

**CONSTRUCTION SPECIFICATION FOR
CONCRETE ROAD BASE**

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TS 3.40.01 SCOPE

This Specification covers the requirements for the construction of Portland cement concrete road base.

TS 3.40.02 REFERENCES

This Specification refers to the following specifications and publications:

Ontario Provincial Standards

OPSS 180 – Management and Disposal of Excess Material
OPSS 919 – Formwork and Falsework
OPSS 1212 – Hot Poured Rubberized Asphalt Joint Sealing Compound

City of Toronto Standard Specifications

TS 2.10 – Construction Specification for General Excavation
TS 4.50 – Construction Specification for Utility Adjustments
TS 501 – Amendments to OPSS 501 – Construction Specification for Compacting
TS 1010 – Amendments to OPSS 1010 – Material Specification for Aggregates – Granular A, B, M, and Select Subgrade Material
TS 1350 – Amendments to OPSS 1350 – Material Specification for Concrete – Material and Production

City of Toronto Standard Drawings

T-216.02-4 – Location and Detail of Joints for Composite Pavements
T-216.02-5 – Utility Isolation in Composite Pavements

Canadian Standards Association (CSA)

CSA A23.1 – Concrete Materials and Methods of Concrete Construction

TS 3.40.03 DEFINITIONS

For the purposes of this specification the following definitions apply:

Base Course: means a layer of specified or selected materials of planned thickness constructed on the subgrade for drainage and to distribute pavement loads.

Geotextile: means a permeable geosynthetic comprised solely of textiles.

Slipform: means the placing, consolidating and extruding of plastic concrete by a machine without the use of fixed side forms.

Specified thickness: means the design thickness specified in the Contract Documents.

Subgrade: means the soil prepared and compacted to support a structure or pavement.

TS 3.40.04 SUBMISSION AND DESIGN REQUIREMENTS

TS 3.40.04.01 General

Any required submissions shall be in writing. All submissions shall be submitted to the City at least three weeks prior to the beginning of the work.

The requirements for submissions and design requirements are given in TS 1350.

TS 3.40.04.02 Materials

Prior to starting the work, the Contractor shall supply the City with Material Safety Data Sheets (MSDS) for all the materials to be incorporated in the work.

The Contractor shall be responsible for selecting the concrete materials and for the mix design for the concrete. The concrete mix proportions shall meet the requirements of CSA A23.1 and this Specification.

The certificate of ready mix facilities and/or the certificate of mobile mix concrete production facilities along with the City of Toronto Form A or B (concrete mix details) shall be submitted as required by Specification TS 1350.

Details of the method of curing and curing materials (including manufacturers' literature, where applicable) shall be submitted to the City.

One copy of the concrete delivery ticket shall be submitted to the City for each load of concrete delivered.

TS 3.40.05 MATERIALS

TS 3.40.05.01 Supply of Materials

Unless otherwise specified in the Contract, the Contractor shall supply all materials necessary for the execution and completion of the work.

TS 3.40.05.02 Concrete

The materials for and the production of concrete road base shall meet the requirements of TS 1350 and the following:

1)	Cement type	Normal Portland GU
2)	Minimum 28 day compressive strength	32 MPa
3)	Class of exposure	C-2
4)	Maximum nominal size of coarse aggregate	37.5 mm or 19 mm
5)	Slump at point of discharge	80 ± 30 mm
6)	Air content	5.5 ± 1.5% for 37.5 mm 6.5 ± 1.5% for 19 mm
7)	Maximum water/cementing materials ratio	0.45

TS 3.40.05.03 Welded Steel Wire Fabric

Welded steel wire fabric shall meet the requirements of TS 1350.

Unless otherwise specified, all welded steel wire fabric detailed on the plans or ordered by the City for incorporation in the road base shall be 152 mm x 152 mm – MW 18.7 x MW 18.7 welded steel wire fabric.

TS 3.40.05.04 Granular Base

Granular base, if required, shall be Granular 'A' and shall meet the requirements of TS 1010.

TS 3.40.05.05 Tie Bars and Load Transfer Devices

Tie bars and load transfer devices shall meet the requirements of TS 1350.

TS 3.40.05.06 Expansion Joint Material

Expansion joint material shall be bituminous fibreboard having a minimum thickness of 12 mm and shall meet the requirements of TS 1350.

TS 3.40.05.07 Joint Sealant

Joint sealant shall be hot-poured rubberized asphalt cement meeting the requirements of OPSS 1212.

TS 3.40.06 EQUIPMENT

TS 3.40.06.01 Forms

Forms shall be steel, wood or metal plate forms and they shall meet the requirements of OPSS 919. They shall be of sufficient cross section and strength, and so secured as to resist the pressure of the concrete when placed, and the impact and vibration of any construction equipment they support without springing or settlement.

Forms shall be pinned or staked in place with not less than 3 pins for each 3 m length, and with a pin at each side of each form butt joint. The top surface of the formwork shall comply with the specified tolerances. The inside face of the form shall be vertical. The form shall deviate from grade by no more than 3 mm in 3 m, and in alignment by no more than 6 mm in 3 m.

Forms shall be cleaned and coated with form oil before each use.

TS 3.40.06.02 Slipform Equipment

Guidelines shall be provided at a constant height above, and at a constant horizontal distance from the edge of the proposed road base. The guidelines may be either wire or heavy-duty string. Guidelines may be omitted when abutting existing pavement or road base.

The paver shall have automatic horizontal and vertical controls to be used in conjunction with at least one guideline. The paver shall be equipped with internal vibrators of sufficient number, size and frequency to provide uniform consolidation to the entire pavement width and depth. The vibrators shall not operate in concrete while the paver is stopped.

TS 3.40.06.03 Finishing Tools

An aluminum or magnesium straight edge, 3 m wide, equipped with a handle to permit operation from the edge of the pavement and aluminum or magnesium floats, shall be used as necessary to finish the concrete road base.

TS 3.40.07 CONSTRUCTION

Prior to starting the work, the Contractor shall submit the verification that either the foreman/lead hand or the supervisor of the placing crew has ACI Flatwork Certification.

TS 3.40.07.01 Excavation

All excavation shall be in accordance with TS 2.10.

Excavation shall be to the lines and grades shown on the contract drawings or as specified by the City. Care shall be taken to prevent damage to appurtenances and utilities which may be in or under the proposed road base.

At the direction of the City, The Contractor shall make good, all damage caused during the course of the work, and return the work to its initial condition.

Excavated material shall be disposed of off the site in conformance with OPSS 180 and at the Contractor's expense.

TS 3.40.07.02 Subgrade Preparation

The subgrade shall be compacted to a minimum of 95 percent of the maximum dry density as specified in TS 501.

The subgrade shall be proof rolled, and any soft or yielding areas shall be subexcavated and replaced with approved material as provided for in the contract, or similar material as the surrounding subgrade, as approved by the City, at the optimum moisture density relationship as specified in TS 501.

If concrete is to be placed directly on the prepared subgrade, the subgrade shall be moistened prior to the placement of concrete, but there should be no standing water. At the time of placing concrete, the subgrade shall not be wet, soft or frozen.

TS 3.40.07.03 Granular Base Placement

Granular base shall be placed to the required thickness and compaction. The moisture content and compaction of the granular base shall be uniform and shall meet the requirements of TS 1010.

The granular base shall be moistened prior to the placement of concrete, but without any standing water. At the time of placing concrete, the base shall not be wet, soft or frozen.

TS 3.40.07.04 Box-outs

Circular box-outs shall be constructed in the concrete road base around each appurtenance conforming to the following requirements:

-
- 1) 25 mm x 50 mm chamfered keyways shall be constructed in the concrete road base at the edges of the box-outs.
 - 2) The edges of the box-out shall be located a minimum of 300 mm from the outside edge of the structure requiring adjustment.
 - 3) The perimeter of the box-out shall consist of curves of a radius not less than 1.0 m. Angular corners will not be permitted.

After the concrete road base has set, the Contractor shall cover the structure with a steel plate or adjust the appurtenance below the level of the concrete road base. The box-out hole shall then be backfilled with granular material and compacted to 95% of the maximum dry density as specified in TS 501. The compacted granular material is to be brought up flush with the level of the concrete road base.

The Contractor shall then place the first lift of hot mix asphalt. The hot mix asphalt shall be machine laid and the area of the box-outs and the concrete base shall be covered in one continuous operation. The hot mix asphalt shall be supplied and placed as specified in TS 310.

After the hot mix asphalt has been approved by the City, the Contractor shall carefully remove the asphalt and granular material over the utility box-out, without lifting or disturbing the adjacent asphalt, so that the final adjustments can be made. Non-contaminated granular material can be reused as part of the road subbase, while all other material is to be disposed of, off the site in accordance with OPSS 180.

Upon completion of adjustments to final grade, all material within the box-outs shall be removed to the top of the compacted granular sub-base. Any loose material shall not be compacted, but shall be removed and disposed of off the site in accordance with OPSS 180.

The box-outs shall then be backfilled with concrete, as per this specification, up to the level of the concrete road base. All joints shall match the existing or proposed joints in the concrete road base and shall be in accordance with the requirements of this specification. A gap of 12 mm wide x 50 mm deep, along the inside edge of the box-out joint, shall be left at the surface of the concrete road base to allow for the application of hot-poured asphalt joint sealer as per this specification.

After the joint has been sealed and the concrete has attained 75% of the required 28 day compressive strength, the base course of hot mix asphalt shall be placed as per TS 310.

TS 3.40.07.05 Utility Adjustment

All utility adjustments shall be in accordance with TS 4.50.

TS 3.40.07.06 Reinforcement, Tie Bars and Load Transfer Devices

Welded steel wire fabric, as required, shall be placed and adequately supported at the mid-slab depth at the locations shown on the drawings, or as directed by the City. Placing the welded steel wire fabric during the concrete placement is permitted provided the final location of the fabric is as required. A minimum cover of 100 mm shall be maintained at all outside edges of the concrete base and at the expansion joints.

Tie bars, as required, shall be inserted at mid depth of the slab, where indicated on the Drawings, in such a manner that no voids are created around the tie bar, and no distortion of the road base surface occurs.

Dowels and load transfer devices shall be placed in assemblies at transverse joint locations in advance of the concreting operation, or by an automatic dowel bar inserter. Dowel assemblies shall be fixed to the subgrade or subbase in such a manner that they remain stable and undisturbed during concrete placement.

Dowel bars shall be evenly spaced and placed parallel to the pavement centreline, the pavement surface and to each other. Dowels shall not deviate more than 3 mm from the pavement alignment.

TS 3.40.07.07 Placing Concrete

Concrete shall be placed and consolidated in accordance with the requirements of CSA A23.1 and the requirements of this Specification. The concrete delivering and spreading operations shall be coordinated as to provide a uniform rate of progress of the paving equipment.

The concrete shall be placed to the specified thickness, line and grade. The concrete shall be consolidated by 50 mm vibrators and other suitable tools to eliminate voids, honeycombing and entrapped air, especially against the formwork.

TS 3.40.07.08 Finishing Concrete

The concrete surface shall be finished while it is still sufficiently plastic to achieve the desired grades, elevation and texture. The surface of the concrete shall not be finished when standing water is present on the surface. The surface shall be uniform, dense, and free from undulations and projections.

The top surface shall be screeded to true grade and cross section and finished with a magnesium or aluminum float is recommended. The finishing shall be performed in a manner that does not draw water to the surface. The surface of the road base shall have no irregularities exceeding 6 mm when tested with a 3 m straightedge in any direction.

The final finish for concrete road base shall have a coarse broomed texture.

TS 3.40.07.09 Joints

Contraction, expansion and construction joints shall be formed in the road base as shown on drawing T-216.02-4. No sawcutting of joints will be permitted.

Joints shall not pass closer than 1m from the edge of a concrete road base box-out.

Joints in the asphalt courses will not be performed under the same contract, unless the contract extends for more than one construction season.

TS 3.40.07.09.01 Contraction Joints

Contraction joints shall be placed at a minimum 7:1 skew or transversely as shown on drawing T-216.02-4. Contraction joints shall also be placed longitudinally (parallel to the centreline) at the centreline and at each edge of the driving lanes. The contraction joints shall be formed such that they are 12 mm wide x 50 mm deep. The maximum distance between contraction joints shall be 30 times the thickness of the road base with a maximum distance of 5.0 m between longitudinal joints and 6.0 m between transverse joints.

Transverse contraction joints in the concrete road base shall meet at the pavement centreline, and where possible, shall align with the joints in the curb and gutter or adjacent structure. Where contraction joints intersect with roadway appurtenances, they shall deviate in alignment to be directed through the centre of the appurtenance, as shown on drawing T- 216.02-5.

TS 3.40.07.09.02 Expansion Joints

Expansion joints shall be constructed to the full thickness of the road base as shown on drawings T-216.02-4. The top surface of the bituminous fibre shall be 50 mm from the surface of the concrete road base. The fibre shall be vertical and straight in alignment. A gap of 12 mm wide x 50 mm deep shall be left at the surface of the concrete road base to allow for the application of hot-poured asphalt joint sealer.

TS 3.40.07.09.03 Construction Joints

At the end of each day's work, or in the event of an unavoidable stoppage of concrete placement extending more than 30 minutes, a keyed construction joint shall be placed as shown on drawing T-216.02-5. Where possible, the construction joint shall coincide with the planned location of a contraction joint. A gap of 12 mm wide x 50 mm deep shall be left at the surface of the concrete road base to allow for the application of hot-poured asphalt joint sealer.

TS 3.40.07.09.04 Joint Sealant

All joints shall be sealed with hot-poured rubberized asphalt cement.

The sealant compound shall be melted slowly with constant agitation until it is in a lump-free, free-flowing state, within the temperature range recommended by the manufacturer for application. Heating above the manufacturer's recommended range for application is not permitted.

Immediately prior to pouring the sealant compound, the joint shall be cleaned and dried using a hot compressed air lance.

The sealant compound shall be placed within two minutes of the hot lance treatment by a manual pouring cone, or hose and wand, fitted with a proper size tip, from a low pressure pump connected to the heating kettle.

The tip of the cone or wand shall be placed to the bottom of the joint to ensure uniform application. The joint shall be filled such that the top of the sealant is 2 mm to 4 mm below the surface of the concrete road base. If after the initial placement, the material subsides below the required level, then additional material shall be applied.

Sealant compound damaged by traffic or the Contractor's operation shall be replaced at the Contractor's expense.

TS 3.40.07.10 Concrete Curing

Concrete curing media shall meet the requirements of TS 1350.

TS 3.40.07.10.01 Curing with Burlap and Water

Burlap mats shall be pre-soaked by immersion in water for at least 6 hours immediately prior to placing. The mats shall cover the entire width and edges of the exposed concrete. The mats shall overlap 300 mm and shall be held down to prevent displacement. The mats shall be maintained in place and kept saturated for a minimum period of 7 days. The Contractor may constantly water the mats or cover them with opaque polyethylene film, or a combination of both, in order to keep the mats saturated.

Alternatively, this method shall be used for a minimum period of 3 days following which the surface shall be cured with curing compound as specified in TS 1350.

TS 3.40.07.10.02 Curing with Geotextile Fabric and Water

Geotextile fabric shall be pre-soaked by immersion in water for at least 6 hours immediately prior to placing. Two layers of fabric shall be applied to the surface of the concrete and shall cover the entire width and edges of the exposed concrete. Strips shall overlap 100 mm and shall be held down to prevent displacement. The fabric shall be maintained in place and kept saturated for a minimum period of 7 days. The Contractor may constantly water the mats or cover them with opaque polyethylene film, or a combination of both, in order to keep the mats saturated.

Alternatively, this method shall be used for a minimum period of 3 days following which the surface shall be cured with curing compound as specified in TS 1350.

TS 3.40.07.10.03 Curing with Polyethylene Film

White, opaque polyethylene film (100 µm thick) shall be placed such that air flow between it and the concrete surface is prevented. The film shall be held down at the edges and laps, and shall be overlapped a minimum of 150 mm, to prevent displacement. The film shall be kept in place for a minimum period of 7 days.

Alternatively, this method shall be used for a minimum period of 3 days following which the surface shall be cured with curing compound as specified in TS 1350.

TS 3.40.07.10.04 Curing with Membrane Compound

Immediately prior to application, the curing compound shall be agitated by mechanical means to provide a homogeneous mixture. Curing compound shall be spray applied in two coats to the concrete surface, with the second coat applied at right angle to the first coat, such that the membrane formed is uniform in thickness and colour and is free of breaks and pinholes. The surface shall be maintained in this condition for a minimum period of 7 days. The rate of application shall not be less than that specified by the manufacturer of the compound.

TS 3.40.07.11 Concrete Road Base Protection

Concrete road base protection shall meet the requirements of TS 1350.

TS 3.40.08 QUALITY ASSURANCE

Quality assurance shall meet the requirements of TS 1350.

TS 3.40.08.01 Concrete Thickness

The thickness of the concrete structure shall be determined by field measurement or in accordance with a thickness measurement method specified in Contract.

The Contract Administrator reserves the right to verify the thickness of the concrete structure for structural integrity check and payment purpose using a non-destructive testing method or by coring.

When a measurement of concrete thickness is carried out by coring, the measurement shall be based on either a 100 mm or a 150 mm diameter core. The diameter of the core shall be at least 3 times the size of the maximum coarse aggregate as per CSA A23.1.

No core shall be taken within 250 mm from the joints or edges. The length of each core shall be determined in accordance with ASTM C 174. Core samples that are broken or obviously damaged shall not be used for concrete thickness determination. The damaged cores shall be replaced by acceptable cores taken from the same subplot(s). Core samples taken for concrete thickness determination shall not be used for compressive strength test.

Regardless of the method used, concrete thickness shall be determined on a lot basis. Each lot shall have 4 sublots of equal size, where each subplot is represented by a thickness measurement. The Contract Administrator will determine the size of the lot(s) and sublots for the purpose of concrete thickness acceptance and payment.

The concrete thickness for a road base in a lot shall be the average concrete thickness of the lot (Tx). The average concrete thickness for a lot shall be calculated from the following formula:

$$Tx = \frac{T1 + T2 + T3 + T4}{4}$$

Where: Tx is the average concrete thickness for a lot, rounded off to the nearest mm.
T1, T2, T3 and T4 are the concrete thickness for Sublots 1, 2, 3 and 4.

For the purpose of the calculation, any individual subplot measurement that is more than 5 % above the specified thickness shall be assumed to be equal to the specified thickness plus 5 %.

A lot will be accepted, on a thickness basis, if the average concrete thickness of the lot equals or exceeds 100 percent of the specified thickness. Payment for the lot will be determined in accordance with TS 3.40.10.01.

At the sole discretion of the Contract Administrator, a lot may be accepted and allowed to remain in place, if the average concrete thickness of the lot is between 95 and 100 percent of the specified thickness. The lot accepted based on the above conditions will not be eligible for full payment. Payment for the lot will be determined in accordance with TS 3.40.10.01. Adjustment of the contract price for the lot shall be based on Table 1.

If the concrete thickness of an individual subplot is less than 95 percent of the specified thickness, the Contractor shall remove and replace the subplot at their expense even if the average concrete thickness of a lot is more than 95 percent of the specified thickness.

All replacement lots shall be accepted on the same basis as the original lot.

TS 3.40.09 MEASUREMENT FOR PAYMENT

TS 3.40.09.01 Concrete Road Base

Measurement will be the surface area of concrete road base placed in square metres.

TS 3.40.10 BASIS FOR PAYMENT

TS 3.40.10.01 Concrete Road Base - Item

Payment at the contract price for the above item shall be full compensation for all labour, equipment, materials and incidentals to do the work. Payment shall include, but not limited to, the supplying, placing and finishing of the concrete road base, the forming of the joints and the supplying and placing of joint sealant.

At the discretion of the Contract Administrator, payment for the item may be adjusted in accordance with TS 3.40.08.01 and Table 1.

The cost of thickness testing shall be borne by the City unless the results indicate a thickness deficiency of 5 percent or more, in which case the Contractor shall bear all costs of testing.

TABLE 1

Thickness Tx	Percent Payment
100 percent of specified thickness or above	100
100 percent of specified thickness to 95 percent of specified thickness	$\frac{(Actual\ Thickness)^2}{(Specified\ Thickness)^2} \times 100$
less than 95 percent of specified thickness	remove and replace at the Contractor's expense