

**Construction Specification for
Keyhole Excavation and Permanent Reinstatement
of Keyhole Cores**

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TS 4.70.01 SCOPE

This specification covers the requirements for keyhole coring, vacuum excavation, backfilling, and reinstatement of the keyhole core in pavements, sidewalks and other improved surfaces as a permanent repair within the City road allowance.

TS 4.70.02 REFERENCES

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

City of Toronto Standard Specifications

| | |
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| TS 1.00 | Construction Specification for Maintenance of Traffic |
| TS 3.45 | Construction Specification for The Repair of Concrete Pavement and Base |
| TS 5.00 | Construction Specification for Sodding |
| TS 5.10 | Construction Specification for Growing Medium |
| TS 13.10 | Construction Specification for Unshrinkable Fill |
| TS 310 | Construction Specification for Hot Mixed, Hot Laid Asphaltic Concrete Paving |
| TS 501 | Amendment to OPSS 501 – Construction Specification for Compacting |
| TS 1010 | Amendment to OPSS.MUNI 1010 – Material Specification for Aggregates – Base, Subbase, Select Subgrade, and Backfill Material |

City of Toronto Publication

| | |
|-----|--------------------------------|
| MCR | Municipal Consent Requirements |
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Ontario Provincial Standard Specifications

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| OPSS 180 | General Specification for the Management of Excess Materials |
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Ontario Ministry of Transportation

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| Ontario Traffic Manual Book 6 | Warning Signs |
| Ontario Traffic Manual Book 7 | Temporary Conditions |

American Society of Testing and Materials

| | |
|-------|---|
| C39 | Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens |
| C109 | Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens) |
| C266 | Standard Test Method for Time of Setting of Hydraulic-Cement Paste by Gillmore Needles |
| C531 | Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes |
| C666A | Test Methods for Characterizing Air Void Systems in Portland Cement Pervious Concrete |
| C666B | Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing |
| C882 | Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear |

American Association of State Highway and Transportation Officials

| | |
|------|--------------------------|
| H-25 | 25 Ton Live Vehicle Load |
|------|--------------------------|

TS 4.70.03 DEFINITIONS

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

Applicant means a person applying for a permit or other consent to cut a street. This shall be extended, where applicable, to include the Applicant's direct employees and its agents, consultants and contractors.

Boulevard means that part of a public street that is not used, or intended to be used, for vehicle travel by the general public, and that is situated between the travelled portion of the road and the adjoining property line.

Bonding Material means a single component, cementitious, rapid hardening, high strength, concrete repair material, used to bond the undamaged keyhole core to the pavement from which it was originally removed.

Composite Pavement means a rigid pavement having an asphalt concrete surfacing over Portland cement concrete base (with or without granular base/subbase). See Rigid Pavement also.

General Manager means the General Manager of Transportation Services for the City of Toronto and his or her designate or successor.

Flexible Pavement means a roadway pavement consisting of a layer(s) of asphalt concrete placed over granular base and granular subbase.

Keyhole Excavation means the operation of coring a circular hole through the roadway pavement or sidewalk using diamond drilling/coring equipment to remove the asphaltic concrete or concrete courses of flexible pavement, rigid pavement, composite pavement and sidewalk and the removal of materials from the ground by water or air vacuum excavation method, and its disposal.

OPSS means Ontario Provincial Standard Specification

OTM means Ontario Traffic Manual, published by MTO.

Permanent Repair means the process whereby a temporary repair completed for keyhole cutting is replaced to reinstate the pavement to a condition acceptable to the City of Toronto.

Rigid Pavement means a pavement having a Portland cement concrete surface or composite structure (asphalt over concrete base) over granular base and/or granular subbase.

Road means the portion of the street designed, improved and ordinarily used by vehicle traffic.

Sidewalk means that part of a public street located within the boulevard that is improved for the exclusive use of pedestrians.

Street means a highway as defined in subsection 1(1) of the Municipal Act, 2001.

Temporary Patch means the asphalt concrete patch installed by the Applicant or its designated contractor.

TS means Toronto Specification

Unshrinkable Fill means a mixture of aggregates, cementing material and water, with or without chemical admixtures, according to TS 13.10.

TS 4.70.04 DESIGN AND SUBMISSION REQUIREMENTS

Refer to the Municipal Consent Requirements.

TS 4.70.05 MATERIALS

TS 4.70.05.01 Bonding Material for Keyhole Cores

Bonding material shall be impervious to water penetration at the joint after application. The bonding material is required to securely bond the undamaged keyhole core to the pavement or sidewalk and to fill the annular space at the joint.

Specifications for the bonding material shall be submitted to the City for review and approval before a bonding material is used. The specifications will include results of laboratory and field testing and shall be according to TS 4.70.05.01.01 and TS 4.70.05.01.02.

TS 4.70.05.01.01 *Laboratory Testing of Bonding Material*

Summary of Tests:

| | |
|---------------------------------|--------------------|
| Compression | ASTM C109 or C39 |
| Freeze / Thaw | ASTM 666A and 666B |
| Set Time | ASTM C266 |
| Bond Strength using Slant Shear | ASTM C882 |
| Thermal Expansion and Shrinkage | ASTM C531 |

TS 4.70.05.01.02 *Field Testing of Bonding Material*

In testing, the bonding material shall, within 30 minutes at 21°C, reach an equivalent traffic loadable condition that is at a minimum two times greater than the AASHTO H-25 standard on simulated loading slabs prepared to yield a standard mix with a 28 day compressive strength of 35 MPa using 19 mm minus aggregates.

TS 4.70.05.02 Unshrinkable Fill as Backfill Material

The materials for and the production of unshrinkable fill shall be according to TS 13.10. Prior to the use of unshrinkable fill, the Contractor shall provide documentation of compliance with the above requirements.

The supplied unshrinkable fill shall be tested and material that does not meet TS 13.10 requirements shall be removed and replaced at the Applicant or its contractor's expense. All costs associated with the removal and replacement of deficient unshrinkable fill shall be borne by the Applicant or its contractor, including the cost of administration and retesting.

TS 4.70.05.03 Imported Granular as Backfill Material

Granular material shall not be used for keyhole backfill; however, granular A according to TS 1010 may be used in lieu of unshrinkable fill in boulevards only where an exemption on the use of unshrinkable fill has been granted by the General Manager.

Where an exemption has been granted, a qualified independent materials engineering and testing firm shall provide Geotechnical Certificates within 7 Days of completion of work to confirm that the approved backfill materials meet specified compaction requirements.

The Granular A shall be managed to prevent contamination, and to preserve or maintain its moisture condition to within ± 2 per cent of its optimum moisture content as determined by a Standard Proctor Maximum Dry Density Test.

TS 4.70.06 EQUIPMENT – Not Used

TS 4.70.07 CONSTRUCTION

TS 4.70.07.01 General

Keyhole excavation will not be permitted within a five year period following the completion of roadway reconstruction, and within a three year period following roadway resurfacing. Exemptions will be granted for emergencies only where the work must be completed immediately because of health and safety reasons, or the provision of essential service is endangered. All other exemption requests must be made in writing to the General Manager.

All construction and maintenance work performed by the Applicant or its contractor using keyhole excavation method shall be carried out in such a manner that the pavement or sidewalk surfaces worked upon are restored and colour matched as close as possible to, if not better than, the original condition of the surface. Excess bonding material shall be removed from the restored surface. A "patched" appearance is visually unacceptable to the abutting properties, and efforts should be made to avoid this in surface restoration wherever possible.

The performance measures of the finished surface shall be according to TS 4.70.08, herein.

TS 4.70.07.02 Keyhole Coring

Pavement and sidewalk cuts for vacuum excavation in keyhole coring shall not be greater than 460 mm in diameter. The surface cut by keyhole coring shall be restored to its original condition with the reinstated core flush with the existing surface, and with the structure of the restored surface matching existing concrete surfaces and asphaltic concrete surfaces.

In the event larger cores, up to 610 mm in diameter, or overlapping cores, or cores closer than one metre from each other, a joint or any longitudinal or transverse crack greater than 3 mm width may be allowed only with the prior approval of the City. The finished surface shall meet the requirements and performance measures of TS 4.70.08, herein.

Cutting of existing pavements shall be performed with an approved keyhole-coring saw. The vertical alignment of the keyhole-coring saw shall be perpendicular to the horizon, and the cutting shall be extended to the full depth of the existing structure.

TS 4.70.07.02.01 *Flexible Pavements*

Keyhole cores will not be permitted in flexible pavements where the asphaltic concrete is less than 100 mm thick. The Applicant or its contractor must demonstrate to the satisfaction of the City staff through a program of coring of the existing pavement that the pavement has a minimum of 100 mm thickness of asphaltic concrete. In addition, Keyhole cores should not be closer than one metre from each other, a joint or any longitudinal or transverse crack greater than 3 mm width.

TS 4.70.07.02.02 *Composite Pavements*

Keyhole cores should not be closer than one metre from each other, a joint or any longitudinal or transverse crack greater than 3 mm width.

TS 4.70.07.02.03 *Sidewalks and Other Hard Surfaces on Boulevard:*

Keyholes should not be closer than 100 mm from a crack greater than 3 mm width, an expansion joint or the edge of sidewalk.

TS 4.70.07.03 *Backfilling*

Materials used in backfilling keyhole excavation shall be according to TS 4.70.05.02 and TS 4.70.05.03, herein.

The City's Road Classification System forms the basis for determining the type of backfilling required in keyhole excavation. Unshrinkable fill shall be used within the pavement portion of the road allowance of expressways, major arterial roads, minor arterial roads, collector roads and local roads. With the written permission of the General Manager, Granular A according to TS 4.70.05.03, herein may be used in lieu of unshrinkable fill in boulevards.

Unshrinkable fill shall be used as the backfilling material on streets, alleys, and sidewalks if prior approval of other backfill materials is not approved. Unshrinkable fill should also be required where the City inspector determines that mechanical compaction devices are impractical or ineffective to adequately compact the backfill materials. The Applicant or its contractor shall bring the unshrinkable fill or other backfill, approved by the City, to a level 50 mm below the base of the pavement structure or to the base of the sidewalk using a vibrator as necessary. A 50 mm thick leveling course of pea gravel (½ inch) shall be placed on the unshrinkable fill when the unshrinkable fill has set. The pea gravel leveling course can be tamped by hand.

Unshrinkable fill shall be used in all cuts made on streets scheduled for reconstruction or resurfacing within the current construction season and when keyhole cores are defective or unusable.

TS 4.70.07.04 *Permanent Surface Restoration with Keyhole Cores*

Where possible, the Applicant or its contractor must reinstate the keyhole core, complete with the bonding material immediately or within 24 hours of cutting the existing pavement unless special permission has been granted by the City inspector.

To ensure that the keyhole core is placed in the same orientation as originally constructed, the Contractor shall place a temporary mark such as paint or chalk to help align the keyhole core.

TS 4.70.07.05 Mitigation of Defective Keyhole Cores

Where the keyhole core is found to be fractured or defective upon removal, or becomes damaged after removal and prior to reinstating the keyhole cuts, the defective or damaged core shall not be used to reinstate the pavement. A core that is fractured in the vertical plane is considered to be defective and shall not be used to reinstate the pavement. If another equivalent core of sound condition and matching existing pavement of the same diameter, depth and composition as the defective core is available, it may be reinstated in substitution of the defective core.

If the keyhole core is limited to the horizontal delamination of two or more successive layers of asphalt concrete, that core may not be considered to be defective if the layers are capable of being rebonded to each other with the bonding compound during reinstatement.

TS 4.70.07.05.01 Temporary Reinstatement

If the core is found to be defective, the pavement shall be temporary reinstated with HL-1. Surface course should be placed and mechanically compacted in uniform lifts not exceeding 50 mm loose thickness with equipment suitable for such purpose.

Extra efforts will be required from the Applicant or its contractor to ensure a proper compaction at the joints between the existing pavement and new asphalt patch. The total thickness of the hot-mix asphalt and HL-1 shall match that of the existing roadway. All vertical and horizontal contact surfaces between the new and existing pavement shall be tack coated. Gaps between the existing and new asphalt must be sealed with hot rubberized asphalt.

TS 4.70.07.06 Temporary Condition

In the event when a keyhole cut cannot be reinstated within 24 hours of cutting, the opening shall be covered with an approved form of an appropriately-sized, circular steel road plate fitted with a collar that, when inserted into the keyhole, will prevent the hole cover from tipping, tilting, bouncing or spinning out of the hole in all kinds of the traffic conditions; or a counter-sunk steel plate set flush with the surface of the pavement and overlapping the cut by no less than 300 mm on all sides. The steel plate must have a non-skid surface and must provide a safe driving surface. This plate must be secured to the pavement and has sufficient thickness and strength to support the traffic without movement or bouncing. An asphalt mix shall be used to jam the plate into the pavement along all edges.

Permission must be sought from City staff before the cores are left on site. If the cores are left on site, they must be kept within the road allowance and away from the pavement and not obstructing pedestrian traffic. The cores must be stored in a safe and secure place on site for not more than 72 hours. After 72 hours, the cores must be removed and they should be stored elsewhere under the safe and secure custody of the Applicant or its contractor. The cores shall be made readily available for restoring the keyhole.

TS 4.70.07.07 Traffic Control

The Applicant and/or its contractor shall comply with all City traffic control standards, including the requirements as stipulated in TS 1.00 as well as the Ontario Traffic Manual Book 7 – Temporary Conditions and Municipal Consent Requirements – Appendix G. Bicycle lanes are considered legal travel lanes herein and must be accommodated as such.

Signs should be used with judicious care and proper consideration of prevailing circumstances according to the Ontario Traffic Manual Book 6 – Warning Signs.

It shall be the duty of the Contractor or any person working, cutting, or conducting excavation in or upon any public place to establish and maintain barriers and warning devices necessary for the safety of the workers and the general public. City inspector may review the contractor's placement of these barriers and warning devices. When, in the judgment of the City inspector, additional barricades or warning devices are necessary, he/she shall so inform the contractor and the contractor shall take prompt action to comply.

TS 4.70.07.08 Management and Disposal of Excess Material

Management and disposal of excess material shall be according to OPSS 180.

The Applicant or its Contractor is required to remove all materials excavated by keyhole excavation off site at their expense.

TS 4.70.07.09 Records

The contractor shall maintain records containing the location and details of all keyhole core repairs. The records shall be made available to the City on request within 7 days.

The records shall be kept for submission to the City of Toronto upon completion in a format that will allow the City to upload this information into a data base for future reference.

A location sketch of the keyhole core is required to illustrate the centre of the keyhole core referenced to two or more physical objects. The location sketch shall include ties of a horizontal distance taken from the curb line at right angles to the keyhole core, a horizontal distance measured from the centre of an identified manhole to the keyhole core, and/or a distance measured from the top of a hydrant (if in close proximity) to the keyhole core.

TS 4.70.08 QUALITY ASSURANCE

TS 4.70.08.01 Surface Tolerance

TS 4.70.08.01.01 Pavements

The reinstated core shall be flush and level with the adjacent pavement. No gap, attributable to the positioning of the core, should be found between the bottom of the straightedge and the surface of the pavement when a one metre long straightedge is placed in any direction on the surface of the keyhole cores, except across the crown or drainage gutters.

TS 4.70.08.01.02 Sidewalks

The reinstated core shall be flush and level with the adjacent pavement. No gap, attributable to the positioning of the core, shall be found between the bottom of the straightedge and the surface of the sidewalk when a one metre long straightedge is placed in any direction on the surface of the keyhole cores of the sidewalk.

TS 4.70.08.02 Removal of Unacceptable Keyhole Cores

All keyhole cores that are damaged or do not meet the surface tolerances shall be removed and reinstalled at the Applicant or its contractor's expense.

A keyhole core is considered unacceptable when one of the following conditions exist:

- a) The keyhole core contains any vertical cracks wider than 3 mm extending full depth or partial depth through the core; or
- b) Any deteriorated piece of the keyhole core is larger than 10 per cent of the overall area of the keyhole core

All unacceptable keyhole cores shall be removed, disposed of offsite, and a matching replacement core shall be installed or a temporary asphalt patch of HL-1 shall be constructed at the keyhole core location. In the case if a defective keyhole cores, this location shall be restored according to TS 4.70.07.05, herein. The keyhole core repair work shall all be completed at the Applicant or its contractor's expense.

TS 4.70.08.03 Warranty

The Applicant will warrant the keyhole for 3 years and shall maintain a rigorous quality control and assurance programs such that each keyhole will be inspected and reported once every 12 months under contract warranty period.

TS 4.70.09 MEASUREMENT FOR PAYMENT

For measurement purposes, a count shall be made of the number of reinstated keyhole cores.

TS 4.70.10 BASIS OF PAYMENT

Payment at the Contract Price shall be full compensation for all labour, Equipment and Material required to do the work. Payment shall include traffic control, coring, vacuum excavation, backfill material, and bonding material.