1026	Certificate of Mobile Mix Concrete Production Facilities

1350.03 DEFINITIONS

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

Agitator Truck means a vehicle in which freshly mixed concrete can be conveyed from the mixing site to the Work Area while being agitated. The containment vessel can either be stationary with an agitator or it can be mobile with a drum rotated continuously so as to agitate the concrete.

Cementing Material means hydraulic cement with or without a supplementary cementing material.

Confidentiality and Indemnity Agreement means a legal agreement between an Owner and the concrete supplier as obtained from the Municipal Engineers Association (MEA) or the Ready Mixed Concrete Association of Ontario (RMCAO).

Curing means the maintenance of a satisfactory moisture content and temperature in concrete for a period of time immediately following placing and finishing so that the desired concrete properties may develop.

High Volume Supplementary Cementing Materials (HVSCM) Concrete means concrete that contains a level of supplementary cementing materials above that typically used in construction.

Hot Weather means those conditions when the air temperature is at or above 28 °C. It is also considered to exist when the air temperature is likely to rise above 28 °C within 24 hours. Temperature refers to shade temperature.

Inspector means a representative of the Owner to which the concrete is being supplied.

Mobile Mix Concrete means concrete that is completely batched and mixed by a mobile mixer truck at the site.

Performance Criteria means requirements to be met as specified in the Contract Documents and as shown in form OPSF 1350-1 or OPSF 1350-2.

Portland Cement means the product obtained by pulverizing clinker consisting essentially of hydraulic calcium silicates to which calcium sulphate, limestone, water, and processing additions may be added at the option of the cement manufacturer.

Pre-Qualification Performance Criteria means requirements to be met as specified in the Contract Documents and as shown in form OPSF 1350-1 or OPSF 1350-2 and have been demonstrated through trial batches or concrete test data from a similar class of concrete as specified in the Trial Batch clause.

Ready Mixed Concrete means concrete that is completely batched at the plant and completely mixed at the plant or while in transit.

Self-Consolidating Concrete (SCC) means a highly flowable, yet stable concrete that can spread readily into place, fill the formwork, and, if applicable, encapsulate the reinforcement without any mechanical consolidation and without undergoing any significant separation of material constituents.

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

Supplementary Cementing Material (SCM) means material that, when used in conjunction with hydraulic cement, contributes to the properties of the hardened concrete through hydraulic or pozzolanic activity or both.

Truck Mixer means a concrete mixer mounted on a truck or other vehicle used for the complete mixing of concrete materials after they have been batched at the plant.

Water-to-Cementing Materials Ratio (W/CM) means the ratio by mass of the amount of water to the total amount of cementing material in a freshly mixed batch of concrete or mortar, stated as a decimal. The amount of water does not include that absorbed by the aggregate.

1350.04 DESIGN AND SUBMISSION REQUIREMENTS

1350.04.01 Design Requirements

1350.04.01.01 Mix Design Alterations

The Contractor may make minor alternations to the stated mix proportions in order to maintain compliance with the overall performance requirements as specified in the Contract Documents. Such deviations shall be according to CSA A23.1.

A minimum of 24 hours notice of deviations in the mix design that alter the sources of supply or the fundamental characteristics of the mix shall be given to the Owner by the Contractor. Resubmission of form OPSF 1350-1 and, if applicable, form OPSF 1350-2, shall be made for such deviations.

1350.04.02 Submission Requirements

Submissions for the performance or prescriptive specification alternative requirements shall be made based on the specification alternative as specified in the Contract Documents.

1350.04.02.01 Performance Specification Alternative

In the case of the performance specification alternative, the Contractor shall be solely responsible for the design of the concrete and to ensure that the requirements of CSA A23.1 and this specification have been met.

At least 14 Days prior to placing any concrete, the Contractor, in concert with the concrete supplier, shall:

- a) Establish the concrete mix properties to meet performance criteria for plastic and hardened concrete, after considering the Contractor's criteria for construction and placement and the Owner's performance criteria.

- b) Submit documentation demonstrating the Owner's pre-qualification performance criteria can be met.
- c) Prepare, submit, and implement a quality control plan to ensure that the Owner's performance criteria can be met. When specified in the Contract Documents, submit documentation demonstrating that the Owner's performance requirements have been met.
- d) Ensure that the concrete supplier submits the following to the Contractor to forward to the Owner.
 - i. Certification that the plant, equipment, and all materials to be used in the concrete comply with the requirements of this specification.
 - ii. Certification that the mix design satisfies the requirements of this specification.
 - iii. Certification that the production and delivery of concrete will meet the requirements of this specification.
 - iv. Certification that the concrete complies with the specified performance criteria.
- e) Provide documentation verifying that the concrete supplier's plant and equipment meet the plant certification requirements of the RMCAO Approved Quality Program.

1350.04.02.01.01 Performance Based Concrete Mix Data

At least 2 weeks prior to the delivery of concrete, the Contractor shall submit to the Owner the attached form OPSF 1350-1 detailing the material and sources of materials to be used for each class of concrete. The form shall be completed for all concrete supplied to the project.

The quantity of chemical admixtures shall be at least the minimum dose specified in the Contract Documents. The Contractor may deviate from the specified minimum dose due to weather conditions and changes in materials. However, written notification of this change shall be provided to the Contract Administrator at least 24 hours prior to the delivery of the concrete by the Contractor.

1350.04.02.01.02 Mix Design Confidentiality and Indemnity Agreement

The Contractor shall ensure that the concrete supplier submits a confidential concrete mix design for the Contract to the Owner on the attached form OPSF 1350-2, when requested by the Contract Administrator, and only after a confidentiality agreement has been signed between the Owner and the concrete supplier.

At least 2 weeks prior to the placing of any concrete, the Owner and the concrete supplier shall execute a confidentiality agreement to cover the protection of proprietary mix proportion information that is to be released as part of form OPSF 1350-2.

1350.04.02.02 Prescriptive Specification Alternative

In the case of the prescriptive specification alternative, the Owner shall be solely responsible for the concrete mix design and to ensure that the requirements of CSA A23.1 and this specification have been met.

The Contractor, in concert with the concrete supplier, shall:

- a) Plan the construction methods based on the Owner's mix proportions and parameters.
- b) Obtain approval from the Owner for any deviations from the specified mix design or parameters.
- c) Identify to the Owner any anticipated problems or deficiencies with the mix parameters related to construction.

- d) Provide verification that the plant, equipment, and materials to be used in the concrete comply with the requirements of this standard.
- e) Demonstrate that the concrete complies with the prescriptive criteria as supplied by the Owner.

1350.04.02.03 Ready Mixed Concrete Operation or Mobile Mix Concrete Operation

At least 1 week prior to the delivery of concrete to the Work Area, the Contractor shall submit to the Owner a current valid Certificate of Ready Mixed Concrete Production Facilities or a current valid Certificate of Mobile Mix Concrete Production Facilities for the plant being used to produce ready mixed concrete, issued under the Approved Quality Program as outlined in the publications, Certificate of Ready Mixed Concrete Production Facilities and Certificate of Mobile Mix Concrete Production Facilities.

1350.04.02.04 Concrete Delivery Ticket

The concrete supplier shall provide 2 copies of the delivery ticket to the Contractor immediately following unloading at the Work Area. The Contractor shall provide one copy of each delivery ticket to the Owner within 1 Business Day of completion of the placement. The concrete delivery ticket shall include:

- a) Name and location of plant.
- b) Date and serial number of the ticket.
- c) Name of Contractor.
- d) Specific designation of the job by name and location.
- e) Specified class or designation of the concrete.
- f) Volume of concrete.
- g) Truck number and cumulative total or load number.
- h) Time stamped when mixing of cement and aggregates commences.
- i) Ordered slump or slump flow.
- j) Time that the discharge of load was completed.
- k) Amount of water added after batching, authorization, and units used.
- l) Amount and type of admixtures added after batching.

1350.05 MATERIALS

1350.05.01 Materials for Concrete

1350.05.01.01 Cementing Materials

Cementing materials shall be according to CAN/CSA A3000.

Portland cement shall be used; however, a portion of it may be replaced by SCM. The SCM shall be ground granulated blast furnace slag, fly ash, or silica fume or any combination of two or all of the materials.

The mass of Portland cement and all SCMs contained in a concrete mix shall be specified on form OPSF 1350-2, if applicable. Furthermore, the Contractor shall disclose on form OPSF 1350-1 and, if applicable, form OPSF 1350-2, when the mix design is classified as a HVSCM as specified in CSA A23.1.

HVSCM 1 concrete shall only be used with prior written approval of the Owner.

Neither slag nor fly ash shall be used for lean concrete base, unless trial mix tests are performed and the results show that the performance requirements of the Owner have been met.

1350.05.01.02 Aggregates

Aggregates shall be according to OPSS 1001 and OPSS 1002.

The maximum nominal size of the aggregate shall not exceed 19.0 mm.

1350.05.01.03 Water

Water for concrete shall be according to OPSS 1302 and CSA A23.1, clause 4.2.2.

1350.05.01.04 Air Entraining and Chemical Admixtures

Air entraining chemical admixtures shall be according to the ASTM C 260.

Chemical admixtures shall be according to ASTM C 494M or when flowing concrete is specified, it shall be according to ASTM C 1017M.

The Contractor shall ensure that the chemical admixtures to be used are compatible with each other and that the performance of the concrete will not be negatively affected.

The Contractor shall use only chemical admixtures specified in the Contract Documents. Specialty chemical admixtures may be used when approved by the Owner.

1350.05.02 Performance Requirements for Concrete

1350.05.02.01 General

In instances where there are conflicts between this specification and other standards, the most stringent performance requirements shall apply.

1350.05.02.02 Exposure Classes of Concrete

Concrete having various exposure classifications shall meet the most stringent requirements of CSA A23.1, Tables 1, 2, and 3.

Classification A exposures do not apply to this specification.

1350.05.02.03 Compressive Strength

The concrete compressive strength shall be according to CSA A23.1, Tables 1, 2, and 3, and as specified in the Contract Documents.

1350.05.02.04 Air Content

The total air content of the concrete, measured with an air meter immediately prior to placing, shall be as shown in CSA A23.1, Table 4. Nominal maximum sizes of coarse aggregate shall be according to CSA A23.1, Table 4 (i.e., 10 mm, 14-20 mm, and 28-40 mm shall be 9.5 mm, 13.2-19.0 mm, and 28-40 mm, respectively).

Air content in hardened concrete shall meet the requirements of CSA A23.1, clauses 4.3.3.2 and 4.3.3.3, and the requirements as shown in Table 3 of this specification.

1350.05.02.05 Slump or Slump Flow

Slump or slump flow shall be consistent with the placement and consolidation methods, equipment, and site conditions.

Slump requirements shall be identified and reviewed by the Contractor and concrete supplier prior to construction. The tolerances for concrete slump acceptance and rejection in the Work Area shall be as follows:

- a) Slumps less than 80 mm - the maximum allowable variation shall be ± 20 mm.
- b) Slumps between 80 to 180 mm - the maximum allowable variation shall be ± 30 mm.
- c) Slumps greater than 180 mm - the maximum allowable variation shall be ± 40 mm.
- d) For SCC, the maximum allowable variation shall be ± 70 mm from the slump specified in the mix design.

Slump or slump flow shall be measured according to CSA A23.2-5C. Maximum slump for non-self-consolidating concrete shall be 240 mm, provided no segregation of the concrete occurs.

1350.05.02.06 Within Batch Uniformity of Concrete

If, in the opinion of the Contract Administrator, there is evidence of non-uniformity of the mixed concrete from a particular mixer, tests shall be carried out by the Contractor on 3 samples of concrete obtained from widely separate portions of the batch while the mixer is being completely emptied at normal operating rate to evaluate the mixing equipment.

Samples shall not be taken prior to 10% or after 90% of the batch has been discharged.

The minimum size of sample shall be 30 litres.

Between samples, the mixer shall not be allowed to turn in the mixing direction. Water shall not be added to the batch at any time after sampling has started.

The following criteria and that of CSA A23.1, Table 13, shall be used to judge whether or not the equipment under test is producing uniform concrete:

- a) Where the result of each test is equal to or less than the acceptance limit, the concrete shall be considered uniform.
- b) Where the result of any single test is greater than the rejection limit, the concrete shall be considered non-uniform.
- c) If a test result falls between acceptance limit and rejection limit, additional tests shall be made on the next consecutive batch or load delivered by that unit.

If, after testing one additional batch or load, the test falls outside the acceptance limit, the equipment shall be rejected.

1350.06 EQUIPMENT

1350.06.01 Batching Plant

The batching plant and equipment shall be according to the certification requirements of the RMCAO.

The batching plant shall have direct communication with the placement operation.

1350.06.02 Mixing Equipment

All mixers shall be according to the certification requirements of RMCAO and shall be capable of discharging the concrete so that the uniformity requirements of CSA A23.1, Table 13, are met.

1350.06.03 Non-Agitating Delivery Equipment

The concrete containment area of non-agitating delivery equipment shall be a smooth watertight steel container equipped with gates that will permit control of the concrete discharge.

1350.07 PRODUCTION

1350.07.01 General

A manufacturer producing ready mixed concrete shall possess a current valid Certificate of Ready Mixed Concrete Production Facilities or a current valid Certificate of Mobile Mix Concrete Production Facilities for the plant being used to produce ready mixed concrete, issued under the Approved Quality Program as outlined in the publications, Certificate of Ready Mixed Concrete Production Facilities and Certificate of Mobile Mix Concrete Production Facilities.

The entire contents of the truck mixer shall be discharged prior to recharging. When any ingredient is added after initial batching, the volume of material in the drum shall not exceed the mixing capacity of the drum.

Proper facilities shall be provided to enable inspection of the quality of the materials used in the production of the concrete. The inspector shall be provided with all reasonable facilities for securing samples to determine whether the concrete and its materials are being supplied according to this specification. Owners wishing to obtain samples of the various raw materials from the concrete supplier shall provide advance notice to the concrete supplier and comply with all concrete supplier health and safety policies.

Where test results fail to meet the minimum requirements of this specification and the Owner and the concrete supplier have already executed a confidentiality agreement, the Contractor shall ensure that the batch records retained by the concrete supplier under the Approved Quality Program shall be made available to the Owner within 5 Business Days of a written request. The Owner shall treat these records in the same manner as form OPSF 1350-2 and they shall remain the confidential information of the concrete supplier.

1350.07.02 Temperature Control

The concrete temperature at the time of discharge from the truck shall be between 10 and 28 °C.

1350.07.03**Records and Reporting**

In addition to the batch records required to conform to the Approved Quality Program, the Contractor shall record the following information on the concrete delivery tickets, when applicable:

- a) The method used to control the temperature of the concrete during hot weather conditions.
- b) The method used to extend the discharge time of the concrete beyond 1.5 hours after introduction of the mix water during hot weather conditions.
- c) The type and quantity of any materials added to the concrete after leaving the batch plant, and the time that each material was added.

1350.07.04**Concrete Strengths 35 MPa or Greater****1350.07.04.01****Trial Batch**

The mix properties for concrete with strengths of 35 MPa or greater shall be confirmed by the performance of a trial batch. The trial batch shall confirm all the performance properties identified for a particular class of concrete in CSA A23.1, Table 2, through the following tests:

- a) Slump.
- b) Plastic air content.
- c) Compressive strength.
- d) Hardened Air Void System (AVS).

The testing of the field trial batch of concrete shall be the responsibility of the Contractor.

At least 30 Days prior to placing concrete with strengths of 35 MPa or greater, the Contractor shall mix a full size trial batch of concrete in the proportions stated in the mix design.

When the concrete is mixed within a truck mixer, the volume of the trial batch shall be the same as the volume of concrete normally mixed in the truck.

When the source of concrete is a ready mixed concrete plant, the trial batch of concrete shall originate from the primary plant to be used for the supply of the concrete and be delivered to the Work Area.

When the approved ready mixed concrete operation is currently supplying or has supplied a similar class of concrete within the last 6 months, permission may be given by the Owner to use concrete test data from that operation without the need for full size field trial batch, providing:

- a) There is no change in the source of any material.
- b) The performance characteristics of the aggregates have not changed significantly.
- c) The concrete mix designated and previously used meets the specified performance requirements.
- d) Documentation of this prior approval is submitted to the Owner.

1350.07.04.02**Early Compressive Strength Determination of Mix Design**

When approved by the Owner, accelerated compressive strengths shown in Table 1 may be used to predict the 28-Day compressive strength of the proposed concrete mix.

The cylinders shall be tested according to CSA A23.2-10C using the autogenous curing test procedure.

1350.07.05 Ready Mixed Concrete

1350.07.05.01 Delivery of Ready Mixed Concrete

1350.07.05.01.01 General

The concrete shall be delivered to the Work Area without segregation in a thoroughly mixed and uniform mass and be discharged with the uniformity required in CSA A23.1, Table 13.

1350.07.05.01.02 Delivery by Non-Agitating Equipment

Concrete that is completely mixed in a stationary mixer may be transported in non-agitating equipment.

Covers shall be used to provide protection to the concrete during inclement weather.

Discharge of concrete shall be completed within 30 minutes of the introduction of the mixing water to the cement and aggregates.

1350.07.05.01.03 Delivery by Agitator or Mixer Trucks

After completion of mixing, concrete shall be transported to the Work Area by means of agitator trucks or truck mixers. The equipment shall be operated at the agitation speed of rotation designated by the manufacturers of the truck.

Discharge of the concrete shall be completed within 90 minutes after the introduction of mixing water to the cement and aggregates. This time may be extended using a set retarder, provided the Owner approves such use.

1350.07.05.01.03.01 Site Addition of Materials

When a truck mixer is used at agitating capacity, no adjustment shall be made to the load of concrete.

In the case of the performance specification alternative, only the concrete supplier, in concert with the Contractor, shall undertake the site addition of materials to the mixer.

When the measured slump or slump flow of the concrete is less than that specified in the mix design, water may be added by the concrete supplier, in concert with the Contractor, to bring the concrete up to the designated slump or slump flow, provided the following criteria are met:

- a) The specified water-to-cementing materials ratio is not exceeded.
- b) No more than 60 minutes has elapsed from the time of batching.
- c) Addition of water is only at the start of discharge (i.e., not more than 10% of the concrete has been discharged).
- d) Not more than the lesser of 16 L/m³ or 10% of the mixing water shall be added.

Air entraining admixture may be added to the load of concrete by the concrete supplier, in concert with the Contractor, prior to discharge, to increase the air content to that specified in the mix design. The use of detraining admixtures to lower the air content of concrete is prohibited.

When any material is added to the concrete, the concrete supplier shall thoroughly mix the load of concrete to meet the uniformity requirements of CSA A23.1, Table 13.

1350.08 QUALITY ASSURANCE

1350.08.01 General

The Owner shall be allowed access to all sampling locations and reserves the right to request a quality assurance (QA) sample at any time from the Contractor. The Contract Administrator may elect to carry out testing of the QA sample to ensure that material used in the Work is according to the requirements of this specification. Testing shall be carried out at a laboratory designated by the Owner. The Owner shall be responsible for all costs associated with QA testing.

Samples of aggregates, cementing materials, water, chemical admixtures, and air entraining admixtures representative of the materials to be used in the work shall be provided, when requested by the Owner.

1350.08.02 Sampling and Testing

1350.08.02.01 General

1350.08.02.01.01 Quality Assurance Testing Staff and Laboratory Requirements

Field sampling and testing of concrete shall be performed by a person holding either of the following certifications:

- a) CSA Certified Concrete Testing Technician, Concrete Testing and Sampling Certificate, or
- b) ACI Concrete Field Testing Technician - Grade 1.

This person shall have a valid original card issued by the certifying agency in his or her possession at all times.

Laboratory tests shall be completed by a laboratory certified according to CSA A283 for the category appropriate to the test required by CSA.

1350.08.02.01.02 Quality Assurance Test Reporting

Concrete test reports shall be immediately distributed electronically to the Owner, Contractor, and concrete supplier using CMATS™. The test results shall include the following information for each individual mix design:

- a) Project identification.
- b) A graphical representation of the specified and actual compressive strength data.
- c) The average strength value for each age that the concrete is tested.
- d) Average slump value for the mix design.
- e) Average plastic air content for the mix design.

Testing shall be completed as shown in Table 2.

1350.08.02.02 Air Content in Hardened Concrete

The air void system in the hardened concrete may be performed on cast cylinder specimens. The air void system shall be tested according to ASTM C 457.

1350.08.02.03 Testing for Uniformity of Mixed Concrete

When required by the Owner, tests to determine the within-batch uniformity of mixed concrete shall be according to the Within Batch Uniformity of Concrete clause, except the acceptance and rejection limits for uniformity shall be according to CSA A23.1, Table 13.

1350.08.02.04 Strength Tests and Requirements

1350.08.02.04.01 Compressive Strength

For the purpose of concrete acceptance on the basis of concrete strength, cylinders shall be made and cured according to CSA A23.2-3C, under standard moisture and temperature conditions, and tested according to CSA A23.2-9C.

A compressive strength test result is the average strength of two standard 100 x 200 mm or 150 x 300 mm concrete cylinders that are representative of concrete taken from one batch of concrete.

To conform to the specified nominal minimum 28-Day compressive strength requirements:

- a) The average of all groups of 3 consecutive strength tests shall be equal to or greater than the specified strength.
- b) No individual strength test shall be more than 3.5 MPa below the specified strength.

1350.08.02.04.02 Flexural Strength

Concrete for pavement and base shall meet the requirements for compressive strength and also flexural strength as stated here. The minimum flexural strength shall be 3.8 MPa at 10 Days.

A flexural strength test is the average of 2 breaks on a standard beam test specimen that is representative of concrete taken from one batch of concrete.

Flexural strength test beams shall be made and cured according to CSA A23.2-3C, depending on the particular circumstances. The method of testing shall be according to CSA A23.2-8C.

Alternatively, a splitting tensile test may be carried out instead of the flexural strength test. One splitting tensile test shall be considered to be the average of 2 standard cylinders that are representative of concrete taken from one batch of concrete. The splitting tensile test cylinders shall be according to CSA A23.2-3C. The method of testing shall be according to CSA A23.2-13C. The minimum splitting tensile strength shall be 2.8 MPa at 10 Days.

To conform to the specified nominal minimum 10-Day strength requirements, the average of all sets of 3 consecutive strength tests shall be equal to or greater than the specified strength.

TABLE 1
2-Day Accelerated Compressive Strengths

Minimum 28-Day Compressive Strengths MPa	Corresponding 2-Day Accelerated Compressive Strengths MPa
20	8.4
25	12.9
30	17.4
35	21.9
40	26.4

TABLE 2
Quality Assurance Tests

Required Test	Test Method
Slump and Slump Flow of Concrete	CSA A23.2-5C
Air Content	CSA A23.2-4C
Compressive Strength	CSA A23.2-3C and CSA A23.2-9C
Accelerating the Cure of Concrete Cylinders and Determining Their Compressive Strength (Accelerated Cured)	CSA A23.2-10C
Yield	CSA A23.2-6C
Chloride Ion Penetrability Test	ASTM C 1202
Linear Shrinkage Test	ASTM C 157M (Note 1)
Note: 1. Drying shall commence after 7 Days of wet curing.	

TABLE 3
Hardened Concrete Air Void System Requirements

Class of Exposure	Total Air Content %	Spacing Factor mm
C-XL, C1, C2, and F1	3.0 minimum	0.230 maximum mean 0.260 maximum individual
Concrete with water/cementing ratios of 0.36 or less	3.0 minimum	0.250 maximum mean 0.300 maximum individual

Concrete Mix Design Submission

Contract _____	Date Submitted _____
Location _____	Submitted To _____
Contractor _____	Contact _____
Batch Plants: Primary _____	Secondary _____
Concrete Supplier: Name _____	
Address _____	
City/Province _____	
Telephone _____	Fax _____ Email _____

SPECIFICATION	MIX CODE					
	Application / Element / Location					
	Structural Requirements					
	- CSA Exposure Class					
	- Maximum W/CM					
	- Minimum Specified Strength, MPa @ Days					
	- Nominal Maximum Aggregate Size, mm					
	- HVSCM Type 1 or 2					
	- Plastic Air Content, %					
	Durability Requirements					
	- Exposure to Sulphate Attack					
	- Alkali Aggregate Reactivity					
	Architectural Requirements					
	- Colour / Texture					
	- Other					
CONTRACTOR REQUIREMENTS	Rate, m³/h					
	Quantity, m³					
	Slump Range, mm					
	Strength @ Age, MPa @ Days					
	Other					
	Specialty Information					
	- Concrete Set, Delay, Normal, Accelerated					
	Method of Placement					
MATERIALS SECTION	Material	Source				
	Cement					
	SCM - Slag					
	SCM - _____					
	Water					
	Fine Agg.					
	Coarse Agg.					
	A.E.A.					
	W.R.					
	S.P.					

Form Submitted By:

Print Name: _____ Signature: _____ Date: _____

Contractor's Representative Receiving Form:

Print Name: _____ Signature: _____ Date: _____

CONFIDENTIAL - Concrete Mix Design Submission

Contract _____ Date Submitted _____

Location _____ Submitted To _____

Contractor _____ Contact _____

Batch Plants: Primary _____ Secondary _____

Concrete Supplier: Name _____

Address _____

City/Province _____

Telephone _____ Fax _____ Email _____

	MIX CODE						
	Application / Element / Location						
SPECIFICATION	Structural Requirements						
	- CSA Exposure Class						
	- Maximum W/CM						
	- Minimum Specified Strength, MPa @ Days						
	- Nominal Maximum Aggregate Size, mm						
	- HVSCM Type 1 or 2						
	- Plastic Air Content, %						
	Durability Requirements						
	- Exposure to Sulphate Attack						
	- Alkali Aggregate Reactivity						
SPECIFICATION	Architectural Requirements						
	- Colour / Texture						
	- Other						
CONTRACTOR REQUIREMENTS	Rate, m ³ /h						
	Quantity, m ³						
	Slump Range, mm						
	Strength @ Age, MPa @ Days						
	Other						
	Specialty Information						
	- Concrete Set, Delay, Normal, Accelerated						
	Method of Placement						
MATERIALS SECTION	Material	Source	Unit	Quantity			
	Cement		kg/m ³				
	SCM - Slag		kg/m ³				
	SCM - _____		kg/m ³				
	Water		L/m ³				
	Fine Agg.						
	Coarse Agg.						
	A.E.A.		mL/100 kg				
	W.R.		mL/100 kg				
	S.P.		mL/100 kg				

Form Submitted By:

Print Name: _____ **Signature:** _____ **Date:** _____

Municipal Representative Receiving Form:

Print Name: _____ **Signature:** _____ **Date:** _____

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

This specification is intended for use by municipalities requiring ready mixed concrete.

The designer should specify the following in the Contract Documents:

- The Owner's choice of concrete specification alternatives, either Performance Specifications or Prescriptive Specifications. (1350.04.02)
- Minimum dose of chemical admixtures. (1350.04.02.01.01)
- Chemical admixtures. (1350.05.01.04)

The designer should determine if a quality control program is to be prepared and implemented. If so, the requirement for it should be specified in the Contract Documents. (1350.04.02.01)

The designer may consider the following and specify this requirement for air content in hardened concrete in the Contract Documents:

When the approved ready mixed concrete operation is currently supplying or has supplied a similar class of concrete within the last 6 months, permission may be given to waive this testing requirement, providing that:

- a) There is no change in the source of any material.
- b) The concrete mix designated and used previously meets the specified performance requirements.
- c) Documentation of this prior approval is submitted to the Owner.

CSA A23.1, Table 5, lists the alternative methods for specifying concrete. The designer should review this table when determining which concrete specification alternative is to be used in the Contract. CSA A23.1, Annex J, discusses the selection of alternatives for specifying concrete requirements. These alternatives include:

Performance - When the Owner requires the concrete supplier to assume the responsibility for performance of the concrete as delivered and the Contractor to assume responsibility for the concrete in place.

For this alternative, the Owner should specify the following in the Contract Documents:

- a) Required structural criteria including strength at age.
- b) Required durability criteria including class of exposure.
- c) Additional criteria for durability, volume stability, architectural requirements, sustainability, and any additional Owner performance, pre-qualification or verification criteria.

Appendix 1350-A

- d) Quality management requirements.
- e) Certification of the concrete supplier through the Approved Quality Program.
- f) Any other properties that may be required to meet the Owner's performance requirements.

Prescriptive - When the Owner assumes responsibility for the performance of the concrete.

For this alternative, the Owner should specify the following in the Contract Documents:

- a) Mix proportions, including the quantities of any or all materials (admixtures, aggregates, cementing materials, and water) by mass per cubic metre of concrete;
- b) The range of air content;
- c) The slump range;
- d) Use of a concrete quality plan, if required;
- e) Other requirements.

CSA A23.1, Annex K, discusses concrete made with a high volume of supplementary concreting materials (HVSCM).

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

Related Ontario Provincial Standards Drawings

No information provided here.



MATERIAL SPECIFICATION FOR UNSHRINKABLE BACKFILL

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1359.09	OWNER PURCHASE OF MATERIAL - Not Used

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1359-A	Commentary

1359.01 SCOPE

This specification covers the requirements for treated aggregate known as unshrinkable backfill, in underground service and Utility trenches, and around in-ground structures.

1359.01.01 Significance and Use of Appendices

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

Use of this specification or any other specification shall be as specified in the Contract Documents.

1359.01.02 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.

1359.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Material

OPSS 1010	Aggregates - Base, Subbase Select Subgrade, and Backfill Material
OPSS 1301	Cementing Materials
OPSS 1302	Water
OPSS 1350	Concrete - Materials and Production

Canadian Standards Association

A23.2-3C	Making and Curing Concrete Compression and Flexural Test Specimens [Part of CAN/CSA A23.1/A23.2-14, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete]
A23.2-9C	Compressive Strength of Cylindrical Concrete Specimens [Part of CAN/CSA A23.1/A23.2-14, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete]
A3001-13	Cementitious Materials for Use in Concrete [Part of CAN/CSA A3000-13 Cementitious Materials Compendium]

Ministry of Transportation, Ontario, Publications

MTO Laboratory Testing Manual:

LS-407 Method of Test for Compressive Strength of Moulded Cylinders

1359.03 DEFINITIONS

For the purpose of this specification, the following definition applies:

Reclaimed Concrete Material (RCM) means removed or processed old hydraulic cement concrete.

Unshrinkable Backfill means a self-compacting cement treated aggregate with flowable consistency and controlled low strength properties.

1359.04 DESIGN AND SUBMISSION REQUIREMENTS

1359.04.01 Submission Requirements

The unshrinkable backfill mix shall be designed and the unshrinkable backfill mix design data submitted using the Concrete Mix Design Submission forms as specified in the Contract Documents.

The mix design submission shall be accompanied by data on 28-Day compressive strengths of the backfill.

1359.05 MATERIALS

1359.05.01 Cementing Materials

Cementing materials shall be according to OPSS 1301.

1359.05.02 Water

Water shall be according to OPSS 1302.

1359.05.03 Aggregates

Aggregates shall be according to OPSS 1010 Granular A, and shall have a maximum aggregate size of 25 mm.

Coarse aggregate shall be crushed stone, crushed gravel, natural gravel, recycled concrete material (RCM), or a combination thereof. The typical maximum nominal size is 25 mm, or as specified in the Contract Documents. Fine aggregates shall be natural sand, crushed sand, recycled concrete aggregates, or a combination thereof. Coarse and fine aggregate shall meet the requirements in Table 1. Slag aggregate, glass and ceramics shall not be used.

1359.05.03.01 Use of Recycled Concrete Material

The producer shall ensure that the level of RCM used in the fill does not compromise the performance of the fill. Recycled aggregates shall satisfy environmental regulations.

The maximum passing the 75 µm shall be 5% or less of the total aggregate weight.

1359.05.03.02 Grading

The grading of the combined aggregate shall be selected to produce unshrinkable fill that meets the performance requirements of the intended application and the requirements of this Standard.

1359.05.04 Mix Requirements

Mix requirements shall be according to the following:

- a) The unshrinkable backfill shall contain 25 kg/m³ of Type GU Portland cement according to CAN/CSA A3001 and may contain additional supplementary cementing materials.
- b) Slump at point of discharge shall be a minimum of 150 mm and the unshrinkable backfill shall be uniformly mixed throughout.
- c) The material shall be designed so that it can flow into the excavation and fill the entire space without vibration and segregation.
- c) The 28-Day compressive strength shall be a maximum of 0.40 MPa.
- e) The mixture may contain foaming agents.

1359.05.05 Unshrinkable Backfill Material Placement Requirements

The material shall be placed into the excavation so that it fills the entire space without voids being created beneath horizontal projections or in other locations within the excavation.

The unshrinkable backfill material shall be completely placed within a period of 2 hours from the time of the batching.

The unshrinkable backfill material shall be protected from cold weather according to OPSS 350.

When shoring, bracing, or sheeting shall be removed, the support system shall be removed prior to or during the backfilling operation.

When placed behind abutment as backfill, layers of unshrinkable backfill material shall be placed alternately at each abutment. The layers shall not exceed 400 mm and the height of the layers shall be approximately the same. At no time shall the difference in elevation be greater than 400 mm. Each layer shall be allowed to set for a period of minimum of 4 hours before a new layer is placed.

Where vehicular traffic, including construction equipment, shall be accommodated, the unshrinkable backfill shall be protected by covering it with a steel plate suitable for the traffic loading for a minimum of 24 hours.

1359.06 EQUIPMENT

1359.06.01 Mixing Equipment

A central mixing, dry batch plant, or volumetric mixer capable of accurately proportioning aggregate, cement, and water shall be used, according to OPSS 1350.

1359.06.02 Transport Equipment

Unless produced on site with a volumetric mixer, unshrinkable backfill shall be transported to the site by means of ready mix trucks.

Ready mix trucks may be required to meet local environmental requirements as specified in the Contract Documents.

1359.08**QUALITY ASSURANCE****1359.08.01****Testing Requirements**

Compressive strength testing shall be according to CSA-A23.2-3C, CSA-A23.2-9C, and LS-407 and with the following requirements:

- a) Only cardboard moulds shall be used to cast the test cylinders. A disc of wax paper matching the inside diameter of the cylinder mould shall be placed at the base of the cylinder mould prior to casting. The interior sidewalls of the cardboard mould shall be treated with a light coating of release agent to assist in the demoulding operation.
- b) The cylinders shall only be demoulded on the same day of testing for compressive strength.
- c) The load indicating mechanism of the compression testing machine shall be capable of showing load changes of 100 newtons or less. The loading rate shall be 0.11 MPa/s or lower.
- d) The minimum test requirement shall be one set of two test cylinders, per supplier, per day.

1359.08.02**Acceptance**

Unshrinkable backfill shall be accepted when

- a) the material does not deform under traffic loading, and
- b) the compressive strength requirements are met.

Table 1: Requirements for fine and coarse aggregates for use in unshrinkable fill

Test	Coarse	Fine
Micro-Deval abrasion (%) (LS-618 & LS-619)	Max. 25%	Max. 30%
% passing 75 µm* (LS-601)	Max. 3%	Max. 5%
Organic Impurities	N/A	Standard colour No. 3
Sulphate content (SO ₄) ‡ (CSA A23.2-3B or 8B)	Max. 1.5%	Max. 1.5%
Water soluble chloride (ASTM D1411)†	Max. 0.10%	Max. 0.10%
*This requirement may be waived provided that the % passing the 80 micron sieve for the combined aggregate does not exceed 5% of the total. †This requirement is specified if fill is to be in contact with concrete or steel pipe. ‡For unshrinkable fill in contact with permanent concrete elements, the limit of SO₄ in aggregates RCA shall be a maximum of 0.20%, unless the permanent concrete element meets the requirements of S1, S2, or S3 of CSA A23.1-14 Table 3 as appropriate. RCM used in unshrinkable fill to be placed in contact with sulphate-bearing soil or ground water with sulphate shall be produced from sulphate resistant concrete.		

Appendix 1359-A, November 2016

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

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Concrete Mix Design Submission forms shall be used. (1359.04.01)
- May allow up to 50mm as the nominal size as the application may warrant. (1359.05.03)
- Ready mix truck may be required to have washout systems in order to meet local, environmental requirements (1359.06.02)

For shallow applications within the depth of frost penetration, differential frost heaving may occur.

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

Related Ontario Provincial Standard Drawings

OPSD 509.010 Pavement Reinstatement for Utility Cuts



MATERIAL SPECIFICATION FOR STEEL REINFORCEMENT FOR CONCRETE

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APPENDICES

1440-A	Commentary

1440.01	SCOPE

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

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

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

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

Ontario Provincial Standard Specifications, 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
S6-14 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 2016
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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Designer Action/Considerations

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

Related Ontario Provincial Standard Drawings

No information provided here.



**MATERIAL SPECIFICATION FOR
STEEL BEAM GUIDE RAIL**

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1504.01	SCOPE
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1504.07	PRODUCTION
1504.08	QUALITY ASSURANCE - Not Used
1504.09	OWNER PURCHASE OF MATERIAL

APPENDICES

1504-A	Commentary

1504.01 SCOPE

This specification covers the requirements for steel beam guide rail, terminal sections, fabricated bases, and installation hardware.

1504.01.01 Specification Significance and Use

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

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

1504.01.02 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.

1504.02 REFERENCES

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

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

CSA Standards

G40.20-13/G40.21-13	General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steels
G164-M92 (R2003)	Hot Dip Galvanizing of Irregularly Shaped Articles
W59-13	Welded Steel Construction (Metal Arc Welding)

ASTM International

A 307-14 Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength

1504.05 MATERIALS

1504.05.01 Rail and Terminal Sections

Rail elements shall have a minimum yield strength of 345 MPa.

After fabrication, all rail elements and terminal sections shall be hot dip galvanized according to CAN/CSA G164.

1504.05.02 Fabricated Steel Bases

Steel bases shall be fabricated according to CSA G40.20/G40.21. After fabrication, steel bases shall be hot dip galvanized according to CAN/CSA G164.

1504.05.03 Installation Hardware

All bolts, nuts, and washers shall be according to ASTM A 307 and hot dip galvanized according to CAN/CSA G164.

1504.07 PRODUCTION

1504.07.01 Steel Beam Guide Rail and Terminal Sections

Steel beam guide rail shall consist of rail elements fabricated to develop continuous beam strength with a cross-section as specified in the Contract Documents.

Bolt holes in rail elements, terminal sections, and fabricated bases shall be perpendicular to the surface and shall not deviate more than 1.0 mm in any direction from the true location. Rail element and terminal section ends shall be cut square.

After fabrication, prefabricated curved steel rail elements shall be galvanized according to CAN/CSA G164.

Steel beam guide rail components furnished under this specification shall be interchangeable with similar components regardless of the source or manufacturer.

1504.07.02 Marking

As a minimum, each rail element shall be marked with the following information:

- a) Name, trademark, or brand of the manufacturer.
- b) Standard designation 1504. M180A2 will be accepted as an equivalent standard designation.
- c) Identification symbols or code for heat.
- d) Week number and year of production.

Markings shall be clearly and permanently stamped in the valley of the centre corrugation, placed at a location clear of the splice overlap, and shall not be obscured after installation. The height of the letters and numerals shall be within the range of 19 to 32 mm.

1504.07.03 Welding

All welds shall be according to CSA W59 and shall be continuous.

1504.09 OWNER PURCHASE OF MATERIAL

1504.09.01 Measurement and Payment

For measurement purposes, a count shall be made of the number of steel beam guide rail elements delivered and accepted.

For measurement purposes, a count shall be made of the number of terminal sections delivered and accepted.

For measurement purposes, a count shall be made of the number of fabricated steel bases for guide rail posts delivered and accepted.

Installation hardware shall be measured in the units specified in the purchasing order, delivered and accepted.

Payment at the price specified in the purchasing order shall be for the supply of steel beam guide rail elements, terminal sections, fabricated steel bases, and installation hardware delivered to the destination or destinations at the dates and times specified.

The cost of all testing, except that performed in the Owner's laboratory, shall be included in the price.

Appendix 1504-A, November 2016
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

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

Related Ontario Provincial Standard Drawings

OPSD 912.101	Guide Rail System, Steel Beam, Rail, Component
OPSD 912.104	Guide Rail System, Steel Beam, Steel Post with Wooden Offset Block, Component
OPSD 912.105	Guide Rail System, Steel Beam, Base Plate, Component



MATERIAL SPECIFICATION FOR CHANNEL COMPONENTS FOR STEEL BEAM GUIDE RAIL

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1505.02	REFERENCES
1505.03	DEFINITIONS - Not Used
1505.04	DESIGN AND SUBMISSION REQUIREMENTS - Not Used
1505.05	MATERIALS
1505.06	EQUIPMENT - Not Used
1505.07	PRODUCTION
1505.08	QUALITY ASSURANCE - Not Used
1505.09	OWNER PURCHASE OF MATERIAL

APPENDICES

1505-A	Commentary

1505.01 SCOPE

This specification covers the requirements for steel channel and installation hardware.

1505.01.01 Specification Significance and Use

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

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

1505.01.02 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.

1505.02 REFERENCES

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

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

CSA Standards

G164-M92 (R2003)	Hot Dip Galvanizing of Irregularly Shaped Articles
S136-12	Cold-Formed Steel Structural Members

ASTM International

A 307-14	Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength

1505.05 MATERIALS

1505.05.01 Cold Rolled Channel

Channels shall be cold rolled steel sections according to CSA S136 and have a minimum yield strength of 345 MPa. After fabrication, sections shall be hot dip galvanized according to CAN/CSA G164.

1505.05.02 Installation Hardware

All bolts, nuts, and washers shall be according to ASTM A 307 and be hot dip galvanized according to CAN/CSA G164.

1505.07 PRODUCTION

1505.07.01 Fabrication Tolerances and Workmanship

Bolt holes in steel channels shall be perpendicular to the surface and shall not deviate more than 1.0 mm in any direction from the true location. Steel channel ends shall be cut square.

After fabrication, curved steel channels shall be hot dip galvanized according to CAN/CSA G164.

1505.07.02 Marking

As a minimum, each steel channel section shall be marked with the following information:

- a) Name, trademark, or brand of the manufacturer.
- b) Standard designation 1505.
- c) Identification symbols or code for heat.
- d) Week number and year of production.

Markings shall be clearly and permanently stamped in the valley of the steel channel, placed at a location clear of the splice overlap, and shall not be obscured after installation. The height of the letters and numerals shall be within the range of 19 to 32 mm.

1505.09 OWNER PURCHASE OF MATERIAL

1505.09.01 Measurement and Payment

For measurement purposes, a count shall be made of the number of steel channel sections delivered and accepted.

Installation hardware shall be measured in the units specified in the purchasing order, delivered and accepted.

Payment at the price specified in the purchasing order shall be for the supply of steel channels and installation hardware delivered to the destination or destinations at the dates and times specified.

The cost of all testing, except that performed in the Owner's laboratory, shall be included in the price.

Appendix 1505-A, November 2016
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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Designer Action/Considerations

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

Related Ontario Provincial Standard Drawings

OPSD 912.102 Guide Rail System, Steel Beam, Channel, Component



MATERIAL SPECIFICATION FOR STANDARD HIGHWAY FENCE COMPONENTS

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1540.08	QUALITY ASSURANCE - Not Used
1540.09	OWNER PURCHASE OF MATERIAL - Not Used

APPENDICES

1540-A	Commentary

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

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

1540.01.02

Appendices Significance and Use

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1540.02

REFERENCES

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

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

Ontario Provincial Standard Specifications, Material

OPSS 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
948-12-9.75	9	1219	3.50	305	ASTM A 641
949-12-12.5	9	1219	2.51	305	ASTM A 116

Appendix 1540-A, November 2016
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

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Designer Action/Considerations

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

Related Ontario Provincial Standard Drawings

OPSD 971.101	Fence, Highway, in Earth, Shale, Loose Rock or Friable Rock, Installation
OPSD 971.102	Fence, Highway, in Solid Rock, Installation
OPSD 971.103	Fence, Highway, Installation Details



MATERIAL SPECIFICATION FOR WOOD, PRESERVATIVE TREATMENT, AND SHOP FABRICATION

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1601.05	MATERIALS
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1601.07	PRODUCTION
1601.08	QUALITY ASSURANCE
1601.09	OWNER PURCHASE OF MATERIAL

APPENDICES

1601-A	Commentary

1601.01 SCOPE

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

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

1601.01.02 Appendices Significance and Use

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Appendices are developed for the Owner's use only.

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1601.02 REFERENCES

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

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

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 AWPA 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 AWPA P5, Type A, B, or C.
- d) Ammoniacal Copper Arsenate (ACA) shall be according to AWPA 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 greenhouse 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.

1601.09 OWNER PURCHASE OF MATERIAL

1601.09.01 Measurement and Payment

For measurement purposes, a count shall be made of the wooden posts or wooden blocks of each size supplied.

For measurement purposes, a count shall be made of the wooden piles of each length supplied.

Measurement of other wood shall be as specified in the purchasing order.

Payment at the price specified in the purchasing order shall be for the supply of the wooden posts, wooden blocks, wooden piles, or other wood delivered to the destination on the date and time specified.

The cost of all testing, except that performed in the Owner's laboratory shall be included in the price.

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

The designer should specify the following in the Contract Documents:

- Grade, species, size, and surface finish of all wood in permanent structures. (1601.05.01)

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

Related Ontario Provincial Standard Drawings

No information provided here.



MATERIAL SPECIFICATION FOR PAINT COATING SYSTEMS FOR STRUCTURAL STEEL

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1704-A	Commentary

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

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

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 911 Coating Structural Steel Systems

Ontario Provincial Standard Specifications, Material

OPSS 1714 Field Reacted Polymeric Pavement Marking Materials

CSA Standards

G-164-M92 (R2003) Hot Dip Galvanizing of Irregularly Shaped Articles

Canadian General Standards Board (CGSB)

1-GP-71 No. 5-96 Methods of Testing Paints and Pigments - Drying Times of Paints and Related Coatings

ASTM International

B 117-07a	Standard Practice for Operating Salt Spray (Fog) Apparatus
D 523-08	Standard Test Method for Specular Gloss
D 562-01(2005)	Standard Test Method for Consistency of Paints Measuring Krebs Unit (KU) Viscosity Using the Stormer-Type Viscometer
D 609-00 (2006)	Standard Practice for Preparation of Cold-Rolled Steel Panels for Testing Paint, Varnish, Conversion Coatings, and Related Coating Products
D 610-08	Standard Test Method for Evaluating Degree of Rusting on Painted Steel Surfaces
D 660-93 (2005)	Standard Test Method for Evaluating Degree of Checking of Exterior Paints
D 661-93 (2005)	Standard Test Method for Evaluating Degree of Cracking of Exterior Paints
D 714-02e1	Standard Test Method for Evaluating Degree of Blistering of Paints
D 772-86(2005)	Standard Test Method for Evaluating Degree of Flaking (Scaling) of Exterior Paints

D 1210-05	Standard Test Method for Fineness of Dispersion of Pigment-Vehicle Systems by Hegman-Type Gage
D 1475-98(2008)	Standard Test Method for Density of Liquid Coatings, Inks, and Related Products
D 1654-08	Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environment
D 2369-07	Standard Test Method for Volatile Content of Coatings
D 2371-85(2005)	Standard Test Method for Pigment Content of Solvent-Reducible Paints
D 2621-87(2005)	Standard Test Method for Infrared Identification of Vehicle Solids From Solvent-Reducible Paints
D 3271-87(2006)	Standard Practice for Direct Injection of Solvent-Reducible Paints Into a Gas Chromatograph for Solvent Analysis
D 3723-05	Standard Test Method for Pigment Content of Water-Emulsion Paints by Low-Temperature Ashing
D 3960-05	Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings
D 4214-07	Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films
D 4400-99(2007)	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 4541-02	Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
D 4587-05	Standard Practice for Fluorescent UV-Condensation Exposures of Paint and Related Coatings
D 5894-05	Standard Practice for Cyclic Salt Fog/UV Exposure of Painted Metal, (Alternating Exposures in a Fog/Dry Cabinet and a UV/Condensation Cabinet)
D 6386-99(2005)	Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting
E 1347-06	Standard Test Method for Color and Color-Difference Measurement by Tristimulus (Filter) Colorimetry

ASTM International Manual Series: MNL 17

Paint and Coating Testing Manual, 14th Edition of the Gardner-Sward Handbook

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

Joint Publications of the SSPC and National Association of Corrosion Engineers (NACE)

SP 10/NACE No. 2, September 2000 Near-White Blast Cleaning

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, 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 for 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) 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.

1704.05.01.04 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.

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 can 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 can 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.

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 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 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 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 CAN/CSA G164-M. 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.

1704.08.01.02.02 Paint 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 in accordance with CGSB 1-GP-71, Method 129.1, except that each score line shall be only 100 mm long.

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 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 abrasive blast cleaned surfaces and galvanized surfaces and 2,500 hours for 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 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.

1704.09 OWNER PURCHASE OF MATERIAL

1704.09.01 Measurement and Payment

Paint coating and paint coating system shall be measured by volume in litres.

Payment at the price specified in the purchasing order shall be for the supply of the paint coating or paint coating system delivered to the destination on the date and time specified.

The cost of all testing, except that performed in the Owner's laboratory, shall be included in the price.

TABLE 1
Performance Tests for Paint Coating Systems

Type of Test	CGSB 1-GP-71 Method	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 Paint coating system on marginally prepared test panels	122.1	D 4587 Test Condition D	Exposed to: 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 Paint coating system on marginally prepared test panels	-	D 5894	Exposed to: 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	13.4 12.1 - - - - - - -	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

	CGSB 1-GP-71 Method	ASTM	Acceptance Criteria (Note 1)	
			Tolerance (Note 2)	Others
Physical Tests on Mixed Coating:				
Density	2.1	D 1475	5%	-
Consistency, Krieb Units (KU)	4.5	D 562	± 10 or 25% (Note 3)	-
Dry Time:	5-96	-		
To Touch		-	± 30%	-
Hard Dry		-	± 30%	-
Hiding Power Determination Using Pfund Black and White Cryptometer		Paint and Coating Testing Manual	± 1.5 (Note 4)	-
Skimming	10.1	-	-	-
Fineness of Grind, Hegman Units (HU)		D 1210	± 2	-
Sag Resistance		D 4400	± 20%	-
Coating Composition:				
Pigment Content by % mass	21.1	D 4451, D 2371, D 3723	± 5%	-
Vehicle Solids Content by % mass @ 24 hours	19.1	-	± 5%	-
Volatile Content by % mass @ 2 hours and 24 hours	17.1	D 2369	± 5%	-
Pigment Composition by Chemical and Instrumental Analysis	-	-	-	Chemical Analysis clause (Note 5)
VOC Content	-	D 3960	± 10% but the total not exceeding 340 g/L	-
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	13.4	D 523	± 30%	-
Colour Difference (ΔE)	12.1	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.				

PAINT COATING DATA FORM

STRUCTURAL STEEL COATING SYSTEM and COATING GALVANIZED SURFACES

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	CGSB 1-GP-71 No. 5-96	
Hard dry		

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

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

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
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APPENDICES

1820-A	Commentary

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

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

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

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

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)

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.

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.

1820.09 OWNER PURCHASE OF MATERIAL

1820.09.01 Measurement and Payment

Circular concrete pipe and elliptical concrete pipe shall be measured in metres along the length of the pipe.

Payment at the price specified in the purchasing order shall be for the supply of the circular concrete pipe and elliptical concrete pipe including gaskets, delivered to the destination on the date and time specified.

The cost of all testing, except that performed in the Owner's laboratory, shall be included in the price.



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

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

Related Ontario Provincial Standard Drawings

OPSD 802.030	Rigid Pipe Bedding, Cover, and Backfill, Type 1 or 2 Soil - Earth Excavation
OPSD 802.031	Rigid Pipe Bedding, Cover, and Backfill, Type 3 Soil - Earth Excavation
OPSD 802.032	Rigid Pipe Bedding, Cover, and Backfill, Type 4 Soil - Earth Excavation
OPSD 802.033	Rigid Pipe Bedding, Cover, and Backfill, Rock Excavation
OPSD 802.034	Rigid Pipe Bedding and Cover in Embankment, Original Ground: Earth or Rock
OPSD 802.050	Horizontal Elliptical Rigid Pipe Bedding, Cover, and Backfill Type 1 or 2 Soil - Earth Excavation
OPSD 802.051	Horizontal Elliptical Rigid Pipe Bedding, Cover, and Backfill Type 3 Soil - Earth Excavation
OPSD 802.052	Horizontal Elliptical Rigid Pipe Bedding, Cover, and Backfill Type 4 Soil - Earth Excavation
OPSD 802.053	Horizontal Elliptical Rigid Pipe Bedding, Cover, and Backfill Rock Excavation
OPSD 802.054	Horizontal Elliptical Rigid Pipe Bedding and Cover in Embankment Original Ground: Earth or Rock
OPSD 807.010	Height of Fill Table, Reinforced Concrete Pipe - Confined Trench, Class 50-D, 65-D, 100-D, and 140-D
OPSD 807.030	Height of Fill Table, Reinforced Concrete Pipe - Embankment, Class 50-D, 65-D, 100-D, and 140-D
OPSD 807.040	Height of Fill Table, Non-Reinforced Concrete Pipe, Class 3
OPSD 807.050	Height of Fill Table, Horizontal Elliptical Concrete Pipe, Class HE-A, HE-I, HE-II, HE-III, and HE-IV



NOTICE TO USERS OF OPSS.MUNI 1841

CONSTRUCTION SPECIFICATION FOR NON-PRESSURE POLYVINYL CHLORIDE PIPE PRODUCTS

OPSS.MUNI 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
HEAVY CLASS STEEL AND
SECTIONAL STEEL POLES, BASE MOUNTED**

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2422.09	OWNER PURCHASE OF MATERIAL

APPENDICES

Appendix 2422-A	Commentary

2422.01	SCOPE

This specification covers the requirements for base mounted galvanized heavy class steel and sectional steel poles 6.0, 7.5, 9.0, and 10.50 metres in height.

2422.01.01 Specification Significance and Use

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

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

2422.01.02

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.

2422.02

REFERENCES

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

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

Ontario Ministry of Transportation Publications

Structural Manual

CSA Standards

G40.20-13/G40.21-13 General Requirements for Rolled or Welded Structural Quality Steel/ Structural Quality Steel

G164-M92 (R2003) Hot Dip Galvanizing of Irregularly Shaped Articles

S6-14 Canadian Highway Bridge Design Code

W59-13 Welded Steel Construction (Metal Arc Welding)

American Association of State Highway and Transportation Officials (AASHTO)

LTS-5-M Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, 5th Edition, Interim Revisions (2010)

2422.03**DEFINITIONS**

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

Engineer means a professional engineer licensed by the Professional Engineers Ontario to practice in the Province of Ontario.

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

2422.04**DESIGN AND SUBMISSION REQUIREMENTS****2422.04.01****Design Requirements**

All poles shall be designed to support the required traffic signal and lighting system components and shall be according to CSA S6 and MTO Structural Manual. All poles shall be according to CSA S6 and AASHTO LTS-5-M for fatigue requirements, AASHTO Fatigue Importance Category 2.

2422.04.01.01**Wind Loading**

Wind loading shall be based on the maximum wind pressure for Ontario according to CSA S6.

2422.04.01.02**Ice Loading**

Ice loading shall be based on the maximum ice loading for Ontario according to CSA S6.

2422.04.01.03**Geometric Parameters**

Latitude of design and fabrication details is at the discretion of the supplier and is subject to approval of the design by the Owner.

2422.04.01.04**Supported Load Parameters**

Design calculations shall employ force and dimensions for various items of equipment to be mounted on the poles as shown in Table 1.

2422.04.01.05**Heavy Class Steel and Sectional Steel Pole**

Heavy class steel and sectional steel poles used for traffic signal or combination traffic signal and lighting system shall be capable of bearing the loads associated with configurations shown in Table 2.

2422.04.01.06**Location of Equipment**

Mast arms shall be to be solidly attached to the pole at a height above the pole base plate as given by:

$$H_A = 5,650 \text{ mm} - H$$

where: H_A = mast arm height above the pole base plate
 H = mast arm height from Table 1

Where more than one mast arm is considered, the shorter arm shall be attached to the pole at a point 300 mm above that of the longer arm.

Pedestrian heads shall be mounted at a height of 2,750 mm above the pole base plate.

Luminaire brackets shall be mounted at a point 150 mm from the top of the pole.

2422.04.02 Submission Requirements

2422.04.02.01 Product Drawings

The heavy class steel and sectional steel pole manufacturer shall submit the product drawings and the design assumptions and calculations for the poles to the Owner for approval.

As a minimum, the product drawings shall include the following information:

- a) Material properties and standards.
- b) Dimensions.
- c) Hardware requirements.
- d) Plans, elevations, sections, and details to show pole structural details.
- e) Anchor bolt locations.
- f) Welds.
- g) Joining method for heavy class steel poles sections.

The product drawings and calculations shall bear the seals and signatures of the design and checking Engineers.

2422.04.02.02 Working Drawings

Working Drawings shall be prepared for the fabrication of heavy class steel and sectional steel poles.

The Contractor shall submit 3 sets of Working Drawings to the Contract Administrator at least 14 Days prior to the commencement of fabrication of the heavy class steel and sectional steel poles for information purposes only. An Engineer shall affix his or her seal and signature on the Working Drawings verifying that the Working Drawings are consistent with the Contract Documents and sound engineering practices.

Where multi-discipline engineering work is depicted on the same Working Drawing and a single engineer is unable to seal and sign the Working Drawing for all aspects of the work, the drawing shall be signed and sealed by as many additional engineers as necessary.

As a minimum, the Working Drawings shall include the following information:

- a) Detailed dimensions.
- b) Plans, elevations, sections, and details to show pole structural details.
- c) Equipment layout.
- d) Anchor bolt locations.
- e) Exact pole weight.
- f) Detailed bill of materials.
- g) Details of equipment nameplates.

A copy of the Working Drawings shall be retained at the fabricator's plant during and after the heavy class steel and sectional steel pole fabrication.

2422.05 MATERIALS

2422.05.01 General

All steel used in the production of poles shall be according to CAN/CSA G40.21, Grade 300WT, for pole shafts, base plates, and gussets.

All galvanized steel shall be according to CSA G164.

All welding shall be according to CSA W59.

2422.07 PRODUCTION

2422.07.01 General

General requirements for electrical work shall be as specified in the Contract Documents.

All welds, except for fillet welds, shall be ground smooth.

The pole base plate for any height of pole shall be made with mounting holes suitable for the anchor rod or anchorage assembly. The pole base plate shall be reinforced with four welded gussets equally spaced around the pole or with a welded collar or combination of both welded collar and gussets.

The underside of the anchor base shall be true, distortion free, and perpendicular to the centreline of the pole shaft after fabrication.

A waterproof, removable galvanized steel top cap shall be furnished with the pole. The cap shall blend with the general pole design to present a neat overall appearance. The cap shall be rigidly secured to the top of the pole by a hexagonal head stainless steel set screw.

Wiring apertures at the bracket mounting level and at the handhole shall be accurately positioned on the pole. The wiring apertures shall provide a smooth cable entrance.

For lighting applications, a wiring aperture, complete with rubber grommet, shall be provided.

Handholes, complete with covers, shall be reinforced with a steel handhole frame of such strength and cross-section that the strength of the pole is not reduced.

2422.07.02 Heavy Class Steel Poles

The poles, as specified in the Contract Documents, shall be round or octagonal in cross-section and shall taper uniformly inwards from the base for the height of the pole.

Poles shall have one or two longitudinal automatically electrically welded joints from top to bottom.

The maximum permitted number of circumferential (transverse) welded joints shall be as shown in Table 3.

The pole sections shall be joined by an electrical weld before galvanizing.

Sweep shall not exceed 3.2 mm per 4.57 m, and the overall sweep shall not be greater than:

$$(\text{Pole height (m)}/4.57 \text{ m}) \times 3.2 \text{ mm}$$

In all cases, the base shall telescope the butt end of the pole and be secured with one continuous weld on the inside of the base at the end of the pole and another continuous weld on the outside at the top of the base. All welding at base shall be made in such a manner as to ensure that the welded connection shall develop the same strength of the adjacent pole section to resist any bending action.

2422.07.03 Heavy Class Sectional Steel Poles

The pole sections shall be of round tapered construction so that a number of sections may be assembled by means of an overlapping press fit to form a tapered steel pole of the height specified in the Contract Documents.

Each section shall have one longitudinal automatically electrically welded joint from top to bottom.

Each section shall be stencilled with O-L (nominal overlap requirement) and graduations in one-inch increments.

2422.07.04 Ground Bar

A ground bar with a bronze ground connector suitable for No. 6 AWG wire shall be welded to the inside of each pole. The bronze ground connector shall be attached to the ground bar before shipment.

2422.07.05 Marking

Each pole shall have identification marking located approximately 300 mm above the top of the handhole showing the following:

- a) Manufacturer's name or trade mark.
- b) Height of pole.
- c) Gauge of steel.
- d) Bolt circle diameter.
- e) Designation OPSS 2422.
- f) Date of manufacture (i.e., yyyy-mm-dd).

This marking shall be on a corrosion-resistant metal plate securely attached to the surface of the pole.

2422.07.06 Packaging and Shipping

Each pole shall be shipped complete with hardware suitably packaged to ensure that all parts are delivered as an entity.

The Contractor shall advise the Owner of the shipping date 3 Business Days prior to delivery.

2422.08 QUALITY ASSURANCE

2422.08.01 Inspection

All work is subject to an inspection by the Owner's representative prior to shipment.

The supplier shall notify the Owner of the date that the fabrication of the poles is to commence.

The Owner's representative shall have free access to the place of fabrication of the poles for the purpose of inspecting and examining plant records and certificates while work on the poles is being performed; materials used; process of fabrication, including welding and galvanizing; and to make any tests as may be considered necessary.

2422.09 OWNER PURCHASE OF MATERIAL

2422.09.01 Working Drawings

Within 30 Days of receipt of a purchasing order to supply heavy class steel and sectional steel poles, the supplier shall submit 4 copies of pole Working Drawings, as described in the Submission Requirements subsection, to the Owner, for approval.

Working Drawings shall be given final approval by the Owner, if found to be acceptable, or shall be marked with deficiencies, if unacceptable.

Unacceptable drawings shall be returned to the supplier for correction. The supplier shall resubmit 4 copies of corrected Working Drawings within 14 Days. When the resubmitted drawings are acceptable to the Owner, they shall be given final approval.

One copy of the final approved drawings shall be returned to the supplier along with written notification to commence fabrication. Within 14 Days of receipt of the notification to commence fabrication, the supplier shall submit 4 copies of all final approved Working Drawings to the Owner.

Fabrication of the equipment shall not commence until the supplier has received final approved Working Drawings and written notification to commence fabrication from the Owner. All fabrication shall conform to the dimensions indicated on the final approved Working Drawings.

The supplier shall advise the Owner of the shipping date 3 Business Days prior to delivery.

2422.09.02 Measurement and Payment

For measurement purposes, a count shall be made of the number of heavy class steel and sectional steel poles supplied and accepted.

Payment at the price specified in the purchasing order shall be for the supply of the heavy class steel and sectional steel poles delivered to the destination on the date and time specified.

The cost of all testing, except that performed by the Owner, shall be included in the price.

TABLE 1
Supported Load Parameters

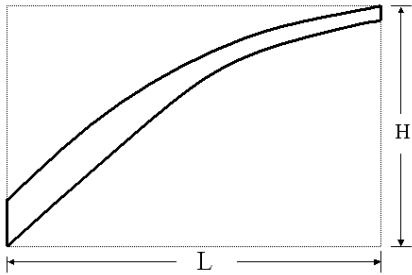
Item of Equipment	Dimensions mm	Projected Area m ²	Weight N
Roadway Lighting Luminaire (Ovuloid)	990 L x 380 H	0.22	107
Roadway Lighting Bracket (Aluminum)	2400 L x 1200 H (tapered)	0.15	112
Double Arm Brackets (Aluminum)	400 L x 42 Dia. (2 per set)	0.04	24
Mast Arm (Aluminum) 	610 L x 250 H (tapered)	0.04	78
	1200 L x 530 H (tapered)	0.10	91
	1800 L x 610 H (tapered)	0.15	114
	2400 L x 840 H (tapered)	0.19	65
	3000 L x 610 H (tapered)	0.23	94
	3600 L x 840 H (tapered)	0.38	113
	4600 L x 1070 H (tapered)	0.47	216
	5500 L x 910 H (tapered)	0.70	324
	6100 L x 1070 H (tapered)	0.79	307
	6700 L x 1150 H (tapered)	0.85	354
	7600 L x 1140 H (tapered)	1.10	504
Traffic Signal Heads (Aluminum: 4-Section)	1650 H x 610 W	1.01	123
Pedestrian Heads (Aluminum: 2-Section)	690 H x 345 W	0.23	78
Traffic Signs	Varies: see Table 2	1.50	23

TABLE 2
Heavy Class Steel and Sectional Steel Pole Configurations

Pole Height m	Luminaire and Bracket set	Longest Mast Arm with Head m	Maximum Mast Arm Total Length (Note 1) m	Number of Pedestrian Heads (Note 2)	Traffic Signs (Note 3) m ²
10.5	1	7.6	13.1	2	0.75
9.0	1	7.6	13.1	2	0.75
7.5	1	7.6	13.1	2	0.75
6.0	0	7.6	13.1	2	0.75
Notes: 1. Mast arm total length applies to the sum of the lengths of two mast arms at 90-degree orientation. 2. Two pedestrian heads at 90-degree orientation include a set of double arm brackets for each. 3. Traffic signs shall be split to give 0.25 m ² mounted on the mast arm beside the signal head and 0.5 m ² mounted at 2.75 m height above the pole base plate.					

TABLE 3
Circumferential Welded Joints

Pole Height m	Maximum Number of Welds
6.0	1
7.5	1
9.0	1
10.5	2

Appendix 2422-A: November 2016
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 HIGH PRESSURE SODIUM LUMINAIRES FOR UNDERPASS LIGHTING

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2434-A	Commentary

2434.01 SCOPE

This specification covers the requirements for underpass luminaires with integral ballast for use with 70 to 400 watt high pressure sodium lamps.

2434.01.01 Specification Significance and Use

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

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

2434.01.02 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.

2434.02 REFERENCES

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

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

CSA Standards

C22.2 No. 89-15	Swimming-Pool Luminaires, Submersible Luminaires and Accessories
C863-16	Energy Efficiency of High-Intensity Discharge (HID) and Low-Pressure Sodium (LPS) Lamp Ballasts

American National Standards Institute (ANSI)

C136.31-2010	Roadway and Area Lighting Equipment - Luminaire Vibration

ASTM International

B 117-11	Standard Practice for Operating Salt Spray (Fog) Apparatus
D 1654-08	Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments

International Electrotechnical Commission (IEC)

60598 (2014-05)	Luminaires
62262 (2002-02)	Degrees of Protection Provided by Enclosures for Electrical Equipment Against External Mechanical Impacts (IK code)

2434.04 DESIGN AND SUBMISSION REQUIREMENTS

2434.04.01 Design Requirements

2434.04.01.01 Photometric Requirements

Photometric test results shall be provided for the luminaires supplied and shall include the following data:

- a) Isolux curves and mounting height correction factors.
- b) Utilization charts or graphs.
- c) Candlepower distribution curves indicating peak intensity.
- d) Luminous intensity tables to Illuminating Engineering Society format (I-tables).
- e) Luminaire efficiency values.
- f) Luminous outputs above and below horizontal.
- g) Lamp lumen outputs and wattages.

2434.04.01.02 Electrical Requirements

All electrical components and assembled luminaires shall be according to CSA C22.2 No. 89.

Ballasts, lamp sockets, ground connectors, internal wiring, and all other components shall be suitable for the supply voltage as specified in the Contract Documents and the maximum temperature encountered in totally enclosed, outdoor, weatherproof luminaires.

Ballasts shall be constant wattage auto-transformer or isolated secondary transformer type for grounded systems. Auto-transformer type ballasts shall have a maximum tolerance of 12% variation in lamp wattage for a 5% variation in line voltage. Isolated secondary transformer type ballasts shall have a maximum tolerance of 12% variation in lamp wattage for a 10% variation in line voltage.

Ballasts shall be Class H, 180 °C insulation; 60 hertz; and low temperature, -35 °C with a power factor not less than 0.90.

The minimum nominal secondary open circuit voltage of the ballast for various lamps shall be sufficient to provide reliable starting at -35 °C.

Ballasts shall be suitable for the lamp's nominal operating voltage. Terminal blocks shall be held rigidly and shall provide a positive connection for terminating the field wiring.

The current crest factor of the ballast shall not exceed 1.8 for high pressure sodium lamps.

Energy efficiency of lamp ballasts shall be according to CAN/CSA C863.

All wiring within fixture shall have a minimum temperature rating of 125 °C.

2434.04.01.03**Mechanical Requirements**

The luminaire shall be comprised of a polycarbonate, aluminum, or stainless steel enclosure with a specular reflector and a glass prismatic refractor. Enclosure shall meet a scribe creepage rating of 7 according to ASTM D 1654, when tested for 5,000 hours according to ASTM B 117.

The luminaire shall be provided with a 20 mm threaded duct entry in each end of the enclosure and a cable entry hole in the rear of the enclosure together with a suitable waterproof gasket.

The luminaire shall have continuous captive gasket between the door and enclosure and between the refractor and the enclosure to provide a weatherproof seal.

All fixture hardware shall be Type 316 stainless steel and shall be captive. Proper dielectric insulation shall be provided between luminaire housing and fixture hardware of dissimilar metals, to prevent galvanic reaction.

The luminaire shall be provided with a ground terminal or lug for a single conductor #12 AWG stranded copper wire.

All unused cable and duct entry holes shall be plugged with approved filler caps.

The lamp socket shall be a porcelain-enclosed, nickel-plated brass shell rated for 4,000 volts, and spring-loaded centre contact. The lamp holder shall have an electrically insulated lamp stabilizer and shall hold the lamp's outer envelope to precise alignment with suitable means for vibration damping.

The refractor shall be heat-resistant and non-discolouring, with high resistance to breakage from thermal shock. It shall be securely attached to the housing by hinges and a safety device to hold it in the open position.

The reflector shall be fabricated of polished, chemically brightened, anodized aluminum not subject to distortion and shall be readily removable.

The luminaire shall be accessible with tool-less entry.

The luminaire shall not be subject to damage by vibration when closed and in the operating position.

2434.04.01.04**Other Requirements**

Certified test results shall be provided for the luminaires supplied and shall include the following data:

- a) UL/CSA Listing Report according to CSA C22.2 No. 89.
- b) Minimum IP65 Rating according to IEC 60598.
- c) Minimum IK08 Rating according to IEC 62262.
- d) 1.5G Vibration Test Report according to ANSI C136.31.

2434.04.02 Submission Requirements

2434.04.02.01 Working Drawings

Three copies of Working Drawings shall be submitted to the Contract Administrator a minimum of 14 Days prior to the commencement of fabrication.

As a minimum, the Working Drawings shall include the following information:

- a) All mechanical details, including dimensions, layouts, weights, shield details, and mounting arrangements for components.
- b) All electrical details and certified test reports, including wiring diagrams and component ratings.
- c) All photometric information and certified test reports regarding the luminaires, including, but not limited to lamp position, photometric data sheets, and photometric test reports.
- d) Certified Test Reports for UL/CSA listing, IP rating, IK rating, and ANSI C136.31 vibration.

2434.05 MATERIALS

2434.05.01 Marking

A permanent non-corrosive nameplate shall be attached to the exterior of the luminaire and located so that the marking is clearly visible after installation. The nameplate shall indicate the manufacturer's name or trademark, catalogue number, lamp wattage, and nominal voltage.

A permanent label shall be attached to the interior of the luminaire indicating the manufacturer's name or trademark, catalogue number, date of manufacture, and the American National Standards Institute (ANSI) or Illuminating Engineering Society (IES) photometric classification and distribution type; the suitable supply voltage and frequency; the lamp type; the lamp wattage; and the nominal operating voltage of the lamp so that it is clearly visible during maintenance operations.

A label including a wiring diagram shall be attached to each ballast showing the ballast schematic wiring diagram and shall be visible during maintenance operations.

For asymmetrical luminaires with adjustable optical systems, a permanent embossed identification mark shall be located on the luminaire that is clearly visible and identifiable as an orientation mark.

2434.07 PRODUCTION

2434.07.01 Ballast Assemblies

Ballast assemblies shall be factory pre-wired with all connections clearly marked and identified.

2434.07.02 Lamp Socket Positions

The lamp socket position shall be pre-set and legibly marked at the factory for the specified distribution.

2434.08 QUALITY ASSURANCE

2434.08.01 Inspection

The supplier shall notify the Owner of the date that the fabrication of the luminaires is to commence.

The Owner's representative shall have access to the place of fabrication for the purpose of inspecting and examining plant records, certificates, materials used, fabrication process, and to make any tests as may be considered necessary, while the work is being performed.

All luminaires are subject to an inspection by the Owner's representative prior to shipment.

2434.09 OWNER PURCHASE OF MATERIAL

2434.09.01 Packaging and Shipment

The supplier shall provide 3 copies of the luminaire ballast engineering data and shielding data such as material type, gauge thickness, and mounting arrangement to the Owner.

Each luminaire shall be shipped complete with hardware suitably packaged to ensure that all parts are delivered as an entity. A complete parts list shall be included in the shipment. All cartons shall be marked with the ANSI or IES luminaire classification and distribution types.

The supplier is responsible for loading, delivery, and off-loading of luminaires to designated areas. Luminaires shall be subject to inspection during and on completion of off-loading. If any damage to the luminaires is encountered during the inspection, the supplier shall be responsible for the necessary corrective measures subject to the approval of the Owner.

The supplier shall advise the Owner 3 Working Days prior to the shipping date of the intent to deliver and confirm that arrangements for off-loading have been made.

2434.09.02 Measurement and Payment

For measurement purposes, a count shall be made of the number of the underpass luminaires delivered and accepted.

Payment at the price specified in the purchasing order shall be full compensation for the supply and delivery of the underpass lighting luminaires to the destination at the date and time specified.

The cost of all testing, except that performed in the Owner's laboratory, shall be included in the price.

Appendix 2434-A, November 2016
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

The designer should specify the following in the Contract Documents:

- Supply voltage to the luminaires. (2434.04.01.02)

For Owner purchase of material, the following technical information should be given to the supplier in the purchasing order:

- a) Nominal line voltages.
- b) Lamp wattages.
- c) Lamp types and ANSI designations.
- d) Ballast types.
- e) ANSI or IES luminaire classifications and distribution types.
- f) Photometric curves or test report numbers.
- g) Shielding requirements.

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

Related Ontario Provincial Standard Drawings

OPSD 2305.020	Underpass Luminaires, Wall Mounted Installation
OPSD 2310.010	Underpass Luminaire, Ceiling Mounted Installation With T Bracket
OPSD 2310.020	T Bracket For Ceiling Mounted Underpass Luminaire
OPSD 2310.030	Wedge Mounting Bracket For Underpass Luminaire
OPSD 2310.040	Support Bracket For Column Mounted Underpass Luminaire
OPSD 2315.010	Underpass Luminaire, Wiring Detail



MATERIAL SPECIFICATION FOR SECTIONAL STEEL POLES

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2453-A	Commentary

2453.01 SCOPE

This specification covers the requirements for sectional steel poles.

2453.01.01 Specification Significance and Use

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

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

2453.01.02

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.

2453.02

REFERENCES

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

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

Ontario Ministry of Transportation Publications

Ontario Traffic Manual (OTM):
Book 12 - Traffic Signals

Structural Manual

CSA Standards

G40.21-13	General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel
S6-14	Canadian Highway Bridge Design Code
W59-13	Welded Steel Construction (Metal Arc Welding)

American Association of State Highway and Transportation Officials (AASHTO)

LTS-5-M Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, 5th Edition, Interim Revisions (2010)

ASTM International

A 123/A 123M-15 Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

2453.03**DEFINITIONS**

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

Engineer means a professional engineer licensed by the Professional Engineers Ontario to practice in the Province of Ontario.

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

2453.04**DESIGN AND SUBMISSION REQUIREMENTS****2453.04.01****Design Requirements**

All poles shall be designed to support the required traffic signal and lighting system components and shall be according to CSA S6 and MTO Structural Manual. All poles shall be according to CSA S6 and AASHTO LTS-5-M for fatigue requirements, AASHTO Fatigue Importance Category 2.

2453.04.01.01**Wind Loading**

Wind loading shall be based on the maximum wind pressure for Ontario according to CSA S6.

2453.04.01.02**Ice Loading**

Ice loading shall be based on the maximum ice loading in Ontario according to CSA S6.

2453.04.01.03**Geometric Parameters**

Latitude of design and fabrication details is at the discretion of the supplier and is subject to approval of the design by the Owner.

2453.04.01.04**Supported Load Parameters**

Design calculations shall employ force and dimensions for various items of equipment to be mounted on the poles as shown in Table 1.

2453.04.01.05**Sectional Steel Poles**

Sectional steel poles used for traffic signal or combination of traffic signal and lighting system shall be base mounted and shall be capable of bearing the loads associated with configurations shown in Table 2.

Direct buried sectional steel poles shall be capable of bearing the loads associated with the equipment shown in Table 3.

Flasher/sign poles shall be capable of bearing the loads associated with the equipment shown in Table 4.

2453.04.01.06 Location of Equipment

Mast arms shall be solidly attached to the pole at a height above the pole base plate as given by:

$$H_A = 5,650 \text{ mm} - H$$

Where:

H_A = mast arm height above the pole base plate

H = mast arm height from Table 1

When more than one mast arm is considered, the shorter arm shall be attached to the pole at a point 300 mm above that of the longer arm.

Pedestrian heads shall be mounted as specified in the Contract Documents.

Luminaire brackets shall be mounted at a point 150 mm from the top of the pole.

2453.04.02 Submission Requirements

2453.04.02.01 Product Drawings

The sectional steel pole manufacturer shall submit the product drawings and the design assumptions and calculations for the poles to the Owner for approval.

As a minimum, the product drawings shall include the following information:

- a) Material properties and standards.
- b) Dimensions.
- c) Hardware requirements.
- d) Plans, elevations, sections, and details to show pole structural details.
- e) Anchor bolt locations.
- f) Welds.
- g) Joining method for sectional steel poles sections.

The product drawings and calculations shall bear the seals and signatures of the design and checking Engineers.

2453.04.02.02 Working Drawings

Working Drawings shall be prepared for the fabrication of sectional steel poles.

The Contractor shall submit 3 sets of Working Drawings to the Contract Administrator at least 14 Days prior to the commencement of fabrication of the sectional steel poles for information purposes only. An Engineer shall affix his or her seal and signature on the Working Drawings verifying that the Working Drawings are consistent with the Contract Documents and sound engineering practices.

When multi-discipline engineering work is depicted on the same Working Drawing and a single engineer is unable to seal and sign the Working Drawing for all aspects of the work, the drawing shall be signed and sealed by as many additional engineers as necessary.

As a minimum, the Working Drawings shall include the following information:

- a) Detailed dimensions.
- b) Plans, elevations, sections, and details to show pole structural details.
- c) Equipment layout.
- d) Anchor bolt locations.
- e) Exact pole weight.
- f) Detailed bill of materials.
- g) Details of equipment nameplates.

2453.05 MATERIALS

2453.05.01 General

All steel used in the production of poles shall be according to CAN/CSA G40.21, Grade 300WT, Category 2, for pole shafts, base plates, and gussets.

All welding shall be according to CSA W59.

2453.07 PRODUCTION

2453.07.01 General

General requirements for electrical work shall be as specified in the Contract Documents.

The pole base plate for any height of pole shall be made with mounting holes suitable for the anchor rod or anchorage assembly.

The underside of the anchor base shall be true, distortion free, and perpendicular to the centreline of the pole shaft after fabrication.

A waterproof, removable galvanized steel top cap shall be furnished with the pole. The cap shall blend with the general pole design to present a neat overall appearance. The cap shall be rigidly secured to the top of the pole by a hexagonal head stainless steel set screw.

Wiring apertures at the bracket mounting level and at the handhole shall be accurately positioned on the pole.

All wiring apertures shall provide a smooth cable entrance and be complete with rubber grommets.

Handholes, complete with covers, shall be reinforced with a steel handhole frame of such strength and cross-section that the strength of the pole is not reduced.

2453.07.01.01 Galvanizing

All components shall be hot dip galvanized according to ASTM A 123.

2453.07.02 Steel Sections

2453.07.02.01 General

The following covers types and lengths of sectional steel poles:

- a) Base mounted: 7.00, 8.70, and 10.50 m
- b) Direct buried: 5.25, 7.00, 8.70, 10.25, and 12.00 m
- c) Flasher/sign: 3.30 m

Pole sections shall be of round tapered construction so that a number of sections may be assembled by means of an overlapping press fit to form a tapered steel pole of the desired length.

Each section shall have one longitudinal automated electrically welded joint from top to bottom.

Each section shall be stencilled with O-L and graduations in one inch increments. O-L represents the nominal overlap requirement for each section.

2453.07.02.02 Base Mounted and Direct Buried Poles, 5.25 m and Longer

For lighting applications, a wiring aperture, complete with 28.5 mm ID rubber grommet shall be drilled 300 mm from the top of the pole.

Each base mounted pole shall be supplied with a reinforced 180 x 300 mm handhole, complete with cover. Each direct buried pole shall be supplied with a reinforced 100 x 200 mm handhole, complete with cover. A 6 x 38 x 250 mm long plate shall be welded inside the pole opposite the handhole. A ground connector shall be mounted on the plate. The ground connector shall be suitable for No. 6 AWG wire.

The centre of the handhole on base mounted poles shall be 1.1 m from the bottom of the pole and on direct buried poles the centre of the handhole shall be 2.75 m from the bottom of the pole.

Base mounted poles shall have a steel plate anchor base with 4 holes on a 449 mm bolt circle, suitable for mounting on 32 mm diameter studs.

Direct buried sectional steel poles shall have 65 x 300 mm wiring apertures on each side of the pole, the centre of the apertures shall be 1.25 m from the bottom of the pole.

2453.07.02.03 Flasher Poles

The flasher pole shall be comprised of two pole sections totalling 2.3 m in length with a 1.2 m length of 50 mm IPS Schedule 40 pipe inserted 230 mm into the top and welded in place to provide a total length of 3.3 m.

The top end of the extension shall be threaded and the thread cleaned after galvanizing.

Each pole shall be supplied with a 75 x 100 mm handhole, complete with cover. The bottom edge of the handhole shall be 150 mm from the bottom of the pole.

A ground terminal shall be provided in the handhole.

The flasher pole shall be supplied with a steel plate anchor base with 4 holes on a 150 mm bolt circle, suitable for mounting on 16 mm diameter studs.

2453.07.03 Marking

Each pole shall have identification marking located approximately 100 mm above the top of the handhole showing the following:

- a) Manufacturer's name or trademark.
- b) Length.
- c) Designation OPSS 2453.
- d) Manufacturer's catalogue number.
- e) Date of manufacture (i.e., yyyy-mm-dd).

This marking shall be on a corrosion-resistant metal plate securely attached to the surface of the pole.

2453.07.04 Ground Bar

A ground bar with a bronze ground connector suitable for No. 6 AWG wire shall be welded to the inside of each pole. The bronze ground connector shall be attached to the ground bar before shipment.

2453.07.05 Packaging and Shipping

Each pole shall be shipped complete with hardware suitably packaged to ensure that all parts are delivered as an entity.

The Contractor shall advise the Owner of the shipping date 3 Business Days prior to delivery.

2453.08 QUALITY ASSURANCE

2453.08.01 Inspection

All work is subject to an inspection by the Owner's representative prior to shipment.

The supplier shall notify the Owner of the date that the fabrication of the poles is to commence.

The Owner's representative shall have free access to the place of fabrication of the poles for the purpose of inspecting and examining plant records and certificates while work on the poles is being performed; materials used; process of fabrication, including welding and galvanizing; and to make any tests as may be considered necessary.

2453.09 OWNER PURCHASE OF MATERIAL

2453.09.01 Working Drawings and Shipment

Within 30 Days of receipt of a purchasing order to supply sectional steel poles, the supplier shall submit 3 copies of pole Working Drawings, as described in the Submission Requirements subsection, to the Owner.

The supplier shall advise the Owner of the shipping date 3 Business Days prior to delivery.

2453.09.02**Measurement and Payment**

For measurement purposes, a count shall be made of the number of sectional steel poles supplied and accepted.

Payment at the price specified in the purchasing order shall be for the supply of the sectional steel poles delivered to the destination on the date and time specified.

The cost of all testing, except that performed by the Owner, shall be included in the price.

TABLE 1
Supported Load Parameters

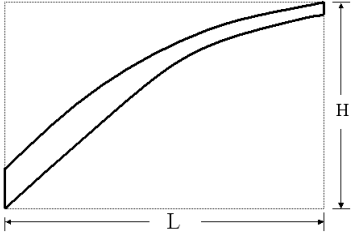
Item of Equipment	Dimensions mm	Projected Area m ²	Weight N
Roadway Lighting Luminaire (Ovuloid)	990 L x 380 H	0.22	107
Roadway Lighting Bracket (Aluminum)	2400 L x 1200 H (tapered)	0.15	112
Double Arm Brackets (Aluminum)	400 L x 42 Dia. (2 per set)	0.04	24
Mast Arm (Aluminum) 	610 L x 250 H (tapered)	0.04	78
	1200 L x 530 H (tapered)	0.10	91
	1800 L x 610 H (tapered)	0.15	114
	2400 L x 840 H (tapered)	0.19	65
	3000 L x 610 H (tapered)	0.23	94
	3600 L x 840 H (tapered)	0.38	113
	4600 L x 1070 H (tapered)	0.47	216
	5500 L x 910 H (tapered)	0.70	324
Traffic Signal Heads (Aluminum: 4-Section)	1650 H x 610 W	1.01	123
Pedestrian Heads (Aluminum: 2-Section)	690 H x 345 W	0.23	78
Traffic Signs	Varies: see Table 2	1.50	23

TABLE 2
Base Mounted Sectional Steel Pole Configurations

Pole Height m	Luminaire and Bracket set	Longest Mast Arm with Head m	Maximum Mast Arm Total Length (Note 1) m	Number of Pedestrian Heads (Note 2)	Traffic Signs (Note 3) m ²	Street Name Sign (Note 4) m ²
7.00	1	5.5	11.0	2	0.75	0.97
8.70	1	5.5	11.0	2	0.75	0.97
10.50	1	5.5	11.0	2	0.75	0.97

Notes:

1. Mast arm total length applies to the sum of the lengths of two mast arms at 90-degree orientation.
2. Two pedestrian heads at 90-degree orientation include a set of double arm brackets for each.
3. Traffic signs shall be split to give 0.25 m² mounted on the mast arm beside the signal head and 0.5 m² mounted at 2.75 m height above the pole base plate.
4. Street name or roadway identification sign shall have a maximum height of 0.45 m and a maximum length of 2.10 m. The sign shall be mounted on each mast arm or pole and the distance between the centre of the sign and the surface of the pole shall not exceed half the length (L) of the mast arm. Pole mounted street name signs shall be mounted at the same height as the mast arm mounted signs or at the top of the pole, whichever is less.

TABLE 3
Direct Buried Sectional Steel Pole Configurations

Pole Height m	Luminaire and Bracket (Note 1) set	Supply Control Cabinet Type 1 (Note 2) each
5.25	2	N/A
5.25	N/A	2
7.00	2	N/A
7.00	N/A	2
8.70	2	N/A
8.70	N/A	2
10.25	2	N/A
10.25	N/A	2
12.00	2	N/A
12.00	N/A	2
Notes: 1. See Table 1. 2. Each supply control cabinet shall have maximum dimensions of 865 mm H x 465 mm W x 250 mm D and a maximum weight of 700 N.		

TABLE 4
Flasher/Sign Pole Configurations

Pole Height m	Beacons (Note 1) each	Traffic Signal Head (3 display sections) (Note 1) each	Traffic Signs m²
3.3	2	N/A	0.5
3.3	N/A	1	0.5
Note: 1. Each beacon or traffic signal display shall be a 300 mm display according to OTM Book 12 and the total weight of the beacons or the three section traffic signal head shall be a maximum of 200 N.			

Appendix 2453-A, November 2016
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 SECTIONAL STEEL HIGH MAST LIGHTING POLES

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2471.09	OWNER PURCHASE OF MATERIAL - Not Used

APPENDICES

2471-A	Commentary

2471.01 SCOPE

This specification covers the requirements for base mounted sectional steel high mast lighting poles 25, 30, 35, 40, and 45 metres in height with a multisided cross-section.

2471.01.01 Specification Significance and Use

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

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

2471.01.02 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.

2471.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 906	Structural Steel
OPSS 911	Coating Structural Steel Systems

Ontario Ministry of Transportation Publications

Structural Manual

CSA Standards

B95-1962 (R2002)	Surface Texture (Roughness, Waviness and Lay)
G40.20-13/G40.21-13	General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel
G164-M92 (R2003)	Hot Dip Galvanizing of Irregularly Shaped Articles
S6-14	Canadian Highway Bridge Design Code
W47.1-09 (R2014)	Certification of Companies for Fusion Welding of Steel
W59-13	Welded Steel Construction (Metal Arc Welding)
W178.1-14	Certification of Welding Inspection Organizations
W178.2-14	Certification of Welding Inspectors

ASTM International

A 500/A 500M-13	Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

Canadian General Standards Board (CGSB)

48.9712-2014 Non-Destructive Testing - Qualification and Certification of NDT Personnel

American Association of State Highway and Transportation Officials (AASHTO)

LTS-5-M Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, 5th Edition, Interim Revisions (2010)

International Organization for Standardization/International Electrotechnical Commission(ISO/IEC)

17025:2005 General Requirements for the Competence of the Testing and Calibration Laboratories

Others

Federal Standard 595C Color Standards

2471.03 DEFINITIONS

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

CWB means Canadian Welding Bureau.

Engineer means a professional engineer licensed by the Professional Engineers Ontario to practice in the Province of Ontario.

Multisided means having either eight or twelve sides as specified in the Contract Documents.

NACE CIP means National Association of Corrosion Engineers Coating Inspection Program.

SSPC means The Society for Protective Coatings.

2471.04 DESIGN AND SUBMISSION REQUIREMENTS

2471.04.01 Design Requirements

Sectional steel high mast lighting poles shall be according to CSA S6; MTO Structural Manual; AASHTO LTS-5M; and as specified in the Contract Documents. Each pole shall be capable of supporting a total maximum load of 2,000 kg with a combined effective projected area of all the luminaires, shroud, and shields not exceeding 4.0 m².

2471.04.02 Submission Requirements

2471.04.02.01 Working Drawings

Working Drawings shall be prepared for the fabrication of the sectional steel high mast lighting poles.

The Contractor shall submit 3 sets of Working Drawings to the Contract Administrator 14 Days prior to commencement of fabrication of the sectional steel high mast lighting poles, for information purposes only. An Engineer shall affix his or her seal and signature on the Working Drawings verifying that the Working Drawings are consistent with the Contract Documents and sound engineering practices.

Where multi-discipline engineering work is depicted on the same Working Drawing and a single engineer is unable to seal and sign the Working Drawings for all aspects of the work, the drawing shall be signed and sealed by as many additional engineers as necessary.

A copy of the Working Drawings shall be retained at the fabricator's plant during and after pole fabrication.

The Working Drawings shall contain all information necessary to fabricate the sectional steel high mast lighting poles including:

- a) Dimensioned drawings, including lengths, sizes, cross-sections, and details of the sectional steel pole, and exact weights of pole sections.
- b) Final forces for field assembly of pole sections.
- c) Details for the mounting supports of the winch assembly, the head frame assembly, and the electrical panel assembly.
- d) Details of access opening and of access door.
- e) Welding details, including welding procedures to be used for each joint.
- f) Detailed bill of materials.
- g) Details of identification nameplates.

2471.04.02.02 Mill Test Certificates

Mill test certificates shall be submitted according to OPSS 906.

2471.04.02.03 Welding Procedures

Welding procedure data sheets for each joint configuration to be welded shall be prepared according to CSA W59, stamped with CWB's acceptance, and available for review during fabrication of the sectional steel high mast lighting poles. The Contractor shall submit 3 sets of welding procedures to the Contract Administrator 14 Days prior to commencement of fabrication of the sectional steel high mast lighting poles, for information purposes only.

2471.04.02.04 Welder's Qualification

Welders shall have valid CWB issued qualification cards indicating the welding processes and the positions for which they are qualified to weld. Prior to the commencement of fabrication, the Contractor shall submit 3 copies of the Welders' and Welding Operators' current qualification cards to the Contract Administrator.

2471.05 MATERIALS

2471.05.01 Steel

All structural steel shall be CSA G40.20/G40.21, Grade 350 WT, Category 3.

Steel for tenon pipe shall be CSA G40.20/G40.21, Grade 300W, or A 500M Grade C.

For pole masts, silicon content shall be less than or equal to 0.06%.

2471.05.02 Electrodes

Electrodes and flux used for welding shall have a low hydrogen content and shall be as specified in the fabricator's CWB approved welding procedures.

2471.05.03 Paint Coatings

Paint coatings shall be according to OPSS 911 and the Contract Documents.

The colour of the finish coat shall be equivalent to 16307 grey according to Federal Standard 595C.

2471.07 PRODUCTION

General requirements for electrical work shall be as specified in the Contract Documents.

Fabrication shall be according to CSA S6 and CSA W59 and the Working Drawings.

2471.07.01 Tolerances

Fabrication shall be according to the dimensions on the sealed and signed Working Drawings.

The dimensions of the assembled high mast lighting pole shall be within the following tolerances:

- a) Overall height of pole mast: 5 mm for every 1 m in height.
- b) Cross-sectional width of shaft across flats:
 - i) 1.0%, for widths less than 500 mm,
 - ii) 0.75% for widths greater than 500 mm.
- c) Maximum sweep of the pole mast on its overall length measured from a chord joining the extremities and the centreline of the mast shall not exceed 0.2% of its overall length.
- d) Maximum deviation from straight of the shaft wall on any 3 m length of pole mast shall not exceed 5 mm.
- e) Offset between the centreline of the top section of the pole and the centreline of the bottom section of the pole shall not exceed 150 mm.
- f) Offset between the centreline of the base plate and the centre of the pole mast at base shall not exceed 5 mm.
- g) Wall thickness shall be within the tolerance permitted in CSA G40.20/G40.21 and ASTM A 500M.

2471.07.02**Fabrication**

The pole mast shall be cold formed from steel plate and each section shall be fabricated with one or two continuous longitudinal welds. If two welds are used, they shall be on opposite sides of the pole shaft.

One circumferential shop splice per section shall be permitted. Where possible, the shop splice shall be completed prior to forming the pole cross-section.

In the area of the lap splice there shall be no protrusions preventing proper alignment of one section with the next. Any excess weld material shall be removed by grinding to form a smooth surface maintaining a uniformly tapered section.

Each pole shall be supplied with a reinforced handhole complete with a cover. The cover shall have provision for padlocking and shall be fitted with a silicone rubber gasket such that, upon locking, the cover shall be tightly fitted to the handhole.

Each pole shall be supplied with the appropriate mounting plate, brackets, and other attachments required for the installation of the raising and lowering equipment. The mounting plate, brackets, and other attachments shall be attached to the shaft wall by welds as specified in the Contract Documents. Nuts for securing the electrical panel shall be welded to the back of the mounting plate at each mounting hole as specified in the Working Drawings.

The head frame shall be assembled to the pole by means of a tenon mounting system. The tenon shall be compatible with the head frame and raising and lowering device.

In the tenon mounting system, a circular plate with nominal thickness of 12 mm shall be welded to the top of pole as specified in the Contract Documents. The plate shall have a circular opening through its centre, equal to the outside diameter of the tenon, through which the tenon shall be inserted.

The pole section joints shall be slip fitted connections as specified in the Contract Documents. Joint details shall not interfere with the raising or lowering of the luminaire assembly.

The maximum overlap shall be such that the height of the completed mast complies with the permitted overall tolerances.

Shop trial-assembly shall be carried out to check the fit of the sections. The manufacturer shall determine the necessary compressive assembly forces and lap lengths to be achieved during the pre-assembly operation to ensure the final field assembly shall meet the requirements of the Contract Documents. Sections shall be match-marked to facilitate the field assembly. The markings shall be permanent and the location, size, and marking medium shall not interfere with the slip joint.

All cut edges of the base plate shall have a surface finish not greater than 1,000 as defined in CSA B95. All corners shall be ground to a radius of 3 mm.

2471.07.03**Welding**

All welding shall be according to CSA W59, including its provisions for cyclically loaded structures, and shall be undertaken by a manufacturer certified by CWB according to CSA W47.1, division 2.1 or better.

During fabrication, upon request the Contractor shall make available to the inspector the CWB approved qualification cards for each, Welder and Welding Operator to be employed on the work.

Welds for circumferential splices shall be full strength complete joint penetration.

The longitudinal seam welds shall be single V and shall be made from the outside of the structure. Throat thickness shall be according to CSA W59, to ensure a minimum of 60% joint penetration.

Welds within the lap of the slip joints plus an additional 150 mm extending from the slip joint shall be full strength complete penetration groove welds, and shall be ground smooth.

The section of weld that does not meet the acceptance standards shall be removed, re-welded, and re-examined.

2471.07.04 Coating

2471.07.04.01 Galvanizing

All steel components of sectional steel high mast lighting poles shall be hot dip galvanized according to OPSS 911.

2471.07.04.02 Paint Coating

After galvanizing and prior to paint coating, each component of the sectional steel high mast lighting pole shall be checked for continuity and smoothness of the galvanized coating. Any deficiencies in galvanized coating shall be corrected according to OPSS 911.

Components specified to be paint coated shall then be paint coated after surface preparation according to OPSS 911, using one of the paint coating systems specified in the Contract Documents. The dry film thickness of galvanized coating after surface preparation by sweep blasting shall be at least 87 µm.

During trial-assembly care shall be taken not to damage the coatings of the pole. Any damage to the coatings that occur during the trial-assembly or any other operations shall be repaired according to OPSS 911.

2471.07.05 Identification Nameplate

Each sectional steel high mast lighting pole shall have an identification nameplate as specified in the Contract Documents.

The nameplate shall be made of stainless steel and shall be securely attached to the outside upper part of the handhole cover by rivets. A neoprene or rubber gasket shall be placed between the handhole cover and the nameplate to prevent corrosion effects.

2471.07.06 Quality Control

The Contractor shall notify the Contract Administrator of the fabrication, testing, and delivery dates.

The manufacturer shall issue a certificate of compliance certifying that the sectional steel high mast lighting poles comply with the Contract Documents.

2471.07.06.01 Inspection, Testing, and Reporting

The manufacturer's welding inspector shall inspect and test the sectional steel high mast lighting poles as follows:

(a) Visual Inspection

The fabrication of steel components shall be visually inspected to ensure material, dimensions, fit-up, and welding are according to specifications. Certification of conformance by the inspector for each phase of the fabrication shall be based on the applicable Working Drawings, codes, and specifications.

The manufacturer's inspector shall witness the trial assembly of the pole sections to ensure compliance with contract requirements.

Each phase of the cleaning and coating work shall be inspected to ensure conformity to the Contract Documents prior to proceeding to the next phase. Acceptance of the surface preparation and coating thickness measurements shall be according to OPSS 911, CSA G164, and the applicable SSPC Standards.

When the sectional steel high mast lighting poles have been delivered to the Working Area and prior to installation, the manufacturer's inspector with the required credentials shall inspect them to ensure that all the components of the high mast lighting poles are according to the Contract Documents.

(b) Non-Destructive Testing

All full penetration groove welds, including shaft to base welds, circumferential splices in shaft and welds at slip joints, shall be 100% examined. Longitudinal welds at the bottom of the shaft shall be tested 100% for a length of 2.0 m from the base plate. All testing of groove welds shall be by radiographic or ultrasonic test method and shall be according to CSA W59 for cyclically loaded structures. Any repair welds shall be tested by appropriate methods as determined by the manufacturer's Engineer.

(c) Reporting

Prior to installation of the poles, the Contractor shall submit 2 copies of the manufacturer's inspection reports, containing the results of all the inspection and testing performed during welding, fabrication and coating work, to the Contract Administrator. The inspection report shall be completed and certified by the manufacturer's inspector and approved by the manufacturer's Engineer.

2471.07.06.02 Certification of the Welding Inspection Company

The company undertaking welding inspection shall be certified under the Bridges category according to CSA W178.1. The certification shall encompass at least the following methods: visual, radiograph, ultrasonic, dye penetrant, and magnetic particle.

2471.07.06.03 Certification of Welding inspectors for Visual Inspection and Non-Destructive Testing

Visual inspection of the sectional steel high mast lighting poles shall be performed by welding inspectors certified by CWB according to CSA W178.2. The certification shall be to Level II or III.

Non-destructive testing of the sectional steel high mast lighting poles shall be performed by an ultrasonic or radiographic technician or both, certified to Level II or Level III according to CGSB 48.9712.

2471.07.06.04 Certification of Coating Inspectors

Each Coating Inspector shall have:

- a) Successfully completed NACE CIP Level 1 and Level 2 with a minimum of 3 years of proven coating inspection experience;
- or,
- b) Successfully completed NACE CIP Level 1, or be a graduate of the MTO's Coating Course and be working under the direct technical supervision of a currently Certified NACE CIP Level 3 inspector.

2471.08**QUALITY ASSURANCE**

Sectional steel high mast lighting poles are subject to inspection by the Contract Administrator at any time during the course of fabrication and installation. The Contractor shall notify the Contract Administrator of the fabrication, testing, and delivery dates.

Welding is subject to inspection by the Contract Administrator using both visual and non-destructive testing procedures and techniques according to CSA W59 for cyclically loaded structures.

The surface preparation and coating of sectional high mast steel lighting poles are subject to inspection by the Contract Administrator during the coating work. Acceptance of the work shall be based on the applicable OPS specification and SSPC Standards.

**Appendix 2471-A, November 2016
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

The designer should specify the following in the Contract Documents:

- Coating requirements. (2471.07.05.03)
- Shaft wall attachment requirements. (2471.07.02)
- Paint coating system. (2471.07.04.02)
- Sectional steel high mast lighting pole requirements. (2471.07.06)

The designer should determine if the following is required and, if it is, specify it in the Contract Documents:

- Additional pole design requirements. (2471.04.01)

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

Related Ontario Provincial Standard Drawings

OPSD 2450.011	High Mast Lighting Pole 25, 30, and 35 m 8-Sided Pole
OPSD 2450.021	High Mast Lighting Pole 40 and 45 m 12-Sided Pole
OPSD 2453.010	High Mast Lighting Pole Cable Holder and Storage Hook Details
OPSD 2453.020	High Mast Lighting Pole, Handhole Cover Hinges, Latches, and Padlock
OPSD 2453.050	High Mast Lighting Pole Nameplate Details



**MATERIAL SPECIFICATION FOR
ANCHORAGE ASSEMBLY - HIGH MAST LIGHTING POLE**

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2474-A	Commentary

2474.01 SCOPE

This specification covers the requirements of anchorage assemblies for the 25, 30, 35, 40, and 45 m base mounted sectional steel high mast lighting poles.

2474.01.01 Specification Significance and Use

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

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

2474.01.02 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.

2474.02 REFERENCES

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

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

CSA Standards

G40.20-13/G40.21-13	General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel
G164-M92 (R2003)	Hot Dip Galvanizing of Irregularly Shaped Articles
W59-13	Welded Steel Construction (Metal Arc Welding)
W178.2-14	Certification of Welding Inspectors

Canadian General Standards Board

48.9712-2014 Non-Destructive Testing - Qualification and Certification of NDT Personnel

ASTM International

A 153/A 153M-16	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
A 449-14	Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use
A 563-15	Carbon and Alloy Steel Nuts

2474.04 DESIGN AND SUBMISSION REQUIREMENTS

2474.04.01 Submission Requirements

2474.04.01.01 Working Drawings

The Contractor shall submit 6 sets of Working Drawings to the Contract Administrator at least 14 Days prior to the commencement of fabrication. An Engineer shall affix his or her seal and signature on the Working Drawings verifying that the drawings are consistent with the Contract Documents and sound engineering practices.

When multi-discipline engineering work is depicted on the same Working Drawing and a single Engineer is unable to seal and sign the Working Drawing for all aspects of the work, the drawing shall be signed and sealed by as many additional Engineers, as necessary.

As a minimum, the Working Drawings for anchorage assemblies shall include the following information:

- a) Dimensioned drawings, including plans, elevations, sections of the anchor rods, nuts, top and bottom plates, and their exact weights.
- b) Mill test certificates reports of all steel being used.

2474.05 MATERIALS

2474.05.01 Steel

Anchor rods shall be made of new billet steel round bar, quenched and tempered medium carbon steel, with a minimum yield strength of 517 MPa and a minimum tensile strength of 725 MPa, and shall satisfy Charpy V Notch test requirements of 20 joules at minus 30 °C.

The length, number, and size of the anchor rods shall be as specified in the Contract Documents.

Other general requirements shall be according to ASTM A 449 for anchor rods and ASTM A 563 for anchor rod nuts.

Anchor assembly top and bottom plates shall be made of PL10 x 100 mm according to CSA G40.20/G40.21, Grade 300W.

2474.05.02 Anchorage Setting Templates

The anchorage setting template shall be made of 20 mm thick plywood or hard wood or metal. Metal templates shall be a minimum of 12 gauge steel.

2474.07 PRODUCTION

2474.07.01 General

All fabrication shall be according to dimensions specified in the Working Drawings and as specified in the Contract Documents.

Anchorage assembly shall be supplied complete, as specified in the Contract Documents. Each assembly shall be supplied complete with anchor rods, hexagonal nuts, hardened steel washers, and steel top and bottom plates.

Each anchorage assembly shall be supplied with one anchorage setting template for positioning of the anchor rods to suit the required bolt circle diameter of the pole.

2474.07.02 Tolerance

Dimensions, threads, and hexagonal nuts tolerances shall be according to ASTM A 563, Grade DH. Exposed nuts are to be tapped oversized according to ASTM A 563 to allow for the thickness of the zinc coating on the rod threads.

2474.07.03 Welding

Hexagonal nuts shall be welded to the top and bottom plates according to CSA W59.

2474.07.04 Coating

The anchorage assembly shall be completely galvanized according to CAN/CSA G164M or ASTM A 153.

The exposed hexagonal nuts and washers shall be galvanized according to CAN/CSA G164M or ASTM A 153.

2474.07.05 Quality Control

The manufacturer shall certify that the anchorage assembly is according to the strength and material requirements as specified in the Contract Documents.

The manufacturer shall provide an inspector to inspect and test the anchorage assemblies. The manufacturer's inspector shall be certified for testing bridges according to CSA W178.2. The certification shall be either Level 2 or Level 3 for the methods used as specified in CAN/CGSB 48.9712.

The manufacturer's inspector shall inspect the place of manufacture of the anchorage assemblies while work on the units is being performed and shall inspect and examine the plant records and certificates, the materials used, and the fabrication process and shall conduct any tests as it may be considered necessary.

The manufacturer shall submit two copies of the completed inspection report to the Owner. Inspection reports shall be completed and certified by the manufacturer's inspector.

When the anchorage assemblies have been delivered to the Working Area and prior to installation, the manufacturer's inspector shall inspect the anchorage assemblies to ensure that they meet all the Contract requirements.

2474.07.06 Testing

Visual inspection of the anchorage assemblies shall be performed by welding inspectors certified by the Canadian Welding Bureau under CSA W178.2 at a Level 3 category or working under a Level 2 inspector.

2474.07.07 Packaging and Shipment

Each anchorage assembly shall be shipped complete with hardware suitably packaged to ensure that all parts are delivered as an entity. A complete parts list shall be included in the shipment.

The supplier shall be responsible for loading, delivery, and off-loading of the anchorage assemblies to the designated areas. Anchorage assemblies shall be subject to inspection during and on completion of off-loading. If any damage is encountered during the off-loading inspection, the supplier shall be responsible for the necessary corrective measures subject to the approval of the Owner.

2474.08 QUALITY ASSURANCE

2474.08.01 Welding

All welding shall be subject to a visual inspection. Procedures and techniques for visual testing shall be according to CSA W59, Clause 7 and 8.

If faulty welding or material is encountered during the inspection procedures, the manufacturer shall submit corrective measures to the Contract Administrator for approval.

2474.08.02 Inspection

The Contract Administrator shall be notified a minimum of 3 Business Days prior to the start of fabrication, testing, and delivery dates.

The Contract Administrator shall have free access to the place of manufacture of the anchorage assemblies for the purpose of inspecting and examining plant records and certificates; materials used; process of manufacturing, including welding and galvanizing; and to make any tests as may be considered necessary, while the anchorage assembly is being fabricated.

All anchorage assemblies may be subject to an inspection by the Contract Administrator prior to shipment.

2474.09 OWNER PURCHASE OF MATERIAL

2474.09.01 Measurement and Payment

For measurement purposes, a count shall be made of the number of anchorage assemblies supplied and accepted.

Payment at the price specified in the purchasing order shall be for the supply of the anchorage assemblies delivered to the destination on the date and time specified.

The cost of all testing, except that performed by the Owner, shall be included in the price.

Appendix 2474-A, November 2016
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

The designer shall specify the following in the Contract Documents:

- Length, number, and size of the anchor rods. (2474.05.01)
- Fabrication dimensions. (2474.07.01)
- Supply of anchorage assembly. (2474.07.01)

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

Related Ontario Provincial Standard Drawings

OPSD 2218.010	High Mast Lighting Pole Anchorage Assembly Placement
OPSD 2456.011	High Mast Lighting Pole Anchorage Assembly Details