CONSTRUCTION SPECIFICATION FOR CONCRETE PAVEMENT AND CONCRETE BASE

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350.01 SCOPE

This specification covers the requirements for the construction of concrete pavement and concrete base.

350.01.01 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 Contract Documents.

350.01.02 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.

350.02 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 314	Untreated Granular Subbase, Base, Surface, Shoulder and Stockpiling
OPSS 360	Full Depth Repair of Concrete Pavement and Concrete Base
OPSS 364	Partial Depth Repairs in Concrete Pavement
OPSS 369	Sealing or Resealing of Joints and Cracks in Concrete Pavement
OPSS 904	Concrete Structures
OPSS 905	Steel Reinforcement for Concrete
OPSS 914	Waterproofing Bridge Decks with Hot Applied Asphalt Membrane
OPSS 919	Formwork and Falsework

Ontario Provincial Standard Specifications, Material

OPSS 1002	Aggregates - Concrete
OPSS 1302	Water
OPSS 1305	Moisture Vapour Barriers
OPSS 1306	Burlap
OPSS 1308	Joint Filler (Concrete)
OPSS 1315	White Pigmented Curing Compounds for Concrete
OPSS 1350	Concrete - Materials and Production
OPSS 1441	Load Transfer Assemblies
OPSS 1442	Epoxy Coated Steel Reinforcement for Concrete

CSA Standards

CSA A23.1/.2-2019 Concrete Materials and Methods of Concrete Construction/Methods of Test for Concrete

350.03 DEFINITIONS

For the purposes of this specification the following definitions shall apply:

Certificate of Approval for a Waste Management System means as per R.R.O. 1990, Reg. 347: General – Waste Management.

Concrete Pavement means a rigid pavement structure with an exposed concrete surface which may include concrete shoulders.

Concrete Base means a rigid pavement structure which is overlaid with asphaltic concrete, on the same contract, and may include concrete shoulders.

Effluent means liquid that is a direct result of concrete grinding and grooving. Effluent includes any stormwater, or surface drainage that becomes mixed with this material. Effluent is classified as liquid industrial waste Class 146(L).

350.04 DESIGN AND SUBMISSION REQUIREMENTS

350.04.01 Design Requirements

A plan detailing the curing and protection plans shall be submitted. The plan shall describe the method by which in-place minimum or maximum concrete temperatures shall be maintained. No concrete shall be placed unless the plan is approved by the Contract Administrator.

350.04.02 Submission Requirements

Prior to starting the work, documentation shall be submitted, verifying that the Contractor's representative of the placing crew shall be on site and shall have the certification as specified in Contract Documents.

350.04.02.01 Effluent Management

All approvals, releases, and agreements, and conditions that are required for effluent management shall be obtained prior to the commencement of the effluent producing work.

Effluent shall be transported to one of the following receiving sites:

a) A waste disposal site with a Certificate of Approval for a Waste Disposal Site valid for liquid industrial waste Class 146 (L).

b) A waste processing facility with Certificate of Approval for a Waste Disposal Site (Processing) valid for liquid industrial waste Class 146 (L).

A written agreement from the operator of the receiving site or property owner selected to accept the effluent, as well as their Certificate of Approval for a Waste Disposal Site, shall be submitted to the Contract Administrator a minimum of two weeks prior to commencement of the effluent producing work.

A copy of the Certificate of Approval for a Waste Management System shall be submitted to the Contract Administrator prior to the commencement of the effluent producing work.

350.05 MATERIALS

350.05.01 Concrete

Concrete and concrete materials shall be according to OPSS 1350 with the following amendments:

a) The coarse aggregate for concrete pavement and concrete base shall have a combined gradation of nominal maximum size 37.5 mm and 19.0 mm aggregate, and shall be according to OPSS 1002.

b) Concrete shall be according to OPSS 1350, with a minimum specified 28-Day compressive strength of 32 MPa, Class C-2 Exposure.

c) Maximum slag content shall be 25%.

350.05.02 Burlap

Burlap shall be according to OPSS 1306.

350.05.03 Moisture Vapour Barrier for Curing

Moisture vapour barrier for curing shall be according to OPSS 1305.

350.05.04 Curing Compound

White pigmented membrane curing compound for concrete shall be according to OPSS 1315.

350.05.05 Water for Curing

Water for curing shall be according to OPSS 1302.

350.05.06 Tie Bars and Load Transfer Devices

Tie bars shall be according to OPSS 1442 and load transfer devices shall be according to OPSS 1441.

350.05.07 Joint Materials

Expansion joint filler shall be according to OPSS 1308.

Joint sealant material shall be according to OPSS 369.

350.06 EQUIPMENT

350.06.01 Consolidation

Concrete shall be consolidated by means of surface vibrators, internal vibrators, or a combination of both that provide full depth consolidation without segregation.

350.06.02 Hot Poured Rubberized Asphalt Joint Sealing

Hot poured rubberized asphalt joint sealing equipment shall be according to OPSS 914.

350.06.03 Forms

Forms shall be according to OPSS 919.

350.06.04 Automatic Dowel Bar Inserter

Where an automatic dowel bar inserter is used, it shall be capable of placing dowel bars as specified in Contract Documents. The dowel bars shall be inserted to mid-depth of the slab and centred on the transverse joint locations and spaced as shown on the plans. The equipment shall be capable of consolidating the concrete around the dowel bars.

350.06.05 Diamond Grinder

Grinding equipment that causes raveling, aggregate fractures or disturbance to the joints shall not be permitted.

The diamond grinder shall be power-driven, self-propelled equipment specifically designed to grind and texture concrete surfaces. It shall be equipped with a grinding head with at least 50 diamond blades per 300 mm of shaft. The grinding head shall be at least 0.9 m wide. The grinder shall have the capability to adjust the depth, slope, and cross-fall to ensure that concrete is removed to the desired dimensions and uniformly feathered and textured across the width, and length of the repair area.

350.07 CONSTRUCTION

350.07.01 Preparation Work

350.07.01.01 General

Before placing concrete on granular base, the granular immediately ahead of the concrete placing operation shall be wetted down thoroughly. The wetting down shall be carried out without leaving standing water.

350.07.02 Joints

350.07.02.01 General

Type and location(s) of joints shall be as specified in the Contract Documents.

The initial saw cut, for longitudinal and transverse contraction joints, shall be cut as soon as possible, normally within 12 hours of paving operations. Saw cutting operations shall not result in ravelling or other damage to the concrete. The initial cut shall be for one third the depth of the concrete slab.

The joints shall be cleaned and sealed according to OPSS 369.

Dowel bars at the transverse contraction joints shall be placed using load transfer devices or an automatic dowel bar inserter.

350.07.02.02 Load Transfer Devices

Load transfer devices shall be as specified in the Contract Documents.

350.07.02.03 Transverse Construction Joints

Transverse construction joints shall be made at the end of each day's run or when interruptions occur in the concreting operation. Transverse construction joints shall be formed at a contraction or expansion joint, except in exceptional cases of plant breakdown or adverse weather conditions. In these exceptional cases, a construction joint may be formed in the mid slab area subject to the provision that the portion of the slab placed and the portion of the slab to be placed, is not less than 2 m in length. Construction joints in adjacent lanes of pavement shall align with joints in the previously placed lane.

350.07.02.04 Position and Alignment Tolerances

350.07.02.04.01 Dowel Bars

The dowel bars shall be placed within a tolerance of ± 6 mm in the vertical and horizontal planes of the pavement.

The dowel bars shall not be skewed and shall be perpendicular to the face of the joint.

Skewed joints, where applicable, shall be as specified in the Contract Documents.

350.07.02.04.02 Joints

All joints shall be placed within a tolerance of ± 15 mm from the position and alignment of the centre of the dowel bars.

350.07.02.05 Tie Bars

At longitudinal joints, epoxy coated tie bars shall be installed as specified in the Contract Documents. Tie bars shall be inserted so that voids are not created around the bar. Tie bars shall not be placed within 600 mm of a transverse joint.

350.07.02.06 Dowel Bars at Transverse Joints

At all expansion and contraction joints, dowel bars shall be installed as specified in the Contract Documents. The location of dowel bars shall be marked to permit precise joint forming or cutting operations directly over the centre of the dowel bars.

Automatic dowel bars, where used, shall be as specified in the Contract Documents.

350.07.02.07 Protection of Tie Bars and Dowel Bars

Protection of dowel bars shall be according to OPSS 905.

Bars with coating damage greater than 5% of the surface area of each bar shall not be used.

For bars with coating damage of 1% or less of their surface area, all damaged areas, including ends, of the bar coating shall be repaired.

350.07.03 Concrete Placement

Concrete shall be placed at or near its permanent location in such a manner to avoid segregation of the materials. Any excess concrete beyond the pavement edge shall be removed immediately.

Transverse joint load transfer devices shall be laid out and material in place at a minimum of 100 m in advance of the paving operations.

When an interruption in placing concrete of more than 45 minutes occurs, a transverse construction joint shall be formed.

350.07.03.01 Consolidating

Concrete shall be thoroughly consolidated against and along the face of all forms and into the face of previously placed concrete.

For fixed-form placement, hand-held vibrators shall be used to supplement consolidation adjacent and along the full length of the form. They shall also be inserted at regularly spaced intervals along both sides of dowel assemblies. Vibrators shall never be operated longer than 15 seconds in any one location.

For slip-form pavers, the concrete shall be consolidated by vibrators of sufficient number, spacing, and frequency to provide uniform consolidation to the entire pavement width and depth. The vibrators shall not operate while the paver is stopped.

For all methods, vibrators shall not come in contact with the subgrade, subbase, forms, tie bars or dowel assemblies.

350.07.03.02 Finishing

Finishing of the concrete surface shall take place while the concrete is sufficiently plastic to achieve the desired grades, elevations, and texture, according to CSA A23.1.

The surface of the concrete shall be uniform, dense, free from undulations and projections, struck off true to grade and cross-section, and finished with a magnesium or aluminum float.

Care shall be taken to avoid over finishing or working more mortar to the surface than is required.

Excessive fines and water shall not be drawn to the surface.

Surface evaporation retardants shall not be used as an aid for finishing concrete.

The application of water, cement, or combination of both to the concrete surface shall not be permitted as a finishing aid.

Localized defects shall be repaired using concrete.

350.07.03.03 Texturing of Surface

After all finishing operations are completed on concrete pavements, and before initial curing and protection of the concrete, the plastic surface of the concrete shall receive an initial and final texturing as specified in the Contract Documents.

The surface shall be free in all cases from displaced aggregate particles and local projections.

The Contract Administrator shall immediately be notified in writing if any of the defects or conditions listed in the Acceptance of Concrete Surface Texturing subsection are present in the work and shall include the extent of the defects and an explanation of the cause. A proposal for the remedial work for the above defects and conditions shall be submitted to the Contract Administrator for review. The repairs shall not proceed until approval of the proposal has been received from the Contract Administrator. Repairs shall be at no additional cost to the Owner.

350.07.03.04 Surface Tolerance

The surface of the concrete is to be such that when tested with a 3 m long straightedge placed in any location and direction, including the edge of pavement, except across the crown or drainage gutters, there shall not be a gap greater than 3 mm between the bottom of the straightedge and the surface of the pavement.

Diamond grinding shall be required to ensure the concrete surface meets these requirements.

350.07.03.05 Diamond Grinding

The pavement shall be ground in a longitudinal direction, in the normal traffic direction.

The diamond ground surface shall be free of corrugations due to out-of-round wheels on grinding equipment or improper operation of the cutting head, and depressions due to improper starting and stopping during the grinding operation. There shall be no fractured aggregate at the ground surface.

The maximum combined depth of diamond grinding to correct deficiencies, including all grinding passes, shall be 10 mm.
The diamond grinding process shall maintain the existing longitudinal profile and maintain positive surface drainage.

The surface finish shall be closely monitored and shall immediately take necessary control or corrective action as work progresses.

350.07.04 Curing

350.07.04.01 General

Curing shall be according to OPSS 904 with the following exceptions:

Curing shall be applied to all exposed surfaces as soon after the texturizing operation as can be achieved without damaging the surface.

As soon as forms are removed, the sides of the exposed concrete faces shall be sprayed with the white pigmented curing compound at the specified application rate according to the manufacturers specifications or as specified in the Contract Documents. Curing compound that is applied to joint faces shall be removed prior to receiving sealant.

350.07.05 Joint Sealing

Joint sealing shall be according to OPSS 369.

350.07.06 Miscellaneous Protection

350.07.06.01 Rain

Concrete shall not be placed in the rain. Necessary precautions shall be taken to protect plastic concrete from rain.

350.07.06.02 Traffic

Traffic, other than foot traffic, rubber-tired sawing equipment, and rubber-tired side wheels of form mounted placing and finishing equipment necessary to construct adjacent lanes, shall not be permitted on the concrete until it has attained 20 MPa.

For early opening determination, samples required for early strength determination shall be taken and tested. A minimum of one set of two cylinders per 500 m length of paving shall be required. Samples shall remain on site until time of testing.

The concrete pavement shall always be protected from damage to the surface when steel-tracked equipment is used.

350.07.06.03 Shoulders

Shouldering operations may commence once the adjacent concrete has attained 20 MPa. Completion of the shoulders shall be according to OPSS 314.

350.07.06.04 Cold and Hot Weather

The placing and protection for cold weather concrete shall be according to OPSS 904.

Where the ambient air temperature exceeds 28 ^{o}C and the concrete temperature exceeds 25 ^{o}C, the discharge time shall be reduced to a maximum of one hour after the introduction of mixing water. Concrete shall not be placed in ambient air temperatures exceeding 35 ^{o}C.

350.07.06.04.01 Insulation Removal for Saw Cutting

When the concrete pavement or concrete base requires protection by insulation, no more than 25 linear metres of concrete pavement or concrete base shall be exposed for saw cutting operations at any one time. In no case shall any concrete pavement or concrete base be exposed for more than one hour during saw cutting.

350.07.07 Concrete Base

350.07.07.01 General

The work required for concrete base includes the work required for concrete pavement except as modified by this subsection.

350.07.07.02 Joints

A final reservoir cut is not required at the joints.

350.07.07.03 Texturing of Surface

Texturing of the surface is not required.

350.07.07.04 Joint Sealing

The sealing of joints in concrete base is not required.

350.07.07.05 Surface Tolerance

The provisions of Surface Tolerance clause of this specification apply, except that the tolerance is increased to 6 mm.

350.07.08 Management of Effluent from Concrete Grinding and Grooving Operations

350.07.08.01 General

Effluent shall be captured and managed as specified in the Contract Documents.

These requirements do not supersede the obligations imposed by the Contractor's Certificate of Approval for a Waste Management System.

For each shipment of effluent from the construction area to the certified receiving site:

a) The carrier shall have a Certificate of Approval for a Waste Management System valid for liquid industrial waste Class 146 (L), and shall comply with the Carrier Information and Certificate of Approval clauses; and

b) The shipment shall be manifested as specified in the Manifesting clause.

For materials resulting from concrete removal, and materials resulting from concrete repair/construction, appropriate measures including providing such protection system or systems shall be taken to ensure that such materials do not fall into or enter the waterbody or, cause damage to any portion of the pavement structure not designated for removal.

For concrete saw cutting, grooving, or grinding, the appropriate measures including providing such protection system or systems shall be taken to contain any removed material until it is disposed of; and minimize the escape of dust such that no visible dust reaches the waterbody, adjacent wetlands, or property outside the right-of-way limits.
At the completion of the work, a copy of a release signed by the same receiving site operator or property owner shall be submitted to the Contract Administrator.

350.07.08.02 Carrier Information

The carrier shall have a Certificate of Approval for a Waste Management System valid for liquid waste Class 146 (L).

Responsibilities of certified carriers shall include, but not be limited to, the following:

a) Transportation of waste materials produced by the work according to the Certificate of Approval;

b) Responsible for the waste materials including, but not restricted to, manifesting of liquid industrial waste.

350.07.08.03 Certificate of Approval

The Certificate of Approval for a Waste Management System and the receiver's Certificate of Approval for a Waste Disposal Site shall be provided and be valid for the following:

a) The entire period of the work;

b) The entire area within the limits of the work and the entire haul route; and

c) The equipment to be used; and

d) Waste classification 146 (L).

350.07.08.04 Manifesting

A Regulation 347 Form 1 manifest for "Part A" shall be presented on behalf of the carrier to the Contract Administrator.

The Contract Administrator shall be notified a minimum of two weeks prior to the first shipment requiring manifesting, and a minimum of 24 hours' notice prior to each subsequent shipment requiring manifesting.

350.08 QUALITY ASSURANCE

350.08.01 Sampling and Testing

350.08.01.01 Criteria for Determining Unacceptable Concrete

If the tests on cylinders do not show a nominal minimum 28-day compressive strength of 32 MPa, the area represented by the cylinders shall be removed and replaced.

350.08.01.02 Compressive Strength

Testing of compressive strength shall be according to OPSS 1350.

350.08.01.03 Slump and Air Content

Field sampling and testing of plastic concrete for conformance to slump and air content requirements shall be the responsibility of Contract Administrator, as detailed below.

Testing of slump and air content shall be according to OPSS 1350.

The frequency of slump and air content testing shall be according to Table 1.

350.08.01.04 Removal of Unacceptable Concrete

The frequency of compressive strength testing shall be for each load tested according to Table 1.

If results for compressive strength of concrete pavement or concrete base dictates removal and replacement cores shall be taken to establish the extent of the deficient area.

The area to be removed shall be bounded by the nearest contraction joint and longitudinal joint or concrete pavement or concrete base edge outside the deficient area so that there shall be no additional joints.

350.08.01.05 Cracking in Concrete Pavement

All cracking, in excess of one third the depth of the slab thickness shall be repaired as a full depth repair according to OPSS 360.

Cracks less than one-third the thickness of the slab shall be repaired according to OPSS 364.

350.09 MEASUREMENT FOR PAYMENT

350.09.01 Actual Measurement

350.09.01.01 Concrete Pavement or Concrete Base

Measurement shall be the surface area of concrete pavement or concrete base placed in square metres.

350.09.02 Plan Quantity Measurement

350.09.02.01 Concrete Pavement or Concrete Base

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

350.10 BASIS OF PAYMENT

350.10.01 Concrete Pavement - Item
Concrete Base - Item

Payment at the contract price for the above tender items shall be full compensation for all labour, Equipment and Material to do the work.

350.10.01.02 Additional Coring and Testing

Payment shall not be made for additional coring and testing to determine the limits of slab removal for unacceptable concrete.

Table 1
Sampling and Testing - Minimum Frequencies

Tests	**Frequency**
Air Content	A minimum of three loads or until satisfactory control is established. Then 1 random test per 5 truck loads
Slump for Fixed Form Paving	A minimum of three loads or until satisfactory control is established. Then 1 random test per 5 truck loads
Notes: Test Procedures shall be according to CSA A23.2 Satisfactory control is considered to have been established when tests on three consecutive truck loads or batches of concrete are within specification requirements.	

Appendix 350-A, November 2021
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:

- Certification such as Municipal Exterior Flatwork Certification, or ACI Flatwork Certification, or approved equivalent. Where ACI Flatwork Certification means the certification issued by the American Concrete Institute, after demonstrating knowledge and the ability to place, consolidate, finish, edge, joint, cure and protect concrete flatwork. And where Municipal Exterior Flatwork Certification means the certification issued by Ready Mixed Concrete Association of Ontario (RMCAO), after demonstrating knowledge to place, consolidate, finish, edge, joint, cure and protect concrete flatwork. (350.04)

- Dowel bars. (350.06.04)

- Load transfer devices. (350.07.02.02)

- When skewed joints are to be used, consider OPSD 552.050. (350.07.02.04.01)

- Epoxy coated tie bars. (350.07.02.05)

- When an automatic dowel bar inserter is used, the Contractor shall be required to remove a 2 m x full paver width section of concrete pavement or concrete base within the first days paving. Additional sections will be required until the Contractor's operations conform to the specification. The joint to be removed will be selected by the Contract Administrator. The section will be inspected by the Contract Administrator to ensure that the placement and alignment of the dowel bars meet requirements. The section removed shall be repaired according to OPSS 360. (350.07.02.06)

- Initial texturing may be performed with a longitudinal burlap drag to produce a uniform textured surface. Burlap shall be kept in a clean and damp condition, free from encrusted mortar. (350.07.03.03)

- Final texturing options include (but not limited to): Grooving, Tining, Broom Finish, or Burlap Finish. (350.07.03.03)

- When transverse tining is specified for final texturing it shall be achieved using equipment manufactured to produce transverse tining on maximum 16 mm $\pm$ 3 mm centres with a tining depth of 4 mm $\pm$ 1 mm. Tining shall extend to within 75 mm $\pm$ 15 mm of the pavement edge. Tining for small or irregular areas may be done by hand methods. (350.07.03.03)

- When longitudinal grooving is specified as final texture, the pavement surface shall be grooved with a grooving machine longitudinally at are as specified in Contract Documents or as directed by the Contract Administrator. Longitudinally grooved areas shall be straight and run parallel to the longitudinal axis of the pavement, begin and end at lines radial to the pavement center line and shall be centered within the lane width, unless otherwise specified in the Contract Documents. (350.07.03.03)

- The pavement shall be grooved to the full width of the lane under construction within the station-to-station limits established by the Contractor during each shift. (350.07.03.03)

- Grooves shall be cut 2.5 mm in width, with a tolerance of plus 1.5 mm, and between 3.0 and 6.0 mm in depth. Over inductive loop detectors, grooves shall be cut between 1.5 and 3.0 mm in depth. Grooves shall have a centre-to-centre spacing of 19 mm with a tolerance of plus or minus 2.5 mm. Grooves shall

be cut to within 150 mm and no closer than 50 mm of longitudinal joints. (350.07.03.03)

- Grooving that results in ravelling, aggregate fractures, spalls, or disturbance to the transverse or longitudinal joints, shall not be permitted and shall be controlled or corrected immediately as the work progresses. (350.07.03.03)

- If during the course of the work, a single grooving blade on any individual grooving machine becomes incapable of cutting a groove within the specified tolerances, work will be permitted to continue for the remainder of the work shift and the Contractor will not be required to otherwise recut the groove. Should two or more grooving blades on any individual grooving machine become incapable of cutting grooves within the specified tolerances, the Contractor shall cease operations with this machine until repairs are effected. (350.07.03.03)

- Specified application rate of curing compound (350.07.04.01)

- Effluent from concrete grinding and grooving operations (350.07.08.01)

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

Related Ontario Provincial Standard Drawings

No information provided here.