

**Construction Specification for
Porous Asphalt****Table of Contents**

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TS 860.01 SCOPE

This specification covers the requirements for the installation of porous asphalt in low-traffic roadways, parking lanes and bike lanes.

TS 860.02 REFERENCES

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

City of Toronto Standard Specifications

TS 2.10	Construction Specification for General Excavation
TS 3.20	Construction Specification for Tack Coat
TS 310	Construction Specification for Hot Mixed, Hot Laid Asphaltic Concrete Paving
TS 501	Amendment to OPSS.MUNI 501 – Construction Specification for Compacting
TS 856	Construction Specification for Pipes in Green Infrastructure
TS 1101	Amendment to OPSS.MUNI 1101 – Material Specification for Performance Graded Asphalt Cement

Ontario Provincial Standard Specifications

OPSS.MUNI 180	General Specification for the Management of Excess Materials
OPSS.MUNI 1103	Material Specification for Emulsified Asphalt

Canadian Standards Association

A23.2-16A	Resistance to Degradation of Small-size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
A23.2-17A	Resistance to Degradation of Large-size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

American Society for Testing and Materials

C131	Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
D448	Standard Classification for Sizes of Aggregate for Road and Bridge Construction
D698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort
D2434	Standard Test Method for Permeability of Granular Soils (Constant Head)
D2937	Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method
D3385	Standard Test Method for Infiltration Rate of Soils in Field Using Double-Ring Infiltrometer
D3386	Standard Test Method for Coefficient of Linear Thermal Expansion of Electrical Insulating Materials
D6390	Standard Test Method for Determination of Draindown Characteristics in Uncompacted Asphalt Mixtures

American Association of State Highway and Transportation Officials

M288 Standard Specification for Geotextile Specification for Highway Application

T191 Standard Method of Test for Density of Soil In-Place by the Sand-Cone Method

T310 In-Place Density and Moisture Content of Soil and Soil–Aggregate by Nuclear Methods (Shallow Depth)

TS 860.03 DEFINITIONS

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

Asphalt Binder means the asphalt cement that holds the aggregates together.

Bedding Layer / Choker Course means a layer of uncompacted small aggregate that is screeded smooth prior to placement of the permeable pavement.

CCIL means the Canadian Council of Independent Laboratories.

Granular Subbase means a layer of compacted aggregate that is placed above the subgrade.

Granular Base means a layer of compacted aggregate that is placed above the granular subbase.

Edge Restraint means a curb, edging, building or other appurtenance that is intended to confine the bedding layer / choker course so that the permeable asphalt is separated from other impervious streetscape features.

Joint means a vertical contact between the proposed permeable pavement and other pavement or rigid object that exists at the time the permeable pavement is laid.

Permeable Pavement means the hot mix asphalt prepared to mix standards to allow for permeability and is placed on the bedding layer / choker course to create a traversable pavement surface.

TS 860.04 DESIGN AND SUBMISSION REQUIREMENTS

TS 860.04.01 Bedding Layer, Choker Course, Granular Materials

Submit sieve analysis for all bedding materials.

TS 860.04.02 Porous Asphalt Experience Requirements

Submit project experience and personnel qualification examples showing the following for the general contractor or paving contractor:

-
- 1) One example of owner-accepted porous asphalt project, similar or greater in extent to the proposed project completed within the last two years with reference, or
 - 2) Three examples of owner-accepted open graded friction course projects completed in the last two years with reference.

Submit one example of owner-accepted porous asphalt project, similar or greater in extent to the proposed project completed within the last two years with reference for the qualified foreman of the general contractor or paving contractor.

TS 860.04.03 Manufacturers Materials

Provide manufacturer's catalog product data, installation instructions and material safety data sheets for the safe handling of the specified materials and products. Submit viscosity – temperature chart for asphalt cement to be supplied showing Kinematic Viscosity in centistokes, temperature range of 105°C to 165°C.

Submit porous asphalt concrete mix design and trial mix test results to the Contract Administrator for review at least two weeks prior to commencing work.

TS 860.04.04 Paving Plan

Prior to commencing the work, submit a detailed paving plan showing the edge constraints, schedule, sequence of work, equipment and workforce for Contract Administrator approval.

TS 860.05 MATERIALS

TS 860.05.01 Asphalt Binder

Asphalt binder shall be Performance Graded Asphalt Cement (PGAC) according to TS 1101 and as required by the approved mix design. To achieve the required draindown in accordance with ASTM D6390, polymer and/or fiber modified PGAC may be used. Dosage of polymer and fiber additives shall be as required by the approved mix design to achieve required strength characteristics.

TS 860.05.02 Asphalt Concrete Aggregates

Aggregates for use in porous asphalt shall be crushed stone or gravel consisting of hard, durable, angular particles free from clay lumps, cementation, organic material, frozen material and other deleterious materials.

Gradations shall be as per the following:

Table 1: Aggregate gradation

Sieve number	Per cent passing
16 mm	100
12.5 mm	95-100
10 mm	50-75
5 mm	10-30
2.5 mm	5-15
0.080 mm	2-5

Asphalt aggregates shall meet the following minimum requirements:

- 1) Los Angeles abrasion: Grading B, to ASTM C131. Maximum loss by mass of 25%
- 2) Flat and elongated particles (width to length ratio greater than 3): Maximum by mass of 20%
- 3) Crushed coarse aggregate (two or more faces greater than 5mm): Minimum by mass of 95%
- 4) Regardless of compliance with the above specified physical requirements, fine aggregates may be accepted or rejected on basis of past field performance.

TS 860.05.03 Asphalt Concrete Design

Submit the job-mix formula to the Contract Administrator for review and approval.

Minimum physical requirements are as follows:

Table 2: Asphalt mix design physical requirements

Property	Requirement
Voids in Coarse Aggregate of Mixture (VCA), %	Less than Voids in Coarse Aggregate, Dry Rodded Condition (VCA _{DRC})
Voids in Total Mixture (VTM), %	18 minimum
Draindown, %	0.3 maximum
Abrasion Loss (Unaged), %	20 maximum
Abrasion Loss (Aged), %	30 maximum
Tensile Strength Ratio (1 freeze/thaw cycle), %	80 minimum

TS 860.05.04 Granular Subbase

The granular subbase material shall be open-graded crushed stone with 90% fractured faces and LA abrasion less than 40 according to CSA A23.2-16A or A23.2-17A. Rounded material or recycled concrete is not acceptable for vehicular applications. All materials shall be washed, with less than 2% passing the 0.075 mm sieve. Aggregate gradation for the granular subbase shall be according to CSA A23.1 Table 11, Group II, 80-40 mm as shown in Table 3. The ASTM D448 approximation is No. 2 Stone.

Table 3: 80-40 mm Granular subbase gradation

Sieve number	Percent passing
112 mm	100
80 mm	90-100
56 mm	25-60
40 mm	0-15
20 mm	0-5

TS 860.05.05 Granular Base

The granular base material shall be open-graded crushed stone with 90% fracture faces and LA abrasion less than 40 as per CSA A23.2-16A or A23.2-17A. Rounded material or recycled concrete is not acceptable for vehicular applications. All materials shall be washed, with less than 2% passing the 0.075 mm sieve. Aggregate gradation for the granular base shall be according to CSA A23.1 Table 11, Group II, 28-14 mm as shown in Table 4.. The ASTM D448 approximation is No. 57 Stone.

Table 4: 28-14 mm Granular base gradation

Sieve number	Per cent passing
40 mm	100
28 mm	90-100
20 mm	30-65
14 mm	0-15
5 mm	0-5

TS 860.05.06 Geotextile Fabric

Geotextile fabric shall be non-woven needle punch, Class II according to AASHTO M288. For roadway applications use non-woven needle punch Class I according to AASHTO M288. Overlay of geotextile shall be according to AASHTO M288.

TS 860.05.07 Edge Restraints

Where not otherwise retained, provide edge restraints installed around the perimeter of all porous asphalt. Timber shall not be used as an edge restraint. Edge restraints shall be as specified on the Contract Drawings.

TS 860.05.08 Tack Coat Material

Tack coat material shall be SS-1 or SS-1HH emulsified asphalt and shall be according to OPSS.MUNI 1103. The tack application rate shall be according to TS 3.20. Reduction of volatile organic compound (VOC) emissions shall be according to TS 3.20.

TS 860.06 EQUIPMENT

Equipment shall be according to Equipment section in TS 310.

TS 860.06.01 Pavers

Mechanical grade – controlled self-powered pavers that can spread mix within specified tolerances, true to line, grade and crown as shown on the Contract Drawings.

TS 860.06.02 Rollers

Sufficient number of rollers of type and weight to obtain the necessary compaction of the porous asphalt mix. Rollers shall be static, 1200 mm minimum drum diameter and minimum mass of 8 tonne.

TS 860.06.03 Hand Tools

Lutes or rakes with covered teeth for spreading and finishing operations. Tamping irons having a minimum mass of 12 kg and bearing area maximum 310 cm² for compacting material along curbs, gutters, and other structures inaccessible to roller. Mechanical compaction equipment, when approved by the Contract Administrator, may be used instead of tamping irons.

For testing and acceptance, straight edges of 3.0 m length are required.

TS 860.07 CONSTRUCTION

TS 860.07.01 Preparation

Prior to any work, the Contractor shall clean all surfaces of loose and foreign material.

TS 860.07.02 Excavation

Prior to any excavation, the Contractor shall have all utilities located and clearly marked, including an areaway locate to mark all underground walkways, rooms, coal chutes and so on.

The excavation shall be to the lines and grades shown on the Contract Drawings. All surplus or unsuitable material is to be disposed of, off the site, according to OPSS 180.

The subgrade shall be prepared according to TS 2.10. Subgrade grading shall be as specified on the Contract Drawings.

The Contractor shall be required to make good all damage caused during the course of the construction to any part of the roadway, boulevard and private property and to restore the same, to as good or better condition as existed prior to commencement of work.

Care should be made to avoid compacting the subgrade during excavation. If compaction is required, estimate the infiltration rate according to ASTM D3385. Should compaction be required, compact to a minimum of 90% SPMDD according to ASTM D698. Contractor shall provide density results to the Contract Administrator.

Do not install in heavy rain, on frozen aggregates, or on frozen soil subgrade. Verify that the soil subgrade is free from standing water. Keep excavation area free from sediment during the entire construction duration. Any geotextile, base or subbase installed contaminated with sediment shall be removed and replaced with clean material.

The Contractor shall obtain written confirmation that the subgrade preparation is sufficient prior to further installation. Excavation elevations should be within +/- 3 cm.

Subgrade shall be protected from over compaction or contamination by silty run-off or other contaminants. Provide physical barriers or direct traffic to eliminate unnecessary vehicular traffic on the subgrade during construction. Provide flow diversion and erosion and sediment control measures to protect the permeable pavement area from sedimentation until the upstream catchment area is thoroughly stabilized. Areas of subgrade contaminated by the accumulation of silty material following rains or other debris or contamination shall be removed and disposed at the Contractor's expense.

TS 860.07.03 Geotextile

Geotextile shall be placed on sides of soil subgrade, place on bottom only as directed by the Contract Administrator or in Contract Drawings. Geotextile shall be secured in place and overlap a minimum of 0.3 m in the direction of drainage. Damaged geotextile shall be replaced as per the manufacturer's recommendations to the satisfaction of the Contract Administrator, at the Contractor's expense.

TS 860.07.04 Edge Restraints

Install edge restraints as specified on the Contract Drawings. Edge restraint base shall be placed to a depth of 75 mm and shall be installed on a subgrade compacted to a minimum of 95% of maximum dry density according to TS 501.

TS 860.07.05 Underdrainage

If specified on the Contract Drawings, install underdrainage according to TS 856.

TS 860.07.06 Base, Subbase, and Bedding Layer

The Contractor shall notify the Contract Administrator a minimum of 24 hours prior to all base and sub-base work. The subbase/base shall be tested for infiltration by ASTM D3386 or approved alternate. The infiltration shall be no less than 63.5 mm/hr, 50% of the hydraulic conductivity (ASTM D2434) at 95% SPMDD. The density of subbase and base courses shall be determined by AASHTO T191, T310 or ASTM D2937, or as approved methods at the discretion of the Contract Administrator.

TS 860.07.06.01 *Base*

Aggregate base shall be placed in maximum lifts of 100 mm. For each lift, two passes of the vibratory mode shall be made, followed by two passes in the static mode with minimum 9 ton vibratory roller until there is no visible movement of the aggregate. Do not crush aggregate with the roller. Compact to level specified in Contract Drawings, to maximum of 95% SPMDD.

Use 60 kN (minimum) plate compactor for areas that cannot be reached by the roller.

The surface of the compacted subbase shall be such that when tested with a 3 m long straightedge, placed in any direction on the surface, the gap between the straightedge and the surface of the compacted base shall not be greater than 25 mm, at any point.

TS 860.07.06.02 *Subbase*

The Contractor shall notify the Contract Administrator a minimum of 24 hours prior to all base and sub-base work. Aggregate subbase shall be placed in maximum lifts of 200 mm. Protect geotextile during placement of aggregate subbase. For each lift, two passes of the vibratory mode shall be made, followed by two passes in the static mode with minimum 9 ton vibratory roller until there is no visible movement of the aggregate. Do not crush aggregate with the roller. Compact to level specified in Contract Drawings, to maximum of 95% SPMDD.

Use 60 kN (minimum) plate compactor for areas that cannot be reached by the roller.

The surface of the compacted base shall be such that when tested with a 3 m long straightedge, placed in any direction on the surface, the gap between the straightedge and the surface of the compacted subbase shall not be greater than 65 mm, at any point.

TS 860.07.07 *Transportation of Mix*

The Contractor shall ensure the following:

- 1) Transport mix to job site in vehicles cleaned of foreign material. Paint or spray truck beds with light oil, limewater, soap or detergent solution at least once a day or as required. Elevate truck bed and thoroughly drain. No excess solution will be permitted.
- 2) Schedule delivery of material for placing in daylight, unless approved otherwise.
- 3) Deliver material to paver at uniform rate and in an amount within capacity of paving and compacting equipment.
- 4) Deliver loads continuously in covered vehicles and immediately spread on prepared base.

TS 860.07.08 *Tack Coat*

Tack coat shall only be applied on vertical faces of curbs, edges of pre-cast concrete structures, or when paving over areas with impermeable bases. Do not apply asphalt emulsion or tack coat to granular choker course or between asphalt lifts as water infiltration will be restricted. Tack coat requirements and acceptance of tack coating shall be according to TS 3.20.

Placement of tack coat for porous pavement applications shall be limited to vertical faces only.

TS 860.07.09 Placement

The Contractor shall obtain the Contract Administrator's approval of the choker course prior to placing porous asphalt mix. Placement of asphalt mixtures shall only occur when air temperature is above 10°C with a lay down temperature between 120°C and 135°C. Do not place on wet surface.

Place asphalt to thicknesses, grades, and lines as specified on the Contract Drawings.

TS 860.07.10 Joints

Joints shall be according Longitudinal and Transverse Joint clause in TS 310.07.05.04.

TS 860.07.11 Compaction

Compaction shall be according to Compaction clause in TS 310.07.05.05. The Contractor shall place asphalt and perform compaction within the temperature range and density specification recommended by the supplier to achieve target compaction in the field and to meet air void content requirements of the approved mix design. Do not over-compact as more rolling could cause reduction in pavement porosity

TS 860.08 QUALITY ASSURANCE

TS 860.08.01 Surface Tolerance

The surface of the porous asphalt shall be such that when tested with a 3 m long straightedge, placed in any direction on the surface, the gap between the straightedge and the surface of the pavers shall not be greater than 6 mm, at any point.

TS 860.08.02 Permeability Testing

The full permeability of the pavement surface shall be tested by application of clean water at a rate of 23 litres per minute over the surface, using a hose or other distribution devise. Water used for the test shall be clean, free of suspended solids and deleterious liquids. The water will be provided at no extra cost to the City. All applied water shall infiltrate directly without large puddle formation or surface runoff, and shall be observed by the Contract Administrator.

TS 860.08.03 Protection of Pavement

Hardened porous asphalt pavement surface shall be kept clean and free of clogging debris and soils from the Contractor's operations and all upstream and adjacent debris. If debris or soils contaminate the porous pavement voids, the pavement shall be cleaned at the Contractor's expense and to the satisfaction of the Contract Administrator. If porous asphalt pavement cannot be unclogged, it shall be removed and replaced at the Contractor's expense and to the satisfaction of the Contract Administrator.

TS 860.08.04 Defective Work and Acceptance

Work shall be done expertly throughout, without staining or injury to other work. Transition to adjacent impervious asphalt pavement shall be merged neatly with flush, clean lines. Finished pavement shall be even, without pockets, and graded to elevations shown on the Contract Drawings.

The Contractor shall correct irregularities which develop before completion of rolling. If irregularities remain after final compaction, remove surface course and lay new material to specified density.

TS 860.09 MEASUREMENT FOR PAYMENT

TS 860.09.01 Porous Asphalt

Measurement of porous asphalt shall be of the surface area, including any edge restraints and jointing, in square metres (m²). No deduction will be made for poles or utility frames and covers.

TS 860.10 BASIS OF PAYMENT

TS 860.10.01 Porous Asphalt – 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. Payment shall include all excavation, the supply, placing, levelling and compacting of all granular base and sub base, supply and placement of tack coat where required, supply and placement of edge restraints, supply and placement of geotextile and underdrains where required, supply and placement of bedding layer, and supply and placement and compaction of the porous asphalt.