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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for use of Ontario Provincial Standards; therefore, manual holders are cautioned about immediately discarding superseded and cancelled standards.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.

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		
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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



**ONTARIO
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DIVISION 25 - CHEMICALS

CURRENTLY NO SPECIFICATIONS



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MATERIAL SPECIFICATION FOR PERFORMANCE GRADED ASPHALT CEMENT

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APPENDICES

1101-A	Commentary
1101-B	Additional Requirements for Performance Graded Asphalt Cement Further Graded for Traffic Loading Using Multiple Stress Creep Recovery Testing

1101.01	SCOPE
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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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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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APPENDICES

1103-A	Commentary
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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

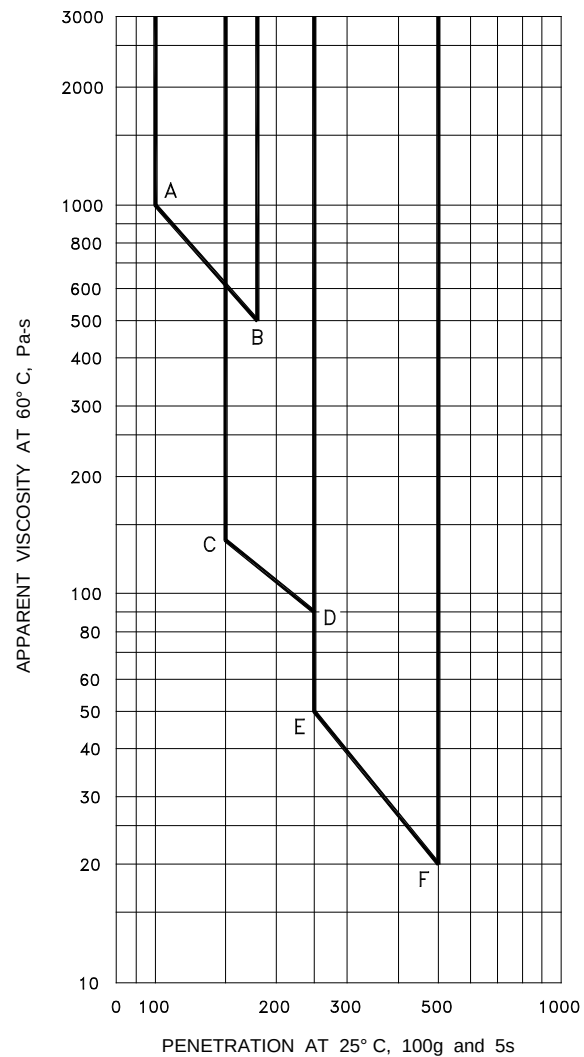
Requirements	Type	Anionic				Cationic				High Float								Test Method
	Grade	RS-1P		RS-2P		CRS-1P		CRS-2P		HFMS-2P(ON)		HF-100SP		HF-150SP		HF-150MP		
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Tests on Emulsion																		
Viscosity, Saybolt Furol Seconds: 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.



MATERIAL SPECIFICATION FOR SC-800 PATCHING MATERIAL

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APPENDICES

1152-A	COMMENTARY
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1152.01	SCOPE
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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
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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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1153.09	OWNER PURCHASE OF MATERIAL - Not Used

APPENDICES

1153-A	Commentary
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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
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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
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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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1203.01 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.

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.

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
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U.S. Military Specifications

MIL-S-8660 C	Silicone Compound
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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	± 3 mm
Overall bearing height	± 3 mm
Machined surface dimensions	± 0.4 mm

Elastomer:

Diameter	a) 0.0 to -1.5 mm for diameters ≤ 500 mm
	b) 0.0 to -2.0 mm for diameters > 500 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 mm $\pm$ 0.25 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
UNSHRINKABLE BACKFILL**

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1359.01	SCOPE
1359.02	REFERENCES
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APPENDICES

1359-A	Commentary
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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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1440-A	Commentary
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1440.01	SCOPE
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This specification covers the requirements for all steel reinforcement used in concrete work.

1440.01.01 Specification Significance and Use

This specification is written as a 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**

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
STEEL BEAM GUIDE RAIL**

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1504.04	DESIGN AND SUBMISSION REQUIREMENTS - Not Used
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1504.08	QUALITY ASSURANCE - Not Used
1504.09	OWNER PURCHASE OF MATERIAL

APPENDICES

1504-A	Commentary
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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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1505.06	EQUIPMENT - Not Used
1505.07	PRODUCTION
1505.08	QUALITY ASSURANCE - Not Used
1505.09	OWNER PURCHASE OF MATERIAL

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1505-A	Commentary
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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.

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

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
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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

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 912.102 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
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1540.01 SCOPE

This specification covers the requirements for highway fence components and hardware.

1540.01.01 Specification Significance and Use

This specification is written as a 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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Appendices are developed for the Owner's use only.

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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

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 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
HEAVY CLASS STEEL AND
SECTIONAL STEEL POLES, BASE MOUNTED**

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2422.08	QUALITY ASSURANCE
2422.09	OWNER PURCHASE OF MATERIAL

APPENDICES

Appendix 2422-A	Commentary
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2422.01	SCOPE
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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.

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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.

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

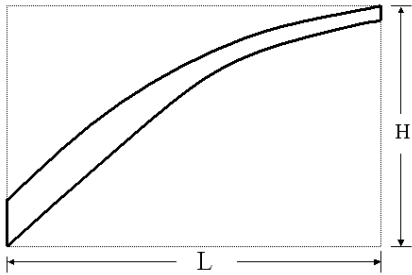
Item of Equipment	Dimensions mm	Projected Area m ²	Weight N
Roadway Lighting Luminaire (Ovuloid)	990 L x 380 H	0.22	107
Roadway Lighting Bracket (Aluminum)	2400 L x 1200 H (tapered)	0.15	112
Double Arm Brackets (Aluminum)	400 L x 42 Dia. (2 per set)	0.04	24
Mast Arm (Aluminum) 	610 L x 250 H (tapered)	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

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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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APPENDICES

2434-A	Commentary
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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

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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
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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
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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

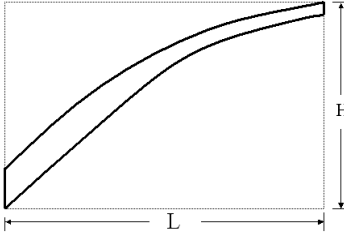
Item of Equipment	Dimensions mm	Projected Area m ²	Weight N
Roadway Lighting Luminaire (Ovuloid)	990 L x 380 H	0.22	107
Roadway Lighting Bracket (Aluminum)	2400 L x 1200 H (tapered)	0.15	112
Double Arm Brackets (Aluminum)	400 L x 42 Dia. (2 per set)	0.04	24
Mast Arm (Aluminum) 	610 L x 250 H (tapered)	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-A	Commentary
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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
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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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2474.01 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

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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