



**CONSTRUCTION SPECIFICATION FOR  
PERVIOUS CONCRETE PAVEMENT  
FOR LOW-VOLUME TRAFFIC APPLICATIONS**

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**356.01 SCOPE**

This specification covers the requirements for the construction of pervious concrete pavement for low-volume traffic applications. This specification includes requirements for a trial section and special equipment and testing requirements.

**356.01.01 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.

## **356.01.02 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.

## **356.02 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 919 Formwork and Falsework

### **Ontario Provincial Standard Specifications, Material**

OPSS 1002 Aggregates - Concrete  
OPSS 1004 Aggregates - Miscellaneous  
OPSS 1305 Moisture Vapour Barriers  
OPSS 1308 Joint Filler in Concrete  
OPSS 1350 Concrete - Materials and Production

### **Ontario Ministry of Transportation Publications**

MTO Laboratory Testing Manual:

LS-443 Method of Test for the Determination of the Void Content of Pervious Concrete Pavement Cores

### **CSA Standards**

A23.2-3C Making and Curing Concrete Compression and Flexural Test Specimens \*  
A23.2-9C Compressive Strength of Cylindrical Concrete Specimens \*  
A23.2-14C Obtaining and Testing Drilled Cores for Compressive Strength Testing \*  
\* [Part of A23.1-09/A23.2-09 - Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete]

## ASTM International

C 1116/C 1116M-09	Standard Specification for Fibre Reinforced Concrete
C 1688/C 1688M-08	Standard Test Method for Density and Void Content of Freshly Mixed Pervious Concrete

### 356.03 DEFINITIONS

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

**Cold Weather** means those conditions when the air temperature is at or below 10 °C. It is also considered to exist when the air temperature is at or is likely to fall below 10 °C within 96 hours after pervious concrete placement. Temperature refers to shade temperature.

**Construction Joint** means the surface where two successive placements of pervious concrete meet or where new pervious concrete is placed against existing concrete across which it is desirable to achieve bond between the two concrete placements.

**Control Joint** means a joint that is created by scoring or sawcutting to prevent uncontrolled cracking due to drying or thermal shrinkage.

**Isolation Joint** means a joint that allows relative movement to take place between adjoining parts of a structure or pavement to prevent damage to the concrete.

**Pervious Concrete Pavement** means a rigid pavement structure that allows water flow into and through the pavement structure.

**Surface Ravelling** means the loss of coarse aggregate from the surface of the pervious concrete pavement.

### 356.04 DESIGN AND SUBMISSION REQUIREMENTS

#### 356.04.01 Submission Requirements

##### 356.04.01.01 Mix Design

The concrete mix design shall be submitted to the Contract Administrator according to OPSS 1350, with the following exceptions:

- a) The mix design shall be submitted before the trial section is placed.
- b) The air void system parameters of the hardened concrete shall not be required.
- c) Pervious concrete mix shall meet the material requirements of this specification.
- d) Strength results are not required with the mix design submission.
- e) Mix design supporting documentation shall include a certificate from the National Ready Mixed Concrete Association (NRMCA) verifying that at least one member of the Contractor's team, who is responsible for the supervision of the placement of the pervious concrete, is certified by the NRMCA Pervious Concrete Contractor Certification program.

**356.04.01.02 Trial Section**

Three Business Days prior to the start of the trial section, the following information shall be submitted to the Contract Administrator:

- a) Date, time, and location of the trial section.
- b) Method and equipment to be used to place and compact the pervious concrete pavement.
- c) Name of the NRMCA certified staff to be present and responsible for supervision of the placement.

**356.05 MATERIALS**

**356.05.01 Forms**

Forms, if used, shall be according to OPSS 919. Form materials shall extend the full depth of the pavement. Forms shall be of sufficient strength and stability to support mechanical equipment without deformation. Spacers, if used, shall be made of wood and shall be the same width as the formwork.

**356.05.02 Isolation Joint Material**

Isolation joint material shall be according to OPSS 1308.

**356.05.03 Moisture Vapour Barrier**

Moisture vapour barrier shall be according to OPSS 1305.

**356.05.04 Pervious Concrete**

The pervious concrete shall have a minimum 28-Day core compressive strength of 15 MPa, when tested according to CSA A23.2-9C and this specification.

Pervious concrete shall be according to OPSS 1350 with the following exceptions:

- a) Pervious concrete plastic density shall be measured according to ASTM C 1688 and shall be within  $\pm 80 \text{ kg/m}^3$  of the plastic density of the trial section.
- b) The pervious concrete in the hardened state shall have a void content between 15 to 25%, when tested according to LS-443.
- c) Coarse and fine aggregate are not required to meet the gradation requirements of OPSS 1002.
- d) A viscosity modifying admixture (VMA) may be used. The trial section shall be used to observe and test the compatibility of the VMA with other admixtures and cementing materials.
- e) Use of water reducer is not required.
- f) Superplasticizer may be used.
- g) Slump requirements shall not apply.
- h) The testing requirements of OPSS 1350 for plastic and hardened air void testing shall not apply. The paste shall be adequately air entrained to provide freeze thaw resistance, with air entraining admixture dosage based on the dosage level typically used for mix designs with similar water to cement ratio.

- i) The coarse aggregate shall have a maximum nominal aggregate size less than or equal to 13.2 mm.
- j) Type III synthetic fibres according to ASTM C 1116 may be used. If used, synthetic fibres shall be added at the plant.
- k) In addition, for municipal-oriented Contracts, the Material Sampling and Testing subsection requirements shall not apply, with the exception of the testing of water, admixtures, and cementing materials.

**356.06 EQUIPMENT**

**356.06.01 General**

Equipment made of aluminium material shall not come in contact with the plastic pervious concrete.

**356.06.02 Placing Equipment**

Equipment used for placing the pervious concrete shall be one of the following:

- a) A slipform paver.
- b) A laser screed.
- c) A razorback steel truss screed, with vibratory or Clary screed.
- d) A vibratory steel screed, or steel roller screed with integral internal vibration.

**356.06.03 Compaction Equipment**

**356.06.03.01 Roller Compaction Equipment**

Rolling compaction shall be achieved using a steel pipe roller that spans the width of the section to be placed and exerts sufficient pressure to provide the necessary compaction.

**356.06.03.02 Hand Tampers**

Hand compaction equipment shall have a maximum width of 300 mm.

**356.06.04 Edging Tools**

Edging tools shall have a 6 mm radius.

**356.06.05 Straight Edges**

Straight edges shall be 3 m in length and made of metal.

**356.07 CONSTRUCTION**

**356.07.01 General**

The Contract Administrator shall be notified in writing of the intent to place the pervious concrete pavement 3 Business Days prior to the start of the placing operation.

### **356.07.02                      Operational Constraints**

Placement of pervious concrete during cold weather is not permitted.

Pervious concrete shall not be placed in the rain. All necessary precautions shall be taken to protect placed plastic pervious concrete from rainfall.

Pervious concrete shall not be placed when the ambient air temperature is above 28 °C or likely to rise above 28 °C, throughout the duration of the placing operation.

Pervious concrete shall not be placed against any material that is at a temperature above 35 °C, or against any material that is at a temperature below 5 °C.

Traffic, other than foot traffic, shall not be permitted on the pervious concrete pavement until the pervious concrete has attained a core compressive strength of 15 MPa.

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

Construction equipment and trucks heavier than 20,000 kg shall not be permitted on the pervious concrete pavement at any time.

When a drainage system is part of the design, it shall be operational prior to the placement of the pervious concrete.

### **356.07.03                      Trial Section**

The trial section shall be constructed, in the presence of the Contract Administrator, to demonstrate the Contractor's ability to successfully produce, place, and finish pervious concrete pavement. The trial section shall be placed a minimum of 4 weeks prior to pervious concrete being placed in the work. The Contract Administrator shall be notified of the trial placement date 3 Business Days in advance.

The trial slab 10 metres long shall be constructed, at the paving thickness specified in the Contract Documents. The width of the trial slab shall be the width of the widest section that is intended to be placed at one time. The location of the trial section shall be proposed to the Contract Administrator for approval. To simulate the effect of travel time, the trial section location shall not be farther from a ready mix plant than the job site. In the event that the trial section location is closer to the plant than the job site, the discharge from the ready mix truck shall be delayed sufficiently to match the estimated travel time.

The trial section shall be constructed with pervious concrete of the same materials and mix design; supplied by the same ready mix plant; and placed, consolidated, and cured using the materials, equipment, and personnel, including NRMCA-certified supervisors that the Contractor intends to use in the work.

All Aspects of coring and conducting tests shall be undertaken on pervious concrete pavement to determine thickness, compressive strength, and void content.

Plastic density and void content shall be determined according to ASTM C 1688 and the test results shall be submitted to the Contract Administrator.

Thickness, compressive strength, and hardened density and void content, shall be determined by dividing the trial section into 6 sections of equal size and shape, removing one 100 mm diameter full-depth core from each of the 6 sections according to CSA A23.2-14C, and testing the cores as follows:

- a) All cores shall be tested for thickness according to the Acceptance of Thickness subsection.
- b) Three cores shall be tested for hardened density and void content according to LS-443.

- c) The remaining three cores shall be tested for 28-Day compressive strength according to CSA A23.2-9C and this specification.

Test results shall be submitted to the Contract Administrator to determine acceptability of the trial section according to the Table 1. Once acceptability of the trial section is confirmed in writing by the Contract Administrator, placement of pervious concrete may commence. If the trial section is not accepted, another trial section shall be constructed. Unacceptable trial sections in the work shall be removed.

Placement in the work can proceed early if all requirements are met, including meeting the specified core compressive strength.

#### **356.07.04                      Placing**

A person certified according to the NRMCA Pervious Concrete Contractor Certification program shall be responsible for the supervision of the placement of the pervious concrete.

Before placing pervious concrete on granular base, the granular immediately ahead of the pervious concrete paving operation shall be wetted down thoroughly without leaving standing water.

The granular base material shall not be disturbed or displaced by any equipment used for the placing operations.

During placement, pervious concrete shall be uniform in consistency with no visible signs of segregation and free of lumps.

Placement shall be continuous.

Pervious concrete shall be deposited within 1.5 m of its final position.

Sufficient material shall be in front of the placement equipment to ensure there are no low spots.

Discharge of individual loads of pervious concrete shall be completed within 90 minutes of the introduction of mix water to the cement. If there is an interruption in placement, the pervious concrete shall be covered with a moisture vapour barrier. When an interruption of more than 20 minutes occurs, a construction joint shall be made.

#### **356.07.05                      Compaction**

Following placement and strike-off, pervious concrete shall be compacted. This compaction process may be done with or without the use of spacers. Spacers, if used, shall be removed after strike-off and before compaction.

The concrete shall be compacted to the level of the top of the forms or to the final elevation, depending on the equipment used for placement, using a steel roller. Longitudinal rolling shall be required, followed immediately by rolling in the transverse direction, if required to remove surface indentation or other surface irregularities. Care shall be taken during compaction that sufficient compactive force is applied, without excessively working or consolidating the concrete surface such that the void structure of the pervious concrete is closed.

Hand tampers shall be used to compact the concrete along the slab edges immediately adjacent to the forms. After placement and compaction, no further finishing shall be performed on the concrete and no material shall be applied to the concrete.

Finishing and edging shall begin as soon as the pervious concrete is discharged from the truck.

### **356.07.06                      Joints**

Control joints shall not be required.

A construction joint should be installed at the end of the day's production or when an interruption of more than 20 minutes occurs in the concrete paving operation.

Isolation joints shall be used when abutting appurtenances and fixed vertical structures, including light pole bases and building foundations. Isolation joint material shall be according to this specification.

Edging and additional compaction with hand tamping tools shall be performed along all form lines and along all isolation joints and construction joints to reduce potential for ravelling under traffic.

### **356.07.07                      Curing**

A moisture vapour barrier shall be placed on the surface of the pervious concrete immediately after compacting the pervious concrete surface, within 2 to 4 m of the compacting operation. Air flow in the space between the moisture vapour barrier and the concrete surface shall be prevented. The moisture vapour barrier strips shall overlap 150 mm and shall be held in place at the edges and laps to prevent displacement, without marring the surface of the concrete. Curing shall continue for a minimum period of 7 Days.

### **356.07.08                      Surface Appearance**

The finished pervious concrete pavement surface shall have a uniform open texture and shall, over a 100 m<sup>2</sup> section, be free of:

- a) a single surface appearance deficiency exceeding 1 m<sup>2</sup>, or
- b) the combined area of multiple surface appearance deficiencies exceeding 2 m<sup>2</sup>.

Surface appearance deficiencies include, but are not limited to, the following:

- a) Tears.
- b) Plastic shrinkage cracking.
- c) Streaking.
- d) Accumulation of paste.
- e) Contamination by tracking, spilling, or placing of mud or other contaminants onto the pavement.
- f) Presence of closed surface.

Surface appearance shall be assessed by a visual survey.

### **356.07.09                      Surface Tolerance**

Except across the crown or drainage gutters, the surface of the pervious concrete pavement shall be such that when tested with a 3 m long straight edge placed in any location and direction, including the edge of pavement and joints, there shall not be a gap greater than 10 mm between the bottom of the straight edge and the surface profile of the pervious concrete pavement.



### **356.07.10 Surface Ravelling**

The surface of the pervious concrete pavement shall not exhibit any surface ravelling based on a visual review.

### **356.07.11 Sampling and Testing**

#### **356.07.11.01 Plastic Pervious Concrete**

Carry out all aspects of sampling and testing of the plastic pervious concrete.

Quality control testing shall consist of plastic density and void content testing. Plastic density and void content shall be measured according to ASTM C 1688. The plastic density shall be within 80 kg/m<sup>3</sup> of the plastic density of the trial section. Quality control testing shall be performed on each load of pervious concrete.

#### **356.07.11.02 Hardened Pervious Concrete**

##### **356.07.11.02.01 General**

After a minimum of 8 Days and a maximum of 10 Days, two sets of three 100 mm diameter cores per subplot shall be taken. The locations for the two sets of cores shall be randomly selected by the Contract Administrator. Each set shall be taken within a 1 m<sup>2</sup> area in each location. No core shall be taken within 250 mm of any joint or edge of slab. Cores shall be drilled through the complete depth of pervious concrete pavement perpendicular to the surface of the slab. Cores shall be drilled according CSA A23.2-14C.

The cores shall be delivered to the quality assurance (QA) laboratory designated by the Owner in the Contract Documents for testing. The cores shall be stored at a temperature of 23 °C ± 2 °C in a moist condition, according to the laboratory curing requirements of CSA A23.2-3C, until time of testing.

The cores shall be tested for:

- a) Thickness according to the Acceptance of Thickness clause.
- b) Hardened void content and density according to LS-443.
- c) Compressive strength according to CSA A23.2-9C except that the load shall be applied until complete failure of the specimen.

##### **356.07.11.02.02 Lot Size**

A lot shall consist of the total quantity of pervious concrete pavement of the same specified thickness on the Contract. Each lot shall be divided into 500 m<sup>2</sup> sublots or a minimum of three sublots. If the quantity of pervious concrete placed on one day is less than 500 m<sup>2</sup>, it shall be considered a subplot.

##### **356.07.11.02.03 Filling of Core Holes**

Each core hole shall be filled immediately after coring with pervious concrete. When pervious concrete is not available, 13.2 mm clear stone may be used to meet the requirements of OPSS 1004 to fill the core hole to 35 mm from the concrete pavement surface and cover with hydraulic cement based concrete patching material. The patching material shall be mixed, handled, and cured according to the manufacturer's instructions. Immediately before filling, the inside surface of each core shall be cleaned by nylon brushing. The patch shall be finished flush with the surface of the surrounding pervious concrete pavement. All excess material shall be removed from the surface of the pervious concrete pavement.

#### **356.07.11.02.04 Identification of Cores**

Each core shall be legibly labelled immediately after its removal from the slab. The core shall be placed into a sample bag and sealed with a tag provided by the Contract Administrator. The core identification numbers shall be specified by the Contract Administrator.

#### **356.07.11.02.05 Transportation of Cores**

Transport cores in a safe manner that avoids damage to the cores. The cores shall be delivered to the laboratory designated by the Owner. The cores shall be delivered on the same day they are obtained. The cores shall be kept at a temperature above 5 °C and protected from moisture loss during transportation.

#### **356.07.12 Management of Excess Material**

Management of excess material shall be according to the Contract Documents.

### **356.08 QUALITY ASSURANCE**

#### **356.08.01 General**

Acceptance shall be based on a visual inspection and QA testing of the completed work as outlined below. Pervious concrete pavement deemed unacceptable shall be repaired according to Table 2.

#### **356.08.02 Acceptance Based on Visual Inspection**

A visual inspection of the pervious concrete pavement surface shall be conducted by the Contract Administrator to determine if any of the following defects are present:

- a) Surface appearance not meeting the requirements of the Surface Appearance subsection.
- b) Surface tolerance not meeting the requirement of the Surface Tolerance subsection.
- c) Slight, moderate, or severe surface ravelling.

Slight surface ravelling is defined as the loss of the top layer of coarse aggregate in less than 1% of the surface area of the lot. Moderate surface ravelling is defined as the loss of the top layer of coarse aggregate in 1 to 10% of the surface area of the lot. Severe surface ravelling is defined as the loss of the top layer of coarse aggregate in more than 10% of the surface area of the lot or the loss of more than one layer of coarse aggregate, exceeding a depth of 26 mm, in any area of the lot.

Visual inspection for ravelling shall be carried out prior to opening to traffic, at the completion of the Contract and at the Warranty Period inspection.

Pervious concrete pavement not meeting surface appearance or surface tolerance requirements shall be deemed unacceptable.

Pervious concrete pavement sublots with slight ravelling shall be accepted. Pervious concrete pavement sublots with moderate surface ravelling or severe surface ravelling shall be deemed unacceptable.

#### **356.08.03 Acceptance for Thickness**

All cores shall be measured for thickness. Untrimmed hardened core samples shall be used to determine placement thickness. For each core, 4 length measurements shall be taken, rounded to the nearest millimetre. The measurements shall be taken at the ends of perpendicular diameters. The thickness of each subplot shall be based on the average length of all cores within the subplot.

Sublots with an average core thickness of more than 6 mm less than the specified thickness or with an individual core thickness of more than 13 mm less than the specified thickness shall be deemed unacceptable.

**356.08.04                      Acceptance for Void Content and Density**

For each subplot, one set of three 100 mm diameter cores shall be measured for void content and density according to LS-443.

Sublots with an average void content less than 15% or more than 25% and any individual void content in excess of 35% shall be deemed unacceptable.

**356.08.05                      Acceptance for Core Compressive Strength**

For each subplot, the second set of three 100 mm diameter cores shall be measured for core compressive strength according to CSA A23.2-9C and this specification.

Sublots with an average core compressive strength less than 15 MPa at 28 Days or an individual core compressive strength less than 11 MPa at 28 Days shall be deemed unacceptable.

**356.09                              MEASUREMENT FOR PAYMENT**

**356.09.01                      Actual Measurement**

**356.09.01.01                  Pervious Concrete Pavement**

Measurement of pervious concrete pavement shall be by surface area in square metres to the nearest 0.1 m<sup>2</sup> of pervious concrete pavement placed.

**356.10                              BASIS OF PAYMENT**

**356.10.01                      Pervious Concrete Pavement - Item**

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work, subject to the payment adjustment specified in Table 2.

The following shall be carried out at no extra cost to the Owner:

- a) Additional trial sections.
- b) Repairs to pervious concrete pavement deemed unacceptable.

**TABLE 1**  
**Pervious Concrete Pavement Trial Section Acceptance Requirements**

Criteria	Acceptance Requirement
Surface Appearance, m <sup>2</sup> per 100 m <sup>2</sup>	No single irregularity ≥ 1
	No combined multiple irregularities ≥ 2
Surface Tolerance, mm gap	≤ 10
Surface Ravelling Severity (Note 1)	None or Slight
Thickness, mm less than specified thickness	Single core not more than 13
	Average of 3 cores not more than 6
Thickness, mm more than specified thickness	Single core < 20
28-Day Core Compressive Strength, MPa	≥ 15
Void Content, %	20 ± 5
Note: 1. Surface ravelling severity definitions according to the Acceptance Based on Visual Inspection subsection.	

**TABLE 2**  
**Repairs to Unacceptable Pervious Concrete Pavement**

Criteria	Repair Requirement	Repair
Surface Tolerance, mm gap	> 10	Submit a proposal for remedial work to the Contract Administrator for approval or remove pervious concrete pavement to full depth as directed by the Contract Administrator and replace with acceptable pervious concrete pavement.
Surface Ravelling Severity (Note 1)	Slight	None.
	Moderate	Sublot represented shall be assessed a payment reduction of 10%.
	Severe	Remove pervious concrete pavement to full depth in the sublot represented and replace with acceptable pervious concrete.
Surface Appearance, m <sup>2</sup> per 100 m <sup>2</sup>	Single irregularity $\geq$ 1 Combined multiple irregularities $\geq$ 2	Remove pervious concrete pavement to full depth in the sublot represented and replace with acceptable pervious concrete.
Thickness, mm less than specified thickness	Single core > 13 Sublot > 6	
28-Day Core Compressive Strength, MPa	Single core < 11 Sublot < 15	
Void Content, %	Single core > 35 Sublot < 15 or > 25	
<p>Note:</p> <p>1. Surface ravelling severity definitions according to the Acceptance Based on Visual Inspection subsection.</p>		

**Appendix 356-A, November 2018  
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**

Pervious concrete pavement is suitable for low-traffic applications, including parking lots, boulevards, and walkways.

The designer should specify the following in the Contract Documents:

- Thickness of pervious concrete pavement. (356.07.03)
- QA laboratory. (356.07.11.02.05)

Pervious concrete pavement is a part of a site-specific stormwater management system. Pervious concrete pavement can reduce the impact of stormwater by reducing runoff volumes and decreasing and delaying peak flows.

The pavement structure design should follow the guidelines of the StreetPave software distributed by the American Concrete Pavement Association or equivalent.

The designer should be aware pervious concrete pavement requires enhanced maintenance processes to ensure long-term performance.

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.