

Construction Specification for
Concrete Road Base

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TS 3.40.01 SCOPE

This specification covers the requirements for the construction of concrete road base.

TS 3.40.02 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 4.50	Construction Specification for Utility Adjustments
TS 310	Construction Specification for Hot Mixed, Hot Laid, Asphaltic Concrete Paving
TS 501	Amendment to OPSS.MUNI 501 – Construction Specification for Compacting
TS 1010	Amendment to OPSS.MUNI 1010 – Material Specification for Aggregates – Base, Subbase, Select Subgrade and Backfill Material
TS 1350	Amendment to OPSS.MUNI 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

Ontario Provincial Standard Specifications

OPSS 180	General Specification for the Management of Excess Materials
OPSS 919	Construction Specification for Formwork and Falsework
OPSS 1212	Material Specification for Hot Poured Rubberized Asphalt Joint Sealing Compound
OPSS 1441	Material Specification for Load Transfer Assemblies
OPSS 1442	Material Specification for Epoxy Coated Reinforcing Steel Bars for Concrete

Canadian Standards Association

A 23.1	Concrete Materials and Methods of Concrete Construction
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American Society of Testing and Materials

C 174	Standard Test Method for Measuring Thickness of Concrete Elements Using Drilled Concrete Cores
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TS 3.40.03 DEFINITIONS

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

12-Bag Mix means a type of concrete containing 480 kilograms of cement in one cubic metre of volume which yields to properties that allow the concrete road base to gain sufficient strength in 4-hours and receive an asphalt layer on the top for quick reopening of traffic lanes. This material only to be used for the permanent restoration of utility cuts.

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.

GU/GUL means general use or general use limestone hydraulic cement.

HE means high early strength hydraulic cement.

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 DESIGN AND SUBMISSION 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 Contract Administrator 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 be according to 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 TS 1350.

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

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

TS 3.40.05 MATERIALS

TS 3.40.05.01 Concrete

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

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

Note^a: The 37.5 mm nominal aggregate may be used for concrete slabs 250 mm thick or greater.

For 7 day concrete:

- Minimum 7 day compressive strength: 32 MPa.

For 24-hour concrete:

- Minimum 24-hour compressive strength: 32 MPa.
- 24 hour concrete can only be manufactured using high early strength hydraulic cement (HE).

TS 3.40.05.02 Concrete 12-Bag Mix

The materials for and the production 12 bag mix concrete shall meet the requirements of TS 1350 and the following:

Cement type	12 Bag Mix – 40 kg/bag
Minimum 28 day compressive strength	32 MPa
Maximum nominal size of coarse aggregate	19 mm
Slump at point of discharge	60 ± 20 mm
Air content	6.0 ± 1.0%

If the ambient air temperature is below 10°C, 2 percent calcium chloride shall be added to the mixing water. The mix shall not contain any set retarding admixtures.

TS 3.40.05.03 Welded Steel Wire Fabric

All welded steel wire fabric detailed on the Contract 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 be according to OPSS 1010.

TS 3.40.05.05 Tie Bars and Load Transfer Devices

Tie bars shall be according to OPSS 1442 and load transfer devices shall be according to OPSS 1441.

TS 3.40.05.06 Expansion Joint Material

Expansion joint material shall be bituminous fibreboard having a minimum thickness of 12 mm.

TS 3.40.05.07 Joint Sealant

Joint sealant shall be hot-poured rubberized asphalt cement and shall be according to OPSS 1212.

TS 3.40.06 EQUIPMENT**TS 3.40.06.01 Forms**

Forms shall be steel, wood or metal plate forms and shall be according to 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 three 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 the Concrete Ontario Municipal Exterior Flatwork Certification (MEFC) or ACI Flatwork Certification.

TS 3.40.07.01 Excavation

All excavation shall be according to TS 2.10.

Excavation shall be to the lines and grades shown on the Contract Drawings. 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 Contract Administrator, 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 according to 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% of the maximum dry density according to TS 501.

The subgrade shall be proof rolled, and any soft or yielding areas shall be sub-excavated 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 according to 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 be according to 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

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

25 mm x 50 mm chamfered keyways shall be constructed in the concrete road base at the edges of the box-outs.

The edges of the box-out shall be located a minimum of 300 mm from the outside edge of the structure requiring adjustment.

The perimeter of the box-out shall consist of curves of a radius not less than one metre. Angular corners shall 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 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 according to TS 310.

After the hot mix asphalt has been approved by the Contract Administrator, 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 according to 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 according to 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 according to 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 per cent of the required 28 day compressive strength, the base course of hot mix asphalt shall be placed according to TS 310.

TS 3.40.07.05 Utility Adjustment

All utility adjustments shall be according to 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 Contract Drawings. 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 Contract 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 according to 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 Placing 12-Bag Mix Concrete

Concrete shall be delivered to the work site and discharged within 1 1/2 hours after the introduction of the mixing water to the cement and aggregates or before the drum has revolved 300 revolutions, whichever comes first. The Contractor shall produce a copy of the delivery ticket for inspection before unloading at the work site. This ticket shall show the time the truck was loaded, the number of bags of cement per cubic metre, the maximum aggregate size, slump, percent of air content, and percent of calcium chloride added.

The concrete truck shall be capable of discharging concrete with a 60 +/-20 mm slump without manual assistance.

The sub-base shall be thoroughly soaked with water five minutes before placing the concrete. The Contractor shall place the concrete in the excavation with the use of vibrators in accordance with CSA A23.1 and screed the surface. Ten to fifteen minutes after screeding the concrete, a white pigmented concrete curing compound shall be applied.

The concrete shall then be protected from traffic for a minimum period of four hours during which time it shall not be subject to loading conditions of any type. After the four hour set period, the asphalt can be placed. Where requested by the Contract Administrator, the Contractor shall use concrete with a 0 mm slump placed and compacted in two layers.

Where requested, the Contractor shall place the asphalt on this repair immediately and where requested, allow traffic on this repair immediately.

TS 3.40.07.09 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 matter 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 or as specified in the Contract Documents.

TS 3.40.07.10 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 one metre from the edge of a concrete road base box-out.

TS 3.40.07.10.01 *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 m between longitudinal joints and 6 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 3.40.07.10.02 *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 3.40.07.10.03 *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 3.40.07.10.04 *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 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 no extra cost to the City.

TS 3.40.07.11 Concrete Curing

Concrete curing media shall be according to TS 1350.

TS 3.40.07.11.01 *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 according to TS 1350.

TS 3.40.07.11.02 *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 according to TS 1350.

TS 3.40.07.11.03 *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 according to TS 1350.

TS 3.40.07.11.04 *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 3.40.07.12 **Concrete Road Base Protection**

Concrete road base protection shall be according to TS 1350.

TS 3.40.08 **QUALITY ASSURANCE**

Quality assurance shall be according to TS 1350.

TS 3.40.08.01 **Visibly Defective or Damaged Concrete**

Concrete that is visibly defective or damaged is not acceptable and shall be removed and replaced at no extra cost to the City.

Concrete is visibly defective or damaged when:

- The concrete is honeycombed.
- The concrete contains embedded debris.
- The concrete has been damaged by freezing.
- The concrete temperature at the time of placement exceeded the requirements of this specification.
- The concrete surface has been damaged by rain.
- The concrete contains footprints or other undesirable impressions.
- The concrete has been subjected to traffic before the concrete attained 20 MPa.
- The concrete has cracked or separated.
- The concrete surface has spalled as defined in the *General Conditions of Contract* that the Contract Administrator will be the sole judge to the determination.
- Expansion and isolation joints are not vertical.
- The concrete sections have heaved or sunk, from their original position.

TS 3.40.08.02 **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 Documents.

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 150 mm diameter core. The diameter of the core shall be at least three times the size of the maximum coarse aggregate according to CSA A23.1.

No core shall be taken within 250 mm from the joints or edges. The length of each core shall be determined according to 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 four 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 concrete road base in a lot shall be the average concrete thickness of the lot (T_x). The average concrete thickness for a lot shall be calculated from the following formula:

$$T_x = \frac{T_1 + T_2 + T_3 + T_4}{4}$$

Where: T_x is the average concrete thickness for a lot, rounded off to the nearest mm.
 T_1 , T_2 , T_3 and T_4 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 per cent above the specified thickness shall be assumed to be equal to the specified thickness plus 5 per cent.

A lot will be accepted, on a thickness basis, if the average concrete thickness of the lot equals or exceeds 100 per cent of the specified thickness. Payment for the lot will be determined according to 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 per cent 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 according to 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 per cent 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 per cent 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 of concrete road base shall be by surface area placed in square metres (m²).

TS 3.40.09.02 Supplemental Cost for 7 Day Concrete

Measurement of 7 day concrete shall be by surface area placed in square metres (m²). Concrete delivery tickets shall not be used for measurement purposes.

TS 3.40.09.03 Supplemental Cost for 24-hour Concrete

Measurement of 24-hour concrete shall be by surface area placed in square metres (m²). Concrete delivery tickets shall not be used for measurement purposes.

TS 3.40.09.04 12-Bag Mix Concrete

Measurement of 12-bag mix concrete shall be by surface area placed in square metres (m²).

TS 3.40.10 BASIS OF PAYMENT**TS 3.40.10.01 Concrete Road Base – 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 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 according to 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 per cent or more, in which case the Contractor shall bear all costs of testing.

Table 1: Payment adjustment

Thickness Tx	Per cent payment
100 per cent of specified thickness or above	100
100 per cent of specified thickness to 95 per cent of specified thickness	$\frac{(Actual\ Thickness)^2}{(Specified\ Thickness)^2} \times 100$
less than 95 per cent of specified thickness	remove and replace at no extra cost to the City

TS 3.40.10.02 Supplemental Cost for 7 Day Concrete – Item

The supplemental cost for 7 day concrete shall be the premium cost in addition to the cost for standard 28 day concrete.

TS 3.40.10.03 Supplemental Cost for 24-hour Concrete – Item

The supplemental cost for 24-hour concrete shall be the premium cost in addition to the cost for 7 day concrete.

TS 3.40.10.04 12-Bag Mix Concrete – 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 the supplying, placing and finishing of the 12-bag mix concrete. The concrete road base placed shall have a thickness of 200 mm. Where required, concrete shall be placed at a thickness greater than 200 mm to match the existing road base thickness.