SPECIFICATION FOR NON-STRUCTURAL CONCRETE

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TS 13.00.01 SCOPE

This Specification covers the requirements for the materials, equipment and methods for proportioning and mixing Portland cement concrete, and related materials, for the construction of road base, sidewalk, curb and gutter, catch basins and all other non-structural concrete items.

TS 13.00.02 REFERENCES

This Specification refers to the following specifications and publications:

Ontario Provincial Standard Specifications, Materials

OPSS 1001 –	Aggregates – General	(Mar. 1993)
OPSS 1002 –	Aggregates – Concrete	(May 1993)
OPSS 1303 –	Air Entraining and Chemical Admixtures for Portland Cement Concrete	(Sept. 1996)
OPSS 1306 –	Burlap	(Sept. 1996)
OPSS 1315 –	White Pigmented Curing Compounds	(Sept. 1996)

American Society for Testing and Materials (ASTM)

ASTM C 171 –	Sheet Materials for Curing Concrete	(Current Edition)
ASTM C 174 –	Measuring Length of Drilled Concrete Cores	(Current Edition)
ASTM C 309 –	Liquid Membrane-Forming Compounds for Curing Concrete	(Current Edition)
ASTM C 457 –	Microscopical Determination of Air-Void Content and the Parameters of the Air-Void System in Hardened Concrete	(Current Edition)
ASTM C 494 –	Chemical Admixtures for Concrete	(Current Edition)
ASTM C 666 –	Resistance of Concrete to Rapid Freezing and Thawing	(Current Edition)
ASTM D 1751 –	Expansion Joint Filler for Concrete Paving and Structural Construction	(Current Edition)

Canadian Standards Association (CSA)

CAN/CSA-A5 –	Portland Cement	(Current Edition)
CAN/CSA-A23.1 –	Concrete Materials and Methods of Concrete Construction	(Current Edition)
CAN/CSA-A23.2 –	Methods of Test for Concrete	(Current Edition)
A283 –	Qualification Code for Concrete Testing Laboratories	(Current Edition)
CAN/CSA-A362 –	Blended Hydraulic Cement	(Current Edition)
CAN/CSA-A363 –	Cementitious Hydraulic Slag	(Current Edition)
CAN/CSA-G30.3 –	Cold Drawn Steel Wire for Concrete Reinforcement	(Current Edition)
CAN/CSA G30.5 –	Welded Steel Wire Fabric for Concrete Reinforcement	(Current Edition)
CAN/CSA-G30.18 –	Billet Steel Bars for Concrete Reinforcement	(Current Edition)
CAN/CSA-G40.21 –	Structural Quality Steels	(Current Edition)

City of Toronto Specifications

TS 904 –	Amendments to OPSS 904 – Construction Specification for Structural

	Concrete	(June 2001)
TS 905 –	Amendments to OPSS 905 – Construction Specification for Reinforcement for Concrete Structures	(June 2001)
TS 1860 –	Amendments to OPSS 1860 – Material Specification for Geotextiles	(June 2001)

Transportation Research Board
NCHRP Report 244 – Concrete Sealers for Protection of Bridge Structures

TS 13.00.03 DEFINITIONS

For the purposes of this specification the following definitions apply:

Admixtures: means ingredients in concrete other than Portland cement, water and aggregates, that are added to the concrete mixture before or during mixing.

Alkali-Aggregate Reactivity: means a chemical reaction between the cementing material and certain minerals in the aggregates which cause expansive cracking in the hardened concrete.

Cementing Material: means Portland cement with or without the addition of supplementary cementing materials.

Crushed Gravel: means at least 2 crushed faces on 100 percent of gravel particles.

Epoxy: means a multi component resin grout.

Falsework: means a temporary structure erected to support work in the process of construction - composed of shoring or vertical posting, formwork for beams and slabs, and lateral bracing.

Formwork: means a total system of support for freshly placed concrete including moulds or sheathing as well as all supporting membranes, hardware and bracing.

Grout: means a mixture of cementing materials, with or without admixtures, and water. The consistency varies from stiff to fluid.

Mortar: means a mixture of cementing materials, sand and water, with a butter-like consistency.

Non-Structural Concrete: means concrete used for the construction of catch basins, maintenance holes, valve chambers, pipe support, road base, sidewalk, curb, curb and gutter and all other concrete that does not classify as structural concrete.

Slurry: means a pourable mixture of cementing materials, sand and water.

Superplastizied (Flowing) Concrete: means normal slump concrete to which a high-range water reducing admixture has been added to produce a high-slump flowing concrete.

Supplementary Cementing Materials: means materials that, when used in conjunction with Portland cement, contribute to the properties of the hardened concrete through hydraulic or pozzolanic activity or both.

Structural Concrete: means any concrete used in the construction of bridges, culverts, tunnels, retaining walls, wharfs or guideways.

Unshrinkable Fill: means a mixture of aggregates, cementing material and water, with or without chemical admixtures, that hardens into a material with higher strength than soil but less than 0.4 MPa compressive strength at 28 days that can be removed with hand tools.

Vitrified Clay Pipe: means pipe made from various clays which are shaped, dried and fired to a point where glass-forming components fuse to form a bond between the crystalline grains.

TS 13.00.04 SUBMISSION AND DESIGN REQUIREMENTS

TS 13.00.04.01 General

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

TS 13.00.04.02 Materials

Prior to starting the work, the Contractor shall supply the Commissioner with material safety data sheets (MSDS) for all the materials to be incorporated in the work.

TS 13.00.04.03 Concrete

Submissions required by the Commissioner regarding concrete mix designs and materials shall provide at least the following information:

(i) The source of each material to be incorporated in the concrete and the name of the concrete supplier.

(ii) Certification that all materials to be incorporated into the concrete mix are compatible in the mix and meet or exceed the requirements given above.

(iii) The proportions of each material for each class of concrete to be incorporated into the work.

(iv) The results of slump, total air content and compressive strength testing at 7-day, 28-day, and other ages if required in the specifications, for each class of concrete to be incorporated into the work, supplied by an independent laboratory certified to CSA A283 (Category I).

(v) If blended hydraulic cements or supplementary cementing materials are proposed, documentation demonstrating satisfactory performance of similar concrete mixes incorporating the proposed cementing materials in similar applications. As a minimum, this satisfactory performance may be shown through the documented visual assessment of at least 5 projects, each at least 3 years old, for each mix incorporating blended hydraulic cement or supplementary cementing materials. Documentation for each visual assessment shall include, as a minimum, the type and source of the cementing material incorporated, concrete mix materials and proportions used, the application in which the concrete has been incorporated (eg. bridge deck, sidewalk, etc.) and the current condition, signed by a professional engineer.

(vi) Alternative to (v)
If supplementary cementing materials are to be incorporated into the concrete mix, certification and documentation signed by a professional engineer, stating that the quality and durability of the concrete with supplementary cementing materials will equal or exceed the quality and durability of the concrete without supplementary cementing materials. Specific documentation relating to deicer chemical scaling resistance and rate of strength gain shall also be submitted.

(vii) The results of testing of the quality of the air voids system of the hardened concrete mix(es) to be incorporated into the work, as determined by ASTM C457, documenting conformance to CAN/CSA-A23.1.14.3.

TS 13.00.04.04 Reinforcing Steel

Submissions required by the Commissioner from the Contractor shall provide at least the following information:

(i) The source of all reinforcing steel products, name of the reinforcing steel fabricator.

(ii) Two copies of the mill certificate and two copies of the stress-strain curves representative of each lot of material to be used for reinforcing steel.

TS 13.00.04.06 Curing Media

Submissions required by the Commissioner from the Contractor shall provide at least the following information:

(i) The source of the curing medium, manufacturer's product installation and certification data.

TS 13.00.04.07 Joint Filler

Submissions required by the Commissioner from the Contractor shall provide at least the following information:

(i) The source of expansion joint filler material, manufacturer's product installation and certification data.

TS 13.00.04.08 Concrete Sealer

Submissions required by the Commissioner from the Contractor shall provide at least the following information:

(i) The source of the concrete sealer and the manufacturer's installation guidelines and data.

(ii) Certification that the sealer meets or exceeds the requirements of NCHRP 244, as stated above.

TS 13.00.04.09 Production of Concrete

Submissions requested by the Commissioner regarding the production of concrete shall provide at least the following information:

(i) Certification of the plant and equipment by the Ready Mix Concrete Association of Ontario.

(ii) Certification that the plant and equipment meet or exceed the requirements of CAN/CSA-A23.1, Section 16, Table 11 for Alternate 1.

TS 13.00.05 MATERIALS

TS 13.00.05.01 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 13.00.05.02 Concrete

TS 13.00.05.02.01 General

This Specification covers the manufacture of either job mixed or ready mixed concrete for use in road base, pavements, curbs, gutters, sidewalks, catch basins and maintenance holes and all other non-structural items.

The Contractor shall be responsible for the collection and disposal of the remains of all concrete used for testing purposes. In order to simplify collection and handling, the Contractor shall set aside a designated location for the temporary piling of this discarded material close to the point of discharge from the delivery truck and shall provide assistance to transport the material into the designated location.

TS 13.00.05.02.02 Portland Cement

Unless otherwise specified, all cement shall be normal Portland cement (Type 10) or high-early strength Portland cement (Type 30) meeting the requirements of CAN/CSA-A5.

High-early strength Portland cement (Type 30) may be used only with the prior approval of the Commissioner.

Additional Type 10 Portland cement may not be used as a means of obtaining high early strength in the concrete.

Blended hydraulic cements shall meet the requirements of CAN/CSA-A362 and CAN/CSA-A363. Blended hydraulic cements may be used only with the prior approval of the Commissioner.

TS 13.00.05.02.03 Supplementary Cementing Materials

Unless otherwise specified, supplementary cementing materials (fly ash, silica fume and/or slag cement) may be used only with the prior approval of the Commissioner. Supplementary cementing materials shall meet the requirements of CAN/CSA-A23.1 and CAN/CSA-A363.

The supplementary cementing materials shall be restricted to the following proportions by mass of the total cementing materials:

(i) Slag cement up to 50 percent.

(ii) Fly ash up to 25 percent.

(iii) Silica fume up to 10 percent
.

(iv) A mixture of slag cement and fly ash up to 50 percent except that the amount of fly ash shall not exceed 25 percent by mass of the total cementing materials.

The minimum total cementing materials content for all concrete shall be 355 kg/m^3.

TS 13.00.05.02.04 Aggregates

TS 13.00.05.02.04.01 General

Aggregates from sources known to cause alkali-aggregate reactivity or D-cracking shall not be used. Aggregates shall be supplied from the MTO Concrete Aggregate Sources List and shall have documented, demonstrated, satisfactory performance for durability, resistance to alkali-aggregate activity (alkali-silicate or alkali-carbonate) and resistance to D-cracking for concrete in severe exposure conditions. As a minimum, this satisfactory performance may be shown through the documented visual assessment of at least 5 exposed concrete deck, slab or pavement projects, each at least 10 years old, for each aggregate source and type. The Contractor's documentation for each visual assessment shall include, as a minimum, the location, type and name of the installation, the aggregate source(s) and types incorporated, concrete materials and mix design used and the current condition, in a signed report by a professional engineer. Additional supporting information on the aggregates, such as CAN/CSA-A23.2-14A (potential expansivity of aggregate), CAN/CSA-A23.2-25A (detection of alkali-silica reactive aggregate) and ASTM D 666 Procedure A (D-cracking) test results, will be of assistance to the Commissioner during assessment of the concrete materials submission.

TS 13.00.05.02.04.01 Fine Aggregate

Fine aggregate shall consist of clean particles of natural or manufactured sand or an approved combination thereof, free from soft, thin, elongated or laminated particles and shall meet the requirements of CAN/CSA-A23.1, OPSS 1001 and OPSS 1002, including the requirements of the latest revision to these documents.

TS 13.00.05.02.04.02 Coarse Aggregate

Coarse aggregate shall consist of hard, strong, uncoated, durable particles of crushed stone or crushed gravel, meeting the requirements of CAN/CSA-A23.1, OPSS 1001 and OPSS 1002, including the requirements of the latest revisions to these documents.

Except where otherwise specified, the nominal maximum size of coarse aggregate shall be either 37.5 mm or 19.0 mm (normally, 37.5 mm aggregate is used in concrete road base only).

TS 13.00.05.02.05 Water

Water for use in concrete and for curing shall meet the requirements of CAN/CSA-A23.1.

TS 13.00.05.02.06 Admixtures

All admixtures shall meet the requirements of ASTM C 494.

When tested in concrete, as described in OPSS 1303, Section 1303.08.02, the admixture shall contain not more than 0.1 percent chloride, expressed in terms of calcium chloride ($CaCl_2$), by mass of cementing materials. Only admixtures containing not more than 0.01 percent chloride by mass of cementing material (designated "Non-Chloride Admixture") shall be used in prestressed concrete.

Water reducing admixtures shall be Type A (Normal Setting), and shall meet the requirements of ASTM C 494. They shall be used at the manufacturers minimum dosage, unless otherwise specified.

TS 13.00.05.03 Reinforcing Steel

TS 13.00.05.03.01 General

Reinforcing steel, including reinforcing steel bars and welded wire steel fabric, shall be supplied from a source on the MTO Designated Sources for Materials List.

TS 13.00.05.03.02 Reinforcing Steel Bars

Deformed reinforcing steel bars shall meet the requirements of OPSS 1440. Unless otherwise specified, reinforcing steel for installation in culverts and head walls shall be grade 400 W.

TS 13.00.05.03.03 Welded Steel Wire Fabric

Welded steel wire fabric shall meet the requirements of CAN/CSA-G30.5.

TS 13.00.05.03.04 Cold Drawn Steel Wire

Cold drawn steel wire shall meet the requirements of CAN/CSA-G30.3.

TS 13.00.05.03.05 Supports

Bar supports shall be made of precast concrete blocks, plastic or wire. Bar supports over 200 mm in height shall be made of bent or welded steel bar. Bar supports shall meet the requirements of CAN/CSA-A23.1, Section 12.7.2.

T 13.00.05.03.06 Dowels

Dowel bars for concrete road base shall be 450 mm x 32 mm plain round bars of grade 350 or better meeting the requirements of CSA-G30.18.

TS 13.00.05.04 Curing Media

TS 13.00.05.04.01 Curing Compound

White pigmented curing compound shall meet the requirements of ASTM C 309 and OPSS 1315.

TS 13.00.05.04.02 Polyethylene Film

White opaque polyethylene film shall meet the requirements of ASTM C 171. A minimum thickness of 6 mils is required.

TS 13.00.05.04.03 Geotextile Fabric

Geotextile fabric used as a curing medium shall be a synthetic, permeable textile meeting the requirements of TS 1860. A minimum thickness of 0.9 mm is required.

TS 13.00.05.04.04 Burlap

Burlap cloth used as a curing medium shall be made from jute or kenaf, and shall meet the requirements of OPSS 1306.

TS 13.00.05.05 Expansion (Isolation) Joint Filler

Expansion joint filler material shall consist of preformed Type A - Non-Extruding and Resilient Bituminous, ASTM D 1751.

Unless otherwise specified or shown on the Standard Drawings, the thickness of the expansion joint filler shall be 12 mm.

T 13.00.05.06 Concrete Sealer

Unless otherwise specified, the sealer shall be a two-coat colourless solution of methyl methacrylate copolymer resins, a penetrating agent and fast evaporating solvent with a minimum solids content of 20 percent and containing no fillers. Application rates and solids content shall be in accordance with certified test results on the NCHRP 244 test series to be submitted prior to construction for approval. Acceptable materials shall meet the following NCHRP 244 performance criteria:

Four Inch Cube Tests: 75 percent effective in reducing water absorption when compared to an untreated control sample.

Southern Exposure Tests: 90 percent effective in reducing chloride ion content when compared to an untreated control sample.

The sealer shall be compatible with the surface over which it is to be applied. The resultant coating shall have the ability to breathe, be water resistant, durable, nonyellowing, and resistant to ultraviolet light and weathering.

TS 13.00.06 EQUIPMENT

In general, equipment for the production of concrete shall meet the requirements of CAN/CSA-A23.1 and to the certification requirements of the Ready Mixed Concrete Association of Ontario.

TS 13.00.07 CONSTRUCTION

TS 13.00.07.01 General

Ready mixed concrete shall be produced at a plant certified by the Ready Mixed Concrete Association of Ontario.

TS 13.00.07.02 Mixing Time and Rate

Mixing time and rate shall meet the requirements of CAN/CSA-A23.1, Section 18.

TS 13.00.07.03 Temperature Control

TS 13.00.07.03.01 General

The temperature of the cementing materials shall be less than 65°C immediately prior to batching.

Unless otherwise specified, the concrete temperature at time of discharge from the truck shall be between 10°C and 28°C.

TS 13.00.07.03.02 Cold and Hot Weather Concrete Production

Precautions for cold and hot weather concrete production shall meet the requirements of CAN/CSA-A23.1.

TS 13.00.07.04 Ready Mix Concrete

The production of ready mixed concrete shall meet the requirements of CAN/CSA-A23.1, Section 18.

TS 13.00.07.05 Delivery of Concrete

After the completion of mixing, the concrete shall be transported to the site by means of agitator trucks only. The equipment shall be operated at the speed of rotation designated by the manufacturer's of the truck as the agitating speed.

The concrete shall be delivered to the site, in a thoroughly mixed and uniform mass. The time between batching and complete discharge shall not exceed 120 minutes, unless otherwise specified. For hot weather concrete the time between batching and complete discharge shall not exceed 60 minutes.

TS 13.00.07.06 Control of Slump and Air Content

No water shall be added after the initial introduction of the mixing water for the batch, except at the start of discharge, when the measured slump of the concrete is less than that specified and no more than 60 minutes have elapsed from the time of batching to the start of discharge. In this case, water may be added by the producer to an amount not exceeding 16 l/m3 or 10 percent of the mix design water. The drum or blades shall then be turned an additional 30 revolutions or more at mixing speed, until the uniformity of the concrete is sufficient. Water shall not be added to the batch at any later time. Concrete may be used as long as it is of such slump that, in the opinion of the Commissioner, it can be placed and properly consolidated without the addition of water to the batch. The Commissioner will determine the air content of the concrete at the point of discharge, in accordance with the provision of CAN/CSA A23.1. Concrete shall be retested for conformance to air content requirements when more than 90 minutes have elapsed since batching. Water added at the job site shall be recorded on the delivery slip.

The air content of the concrete shall, if necessary, be brought up to the specified range by the addition of an air-entraining admixture in the field. Mixing shall follow to ensure proper dispersion. The air content shall be retested. The amount of admixture shall be recorded on the delivery slip.

When superplasticized or flowing concrete is used and the measured slump falls below the specified slump due to delay, it shall be retempered with superplasticizing admixtures only, not water. The amount of admixture shall be recorded on the delivery slip.

TS 13.00.07.07 Delivery Tickets

Delivery tickets shall meet the requirements of CAN/CSA-A23.1.18.4.5.

TS 13.00.07.08 Placing Concrete

Concrete shall be placed and consolidated in accordance with the requirements of Section 19 of CAN/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.

The concrete shall be placed to the specified thickness, line and grade. The concrete shall be consolidated by the use of 50mm vibrators to eliminate voids, honeycombing and entrapped air. Vibrators shall not be used to distribute the concrete.

TS 13.00.07.09 Concrete Curing

TS 13.00.07.09.01 General

All exposed concrete surfaces shall have the curing process commence as soon as possible, and not more than 30 minutes after surface finishing or within one hour of form removal.

Acceptable methods of curing include one or more of the following:

(i) Burlap

(ii) Geotextile fabric and water.

(iii) Polyethylene sheet.

(iv) Curing membrane compound.

Each curing method may be used at ambient temperatures up to 27°C. At temperatures above 27°C, only the geotextile fabric and water procedure is permitted. In cold weather, as described in TS 904, curing compound shall not be used.

TS 13.00.07.09.02 Curing with Burlap and Water

Burlap mats shall be presoaked 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 13.00.07.09.05 of this specification.

TS 13.00.07.09.03 Curing with Geotextile Fabric and Water

Geotextile fabric shall be presoaked 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 13.00.07.09.05 of this specification.

TS 13.00.07.09.04 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 13.00.07.09.05.

TS 13.00.07.09.05 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 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 13.00.07.10 Protection

TS 13.00.07.10.01 Rain

Concrete shall not be placed if rain is sufficiently intense to separate cement (paste) from the surface of the concrete mix or to hinder finishing operations. The surface of the concrete shall not be finished when water is present on the surface.

Concrete already placed shall be protected against the effects of rain until the concrete has sufficiently hardened to resist damage.

TS 13.00.07.10.02 Traffic

The section of newly constructed concrete shall be closed to all vehicular traffic, including construction equipment, until such time as the concrete has attained at least 75 percent of the design compressive strength. Pedestrian traffic shall be kept off the newly constructed concrete for at least 8 hours.

The Contractor shall provide adequate measures to protect the newly constructed concrete section from damage by vehicular or pedestrian traffic.

TS 13.00.07.10.03 Cold and Hot Weather Precautions

When the air temperature is below 5°C or likely to fall below this limit, or when the air temperature is at or above 27°C or is likely to rise above this limit during concrete placing, the Contractor shall comply with the requirements of TS 904, sections 904.07.03.07 and 904.07.03.08.

TS 13.00.08 QUALITY ASSURANCE

TS 13.00.08.01 Acceptance Sampling and Testing

Unless otherwise specified in the contract, all acceptance sampling and testing necessary to determine conformance with the Contract requirements will be performed by the Commissioner. Sampling and testing shall conform to the requirements of CAN/CSA A23.2. The Commissioner will determine the lot sizes. The Contractor shall assist, as necessary, in obtaining samples of concrete mix for testing. The Contractor shall repair any core holes resulting from the removal of concrete samples with suitable concrete or mortar patching mix, at the Contractor's expense.

The Contractor shall be responsible for the collection and disposal of the remains of all concrete used for testing purposes. In order to simplify collection and handling, the Contractor should set aside a designated location for the temporary piling of this discarded material close to the point of discharge from the delivery truck and shall provide assistance to transport the material into the designated location.

TS 13.00.08.02 Acceptance Criteria

TS 13.00.08.02.01 General

Concrete compressive strength, concrete surface tolerance, concrete thickness and proper curing, as specified above, shall be the criteria for acceptance of non-structural concrete.

TS 13.00.08.02.02 Concrete Compressive Strength

The concrete mix shall be sampled in accordance with CAN/CSA A23.2-1C, with compressive strength specimens made in accordance with CAN/CSA A23.2-3C and tested in accordance with CAN/CSA A23.2-9C. Slump (CAN/CSA A23.2-5C), air content (CAN/CSA A23.2-4C) and temperature (ASTM C 1064) tests shall also be determined each time the concrete is sampled for compressive strength.

To meet the specified nominal minimum 28 day strength requirements:

(I) The average of all groups of three consecutive strength tests shall equal or exceed the specified strength.

(ii) No individual strength test shall be more than 3.5 MPa below the specified strength.

A compressive strength test result is the average strength of two 100 x 200 mm or two 150 x 300 mm concrete cylinders tested at the same age. The strength test of the 100 x 200 mm cylinders shall be multiplied by 0.95.

Cores removed for the purpose of determining thickness may be used to determine the compressive strength, at the discretion of the Commissioner. The cores shall be obtained according to CAN/CSA A 23.2-14C.

Concrete represented by compressive strength samples or cores not meeting or exceeding the requirements shall be removed and replaced at the Contractor's expense.

TS 13.00.08.02.03 Concrete Thickness

TS 13.00.08.02.03.01 General

The Commissioner may make measurements to determine the thickness of the concrete.

The minimum acceptable thickness of the concrete shall be the specified thickness minus 5 percent. Concrete constructed to less than 95 percent (85 percent for concrete sidewalk only) of the specified thickness shall be removed and replaced at the Contractor's expense.

Thickness determinations shall be made on a lot basis. Each lot shall have 4 equal sublots represented by a concrete core.

The mean 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 mean concrete thickness for a lot, rounded off to the nearest mm.
$T_1 + T_2 + T_3 + T_4$ are the core lengths for Sublots 1, 2, 3 and 4.

If any individual (sublot) core length is more than 5 mm above the specified slab thickness, its length shall be assumed to be equal to the specified thickness plus 5 mm for the purpose of the calculation of T_x.

TS 13.00.08.02.03.02 Concrete Road Base

The concrete road base shall be divided into lots of up to 1,000 m^2.

The concrete road base thickness shall be based on maximum 100 mm diameter cores. No core shall be taken within 250 mm of panel joints or edges. The length of each core shall be determined in accordance with ASTM C 174.

Cores which are obviously damaged shall not be considered and replacement cores shall be taken as necessary for the determination of slab thickness.

TS 13.00.08.02.03.03 Concrete Curb and Curb and Gutter

Concrete curb and concrete curb and gutter shall be divided into lots of up to 1,000 m.

The concrete curb and concrete curb and gutter thickness shall be based on the depth of the exposed face of the curb and/or gutter, measured in place.

TS 13.00.08.02.03.04 Concrete Sidewalk and Concrete Raised Median

Concrete sidewalk and concrete raised median shall be divided into lots of up to 1,000 m^2.

The concrete thickness shall be based on maximum 100 mm diameter cores. No core shall be taken within 250 mm of panel joints or edges. The length of each core shall be determined in accordance with ASTM C 174.

TS 13.00.08.02.04 Surface Tolerance

TS 13.00.08.02.04.01 General

The Contractor shall grind off or remove and replace panels with variations exceeding the specified surface tolerance. The placement of additional concrete or patching material will not be an acceptable method of achieving the desired surface tolerance.

TS 13.00.08.02.04.02 Concrete Road Base

Except across the crown or drainage gutter, the surface of the concrete road base shall be such that, when tested with a 3 metre long straight edge placed anywhere, in any direction, on the surface, there shall not be a gap greater than 5 mm at any point between the bottom of the straight edge and the surface of the concrete.

Surface tolerance determinations will be made on a lot basis. Each lot shall have 4 equal sublots, sampled on a stratified random basis in accordance with ASTM D 3665.

The concrete road base shall be divided into lots of up to 1,000 m^2.

TS 13.00.08.02.04.03 Concrete Curb and Curb and Gutter

The surface of the concrete curb or the concrete curb and gutter shall be such that, when tested with a 3 metre long straight edge placed anywhere on the surface, longitudinal to the curb, there shall not be a gap greater than 3 mm at any point between the bottom of the straight edge and the surface of the concrete.

TS 13.00.08.02.04.04 Concrete Sidewalk and Concrete Raised Median

The surface of the concrete sidewalk or the concrete raised median shall be such that, when tested with a 3 metre long straight edge placed anywhere, in any direction, on the surface, there shall not be a gap greater than 3 mm at any point between the bottom of the straight edge and the surface of the concrete.

TS 13.00.08.03 Visibly Defective or Damaged Concrete

Concrete that is visibly defective or damaged shall be removed and replaced as directed by the Commissioner. Concrete is visibly defective or damaged when:

(i) The concrete is honeycombed.

(ii) The concrete contains embedded debris.

(iii) The concrete has been damaged by freezing.

(iv) The concrete temperature at the time of placement exceeded the requirements of this Specification.

(v) The concrete surface has been damaged by rain.

(vi) The concrete contains footprints or other undesirable impressions.

(vii) The concrete has been subjected to traffic before the concrete achieved 75 percent of the specified 28 day compressive strength.

(viii) The concrete has cracked or separated.

(ix) The concrete surface has spalled.

(x) Expansion and isolation joints are not vertical.

(xi) The concrete sections have heaved or sunk, from their original position.

TS 13.00.09 MEASUREMENT FOR PAYMENT – Not Used

TS 13.00.10 BASIS OF PAYMENT – Not Used