AMENDMENT TO OPSS 1350, APRIL 2025

Special Provision No. DBSP1350

OPSS 1350, April 2025, is deleted in its entirety and replaced with the following:

DRAFT MATERIAL SPECIFICATION FOR CONCRETE – MATERIALS AND PRODUCTION

1350.01 SCOPE

This specification covers the requirements for materials and methods for proportioning, mixing, transporting, field testing, acceptance, and payment adjustments of concrete material, including provisions for referee testing of compressive strength, air void system parameters, and rapid chloride permeability.

1350.02 REFERENCES

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

Ontario Provincial Standard Specifications, Construction

OPSS 904 Concrete Structures
OPSS 905 Steel Reinforcement for Concrete

Ontario Provincial Standard Specifications, Material

OPSS 1002 Aggregates - Concrete
OPSS 1301 Cementing Materials
OPSS 1302 Water
OPSS 1303 Admixtures for Concrete

Ontario Ministry of Transportation Publications

Designated Sources of Materials (DSM)

Laboratory Testing Manual:
LS-100 Method of Rounding-off Data and Other Numbers
LS-101 Method for Calculation of Per Cent Within Limits
LS-407 Method of Test for Compressive Strength of Moulded Cylinders
LS-410 Method of Test for Compressive Strength of Concrete Cores
LS-413 Method of Test for Non-Volatile Content of Chemical Admixtures, Latex Admixtures and Curing Compounds
LS-414 Method of Test for Relative Density of Chemical Admixtures, Air Entraining Admixtures, Latex Admixtures and Curing Compounds
LS-415 Method of Test for pH of Aqueous Solutions by Glass Electrode
LS-426 Method of Testing Compressive Strength of High Strength Concrete Cylinders
LS-432 Method of Test for Microscopical Determination of Air Void System Parameters in Hardened Concrete

LS-433 Method of Test for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration

MTO Forms:
PH-CC-322 Concrete Construction Report
PH-CC-340 Field Sample Data Sheet - Concrete
PH-CC-433A Concrete Mix Design Submission Form A
PH-CC-433B Concrete Mix Design Submission Form B
PH-CC-434 Sample Letter to Contractor - Concrete Mix Design
PH-CC-845 Daily Concrete Load Test Results

CSA Standards

A23.2-1C Sampling Plastic Concrete*
A23.2-3C Making and Curing Concrete Compression and Flexural Test Specimens*
A23.2-4C Air Content of Plastic Concrete by the Pressure Method*
A23.2-5C Slump and Slump Flow of Concrete*
A23.2-6C Density, Yield, and Cementing Materials Factor of Plastic Concrete*
A23.2-17C Temperature of Freshly Mixed Hydraulic Cement Concrete*
A23.2-1D Moulds for Forming Concrete Test Cylinders Vertically*
A283 Qualification code for testing laboratory
A3004-B6 Physical Test Methods for Cementitious Materials for Use in Concrete and Masonry **
A3001 Cementitious Materials for Use in Concrete**

* [Part of A23.1-24/A23.2-24 - Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete]

** [Part of A3000-23 - Cementitious Materials Compendium]

S6-25 Canadian Highway Bridge Design Code

1350.03 DEFINITIONS

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

High Performance Concrete (HPC) means concrete with a minimum specified 28-Day compressive strength of at least 50 MPa that includes silica fume and may include other supplementary cementing materials and having a specified rapid chloride permeability at 28 to 32 Days of 1,000 coulombs or less.

Limestone Filler means an aggregate of divided limestone powder that may be used in concrete for the purpose of reducing the total amount of Portland cement used. Its use is limited to appropriate applications and exposure conditions after its suitability is determined through physical, chemical and mineralogical testing.

Portland Limestone Cement means cement obtained by intergrinding limestone with Portland cement clinker, as defined in CSA A3001.

Stationary Mixer means a non-mobile mixer installed at a plant for the purpose of mixing concrete.

Steel Reinforcement means as defined in OPSS 905.

Tremie Concrete means a concrete mix specifically designed to be placed under water by means of a tremie.

1350.04 DESIGN AND SUBMISSION REQUIREMENTS

1350.04.01 Design Requirements

1350.04.01.01 Concrete Mix Design

1350.04.01.01.01 General

The concrete mix shall be designed to provide adequate strength and durability for the intended use, including but not limited to resistance to salt scaling on concrete surfaces exposed to de-icers and/or anti-icers, and to meet the requirements as specified in the Contract Documents.

1350.04.01.01.02 Use of Admixtures

Water reducer Type A or D shall be used in all concrete, except in applications where plant addition of superplasticizer is permitted, in which case water reducer may be used at the Contractor's option.

Retarding of concrete set shall be provided when specified in the Contract Documents. If no retarding of set is specified, retarders may be used to delay setting of concrete for a maximum of 3 hours. Longer periods of set retardation shall be used only when specified in the Contract Documents.

Accelerators shall be used only when specified in the Contract Documents.

Superplasticizers shall be used in concrete containing silica fume and concrete in expansion joint end dams. Superplasticizers may be used in other provided the superplasticized concrete meets the Contract requirements and there is no evidence of segregation or inadequate consolidation.

Where rapid chloride permeability is an acceptance requirement, superplasticizers may be added to the concrete at the batch plant or at the site. Where rapid chloride permeability is not an acceptance requirement, superplasticizer shall be added to the concrete at the site.

Type S admixtures listed on the DSM may be used and concrete containing Type S admixture shall meet all requirements of this specification.

1350.04.02 Submission Requirements

1350.04.02.01 Mix Design

1350.04.02.01.01 General

A complete mix design submission shall be provided for concrete of each specified compressive strength that is to be placed in the work, for each of the following:

a) Cast-in-place concrete.

b) Slip formed concrete.

c) Mixes with different sources of materials.

d) Mixes with different admixtures.

e) Precast concrete.

f) Special purpose or unique mixes.

A complete mix design submission shall be provided for each specific concrete mix a minimum of 7 Business Days prior to the placement of that mix in the work. A complete mix design submission consists of the following:

a) A completed MTO form PH-CC-433A (Form A). Form A shall be submitted to the Contract Administrator.

b) A completed MTO form PH-CC-433B (Form B). Prior to the placement of concrete of a given mix design, for each Form A submitted, a corresponding Form B completed by the concrete supplier shall be submitted directly to the Regional Head of Quality Assurance with a copy to the MTO Concrete Section electronic mix design depository. The Form B shall bear the mix design number assigned by the Contractor to the corresponding Form A.

c) Mix design supporting documentation.

Form A and Form B shall identify all materials to be used in the concrete. No material shall be used in the concrete without the knowledge of the Owner.

If the same mix design (i.e., same materials and sources in the same proportions) is to be supplied by multiple plants, submission of separate mix designs and separate supporting documentation is not required.

The mix shall not be placed until the Contractor's Engineer provides written confirmation to the Owner that the concrete mix design submission meets the Contract requirements.

Within 4 Business Days of receiving a complete mix design submission, the Contract Administrator will provide the Contractor with a MTO form PH-CC-434, Letter to Contractor - Concrete Mix Design, confirming the submission meets the requirements or advising the Contractor of any requirements that have not been met. The mix shall not be placed until the Contract Administrator provides written confirmation that Form A and the mix design supporting documentation meet the requirements specified in the Contract Documents.

1350.04.02.01.02 Changes to Mix Design Submission

The following adjustments to the submitted mix design may be made without having to submit a new mix design or supporting data:

a) Total cementing material content: ± 5% of quantity stated on Form B.

b) Supplementary cementing materials: +0/-5% of quantity stated on Form B.

c) Admixtures: Variation within range of dosage stated on Form B.

d) Water: Variation within range stated on Form B.

Removal of a material from the mix or addition of retarding admixture Type B or D requires submission of a new mix design but does not require resubmission of mix design supporting documentation.

A new mix design, including supporting documentation, shall be provided prior to placing concrete, if any of the following mix design changes are made:

a) Changing sources of materials used in the concrete.

b) Substituting a material or product for another from the same source.

c) Adding any material to the concrete that was not on the original mix design, except retarding admixture Type B or D.

d) Adjusting the quantities of the stated materials in the concrete outside of the ranges provided in points a), b), c), or d) above.

The submission process for new or modified mix designs is the same as for the original mix design, except that when supporting documentation is not required, the confirmation by the Contract Administrator shall be provided within 1 Business Day.

1350.04.02.01.03 Mix Design Number

Each mix design submitted shall be identified with a mix design number consisting of the following:

a) 8-digit Contract number, followed by;

b) 2 digits indicating the specified compressive strength of concrete, followed by;

c) 2 digits indicating the number of the submission for that Contract (e.g., 01 for the first mix design of a specified strength, 02 for the second, and so on) followed, optionally and if applicable, by

d) 1 digit indicating the number of revisions of a mix design submitted previously (e.g., 1 for first revision, 2 for second revision, and so on). When a revised mix design is submitted, only the latest revision shall be used.

1350.04.02.01.04 Mix Design Supporting Documentation

Supporting documentation shall include the following:

a) A currently valid Certificate of Ready Mixed Concrete Production Facilities as issued by the Ready Mixed Concrete Association of Ontario (RMCAO) for any plant to be used on the Contract.

b) The range of concrete production rates required for the work.

c) Documentation for aggregates used in concrete demonstrating compliance with the requirements of OPSS 1002.

d) Water test results, if water other than municipal drinking water is used, demonstrating compliance with the requirements as specified in the Contract Documents.

e) A certificate verifying the cement is free from early stiffening tendencies when tested according to CSA A3004-B6, if non-agitating trucks are used.

f) Any other requirements specified elsewhere in the Contract Documents.

Documentation applicable to multiple mix designs need only be submitted once for a Contract.

All required supporting test data and certificates shall be less than 12 months old at the time the concrete mix design is submitted.

1350.04.02.02 Certification of Ready Mixed Concrete Production Facilities

For multi-year Contracts, verification that the plant continues to hold a valid Certificate of Ready Mixed Concrete Production Facilities, as issued by the RMCAO shall be submitted to the Contract Administrator for all plants supplying concrete to the Work.

1350.05 MATERIALS

1350.05.01 Admixtures for Concrete

Air entraining, chemical, and superplasticizing admixtures for concrete shall be according to OPSS 1303.

1350.05.02 Aggregates

1350.05.02.01 General

Aggregates shall be according to OPSS 1002.

1350.05.02.02 Limestone Filler

Limestone filler shall be according to the following:

a) Requirements specified in OPSS 1002 with the exception that use of limestone filler is not confined to self-consolidating concrete (SCC).

b) Requirements specified in CSA A23.1, Annex L, L2 Organic Impurities.

c) Tequirements specified in CSA A3001, Clause 4.4.3 a) for calcium carbonate content.

d) Restricted to a maximum of 15% of the cement by mass.

1350.05.03 Cementing Materials

Cementing materials shall be according to OPSS 1301 and the following:

a) For all concrete other than silica fume overlays and HPC, Portland cement or Portland limestone cement shall be used. A portion of it may be replaced by ground granulated blast furnace slag or fly ash or both. At the Contractor's option, silica fume in the form of a blended cement containing silica fume, may be added to the concrete mix to achieve reduced permeability. Where silica fume is used, the allowable limit for concrete permeability shall be reduced to 1,000 coulombs and the curing requirements of OPSS 904 for HPC shall apply.

b) For silica fume overlays and HPC, blended hydraulic cement containing silica fume shall be used. A portion of it may be replaced by Portland cement or Portland limestone cement, or ground granulated blast furnace slag or fly ash, or both.

c) Fresh concrete made with different types of Portland cement shall not be used in the same component. Portland limestone cement shall not be used in concrete in combination with limestone filler.

Ground granulated blast furnace slag or fly ash or a combination of the two materials and shall be restricted to the following proportions by mass of the total cementing material:

a) Slag up to 25%.

b) Fly ash up to 10%, except for silica fume overlays and HPC where up to 25% is permitted.

c) A mixture of slag and fly ash up to 25%, except the amount of fly ash shall not exceed 10% by mass of the total cementing materials, in concrete other than silica fume overlays and HPC.

For tremie concrete, the minimum cementing material content shall be 415 kg per cubic metre of concrete.

1350.05.04 Concrete

1350.05.04.01 General

The selection of materials and design of the concrete mix shall be optimized to achieve GHG reduction of a minimum of 10% while maintaining the concrete performance requirements for the application and environment.

The 10% GHG reduction shall be obtained through the use of one or a combination of the following options:

a) Use of Portland limestone cement.

b) Use of slag or fly ash to replace at least 10% of the cement content of the mix.

c) Use of limestone filler to reduce the cement content of the mix by at least 10% through enhanced particle packing, optimized aggregate gradation or other means.

1350.05.04.02 Plastic Concrete Requirements

Target values for air content and slump shall be identified for all plastic concrete on mix design Forms A and B.

The plastic concrete shall meet the following requirements:

a) Concrete shall be free of lumps and segregation and shall have consistent air content and slump throughout each load.

b) Plastic air content shall meet the requirements specified in Table 1DB.

c) Slump shall meet the requirements specified in Table 1DB. The maximum allowable slump, including tolerance, shall be 100 mm, except for tremie concrete, which shall be 180 mm including tolerance.

d) The concrete temperature at the time of discharge from the truck shall be at or between 10 and 28 °C, with the exception of HPC and silica fume overlays, which shall be at or between 10 and 25 °C.

When superplasticizer is to be added to the concrete according to the Use of Admixtures clause, the following shall apply:

a) For superplasticizers added at the plant, the target slump for the after the addition of superplasticizer shall be identified. The tolerance on measurement of concrete slump after addition of superplasticizer shall be ± 30 mm and the maximum slump including tolerance shall not exceed 230 mm.

b) For superplasticizers added at the site, target slumps for the concrete both prior to and after the addition of superplasticizer shall be identified. The tolerance on the measurement of concrete slump prior to the addition of superplasticizer shall be ± 20 mm and the maximum slump including tolerance shall not exceed 100 mm. The tolerance on measurement of concrete slump after addition of superplasticizer shall be ± 30 mm and the maximum slump, including tolerance, shall not exceed 230 mm.

1350.05.04.03 Hardened Concrete Requirements

The hardened concrete shall meet the following requirements:

a) Concrete compressive strength shall be as specified in the Contract Documents.

b) Rapid chloride permeability at 28 to 32 Days when tested according to LS-433 shall be less than or equal to:

   i. 1,000 coulombs for HPC, silica fume overlays and any other concrete containing silica fume.
   ii. 2,500 coulombs for all other concrete.

c) Hardened concrete air void system parameters when tested according to LS-432 shall meet the following requirements:

   i. Each core shall have a minimum air content of 3.0 %.
   ii. Each core shall have a maximum spacing factor of 0.230 mm, except for HPC and silica fume overlays for which each core shall have a maximum spacing factor of 0.250 mm.

1350.05.05 Proprietary Patching Materials

Proprietary patching materials shall be from the Ministry's List of Concrete Patching Materials. The list shall be obtained from the Contract Administrator.

1350.05.06 Water

Water used for production shall be according to OPSS 1302.

1350.06 EQUIPMENT

1350.06.01 Batching Plant

The batching plant and equipment shall be certified by the RMCAO prior to producing concrete for the work, including concrete for any trial batches, and shall meet the requirements for certification throughout the production of concrete.

1350.06.02 Delivery Equipment

Delivery equipment shall be truck mixers, agitator trucks, or non-agitating equipment. Use of non-agitating equipment shall be restricted to delivery for placement of concrete base, concrete pavement, or Portland cement open graded drainage layer (OGDL).

Truck mixers shall consist of concrete mixers mounted on a truck or other vehicle used for the complete mixing of concrete ingredients after they have been batched at the plant. All truck mixers shall be certified by RMCAO and shall display valid certification stickers.

Agitator trucks shall consist of drums or containers mounted on trucks or other vehicles in which completely mixed concrete is kept sufficiently agitated during delivery to prevent segregation.

Non-agitating equipment shall consist of containers mounted on trucks for delivering completely mixed concrete. The body of the container shall be smooth, watertight, made of steel, and equipped with gates that permit control of the discharge of the concrete.

When concrete is discharged from the delivery equipment into a container or other piece of equipment, prior to being discharged into the work, the container or other equipment shall be clean and free of dirt and debris. Any container or other equipment used shall be acceptable to the Owner.

Use of mobile mixers is not permitted.

1350.07 PRODUCTION

1350.07.01 General

Concrete shall be produced at a batching plant. A back-up plant shall be identified for all post-tensioned deck placements.

When multiple plants supply concrete for the same component, all plants, including primary and back-up, shall produce the same mix design using the same aggregates, cementing materials, and admixtures.

The supplementary cementing material shall be weighed separately from the cement, except when the cement and supplementary cementing materials are supplied in blended form.

The entire contents of the mixer shall be discharged and the mixer completely emptied of wash water prior to loading of a new concrete batch. When a truck mixer is used for complete mixing, it shall not be loaded beyond its maximum mixing capacity.

Cementing materials shall not be added by bags or sacks or from a storage facility remote from the ready mix plant.

1350.07.02 Temperature Control

Aggregates shall heated using a method that ensures uniform temperature distribution, avoiding the formation of localized hot spots.

Frozen lumps of aggregate shall not be added to the concrete.

When ice is used as part of mixing water, the ice shall be measured by mass and shall be completely melted by the time concrete mixing is completed.

1350.07.03 Mixing Time and Mixing Rate

The minimum mixing time for concrete shall be as recommended by the equipment manufacturer or the minimum time required to produce concrete meeting the requirements of this specification, whichever is greater.

When a stationary mixer is used for partial mixing of concrete prior to transferring to a truck mixer, the mixing time shall be no more than is required to intermingle the ingredients. After transfer to a truck mixer, further mixing at the designated mixing speed shall be carried out.

After completion of mixing, the truck mixer drum shall be rotated at the designed agitating speed until discharge of concrete commences.

1350.07.04 Delivery

1350.07.04.01 General

Concrete that is transported in non-agitating equipment shall be covered. Concrete delivered by means of agitator trucks or truck mixers shall be transported after completion of mixing.

1350.07.04.02 Discharge Time

When concrete is transported to the site by means of agitating or mixing equipment, discharge of the concrete shall be completed within 1.5 hours after introduction of the mixing water to the cement and aggregates, except when the air temperature exceeds 28 °C and the concrete temperature exceeds 25 °C, the concrete shall be discharged within 1 hour after the introduction of the mixing water.

When concrete or OGDL is transported by means of non-agitating equipment, discharge shall be completed within 30 minutes after introduction of the mixing water to the cement and aggregates.

Use of retarders or other admixtures does not change the specified concrete discharge time.

1350.07.04.03 Delivery Ticket

Each load shall be accompanied by a delivery ticket. The following information shall be printed on each ticket at the plant using an automated printing device:

a) Name and location of plant.

b) Date, including year, month, and day.

c) Contract number.

d) Truck number.

e) Time of batching concrete. Where an electronic ticketing system is not used, time shall be stamped by a time clock within 5 minutes of batching.

f) Mix design number assigned by the Contractor or the supplier's unique mix design number verified to correspond to the mix design number assigned by the Contractor.

g) Specified minimum 28-Day compressive strength of concrete.

In addition, the following shall be recorded in writing on the delivery ticket:

a) The amount of any material added after batching.

b) Rejection of a load or part thereof, if applicable.

c) Time truck arrived at the job site.

d) The time the truck finished discharging into the work.

1350.07.05 Material Sampling and Testing

1350.07.05.01 Contractor Sampling for Quality Control Purposes

The Contractor may obtain samples of plastic concrete for quality control purposes. The Contractor shall not carry out sampling or destructive testing of hardened concrete in the work for quality control purposes without obtaining the written permission of the Owner in advance. The Owner's denial of permission shall not absolve the Contractor of responsibility for the quality of concrete.

1350.07.05.01.01 Compressive Strength Verification

The Contractor shall cast and test cylinders for 28-day compressive strength testing, for each 50 m^3 of concrete placed, as a minimum, to verify that the concrete meets the specified requirements. In addition, the Contractor shall be responsible for casting and testing cylinders for verification of early strength.

Casting, curing, and transportation of concrete cylinders shall be according to CSA A 23.2-3C. Compressive strength shall be determined according to LS-407 and LS-426. Testing shall be carried out at a laboratory certified by CCIL in accordance with CSA A283 as a concrete testing laboratory. Results shall be submitted to the Contract Administrator as they become available.

No referee cylinders are required by the Owner for compressive strength verification testing.

1350.07.05.02 Sampling of Water, Admixtures, Limestone Filler and Cementing Materials

Samples of all cementing materials, admixtures, limestone filler and water (when other than municipal drinking water is used) shall be obtained according to the frequencies shown in Table 2DB, in the presence of the Contract Administrator, for testing by the Owner.

Samples of admixtures and water shall be protected from freezing and high temperatures. Cementing

materials samples shall be protected from moisture.

1350.07.05.03 Testing of Plastic Concrete

Field sampling and testing of concrete shall be performed by a person holding one of the following certifications:

a) Canadian Council of Independent Laboratories (CCIL) Certified Concrete Testing Technician; or

b) ACI Concrete Field Testing Technician, Grade 1; or

c) CSA Standard Concrete Field Testing Technician.

This person shall have a valid, original certification card issued by the certifying agency in their possession.

Samples for determining acceptance of concrete for air and slump shall be grab samples taken according to CSA A23.2-1C after approximately 10% of the load has been discharged into the work. The discharge shall be stopped and no additional concrete shall be discharged or placed into the work until samples have been tested and found acceptable. If the test results indicate that the concrete does not meet the specified requirements and adjustments permitted in the Acceptance and Field Adjustments of Plastic Concrete clause cannot produce acceptable concrete, the remainder of the load shall be rejected.

Temperature shall be measured according to CSA A23.2-17C. Slump shall be measured according to CSA A23.2-5C. Air content shall be measured according to CSA A23.2-4C. The air meter shall be calibrated at least once a year according to CSA A23.2-4C and a copy of the calibration certificate shall be with the air meter and available for review when requested by the Contract Administrator.

1350.07.05.04 Frequency of Testing Slump, Air Content, and Temperature

Quality control testing consisting of slump, air content, and temperature determinations shall be carried out on each load or batch of concrete until satisfactory control is established. Satisfactory control shall be established each Day. It is established when concrete from five consecutive loads or batches is within the specified requirements without field adjustments as defined in the Acceptance and Field Adjustments of Plastic Concrete clause. If any field adjustments are required, testing on each load shall be continued until five consecutive loads or batches meet the requirements with no field adjustment. After satisfactory control has been established, testing shall be carried out on every third load. If testing indicates that a load does not meet the requirements, testing shall resume on each load until satisfactory control is established. The Contract Administrator may require testing of additional loads or batches of concrete.

If multiple plants supply concrete, satisfactory control shall be established for each plant.

In addition to the above, air content, slump, and temperature tests shall be carried out whenever compressive strength test cylinders are cast.

1350.07.05.05 Acceptance and Field Adjustments of Plastic Concrete

The Contractor shall be responsible for all quality control inspection and testing required to ensure that plastic concrete included in the work is according to the submitted mix design and meets the specified requirements for air content, slump, temperature, Visual Acceptance of Plastic Concrete clause, delivery time, and uniformity.

Concrete which does not meet the specified requirements for air content, slump, temperature, Visual Acceptance of Plastic Concrete clause, delivery time or uniformity shall be rejected and not used in work.

Slump of concrete shall be measured prior to and after the addition of superplasticizer. When superplasticizer is added at the plant according to the Use of Admixtures clause, the slump shall be measured after the addition of superplasticizer. Air content shall be measured after any addition of superplasticizer.

For non-superplasticized concrete, when the measured slump is higher than that specified and there is time available to discharge the concrete within the specified time limit, the Contractor shall be permitted to retest the slump once using the unused portion of the same concrete sample. Slump shall be retested within 5 minutes of the completion of the original test.

For superplasticized concrete, when the measured slump is higher than that specified and there is time available to discharge the concrete within the specified time limit, the Contractor shall be permitted to wait and retest the slump using a new sample of concrete when superplasticizer is plant added and rapid chloride permeability is an acceptance requirement, or superplasticizer is added on site and the measured slump prior to addition of superplasticizer is within specified limits.

When the measured plastic air content exceeds the upper test limit and there is time available within the discharge time limit specified, the Contractor shall be permitted to rotate the load at agitation speed and re-test the air content. The use of additives to reduce the air content shall not be permitted.

When a truck mixer is used, the following field adjustments may be carried out prior to acceptance of the load:

a) When the measured air content is low, air-entraining admixture may be added.

b) When the measured or estimated slump is low, the following adjustments may be made:

   i. For concrete mixes that do not include superplasticizer, water may be added:

      (1) Prior to when discharge of concrete from the truck has started; or

      (2) When the measured slump of concrete is lower than the maximum targeted range.

   ii. For concrete mixes with site-added superplasticizer:

      (1) Water may be added before superplasticizer is added at the site. Water additions may be done prior to when discharge of concrete from the truck has started or when the measured slump of concrete is lower than the maximum targeted range,

      (2) No water shall be added after the addition of a superplasticizer. Additional doses of superplasticizer may be added.

   iii. For concrete mixes with plant added superplasticizer:

      (1) No water shall be added.

      (2) Superplasticizer may be added.

No field adjustments shall be carried out after concrete has been accepted, with the exception of superplasticized concrete. For superplasticized concrete, addition of a superplasticizer to increase the slump to assist in placing shall be permitted.

When any material is added to the concrete, the load of concrete shall be mixed for 30 revolutions or more at the designated mixing speed to ensure that the concrete is uniformly mixed. The load shall be re-tested for acceptance.

1350.07.05.06 Visual Acceptance of Plastic Concrete

The Contractor shall visually inspect plastic concrete during discharge and placement to identify the presence of any excessive bleeding, segregation or lumps.

If any segregation is identified, the Contractor shall immediately reject the entire load of concrete.

Any visible lumps present in the concrete shall be removed before concrete is placed in the work. If more than three visible lumps are present in a load of concrete, the remainder of the load shall be immediately rejected and no further concrete from that truckload shall be placed in the work.

If more than three truckloads during the Day's work are observed to contain more than three lumps per truck, concrete placement shall be stopped at the end of the Day or at the end of the placement of the specific structure component, whichever comes first.

No further concrete shall be placed until all of the following occur:

a) An explanation has been submitted to the Contract Administrator of the reasons for the lumps and identifcation of steps that shall be taken to eliminate the reoccurrence of lumps in future work.

b) A trial batch has been carried out in the presence of the Contract Administrator and the Contract Administrator has verified that the concrete is free of lumps.

c) The Contract Administrator has granted written permission for placement to proceed.

1350.07.05.07 Within-Batch Uniformity of Plastic Concrete

When required by the Contract Administrator, determination of the within-batch uniformity of the plastic concrete shall be carried out by testing air content, slump, and density according to CSA A23.2-4C, CSA A23.2-5C, and CSA A23.2-6C, respectively. A 24 hour notice shall be granted when density testing is required as part of within-batch uniformity determination. No advance notice shall be granted for carrying out the slump and air portion of the uniformity testing.

Tests shall be carried out on samples of concrete obtained when approximately 10%, 50%, and 90% of the batch has been discharged while the mixer is being emptied at normal operating rate. The minimum size of sample shall be 30 litres. Between samples, the mixer shall not be allowed to turn in the mixing direction.

The acceptance and rejection limits for uniformity shall be as shown in Table 3DB. When the result of each test is equal to or less than the acceptance limit, the concrete is uniform. When the result of any single test is greater than the rejection limit, the concrete shall be deemed non-uniform.

If the result of any single test exceeds the acceptance limit and is not greater than the rejection limit, all tests shall be made on the next consecutive batch or load delivered by that mixing equipment.

If, after testing one additional batch or load, the test result is greater than the acceptance limit, the concrete is non-uniform.

When the concrete is non-uniform and the mixing equipment is a stationary mixer, no more concrete shall be produced in it until within-batch uniformity has been demonstrated. If the unit is a truck mixer, the truck mixer shall not be used again.

1350.07.05.08 Submission of Plastic Concrete Test Results

After each Day's work, a copy of the delivery ticket for each load of concrete, along witha daily summary and a completed MTO form PH-CC-845, Daily Concrete Load Test Results, shall be submitted to the Contract Administrator. The daily summary shall include the following:

a) Time truck arrived on site;

b) Time truck finished discharging into the work;

c) Air contents, and slumps prior to and after any additions;

d) Concrete temperature;

e) Any adjustments made to each load of concrete, including volume of any water or superplasticizer added; and

f) Rejection of a load or part thereof.

1350.07.05.09 Compressive Strength, Air Void System Parameters and Rapid Chloride Permeability - for Acceptance Testing

1350.07.05.09.01 General

The Contractor shall remove or prepare samples for acceptance testing and referee testing according to Table 4DB. Cores shall be the basis of acceptance of 28-Day compressive strength, air void system parameters and rapid chloride permeability, except for components where cylinders are specified.

The Contractor shall allow and facilitate access to all cores and acceptance cylinders that will be transported by the Contract Administrator to the Regional Quality Assurance Laboratory for testing by the Owner.

The individual test results shall be forwarded to the Contractor as they become available. The Contractor shall forward individual test results and monthly summaries to the concrete supplier.

1350.07.05.09.02 Concrete Cores

The Contractor shall remove cores from each component, divided into sublots for sampling purposes according to Table 4DB. Each core shall be removed at a random location within the sublot specified by the Contract Administrator. All cores shall be removed when the concrete is between 7 to 10 Days of age, and cores from bridge decks and culverts shall be removed prior to application of any waterproofing membrane.

For concrete barriers and barrier walls on structures, the cores shall be removed from the lower sloped portion of the wall at the designated locations. For parapet walls, the cores shall be removed from the lower one-third of the wall at the designated locations.

Steel and glass fibre reinforced polymer (GFRP) reinforcement and other embedded material shall be avoided when possible while coring. The Contractor shall use an appropriate covermeter to establish reinforcement locations, prior to coring.

The Contract number, component identification, lot number, sublot number, exact location of each individual core, date of concrete placement, and date of extraction shall be marked legibly on each core with durable ink. Each core shall be placed in a plastic bag and sealed to prevent loss of moisture, before they are placed in security bags.

The cores shall be protected by the Contractor from extremes in temperature from the time they are removed until they are delivered by the Contract Administrator to the Regional Quality Assurance laboratory within 24 hours of coring. The cores shall be accompanied with a transmittal form and the Form A of the concrete mix design for the component.

1350.07.05.09.03 Concrete Cylinders

1350.07.05.09.03.01 General

The Contractor shall cast, cure and transport the cylinders according to CSA A 23.2-3C.

The concrete cylinders for determination of compressive strength, air void system parameters and rapid chloride permeability shall be 100 mm diameter x 200 mm long

All concrete test cylinders shall be cast in moulds. The moulds shall be single use moulds according to CSA A23.2-1D, made of plastic, with a lid. The lids shall be chemically and physically compatible with the concrete and shall provide watertight closure for the moulds.

Test information shall be recorded on MTO form PH-CC-322. A copy of MTO form PH-CC-322, identification of the component, sublot number, a transmittal form and the Form A of the concrete mix design for the component shall be submitted with each set of the concrete cylinders.

The concrete temperature shall be continuously recorded and monitored immediately adjacent to the cylinders during the field-curing period. The maximum time interval for recording the temperature shall be every 15 minutes.

Cylinder curing temperature records shall be submitted to the Contract Administrator at the completion of the field-curing period.

1350.07.05.09.03.02 Concrete Cylinders for Compressive Strength

For each sublot, one set of three concrete cylinders shall be cast for determination of 28-Day compressive strength and a second set of three cylinders shall be cast for referee testing purposes.

In addition to acceptance cylinders cast according to Table 4DB, the Contractor shall also cast information test cylinders if requested by the Contract Administrator. No referee cylinders shall be cast when cylinders are requested by the Owner for information purposes.

1350.07.05.09.03.03 Concrete Cylinders for RCP and AVS

For components identified in Table 4DB, the Contractor shall cast cylinders for acceptance of air void system parameters and rapid chloride permeability. For each sublot, three concrete cylinders shall be cast. One cylinder shall be used for determination of air void system parameters and one cylinder shall be used for determination of rapid chloride permeability. The remaining cylinder shall be used for referee testing of rapid chloride permeability.

1350.07.06 Filling of Core Holes

Each core hole shall be filled immediately after coring with a proprietary patching material. The patching material shall be comparable to the surrounding concrete in terms of strength and permeability. The patching material shall be mixed, handled, and cured according to the manufacturer's instructions. Immediately prior to filling, the inside surface of each core hole shall be cleaned of the paste left from the coring operation by nylon brushing and all free water shall be removed. The patch shall be finished flush with the surface of the surrounding concrete. All excess material shall be removed from the surface of the concrete. When filling core holes, the proprietary patching material shall be cured with curing compound according to OPSS 904, or shall be cured as recommended by the manufacturer of the proprietary patching material.

1350.08 QUALITY ASSURANCE

1350.08.01 Acceptance of Components Based on 28-Day Compressive Strength, Air Void System Parameters and Rapid Chloride Permeability

1350.08.01.01 General

Concrete components shall be accepted based on 28-Day compressive strength, air void system parameters and rapid chloride permeability, according to this specification.

Referee testing of compressive strength, air void system parameters and rapid chloride permeability for a sublot may only be invoked by the Contractor within 3 Business Days of receiving the test results. The referee testing shall be carried out by referee laboratory designated by the Owner based on the applicable roster. Referee test results shall be forwarded to the Contractor as they become available. The referee testing of compressive strength, air void system parameters and rapid chloride permeability shall be according to this specification.

The cost of referee testing for compressive strength, air void system parameters and rapid chloride permeability shall be as specified in the Contract Documents.

When the referee result confirms the acceptance test result, the Contractor shall be charged the cost of the referee testing. When the referee result does not confirm the acceptance test result, the Owner shall bear the cost.

Unacceptable components shall be subject to removal and replacement at no cost to the Owner. The replacement components shall be evaluated for acceptance on the same basis as the original component. An alternative proposal to removal may be submitted in writing for the Owner's consideration for the unacceptable component. If the Contract Administrator determines that an unacceptable component may remain in the work, it shall be subject to the calculated penalty.

1350.08.01.02 Acceptance of Concrete Compressive Strength

1350.08.01.02.01 Basis of Acceptance

Acceptance of compressive strength of each component shall be based on the average strength of all sublots, rounded to one decimal place. Each sublot is represented by an average strength of three cores or three cylinders.

28-Day compressive strength of a component shall be considered acceptable when it meets all of the following:

a) The average of the component's compressive strength tests shall be equal to or greater than the specified strength.

b) No individual strength test shall be more than 4.0 MPa below the specified strength.

1350.08.01.02.02 Acceptance Testing

Cores shall be tested according to LS-410. Cylinders shall be tested according to LS-407 or LS-426.

1350.08.01.02.03 Structural Adequacy

When the average of the component strength tests is less than the specified strength or when an individual strength test result falls below the specified minimum 28-Day strength by more than 4.0 MPa, the Contractor has the option of doing one of the following;

a) Remove the unacceptable concrete or element, or

b) Prove its structural adequacy and pay a penalty in accordance with the Calculation of Penalty clause.

In order to prove structural adequacy, the Contractor shall take additional 100 mm diameter cores, in the presence of the Contract Administrator, at intervals along the member in order to establish the limits of the unacceptable concrete. The locations of these cores shall be as specified by the Contract Administrator. Cores shall be provided to the Contract Administrator for testing by the Owner according to LS-410.

Once the limits of the unacceptable concrete have been established, the Contractor's Engineer shall carry out a structural analysis to verify that the structural adequacy, as required by the CHBDC, is satisfied. If structural adequacy is verified, the Contractor's Engineer shall issue the Contractor written permission to continue with the work.

A copy of the written permission to continue with the work, signed and stamped by an Engineer, along with the Contractor's Engineer's calculations, including calculations for the volume of the sub-standard concrete, shall be submitted to the Owner.

If structural adequacy is not verified, the deficient concrete or element shall be removed and replaced.

1350.08.01.02.04 Referee Testing

Where 28-Day compressive strength is determined on concrete cores, the referee testing shall be carried out on new cores removed from the component within 24 hours of invoking the referee testing.

The Contractor shall remove a set of three 100 mm diameter and 200 mm long cores for referee testing for each disputed sublot at locations no more than 1 meter from the locations from which the disputed acceptance cores were removed. The core extraction and timing of delivery to the referee laboratory shall be according to the "Concrete Cores" clause of this specification. The referee testing of the cores shall be according to LS-410.

Where 28-Day compressive strength is determined on concrete cylinders, the referee testing process shall be based on duplicate set of three cylinders cast at the same time as the acceptance cylinders. The referee testing of concrete cylinders shall be according to LS-426.

If the difference between the referee test result and the acceptance test result is less than the confirmation value, then the acceptance test result is confirmed, and the acceptance test result shall be used in the determination of

acceptance of the component. If the difference between the referee test result and the acceptance test result is greater than the confirmation value, the acceptance test result is not confirmed, and the acceptance test result shall be disregarded, and the referee test result shall replace the acceptance test result in the acceptance requirements of this specification. The confirmation value for confirming the acceptance test result shall be the greater of 10% of the specified strength or 10% of the strength of the acceptance cylinders, expressed to one decimal place.

If the referee test result is more than 4.0 MPa below the specified strength, the result shall be reviewed to determine if structural adequacy is in question and, if so, the relevant provisions of this specification shall be followed.

1350.08.01.03 Acceptance of Air Void System Parameters in Hardened Concrete

1350.08.01.03.01 Basis of Acceptance

For a component to be considered acceptable, each sample representing the component shall have air content of 3.0% or more and spacing factor of 0.230 mm or less in all concrete except for silica fume overlays and HPC, where the spacing factor shall be 0.250 mm or less.

An unacceptable component is represented by one or more samples that fail to meet the air content and/or spacing factor requirement.

1350.08.01.03.02 Acceptance Testing

One sample per sublot shall be used for determination of air void system parameters according to LS-432. One half of each sample shall be tested to determine the acceptability of concrete. The other half of each sample shall be retained by the Owner for audit purposes.

1350.08.01.03.03 Referee Testing

When referee testing is invoked, all samples representing a component shall be referee tested and the acceptance test results discarded. The sublot referee test results shall replace the acceptance test result in the acceptance requirements of this specification.

Referee testing shall be carried out by the referee laboratory according to LS-432 on the same half of the sample that was tested for acceptance.

1350.08.01.04 Acceptance of Rapid Chloride Permeability

1350.08.01.04.01 Basis of Acceptance

HPC and silica fume overlay components shall be considered acceptable when they meet all of the following:

a) The average of the component's rapid chloride permeability tests shall be equal to or less than 1000 coulombs.

b) No individual rapid chloride permeability test shall be greater than 1250 coulombs.

All other concrete components shall be considered acceptable when they meet all of the following:

a) The average of the component's rapid chloride permeability tests shall be equal to or less than 2,500 coulombs.

b) No individual rapid chloride permeability test shall be greater than 3000 coulombs.

1350.08.01.04.02 Acceptance Testing

For acceptance testing based on cores, one core per sublot shall be used for determination of rapid chloride permeability according to LS-433, and one core shall be retained for referee testing, except for overlays, patches and refacing for which two cores per sublot shall be used for acceptance testing and 2 cores shall be retained for referee testing. Where one core is used for acceptance testing, 2-50 mm long samples shall be cut from it and tested. For overlays, patches and refacing, 1-50 mm sample shall be cut from each of two cores per sublot, and tested for acceptance.

For acceptance testing based on cylinders, one concrete cylinder per sublot shall be used for determination of rapid chloride permeability according to LS-433. Two 50 mm long samples shall be cut from the cylinder and tested. The second cylinder shall be retained for referee testing.

Acceptance testing shall be carried out at 28 to 32 Days.

1350.08.01.04.03 Referee Testing

When acceptance testing is based on cores, the referee testing shall be carried out on.

Referee testing shall be carried out on two 50 mm long samples obtained from the reserved core representing the sublot for which referee testing was invoked, and the results shall be averaged to obtain the test result for the sublot. For overlays, patches and refacing, referee testing shall be carried out on two 50 mm long samples cut from the two reserved cores representing the sublot for which referee testing was invoked, and the results shall be averaged to obtain the test result for the sublot.

When acceptance testing is based on concrete cylinders, the referee testing shall be carried out on duplicate concrete cylinders cast at the same time as the acceptance cylinder.

The referee testing shall be according to LS-433.

For silica fume overlays, HPC and any other concrete containing silica fume:

a) When the referee result is greater than the acceptance test result or no more than 300 coulombs below the acceptance test result, the acceptance test result is then confirmed and shall remain valid.

b) When the referee test result for the lot is more than 300 coulombs below the acceptance test result, the acceptance test result is then not confirmed and the referee test result shall replace the acceptance test result in the acceptance requirements of this specification.

For all other concrete:

a) When the referee result is greater than the acceptance test result or no more than 500 coulombs below the acceptance test result, the acceptance test result is then confirmed and shall remain valid.

b) When the referee test result for the lot is more than 500 coulombs below the acceptance test result, the acceptance test results is then not confirmed and the referee test result shall replace the acceptance test result in the acceptance requirements of this specification.

1350.08.01.05 Calculation of Penalty

If the Contract Administrator permits unacceptable components to remain in the work in accordance with the General clause of 1350.08 of this specification, the penalty shall be calculated as follows:

1350.08.01.05.01 28-Day Compressive Strength

For the purpose of calculating penalty based on compressive strength, the average strength of the sublot shall be rounded to one decimal place. The penalty for compressive strength shall be calculated according to Table 5DB.

1350.08.01.05.02 Air Void System Parameters

For the purpose of calculating penalty based on air void system parameters, the Contract Administrator shall round-off spacing factor test data to two decimal places and air content test data to one decimal place according to LS-100.

Penalty for unacceptable components shall be calculated by averaging penalties corresponding to individual sample results. The penalty values in $/m³ of concrete for individual samples are given in Table 6DB and 7DB. Any samples in an unacceptable component, that meet the specified requirements for air void system parameters, shall be assigned a penalty of $ 0/m³ of concrete.

Penalty for unacceptable component shall be calculated according to the following:

$$PA = (P1 + P2 ... + Pn)/n$$

Where:

PA = penalty in dollars per cubic metre of concrete ($/m³)

P1, P2… Pn = penalties for individual samples from Tables 6DB and 7DB as applicable, in dollars per cubic metre of concrete ($/m³)

1350.08.01.05.03 Rapid Chloride Permeability

For the purpose of calculating penalty based on rapid chloride permeability, the Contract Administrator shall calculate the average rapid chloride permeability value per component. The penalty for rapid chloride permeability shall be calculated in accordance with Tables 8DB and 9DB.

1350.08.01.05.04 Calculation of Penalty for a Component

Combined penalty in $/m³ for a component shall be calculated by adding penalties based on compressive strength, air void system parameters and rapid chloride permeability for that component.

$P = PC+PA+PR (\$/m^3)$

Where:

P = combined penalty in dollars per cubic metre of concrete ($/m³)
PC = penalty based on compressive strength ($/m³)
PA = penalty based on air void system parameters ($/m³)
PR = penalty based on rapid chloride permeability ($/m³)

For the purpose of calculating the penalty, the quantity of concrete in each component shall be calculated by the Contract Administrator based on the neat lines called for in the Engineering Documents, and the penalty in dollars for a component shall be calculated as follows:

Penalty for a component ($) = component quantity (m³) x P ($/m³)

1350.08.02 Acceptance of Admixtures, Water and Cementing Materials

1350.08.02.01 Admixtures

1350.08.02.01.01 General

Air entraining admixtures shall be tested by the Owner for pH and relative density. Chemical and superplasticizing admixtures shall be tested by the Owner for relative density and non-volatile content. Testing shall be according to LS-413, LS-414, and LS-415, as applicable.

One 750 ml admixture sample shall be used for acceptance testing. The other 750 ml admixture sample shall be reserved for referee testing.

Individual test results shall be forwarded to the Contractor, as they become available.

1350.08.02.01.02 Basis of Acceptance

Relative density, pH and non-volatile content shall be according to OPSS 1303. Admixtures represented by sample test results that fail to fall within the specified tolerances for pH, relative density, or non-volatile content shall be deemed unacceptable and no further concrete shall be produced with that supply of admixture.

For each admixture represented by sample test results that exceed the tolerances specified by OPSS 1303 and before any additional concrete can be placed, the Contractor shall remove and replace the admixture with a new supply of admixture meeting the requirements of OPSS 1303.

For each sample of air-entraining admixture that exceeds the tolerances for relative density, or pH, or both, as shown in Table 10DB, in addition to the removal and replacement of the admixture represented by the sample, a payment reduction of $5,000 shall be assessed.

For each chemical admixture sample that exceeds the tolerances for relative density, or non-volatile content or both, as shown in Table 10DB, in addition to the removal and replacement of the admixture represented by the sample, a payment reduction of $5,000 shall be assessed.

For each superplasticizing admixture sample that exceeds the tolerances for relative density, or non-volatile content or both, as shown in Table 10 DB in addition to the removal and replacement of the admixture represented by the sample, a payment reduction of $5,000 shall be assessed.

Notwithstanding the above, concrete made with admixtures that do not meet the specified requirement may be subject to additional financial penalty or removal if the deficiency has the capacity to adversely impact the short or long term performance of the concrete.

1350.08.02.01.03 Referee Testing

Referee testing of admixtures may only be invoked by the Contractor within 3 Business Days of receiving the test results. Referee testing shall be carried out on the reserved referee sample.

The referee laboratory shall be designated by the Owner based on the applicable roster. Referee samples shall be transported from the Regional Quality Assurance laboratory to the Referee Laboratory by the Owner, and testing shall be carried out according to LS-413, LS-414, and LS-415, as applicable.

Referee test results shall be forwarded to the Contractor, as they become available.

The referee test results shall replace the original results.

The cost of referee testing shall be as specified in the Contract Documents.

When the referee results indicate that the refereed sample is acceptable, the Owner shall bear the cost. When the referee results indicate that the refereed sample is not acceptable, the Contractor shall be charged the cost of the admixture referee testing.

1350.08.02.02 Water Other than Municipal Drinking Water

1350.08.02.02.01 General

Samples of water, other than municipal water, shall be tested by the Owner according to OPSS 1302.

One 1-litre water sample shall be used for acceptance testing. The other 1-litre water sample shall be reserved for referee testing.

Individual test results shall be forwarded to the Contractor, as they become available.

1350.08.02.02.02 Basis of Acceptance

Water that fails the requirements of OPSS 1302 shall be deemed unacceptable and the source of water represented by the failed samples shall not be used for making of concrete.

Concrete made with water that does not meet the specified requirements is unacceptable and may be subject to financial penalty or removal if there is potential for the short-term or long-term performance of the concrete to be adversely affected.

1350.08.02.02.03 Referee Testing

Referee testing of water may only be invoked by the Contractor within 3 Business Days of receiving the test results. Referee testing shall be carried out on the reserved referee sample.

The referee laboratory shall be designated by the Owner based upon the applicable roster. Referee samples shall be transported from the Regional Quality Assurance laboratory to the Referee Laboratory by the Owner, and testing shall be carried out according to OPSS 1302.

Referee test results shall be forwarded to the Contractor, as they become available.

The referee test results shall replace the original result.

The cost of referee testing shall be as specified in the Contract Documents.

When the referee results indicate that the refereed sample is acceptable, the Owner shall bear the cost. When the referee results indicate that the refereed sample is not acceptable, the Contractor shall be charged the cost of the water referee testing.

1350.08.02.03 Cementing Materials

1350.08.02.03.01 General

Cementing materials shall be tested by the Owner for fineness, initial time of set, compressive strength, and slag activity index or pozzolanic strength activity index, as applicable, according to CSA A3000.

One 10-kilogram sample shall be taken and divided into two 5-kilogram samples. One 5-kilogram sample shall be used for acceptance testing. The second 5-kilogram sample shall be reserved for referee testing.

Individual test results shall be forwarded to the Contractor as they become available.

1350.08.02.03.02 Basis of Acceptance

Cementing materials that do not comply with the requirements of OPSS 1301 and CSA A3001 shall not be used for making of concrete.

Concrete made with cementing materials that do not meet the specified requirements is unacceptable and may be subject to financial penalty or removal if there is potential for the short-term or long-term performance of the concrete to be adversely affected.

1350.08.02.03.03 Referee Testing

Referee testing of cementing materials may only be invoked by the Contractor within 3 Business Days of receiving the test results. Referee testing shall be carried out on the reserved referee sample.

Referee testing shall be carried out according to CSA A3000 by the Owner's laboratory or an independent laboratory acceptable to the Contractor and the Owner in the presence of the Contractor or his designate.

Referee results shall be reported to the Contractor, as they are available.

The referee test results shall replace the original result.

The cost of referee testing shall be as specified in the Contract Documents.

When the referee results indicate that the refereed sample is acceptable, the Owner shall bear the cost. When the referee results indicate that the refereed sample is not acceptable, the Contractor shall be charged the cost of the cementing material referee testing.

TABLE 1DB
Slump and Air Content of Plastic Concrete

Component	Slump mm (Note 1)	Air Content in Plastic Concrete %
Slip formed Concrete Barriers	Target slump ± 10	Target air ± 1.5
Tremie Concrete	Target slump ± 30	When required 5.0 ± 1.5
All Other Concrete	Target slump ± 20	Target air ± 1.5

Note:

1. When superplasticizer is used, requirements shall be as specified in the Concrete subsection.

TABLE 2DB
Admixtures, Water, and Cementing Materials - Minimum Frequencies for Sampling and Testing

Material	Use or Type of Construction	Minimum Sampling Frequency (Note 1)	Minimum Sample Size (Note 2)
Air Entraining and Chemical and Superplasticizing Admixtures	All concrete.	One sample shall be taken at the beginning of concrete placement in each calendar year, no more than 30 Days prior to concrete placement. One additional sample shall be taken during the calendar year.	Two samples shall be taken. Each shall be at least 750 ml.
Water Other Than Municipal Drinking Water	All concrete.		Two samples shall be taken. Each shall be at least 1 litre.
Cementing Materials: Portland Cement, Portland Limestone Cement, Slag, Fly Ash, Blended Silica Fume Cement	Concrete pavement and base.	One sample per Contract or one sample per each 10,000 m^3 of concrete, whichever is more frequent.	10 kg of each cementing material used.
	Precast components.	One sample per calendar year.	
	All other concrete.	One sample per Contract or one sample per each 5,000 m^3 of concrete, whichever is more frequent.	

Notes:

1. Additional samples shall be taken every time there is a change in material source.
2. Admixture and water samples shall be contained in a new, clean 1 litre bottle of a suitable plastic with a lid accompanied by MTO form PH-CC-340, Field Sample Data Sheet - Concrete. Cementing material samples shall be contained in a canvas bag with plastic insert, accompanied by MTO form PH-CC-340, Field Sample Data Sheet - Concrete.
3. Minimum sampling and testing frequencies for limestone filler shall be the same as those shown for cementing materials.

TABLE 3DB
Determination of Within-Batch Uniformity of the Concrete

Test	Range Between Highest and Lowest Values of Three Test Samples	
	Acceptable If Equal to or Less Than	**Rejectable If Greater Than**
Density, kg/m^3	32	50
Air Content in Plastic Concrete,%	0.7	1.0
Slump, mm	30	50

TABLE 4DB

Frequency of Sampling for Compressive Strength, Air Void System Parameters and Rapid Chloride Permeability (Note 4, 5)

Component	Sublot Size	Core Size (Note 7)	Number of Acceptance and Referee Cores	Number of Acceptance and Referee Cylinders 100 diameter and 200 mm long
Sidewalk on structure	500 lineal metres per stage	100 mm diameter and 200 mm long	6 (1 AVS, 1 RCP, 1 RCP referee 3 Strength)	Not applicable
Curb on Structure	500 lineal metres per stage			
Median on Structure	500 lineal metres per stage			
Parapet or Barrier Wall on Structure	500 lineal metres per structure per stage			
Bridge Deck-Thin Slab Deck	500 m^2 per stage			
Abutment, Wingwall, Cast-in-Place Retaining Wall	Each abutment, wingwall, cast-in-place retaining wall or a stage thereof			
Pier Column	Each pier column (Note 1)			
Pier Cap	Each pier cap			
Caissons (Bridges)	Each			
Arches and Spandrels	Between piers or between pier and abutment			
Bridge Deck-Post-Tensioned Deck	300 m^2 per stage	100 mm diameter and 200 mm long	6 (1 AVS, 1 RCP, 1 RCP referee 3 Strength)	Not applicable
Culvert	1,000 m^2 of floor area of cast-in-place concrete culvert (Note 2)			
	All cast-in-place concrete associated with a precast culvert, per stage			
Protection Slabs and Distribution Slabs	300 m^2 per stage			
Concrete Buttress and Concrete Appurtenances	Each			
Toe Wall	500 lineal metres per stage			
Approach Slab	500 m^2 per stage			
Concrete Barrier (not on structure)	Slipformed: 1,000 lineal metres (Note 3) Formed, including transitions: 250 lineal metres (Note 3)	100 mm diameter and 200 mm long	5 (1 AVS, 1 RCP, 1 RCP referee 3 Strength)	Not applicable
Silica Fume Bridge Deck Overlays	300 m^2 per placement per individual structure (Note 6)	150 mm diameter and 100 mm long	1 AVS	3 strength, 3 strength referee
		100 mm diameter and 70-100 mm long	2 RCP 2 RCP referee	

Component	Sublot Size	Core Size (Note 7)	Number of Acceptance and Referee Cores	Number of Acceptance and Referee Cylinders 100 diameter and 200 mm long
Bridge Deck Overlays	300 m² per placement per individual structure (Note 6)	150 mm diameter and 100 mm long	1 AVS	3 strength, 3 strength referee
		100 mm diameter and 70-100 mm long	2 RCP, 2 RCP referee	
Sidewalk	500 lineal metres (Note 3)	100 mm diameter and a minimum of 125 mm long	2 AVS	3 strength, 3 strength referee
Curb with Gutter	500 lineal metres (Note 3)			
Concrete Patches and Refacing	a) Approximately equal in size and not greater than 100 m², for each individual structure.	150 mm diameter and 100 mm long	2 AVS	3 strength, 3 strength referee
		100 mm diameter and 70-100 mm long	2 RCP, 2 RCP referee	
	b) Where the total area of patches or refacing on a structure is less than 20 m².	-	No cores	1 AVS, 1 RCP, 1 RCP referee, 3 strength, 3 strength referee
Footings below ground	Each footing	100 mm diameter and 200 mm long	3 Strength	No cylinders
Footings which extend above ground (high mast poles and sign supports)	40 m^3 (Note 8)	100 mm diameter and 200 mm long	3 Strength 1 AVS 1 RCP, 1 RCP referee	No cylinders

Notes for Table 4DB:

1. Multiple pier columns from the same pier grouping cast on the same Day shall be grouped into a single sublot.
2. The total floor area of a component shall be added together and then divided into sublots of specified size. Where a culvert has no floor, the area of the upper surface shall be used as the basis of determining sublots.
3. The total length of a component shall be added together and then divided into sublots of specified size.
4. For components not listed in the table, sampling shall be as directed by the Contract Administrator.
5. Sampling frequency can be adjusted by the Owner to suit specific contract details.
6. If typical depth of overlay is less than 70 mm, the Contract Administrator shall identify areas for coring that provide the required core lengths.
7. The Contract Administrator may direct the Contractor to obtain cores with different dimensions for certain components.
8. The total volume of concrete in footing for high mast poles and sign supports per Contract shall be added together and then divided into lots of specified size. Cores shall be taken from above ground portion of the footing.

Table 5DB
Penalty for 28-Day Compressive Strength

28 Day Compressive Strength of a Component (MPa)	Penalty ($/m³)
Average up to 1 MPa less than specified strength	160
Average up to 2 MPa less than specified strength	320
Average up to 3 MPa less than specified strength	480
Average up to 4 MPa less than specified strength	640
Average >4MPa less than specified strength	remove and replace

Table 6DB
Penalty for Air Void System Parameters of Hardened Concrete for Concrete Other Than Silica Fume Overlays and HPC
$/m³

Spacing Factor, mm	Air Content, %				
	1.0≤1.5	**>1.5≤2.0**	**>2.0≤2.5**	**>2.5≤3.0**	**>3.0**
≤0.230	800	570	340	110	0
>0.230 ≤ 0.350	1070	840	610	380	270
>0.350 ≤ 0.400	1450	1230	1000	790	670
>0.400	remove and replace				

Note:
When a sample in an unacceptable component has an air content of 3% or higher and a spacing factor lower than 0.230 mm in concrete other than silica fume overlays and HPC, the sample shall be assigned a value of 0 $/m³ for the purpose of calculating a penalty.

Table 7DB
Penalty for Air Void System Parameters of Hardened Concrete for HPC and Silica Fume Overlays $/m³

Spacing Factor, mm	Air Content, %				
	1.0≤1.5	**>1.5≤2.0**	**>2.0≤2.5**	**>2.5≤3.0**	**>3.0**
≤0.250	895	640	380	125	0
>0.250 ≤ 0.350	1150	895	640	380	255
>0.350 ≤ 0.400	1620	1300	1010	760	640
>0.400	remove and replace				

Note:
When a sample in an unacceptable component has an air content of 3% or higher and a spacing factor lower than 0.250 mm in silica fume overlays and HPC, the sample shall be assigned a value of 0 $/m³ for the purpose of calculating a penalty.

Table 8DB
Penalty for Rapid Chloride Permeability in Components Other than SF Overlays and HPC

Rapid Chloride Permeability of a Component (coulombs)	Penalty ($/m³)
Individual RCP >3000 coulombs, average ≤ 2500 coulombs	100
Average >2500≤3000	150
Average >3000≤3500	300
Average >3500	Remove and replace

Table 9DB
Penalty for Rapid Chloride Permeability in Silica Fume (SF) Overlays and HPC Components

Rapid Chloride Permeability of a Component (coulombs)	Penalty ($/m³)
Individual RCP>1250 coulombs, average ≤ 1000 coulombs	100
Average >1000≤1500	150
Average >1500≤2000	300
Average >2000	Remove and replace

TABLE 10DB
Admixture Test Result Tolerances for Acceptance Purposes

Test Result	Air Entraining Admixtures	Chemical and Superplasticizing Admixtures
Relative Density	a) ± 0.010 where the value of relative density shown on DSM is 1.050 or less b) ± X where the value of relative density shown on DSM is greater than 1.050; Where X = (relative density shown on DSM -1.000) / 5	
Non-volatile Content	Not required	± 3.0% of the value shown on DSM *
pH	± 2.0 of the value shown on DSM	Not required
* Example: If value shown on DSM is 10.0 %, no payment reduction will be applied if the result is between 7.0% and 13.0 %.		

WARRANT: In design-build contracts with new structural concrete except structural culvert work covered by NSSP DBSP 3271.

CUSTODIAN: Mohammad Aqel, Head, Concrete Section, Engineering Materials Office