

## Construction Specification for Concrete Unit Pavers

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## **TS 3.80.01                      SCOPE**

This specification covers the requirements for the installation of concrete unit pavers.

## **TS 3.80.02                      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 501  | Amendment to OPSS.MUNI 501 – Construction Specification for Compacting   |
| TS 1003 | Amendment to OPSS 1003 – Material Specification for Aggregates – Hot Mixed, Hot Laid, Asphaltic Concrete                   |
| TS 1010 | Amendment to OPSS 1010.MUNI – Material Specification for Aggregates – Base, Subbase, Select Subgrade and Backfill Material |
| TS 1350 | Amendment to OPSS 1350.MUNI – Material Specification for Concrete – Material and Production                                |

### **City of Toronto Standard Drawings**

|             |   |
|-------------|---|
| T-310.020-2 | Sidewalk Paved with Unit Paver Band at Curb                 |
| T-310.050-2 | Vehicular Crossing of Sidewalk with Unit Paver Installation |
| T-561.030-1 | Unit Pavers on Concrete Base Non-Vehicular Locations        |
| T-561.030-2 | Unit Pavers on Granular Base Non-Vehicular Locations        |

### **Ontario Provincial Standard Specifications**

|                |  |
|----------------|--|
| OPSS 180       | General Specification for the Management of Excess Materials |
| OPSS.MUNI 1002 | Material Specification for Aggregates – Concrete             |
| OPSS.MUNI 1004 | Material Specification for Aggregates – Miscellaneous        |
| OPSS 1860      | Material Specification for Geotextiles                       |

### **Canadian Standards Association**

|           |                              |
|-----------|------------------------------|
| A23.2-11C | Water Absorption of Concrete |
| A231.2    | Precast Concrete Pavers      |

### **American Society for Testing and Materials**

|      |   |
|------|---|
| C144 | Standard Specification for Aggregate for Masonry Mortar |
|------|---|

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### **TS 3.80.03                      DEFINITIONS**

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

**Aspect Ratio** means the overall length of a paver divided by its thickness. Example: A 100 mm wide by 200 mm long by 80 mm thick paver has an aspect ratio of 2.5. Compare to Plan Ratio.

**Bedding Sand** means a layer of uncompacted sand that is screeded smooth prior to placement of the pavers.

**Concrete Paver** means a precast concrete paving product according to CSA A231.2.

**Edge Paver** means a precast concrete unit made or field cut with a straight side for placement flush with a concrete curb or other edge restraint.

**Edge Restraint** means a curb, edging, building or other appurtenance that is intended to confine the bedding sand and concrete pavers so that the pavers do not spread and lose interlock.

**Laying Face** means the exposed vertical face of a row of pavers on the bedding sand.

**Plan Ratio** means the overall length of a paver divided by its width. Compare to Aspect Ratio.

### **TS 3.80.04                      DESIGN AND SUBMISSION REQUIREMENTS – Not Used**

### **TS 3.80.05                      MATERIALS**

#### **TS 3.80.05.01                  Granular Subbase**

The granular subbase material shall be Granular A according to TS 1010.

#### **TS 3.80.05.02                  Concrete Base**

The materials for and the production of concrete base shall be according to TS 1350 and the following:

- |  |  |
|--|--|
| 1) Cement type                                   | Normal Portland GU /<br>Portland limestone GUL |
| 2) Minimum 28 day cylinder compressive strength  | 32 MPa   |
| 3) Class of exposure                             | C-2  |
| 4) Nominal maximum size of coarse aggregate      | 19 mm  |
| 5) Slump at point of discharge (formed concrete) | 80 ± 30 mm                                     |
| 6) Total air content                             | 6.5 ± 1.5%                                     |
| 7) Maximum water/cementing materials ratio       | 0.45   |

#### **TS 3.80.05.03                  Granular Base**

The granular base material shall be Granular A according to TS 1010.

#### **TS 3.80.05.04                  Bedding Sand**

Bedding sand shall be according to OPSS 1002 for fine aggregates, except that the gradation shall be as follows:

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**Table 1: Bedding sand gradation**

| Sieve number | Per cent passing |
|--------------|------------------|
| 9.52 mm      | 100              |
| 4.75 mm      | 95-100           |
| 2.36 mm      | 80-100           |
| 1.18 mm      | 50-85            |
| 600 µm       | 25-60            |
| 300 µm       | 10-30            |
| 150 µm       | 5-15             |
| 75 µm        | 0-10             |

For applications under vehicular traffic, a manufactured sand shall be used.

Limestone screenings or stone dust shall not be used.

#### **TS 3.80.05.05 Joint Sand**

Joint sand shall be according to OPSS.MUNI 1004 for mortar sand, except that the gradation shall be as follows:

**Table 2: Joint sand gradation**

| Sieve number | Per cent passing |
|--------------|------------------|
| 1.18 mm      | 100              |
| 75 µm        | 0-10             |

#### **TS 3.80.05.06 Polymeric Sand – High Strength**

Polymeric sand shall be blended native sands according to ASTM C144 sand mixed with synthetic polymers for pavement joint stabilization.

#### **TS 3.80.05.07 Concrete Pavers**

Concrete pavers shall be according to CSA A231.2.

Concrete pavers shall be uniform in size and texture. Units having imperfections, chipped edges or cracks shall not be used. The colour and finish shall be as specified in the Contract Documents.

Concrete pavers shall be 200 mm x 200 mm or as specified in the Contract Documents and shall be of the specified depth of 70 mm or 80 mm or as specified in the Contract Documents. The concrete pavers shall not differ in length or width by more than  $\pm 1.6$  mm and in depth by more than  $\pm 3.2$  mm.

Concrete pavers shall be tested according to CSA A231.2, in sets of 5 units. The number of sets shall be determined by the City.

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Each individual concrete paver shall have a compressive strength of not less than 50 MPa and the average of the 5 units shall not be less than 55 MPa.

Concrete pavers shall be tested according to CSA A23.2-11C for water absorption. The average absorption of the test set shall not be greater than 5 per cent and no individual paver shall be greater than 7 per cent.

The average weight loss of a set of concrete pavers subjected to 50 freeze/thaw cycles, while immersed in a 3 per cent sodium chloride solution, shall not exceed one per cent of the initial dry weight.

Failure to meet any of the requirements will result in the rejection of all of the concrete pavers represented by the failed set. All rejected pavers shall be replaced, with all associated costs, including the testing of the replacement set, at no extra cost to the City.

### **TS 3.80.05.08            19 mm Type II Clear Stone**

Clear stone shall be 19 mm Type II, according to OPSS.MUNI 1004 and meet the following physical properties.

**Table 3: Clear Stone – 19 mm Type II**

| <b>Laboratory test</b>                                    | <b>MTO test number</b> | <b>Clear Stone 19 mm Type II</b> |
|---|------------------------|----------------------------------|
| loss by washing, pass 75µm sieve, % maximum               | LS-601                 | 1.3 <sup>b</sup>                 |
| absorption by mass, % maximum                             | LS-604                 | 2                                |
| magnesium sulphate soundness, % maximum loss <sup>c</sup> | LS-606                 | 15                               |
| percent crushed particles, % minimum                      | LS-607                 | 80                               |
| particles with 2 faces crushed, % minimum                 | LS-617                 | –                                |
| flat and elongated particles, % maximum                   | LS-608                 | 20                               |
| Petrographic Number (HL), maximum                         | LS-609                 | –                                |
| insoluble residue, retained 75µm sieve, % minimum         | LS-613                 | –                                |
| freezing and thawing, % loss maximum                      | LS-614                 | 15 <sup>c</sup>                  |
| micro-deval abrasion Loss, % maximum                      | LS-618                 | 21                               |

### **TS 3.80.05.09            Geotextile Fabric**

Geotextile fabric shall be non-woven, Class I according to OPSS 1860 with an FOS of 60 to 120 µm.

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## **TS 3.80.06                    EQUIPMENT**

Concrete pavers shall be set into the bedding sand using a high frequency, low amplitude, mechanical flat plate vibratory compactor having a plate area sufficient to cover a minimum of 12 pavers (200 mm x 200 mm). The compactor shall transmit an effective force of not less than 75 kN per square metre of plate area. The frequency of vibration shall be within the range of 75 to 100 Hz.

## **TS 3.80.07                    CONSTRUCTION**

### **TS 3.80.07.01                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.

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.

### **TS 3.80.07.02                Base**

The concrete pavers shall be placed using a granular or a concrete base, as specified in the Contract Documents.

#### **TS 3.80.07.02.01            *Granular Base***

Granular base shall be placed in depths of 150 mm, for walkways and boulevards, and 200 mm, for pavements and driveways. It shall be compacted to a minimum of 100% of maximum dry density according to TS 501.

#### **TS 3.80.07.02.02            *Concrete Base***

Prior to the placement of the concrete base, the Contractor shall construct a granular subbase. The subbase shall be placed to a depth of 75 mm and shall be compacted to a minimum of 95% of maximum dry density according to TS 501.

The concrete base shall be poured to a minimum depth of 100 mm. At the outer limits of the concrete pavers, the concrete depth shall be increased to form a 200 mm wide edge restraint, level with the proposed surface of the pavers. The 200 mm wide edge restraint shall be omitted when the pavers are placed adjacent to a concrete curb.

At all maintenance holes, valve boxes, handwells and so forth, the surrounding concrete shall be increased to the proposed surface of the pavers. The concrete shall be squared off and the outer edge of the appurtenance shall be encased by a minimum of 50 mm of concrete. The size and location of the raised concrete shall be governed by the alignment of the concrete pavers. No concrete paver shall be cut or trimmed to less than half of its original dimensions.

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The slope of the concrete base shall match the final slope of the concrete pavers. Plastic drain pipes (50 mm diameter) shall be placed at the low side of the base, spaced at every 3 m along the length of the concrete base. The drain shall be a minimum of 400 mm long and shall be flush with the top of the base. A drainage pocket shall be constructed at every drain. The pocket shall consist of Clear Stone placed 200 mm wide x 200 mm long x 300 mm deep from the bottom of the concrete base. It shall be situated to drain into the granular material at the back of the curb. If the drain cannot be discharged into a well-draining granular material, the drainage pocket shall be increased to 300 mm wide x 300 mm long. Prior to placing the bedding sand, the drain shall be covered by centering a 200 mm x 200 mm piece of geotextile fabric over the opening.

### **TS 3.80.07.03            Bedding**

The bedding sand shall be placed loosely, in a uniform layer with sufficient depth to achieve the final compacted thickness of 20 to 30 mm.

The bedding sand shall be screeded in a loose condition and protected against compaction prior to placement of the concrete pavers. Concrete pavers shall be placed only on loose, moist bedding sand.

### **TS 3.80.07.04            Concrete Paver Placement**

Concrete pavers shall be installed in the specified pattern.

Concrete pavers shall be placed uniformly and hand tight, such that all joints are correctly aligned.

Where concrete pavers require trimming, they shall be cut with a quick-cut saw or a guillotine, to give a straight edge.

After placement, compactive effort shall be applied to the concrete pavers until the bedding sand is compacted to achieve the proper grade and the pavers are free of movement. At least three passes of a plate compactor shall be made across the surface of the concrete pavers.

After initial compaction, dry joint sand shall be broomed to fill in the joints and spread uniformly over the concrete pavers to a depth of not less than 5 mm. At least two passes of a plate compactor shall be applied to the surface while simultaneously sweeping the sand into the joints. Water shall be sprinkled over the sand to ensure proper compaction. Joints shall be completely filled at the completion of compaction. Excess sand shall then be removed from the pavement surface by brooming.

## **TS 3.80.08            QUALITY ASSURANCE**

### **TS 3.80.08.01            Surface Tolerance**

The surface of the concrete pavers 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 3 mm, at any point.

### **TS 3.80.08.02            Acceptance**

If any pavers are loose, chipped or unevenly cut pavers will be rejected. Areas failing to meet the requirement for surface tolerance will be rejected.

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Any rejected pavers or areas shall be removed and either reinstalled or replaced by the Contractor. All costs associated with the removal, reinstallation and replacement of rejected concrete pavers shall be at no extra cost to the City.

**TS 3.80.09                      MEASUREMENT FOR PAYMENT**

**TS 3.80.09.01                  Unit Pavers**

Measurement of unit pavers shall be of the surface area, including any edge restraint, in square metres (m<sup>2</sup>). No deduction will be made for poles or utility frames and covers.

**TS 3.80.10                      BASIS OF PAYMENT**

**TS 3.80.10.01                  Unit Pavers – 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, the supply and placement of concrete base and edge restraints, the supply and placement of drains, the supply and placement of concrete pavers and the filling of all joints.



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### **Appendix 3.80-A, April 2015**

#### **For Use While Designing and Administering City Contracts**

Note: This is a non-mandatory commentary appendix intended to provide information to a designer and contract administrator during the design and construction stage of a contract on the use of this TS specification in a City 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.

Notes to Designer:

The designer should specify the following in the Contract Documents:

- size, shape, colour, thickness and texture of the concrete pavers (3.80.05.06)

Use aspect ratio of pavers (length divided by thickness) to determine the thickness of the paver. For pedestrian and driveway applications, use a max 4:1 ratio. For street/parking applications, use a max 3:1 ratio.

Application should be restricted to roads with traffic speeds of 70 km/h or less.

A herringbone pattern at 45° to the vehicular traffic is recommended for roadway pavements.

Where surface sealers are specified, a reduction in frictional resistance may result.

Related technical publications for designers' use are available from the Interlocking Concrete Pavement Institute (ICPI) at [www.icpi.org](http://www.icpi.org).