

1. GENERAL

1.1 RELATED WORK

- .1 Section 31 24 13 – Roadway Excavation, Embankment and Compaction.
- .2 Section 32 11 23 – Granular Base.

1.2 REFERENCE STANDARDS

- .1 Do cast-in-place concrete work in accordance with the latest edition of CAN/CSA-A23.1 and testing in accordance with the latest edition of CAN/CSA-A23.2, except where specified otherwise.

1.3 PROTECTION OF WORK

- .1 The Contractor shall, at all times and at its entire cost, be responsible for protecting the concrete work against damage from rain, dust, freezing, rapid temperature change, and or other adverse weather until the concrete has thoroughly set up and hardened during the initial seven (7) day curing period as per CSA A23.1.
- .2 The Contractor shall, at its entire cost, protect the concrete work against damage from any form of traffic for a minimum of seven (7) days by use of barricades, fencing, or other means.
- .3 Concrete work that is damaged by rain, dust, freezing, excessive moisture loss, any form of traffic, or any other cause, shall be repaired, or removed and replaced, to the satisfaction of the Engineer, at the Contractor's sole expense.

1.4 MEASUREMENT AND PAYMENT

- .1 The unit price for constructing concrete structures shall include all excavation, removal and disposal of surplus material (including surplus material generated to facilitate placement of forming materials), sub-grade preparation, bedding material, forming, steel reinforcement, supply and placement of concrete, finishing, curing, backfilling and compaction, and all other tasks related to the construction of the concrete structures. The unit prices shall include all costs to complete the required work to support the concrete structure as well as to construct any overbuild outlined within the Plans and Drawings and these Specifications.
- .2 The unit price provided within the Bid Form, associated with the supply and installation of curb, or curb and gutter, shall include all granular base course to match the required thickness of the roadway pavement structure including any overbuild of the granular structure to support the concrete curb, or curb and gutter. The concrete curb, and curb and gutter supply and install unit price within the Bid Form shall be full compensation made due to the Contractor for the supply and placement of all granular base course required within the Plans and Drawings and technical specifications and as such no additional payment will be made due to the Contractor.

- .3 Sidewalk, Curb, Curb and Gutter
 - .1 Payment for sidewalks, curbs, curbs and gutters, drop/depressed curb or curb and gutter for lane/apron/commercial or private crossings shall be as follows:
 - .1 Separate sidewalk will be per lineal metre measured along the centreline of the structure.
 - .2 Curbs or curb and gutter will be per lineal metre measured along the face of the curb.
 - .3 Monolithic sidewalk, curb, and curb and gutter will be per lineal metre for the various structure widths shown within the Bid Form, measured along the face of the curb.
 - .4 Payment for sidewalk and curb or sidewalk and curb and gutter poured separately but abutting will be made at the respective unit price for each structure. The necessary dowels, rebar, and joint filler shall be included in the respective unit price of either the curb or the sidewalk.
- .4 Concrete Medians and Islands
 - .1 Measurement of concrete medians and islands will be either per square metre or linear metre, as specified within the Bid Form for concrete median or island built in accordance with the dimensions specified or shown on the Plans and Drawings.
 - .2 Square metre measurements will be the measured surface area of the completed structure. Linear measurement will be made along the centreline of the completed structure.
- .5 Curb Ramps
 - .1 Measurement of curb ramps will be per each structure installed or square metre, as specified within the Bid Form.
 - .2 The dropped/depressed curb or curb and gutter will be **included** in the curb ramp unit price.
- .6 Driveway Aprons
 - .1 Measurement of driveway aprons will be per square metre for the structures installed in accordance with the dimensions, as specified within the Bid Form.
 - .2 The dropped/depressed curb or curb and gutter will be **excluded** and measured as per above, in lineal metres.
- .7 Extra Reinforcing Bars
 - .1 The quantity of extra reinforcing bars for which payment will be made shall be the actual number of linear metres of extra reinforcing bars supplied and installed in accordance with the Engineer's instructions. It shall be paid for on an authorized Change Order basis.
 - .2 This item does not include payment for the supply and installation of reinforcing bars specified elsewhere under other items in this section of the specification or on details shown within the Plans and Drawings.
- .8 Swale Gutter
 - .1 Measurement of swale gutters will be per lineal metre for the respective type of swale structure installed in accordance with the dimensions specified or shown on the Plans and Drawings, or as specified within the Bid Form.
 - .2 Linear measurement shall be measured along the centreline of the structure.
 - .3 The unit price for construction of the above structures shall include the supply of all materials, tools, equipment, labour and supervision to do all base preparation,

forming, placing of concrete, jointing, reinforcing, finishing, curing, backfilling, and general cleanup.

- .9 Concrete Fill
 - .1 Measurement of concrete fill will be per cubic metre based on truck haul cards.
 - .2 The unit price for concrete fill within the Bid Form shall include the supply of all materials, tools, equipment, labour and supervision to do the required base preparation, placing of the concrete fill, finishing, curing, and general cleanup.
 - .3 Concrete fill in the narrow strips created through the removal of the pavement structure to facilitate the placement of forming materials is considered incidental to the Work and will receive no separate payment.

2. PRODUCTS

2.1 MATERIALS

- .1 Concrete Mix
 - .1 Portland or Portland Limestone Cement: to CSA A3000 and shall be The HS, HSL, HSb, HSLB, or HSe (A23.1 Table 3) high sulphate resistant, cement.
 - .2 Water shall conform to CSA standard A23.1. Water shall be clean and free from injurious amounts of oil, acid, alkali, organic material or other deleterious substances.
 - .3 Exposure Class: C-2 to CSA-A23.1 (non-structurally reinforced concrete exposed to chlorides, freezing and thawing).
 - .4 Aggregates: maximum nominal size of 20 mm, to the latest version of CSA-A23.1.
 - .5 Air Entraining Admixture: to CSA-A23.1.
 - .6 Chemical Admixtures: to CSA-A23.1.
 - .7 Calcium Chloride: to CSA-A23.1.
 - .8 Pozzolonic-Mineral Admixtures: not permitted for use in concrete.
 - .9 Fly ash: to CSA A3001 Type F.
- .2 Base Course
 - .1 In accordance with Section 32 11 23 – Granular Base.
- .3 Reinforcing Steel
 - .1 Reinforcing steel shall conform to the following requirements:
 - .1 Welded steel wire fabric shall conform to CSA standard G30.5.
 - .2 Billet steel bars shall conform to CSA standard G30.12M.
- .4 Curing Compounds
 - .1 Shall be a liquid type conforming to CGSB Specification 90-GP-1a and shall contain a temporary colour indicator.
- .5 Joint Sealing Compound
 - .1 To be used in the joint between two separately poured concrete structures.
 - .2 Will be an elastic type sealer conforming to ASTM D6690.
- .6 Expansion Joint Filler
 - .1 Expansion joint material shall be Flexcell or approved equivalent, of the same width and depth as the structure and not less than 10 mm thick.

2.2 DESIGN OF CONCRETE MIXES

.1 General

- .1 Concrete mixes shall be designed and/or qualified by a professional engineer registered in the province in which the work is being completed.
- .2 The mix design shall be submitted to the Engineer for approval a minimum of two (2) weeks prior to delivery of any concrete to the site. Under no circumstance is concrete to be placed until an approved concrete mix design has been submitted. Delays incurred because of the concrete mix design will be borne solely by the Contractor. The Engineer shall provide feedback to any submitted concrete mix design within two (2) business days after receiving the concrete mix design. If the submitted concrete mix design is older than one (1) year, a letter from the concrete supplier shall be attached indicating that all parameters of the concrete mix design have not changed from that indicated in the original concrete mix design, including, but not limited to: the source of the aggregate, mix properties and admixtures recommended.

.2 Compressive Strength

- .1 The specified minimum compressive strength at twenty-eight (28) Days is 32MPa.
- .2 For concrete fill, the specified minimum compressive strength at twenty-eight (28) Days is 10MPa.

.3 Air Content

- .1 The total air content of the concrete shall be maintained between the limits of 5% and 8%.

.4 Fly Ash

- .1 No portion of the minimum cement content may be replaced with fly ash. A minimum 300kg Portland or Portland-limestone cement per cubic meter is required; a minimum of 360kg per meter of Portland or Portland-limestone cement per cubic meter is required for HSB, HSLb, or HSe mixes. After September 15, no fly ash shall be used in the mix.

.5 Slump

- .1 The minimum slump permissible will be that which will allow the concrete to be placed efficiently and provide a homogeneous mass.
- .2 The slump permissible for extruded concrete is 25mm ±15mm.
- .3 The slump permissible for hand formed concrete is 80mm ±30mm.

.6 Water/Cement Ratio

- .1 The maximum water/cementitious materials ratio (w/cm) shall be 0.45.

.7 Deleterious Requirements

- .1 In addition to the deleterious requirements contained in CSA-A23.2-14A, the following limits shall apply when the aggregate is tested in accordance with ASTM Standard Practice C295.

Deleterious Substance	Maximum Percent by Mass of Total Sample	
	Fine Aggregate	Coarse Aggregate
Siliceous Shalestone	1.0	0.5
Ironstone	1.5	1.0

Chert	2.0	2.0
Other Deleterious	7.0	3.0

- .2 In accordance with CSA A23.2-15A, fine aggregate limits shall be based on percentage 2.5mm retained material by total mass of fine aggregate samples. Smaller fine aggregate particles have limited risk of popouts.
- .3 Materials above are defined as follows for the purposed of these Specifications:
 - .1 Siliceous Shalestone: light to medium grey, or greenish grey shale generally exhibiting a platy shape. The material absorbs water readily, and turns dark grey, dark green or black on wetting. The shalestone is composed of varying amounts of opal, clay materials and fine quartz.
 - .2 Ironstone: derived from clay ironstone concretions which consist of a relatively hard, dark brown outer shell of limonite and clay surrounding a relatively soft, brown or grey core of siderite and clay. The material has a high absorption.
 - .3 Chert: this chert category also includes cherty limestone and cherty claystones. The rocks are generally dense and hard but contain varying amounts of potentially reactive chalcedony.
 - .4 Other Deleterious: physically weak and/or absorptive rocks such as sandstones, siltstones, argillaceous or deeply weathered carbonate, friable or weathered schists or gneisses.

3. EXECUTION

3.1 GRADE PREPARATION

- .1 Construct embankments using excavated material free from organic matter or other objectionable materials.
- .2 Provide borrow material for fill when a deficiency of excavated material exists.
- .3 Place fill in maximum 150mm thick layers, compacted to a minimum 98% Standard Proctor Density (ASTM D698), with compaction to 100% Standard Proctor Density within 150mm of final grade.
- .4 Obtain the Engineer’s approval of Granular Base and reinforcing steel prior to placing concrete.

3.2 GRANULAR BASE

- .1 Place Granular Base in accordance with Section 32 11 23 – Granular Base.

3.3 CONSTRUCTION WITH FORMS

- .1 Forms may be steel, wood, or fibreglass but shall produce a true line without irregularities in the alignment. Flexible forms shall be used for all structures having a radius of less than 40m. All forms shall be cleaned of hardened concrete or other foreign matter. Sufficient forms shall be placed and checked before concrete is poured to ensure true line and grade. The forms shall be well stayed and braced or otherwise held rigidly to the established line and grade. Any form that has lost its shape or has become dented and rough shall not be used.

- .2 Forms shall be set to the lines and grades established by the Engineer. The concrete abutting the area to be poured shall be saw cut, and dowelling shall be installed as follows:
- .1 Extending a Curb and Gutter or Curb Section:
 - .1 In connecting or tying into an existing curb and gutter or curb section, drill two (2), 10mm diameter holes to a minimum depth of 150mm into the existing curb and gutter or curb section. One hole will be located at the midpoint of the gutter pan or below grade portion of the curb, and the second hole at the midpoint of the curb section. Insert and drive a 450mm long 10M rebar piece into each hole; the rebar should extend a minimum of 300mm into the new curb and gutter or curb section. The rebar installed within the existing curb and gutter or curb section shall be secured using Hilti Hit HY-200 epoxy, or an approved equivalent, installed as per the manufacturer's specifications.
 - .2 Extending a Sidewalk, Slab, or Apron:
 - .1 In connecting or tying into existing sidewalks, slabs, or aprons, drill 10mm diameter holes to a minimum depth of 150mm into the existing sidewalk, slab, or apron section at a spacing of 300mm o/c maximum. The holes will be located at the midpoint of the existing sidewalk, slab, or apron section. Insert and drive a 450mm long 10M rebar piece into each hole; the rebar should extend a minimum of 300mm into the new sidewalk, slab, or apron section. The rebar installed within the existing sidewalk, slab, or apron section shall be secured using Hilti Hit HY-200 epoxy, or an approved equivalent, installed as per the manufacturer's specifications.
 - .3 Joining a Sidewalk, Slab, or Apron to Existing Curb & Gutter or Curb Section:
 - .1 In connecting or tying a sidewalk, slab, or apron into an existing curb and gutter or curb section, drill 10mm diameter holes to a minimum depth of 100mm into the existing curb and gutter or curb section at a spacing of 450mm o/c maximum. The hole will be located at the midpoint of the sidewalk, slab, or apron section, or a minimum of 60mm below the top of the back of the curb and gutter or curb (to be bent as required). Insert and drive a 450mm long 10M rebar piece into each hole; the rebar should extend a minimum of 350mm into the new sidewalk, slab, or apron section. The rebar installed within the existing curb and gutter or curb section shall be secured using Hilti Hit HY-200 epoxy, or an approved equivalent, installed as per the manufacturer's specifications.
 - .4 Joining a Curb and Gutter or Curb to Existing Sidewalk, Slab or Apron Section:
 - .1 In connecting or tying a curb and gutter or curb into an existing sidewalk, slab or apron section, drill 10mm diameter holes to a minimum depth of 150mm into the existing sidewalk, slab or apron section at a spacing of 450mm o/c maximum. The hole will be located at the midpoint of the sidewalk, slab, or apron section. Insert and drive a 250mm long 10M rebar piece into each hole; the rebar should extend a minimum of 100mm into the new curb and gutter or curb section. The rebar installed within the existing sidewalk, slab, or apron section shall be secured using Hilti Hit HY-200 epoxy, or an approved equivalent, installed as per the manufacturer specifications.
- .3 A template, supplied by the Contractor, shall be used to check that there is the specified clearance from the top of the forms to the base. This inspection shall be carried out by the Contractor in the presence of the Engineer.

- .4 Placing Concrete
 - .1 Concrete shall be placed only after the forms have been inspected and approved by the Engineer.
 - .2 Concrete shall be placed only on a base that is sufficiently moist to prevent absorption of water from the freshly placed concrete. Where necessary the base shall be sprinkled with water to raise the moisture content to the desired level.
 - .3 All forms shall be thoroughly moistened or oiled. Chemicals shall not be used to remove ice or hardened concrete from the forms.
 - .4 Concrete shall be handled from the mixer to the place of use as rapidly as possible by methods which will prevent the separation or loss of the ingredients. Concrete shall be deposited in the forms as close as possible to its ultimate location to reduce re-handling or segregation. Under no circumstances shall concrete that has partially hardened be used. Once a pour has started, it shall be carried on as a continuous operation until the section is completed.
 - .5 A mechanical vibrator shall be used during the concrete placing operations as required to eliminate air pockets and honeycombing. To properly consolidate concrete, removing large voids of entrapped air while preserving entrained air and preventing honeycombing.
 - .6 Concrete shall not be poured in the rain and freshly poured concrete surfaces shall be protected from rain, frost, dust, and other physical damage, until it has obtained sufficient strength to resist marking.
 - .7 All pours shall start and stop at a contraction joint and surplus material shall be wasted. Disposal and washout locations shall be confirmed with the Engineer or at the locations as designed on the Plans and Drawings. The Contractor shall be solely responsible for the removal and disposal of all washout areas to the satisfaction of the Engineer.

- .5 Stripping Forms and Lip of Gutter Fill
 - .1 The face of curb form shall be removed within two (2) hours after the initial set to permit proper finishing of the concrete. Curing compound shall be applied immediately following form removal or following any patching that may be necessary immediately upon form removal.
 - .2 Backfill at lip-of-gutter shall be 10MPa or better concrete fill on undisturbed base, tamped in place to the underside of the asphalt.
 - .1 The base of the excavated area must be free from all loose material, mud, and water.

3.4 REINFORCEMENT

- .1 Reinforcement shall be free from mill scale, grease and rust immediately prior to placing the concrete.
- .2 All lane or commercial crossings shall be 180mm deep and reinforced with 150mm welded steel wire fabric. Alternative reinforcing of 10M rebar on a 300mm grid with 7mm cover may be used.
- .3 10M rebar 6m long to be installed at a spacing of 200mm on centre when placing curb and gutter over service connections and hydrant lead trenches, as per the Standard Drawings.

- .4 10M rebar 6m long to be installed at a spacing of 300mm on centre when placing sidewalk over service connections and hydrant lead trenches, as per the Standard Drawings.

3.5 RETEMPERING

- .1 Concrete shall not be re-tempered if test values are within specifications at the time of delivery to the Project Site.
- .2 Concrete may be re-tempered at the Project Site with water and/or air entraining agent if the following requirements are met:
 - .1 Mixing time after the admixture or water has been introduced shall not be less than three (3) minutes at mixing speed.
 - .2 Total mixing and agitating time for the load shall not exceed one-hundred and twenty (120) minutes (as per CSA A23.1).

3.6 CONSTRUCTION WITH EXTRUDING EQUIPMENT

- .1 Slip-form paving machines or concrete-extruding machines may be used for placing concrete provided they meet the following requirements and have been approved by the Engineer prior to commencement of the work.
 - .1 The vibrators on the equipment shall be adequate to produce a dense mass with a smooth surface free of honeycombing.
 - .2 The Equipment shall include automatic grade and line control.
- .2 Any special grading or preparation of the sub-grade required by the Contractor to accommodate its Equipment shall be the responsibility of the Contractor. The roadway and boulevards shall be restored promptly within four (4) Weeks to their original condition.
- .3 Whenever possible, the hand forming and placing of concrete (as may be required at curb returns, driveways, and catch basins) shall be carried out in conjunction with the extrusion operation. Where this procedure is not practical, the "fill-ins" shall be completed within seven (7) Days after construction of the adjacent extruded section.

3.7 EXPANSION AND CONTRACTION JOINTS

- .1 Curb and Gutter
 - .1 Construct joints every 3m, or approximately twenty-five (25) times the slab thickness, whichever is smaller, by means of a marking tool, steel plate, or other approved method.
 - .2 Joints shall not be less than 50mm in depth and shall be 5mm in width.
 - .3 An area of not less than 50% of the concrete shall be continuous through the joint when steel plates are used.
 - .4 The joint shall be edged with a tool having a radius of 5mm.
- .2 Sidewalk
 - .1 Transverse contraction joint shall be constructed every 3m, or approximately twenty-five (25) times the slab thickness, whichever is smaller, by means of a marking tool or other approved method.
 - .2 Joints shall not be less than 50mm in depth and shall be 5mm in width.

- .3 Transverse surface joints shall be midway between the contraction joints and shall be 13mm deep and 5mm wide.
- .4 The joints shall be edged with a tool having a radius of 5mm.

3.8 DIMENSIONS OF CONCRETE STRUCTURES

- .1 Concrete structure dimensions are shown on the Plans and Drawings.
- .2 For repairs to existing sections of curb, curb and gutter, and sidewalk, match dimensions of existing structures.

3.9 CURB RAMPS

- .1 Curb ramps shall be constructed at locations shown on the Plans and Drawings or as directed by the Engineer. They shall be constructed in accordance with the dimensions shown on the Plans and Drawings.

3.10 DRIVEWAY APRONS

- .1 Aprons shall be constructed at locations shown on the Plans and Drawings or as directed by the Engineer. They shall be constructed in accordance with the dimensions shown on the Plans and Drawings.

3.11 EXTRA REINFORCING BARS

- .1 Extra reinforcing bars shall be supplied and installed in concrete structures as directed by the Engineer.
- .2 Where directed by the Engineer, curb and gutter and sidewalks shall be reinforced as shown on the Plans and Drawings.

3.12 FINISHING

- .1 Curb and Gutter
 - .1 The top of the gutter and the top and face of the curb shall be floated using a magnesium float, to a smooth finish and the edges neatly rounded. Steel or Fresno troweling shall be avoided. The final finish shall be lengthwise brushing with a soft bristle brush approved by the Engineer. The appropriate use of evaporation retarders between finishing operations per manufacturers directions is permitted. A mortar coat or water in the finishing process shall not be used.
 - .2 The gutter lip on the curb and gutter shall be lowered where a swale gutter joins the curb and gutter structure to allow for free flow of drainage water.
- .2 Sidewalk
 - .1 The top of the sidewalk shall be floated, using a magnesium float, to a smooth finish. Steel or Fresno troweling shall be avoided. The final finish shall be a transverse brushing with a soft bristle brush approved by the Engineer. The edges shall be neatly rounded. The appropriate use of evaporation retarders between finishing operations per manufacturers directions is permitted. A mortar coat or water shall not be used in the finishing process.

3.13 JOINT SEALING

- .1 A cut or preformed joint, 25mm in depth and a maximum of 12mm wide, shall be provided at the top of all separately poured, abutting concrete structures. An elastic type sealer shall be placed in this joint, in accordance with the manufacturer's recommendations.

3.14 MARKINGS

- .1 Contractors and Year of Construction
 - .1 The Contractor shall mark the concrete structure with an approved marking tool showing the name of the Contractor and the year of construction. These marks shall be made at the ends of each block or at 200m intervals, whichever is less, and at the termination points if the construction is terminated within the middle of a block.
- .2 Curb Boxes
 - .1 Any sidewalks constructed adjacent to curb boxes shall be marked directly opposite the curb box with a marking tool showing the letters "CC", or the impression of a curb box cap.
- .3 The letters and numerals of the marking tools shall be approximately 40mm high.

3.15 CURING

- .1 The surface of the concrete shall be protected from the sun and air by an approved membrane curing material. This protection shall be accomplished by coating the entire exposed surface of the concrete with a liquid compound immediately after the concrete has received its finish treatment. At the time the front and the back forms are removed, the exposed concrete surfaces shall also be coated with the membrane material.
- .2 The membrane material shall be applied uniformly at the manufacturer's recommended rate of application by means of an approved pressure spray distributor.
- .3 The membrane material shall be so applied that the concrete surface is completely coated and sealed in one application.
- .4 Under no circumstances shall any material be added to the curing compound as delivered by the manufacturer.

3.16 BACKFILL

- .1 The Contractor shall backfill behind the concrete structure to the design cross section with select sub-grade material, compacted to 95% of Standard Proctor Density (ASTM D698).
- .2 The backfill shall be placed as shown on the Plans and Drawings or as directed by the Engineer.

- .3 Placing of the backfill shall be done promptly after the forms have been stripped to avoid any possible damage to the concrete structure.
- .4 The Contractor shall leave all cut or fill slopes in a trimmed, neat condition in accordance with the Engineer's stakes or as shown on the Plans and Drawings.

3.17 CONCRETE FILL

- .1 Concrete fill shall be placed, where directed by the Engineer, adjacent to new gutters (including swale gutters) or curbs to replace pavement structure removed to accommodate the setting of forms.
- .2 All loose material, mud, and water shall be removed from the excavation prior to placing any concrete fill. The concrete fill shall be placed to within 75mm of the finished pavement surface. The concrete shall be consolidated using a pencil type vibrator and finished with a wooded trowel. The concrete surface shall be sprayed with an approved curing compound.

3.18 COLD WEATHER REQUIREMENTS

- .1 No concrete shall be poured when the ambient air temperature is lower than 5°C, without suitable means being provided for maintaining the concrete at a temperature of at least 10°C for seven (7) Days following placement of the concrete.
- .2 Concrete shall not be placed on frozen sub-grade.
- .3 The concrete when deposited in the forms shall have a temperature of not less than 10°C nor more than 30°C.
- .4 Insulated tarps and other protective coverings used to conserve heat shall be secured at corners and along edges where slabs are most susceptible to freezing.
- .5 Straw or similar materials for protection against frost shall not be allowed to come in contact with fresh concrete.
- .6 All concrete showing evidence of freezing shall be removed from the job and replaced at the Contractor's expense.

3.19 HOT WEATHER REQUIREMENTS

- .1 When the ambient air temperature is higher than 27°C, the concrete temperature at the time of placing shall not exceed 30°C.
- .2 In the event this limit is exceeded, the concrete operations shall be suspended until the constituent materials of the concrete are cooled.

3.20 TESTING AND INSPECTION

- .1 The Engineer shall inspect all prepared base and forms prior to placement of concrete.

3.21 TOLERANCE

- .1 All exposed concrete surfaces shall be checked by the Contractor with a 3m straight-edge, and any water pockets or deviations in line or grade exceeding 5mm shall be corrected immediately.
- .2 Differences in elevation at any given point from that given on the survey stakes shall not exceed ± 10 mm and the maximum variation between successive survey stakes shall not be greater than 10mm.
- .3 Deviations in alignment at any given point from that given on the survey stakes shall not exceed ± 25 mm and the fluctuations in the alignment between successive survey stakes shall not be greater than 25mm.
- .4 If any tolerances are exceeded, remove or correct the Work as directed by the Engineer.

3.22 FIELD QUALITY CONTROL

- .1 A testing laboratory certified to CSA A283 shall be engaged and paid for by the Owner to perform all quality control tests. Copies of test results shall be sent directly to the Contractor and the concrete producer as per CSA A23.2-25C Clause 6.
- .2 Sampling
 - .1 Samples of concrete shall be obtained in accordance with CSA Test Method A23.2-1C for sampling Plastic Concrete.
- .3 Test Cylinders
 - .1 Four (4) test Cylinders shall be made and stored in accordance with CSA Test Method A23.2-3C for making and curing concrete Compression and Flexural Test Specimens. If the ambient air temperature during the first twenty-four (24) Hours after the cylinder is cast is expected to be outside the range of 15-25°C, an additional seven (7) Day field cure cylinder must be cast and cured in in situ conditions.
 - .2 Not less than one (1) set of strength test cylinders shall be cast to represent each 50 m³ of concrete placed and in no case shall there be less than one set of cylinders cast for each day's pour.
 - .3 Each strength test shall consist of a minimum of three (3) test cylinders; one tested at seven (7) Days and two (2) at twenty-eight (28) Days, with additional cylinders referenced above, tested as required for validation. If field cure test cylinders were cast representing concrete placed after September 30, or outside of the specified temperature range, these shall be tested at seven (7) Days.
 - .4 Compressive strength of test cylinders shall be measured in accordance with CSA Test Method A23.2-9C Compressive Strength of Cylindrical Concrete Specimens.
- .4 Air Content
 - .1 Air content determinations shall be made in accordance with CSA Test Method CSA A23.3-4C air content of plastic concrete by the pressure method.
 - .2 During construction start up, every load or batch of concrete shall be tested until such time as satisfactory control of the air content has been established. The air content shall be determined of any concrete sample used to cast strength test cylinders.

- .3 Whenever a test falls outside the specified limits the testing frequency shall revert to one test per load or batch until such time as satisfactory control is re-established.

.5 Slump

- .1 Slump tests made in accordance with CSA Test Method A23.2-5C.
- .2 Slump of concrete shall be made in conjunction with each strength test.

3.23 FAILURE TO MEET TEST REQUIREMENTS

.1 Strength

- .1 Where there are variations from specified design strength, the following adjustments will be made based on the twenty-eight (28) Day, laboratory cured cylinders.
 - .1 When concrete strength of any set exceeds 95% of design strength, full payment for the Work shall be made at the Contract unit prices.
 - .2 When concrete strength of any set is greater than 80% but less than 95% of design strength, the price paid to the Contractor for the Work represented by that set of cylinders shall be determined by the following formula:

$$P - \left[\frac{2P(A - B)}{A} \right]$$

Where:

P = unit price

A = specified strength

B = average 28-Day cylinder strength.

- .3 If concrete strength of any set is less than 80% of design strength, the work represented by that set of cylinders will be rejected.
- .4 Where the average strength of all tests for the total work falls below design strength, but above 95% of design strength, that work not already having a price adjustment under the preceding clauses shall be subject to the following adjustment. The price paid by the Contractor shall be determined by the following formula:

$$P - \left[\frac{2P(A - B)}{A} \right]$$

Where:

P = unit price

A = specified strength

B = average 28-Day cylinder strength.

.2 Air Content

- .1 If the measured air content falls outside the limits specified, a check test shall be made immediately on another portion of the same sample, within the parameters described in Section 3.5 - Retempering. In the event of a second failure, the load of concrete shall not be used for construction.
- .2 Where deemed necessary, the Engineer will test hardened concrete for air content and spacing factor by the linear traverse method, ASTM Designation C457, Modified

Point – Count Method, Air-Paste Ratio Method of Calculation. Concrete tested by this method using a magnification of 100 to 125X (as per CSA A23.1) and found to have a spacing factor greater than 0.2mm will be rejected, and complete replacement of the work will be required.

- .3 Linear traverse testing cost will be borne by the Contractor, if the concrete is proven defective.
- .4 Linear traverse testing costs will be borne by the Owner when the concrete is proven to meet the above requirements.

.3 Slump

- .1 If the measured slump falls outside the limits specified, a check test shall be made immediately on another portion of the same batch. In the event of a second failure the Engineer may refuse the batch.

.4 Thickness

- .1 At the Engineer's request, the quality assurance laboratory will take one (1) or more sets of cores from the suspect concrete walk or crossing, each comprising of two (2) cores whose average thickness represents not more than 500m² of concrete walk or crossing. If the average core thickness is deficient, that area will be assessed a pay factor according to the following:

Thickness Deficiency (mm)	Pay Factor (% of Contract Price)
6	100.0
7	97.0
8	93.7
9	90.0
10	85.5
11	80.5
7	75.0
13	68.0
14	60.0
15	50.0
Over 15	Remove and Replace

- .2 Concrete walk or crossing with excess thickness may be accepted if surface and grade tolerances are met, but no claim for additional payment will be accepted.

1.1 REJECTED CONCRETE WORK

- .1 Remove and replace rejected concrete work by full segments or slabs between crack control or construction joints.

1.2 PROTECTION OF FINISHED WORK

- .1 Protect finished work from damage. Repair if damaged.
- .2 Do not open walk or crossings to traffic until permitted by the Engineer. When opening to traffic, leave walk or crossings clean and free of debris and remove signs and barricades no longer needed.

1.3 CONCRETE DETERIORATION

- .1 Concrete that shows surface scaling, deterioration and loss of course aggregate during the maintenance period will be rejected and require removal and replacement by the Contractor at no cost to the Owner.

END OF SECTION

REVISION LOG		
DATE	REVISION	COMMENTS
02/01/2024	Clerical Edits, Reference Updates.	Clarify items reference numbers and documents as well as general clerical edits.