Part 1 General

1.1 SECTION INCLUDES

1. Cast-in-place concrete foundation walls, floors and slabs on grade, ramps, and equipment pads.
2. Site work cast-in-place concrete for retaining walls, sidewalks, curbs, light pole base, flagpole base, thrust blocks and manholes.
3. Control, expansion and contraction joint devices associated with concrete work including embedments and joint sealants.

1.2 RELATED REQUIREMENTS

1. Section 03 20 00 - Concrete Reinforcing.
2. Section 03 35 00 - Concrete Finishing.
3. Section 05 12 00 - Structural Steel.
4. Section 05 50 00 - Metal Fabrications.

1.3 REFERENCE STANDARDS

1. CSA A23.1:19/A23.2:19 Concrete materials and methods of concrete construction/test methods and standard practices for concrete
2. CSA A23.3 Design of Concrete Structures

1.4 ACTION SUBMITTALS

1. Product Data: Provide data on joint devices, attachment accessories, admixtures.

1.5 INFORMATIONAL SUBMITTALS

1. Section 01 33 00: Submission procedures.
2. Test Data: Minimum four (4) weeks prior to starting concrete work, submit manufacturer's test data and certification by qualified independent inspection and testing laboratory that following materials will meet specified requirements:
    1. Portland cement.
    2. Blended hydraulic cement.
    3. Supplementary cementing materials.
    4. Grout.
    5. Admixtures.
    6. Aggregates.
    7. Water.
3. Concrete Mix Design: Provide submittal of proposal concrete mix design for consultant review prior to starting construction work.
4. Certification: Provide certification that mix proportions selected will produce concrete of quality, yield and strength as specified in concrete mixes, and will comply with CSA-A23.1/A23.2.

5. Certification: Provide certification that plant, equipment, and materials to be used in concrete comply with requirements of CSA-A23.1/A23.2.
6. Manufacturer's Installation Instructions: Indicate installation procedures and interface required with adjacent Work.
7. Submit testing and inspection results and reports for review by Engineer and do not proceed without written approval when deviations from mix design or parameters are found.

1.6 CLOSEOUT SUBMITTALS

1. Section 01 33 00: Submission procedures.
2. Record Documentation: Accurately record actual locations of embedded utilities and components.

1.7 QUALITY ASSURANCE

1. Perform Work in accordance with CSA-A23.1/A23.2.
2. Acquire cement and aggregate from same source for all work.
3. Conform to CSA-A23.1/A23.2 when concreting during hot weather.
4. Conform to CSA-A23.1/A23.2 when concreting during cold weather.
5. If requested, submit to Engineer, a minimum 4 weeks prior to starting concrete work, valid and recognized certificate from plant delivering concrete.

1.8 DELIVERY, STORAGE AND HANDLING

1. Store material in accordance with CAN/CSA-A23.1.
2. Concrete hauling time: maximum allowable time limit for concrete to be delivered to site of Work and discharged not to exceed 120 minutes after batching.
    1. Modifications to maximum time limit must be agreed to by Engineer and concrete producer as described in CSA-A23.1/A23.2.
    2. Deviations to be submitted for review by Engineer.
3. Concrete delivery: ensure continuous concrete delivery from plant meets CSA A23.1/A23.2.
4. Cement and aggregate shall be stored in such a manner as to prevent deterioration or intrusion of foreign matter. Liquid mixtures shall be protected from freezing and from setline out of solution. Any deteriorated or damaged materials shall not be used for concrete.

1.9 INSPECTION AND TESTING

1. An independent inspection and testing company is to inspect and test the concrete.
2. The contractor shall arrange with the inspector and the Consultant for review of construction.
3. Tests to be carried out under the appropriate CSA standards.
4. A minimum of three (3) compression test specimens are to be taken for each concrete placement, but not less than three (3) cylinders for each 100 cubic

metres of individual placement, all in accordance with CAN/CSA-A23.2. One (1) cylinder shall be tested at seven (7) days and the remaining cylinders at twenty-eight (28) days. Additional test specimens shall be taken at the discretion of the Consultant. Preparation of test cylinders, curing procedure and testing, shall all be carried out by the Inspection and Testing Company.

1. A copy of all test results are to be forwarded directly to the Engineer and Architect, by the Inspection and Testing Company.

5. Materials and workmanship will be subject to the inspection at any time. Co-operate in permitting access for inspection at all places where work is being done or stock is being stored.

6. The Contractor shall supply all necessary samples to the Testing Laboratory for testing. Supply additional labour required to assist the Testing Laboratory in making such tests. The costs of this material and labour shall be borne by the Contractor.

7. Where Work, in the opinion of the Consultant, requires re-inspection, or more stringent inspections because of previous requirements of re-inspections of similar work, such re-inspections shall be at the Contractor's expense.

1.10 SCHEDULING

1. Check the drawings and specifications for the requirements of other trades which will affect the forming and placing of concrete and reinforcing steel.

2. Give instruction and information in writing, or by schedule to other trades, of the requirements necessary for services, materials, or inserts prepared and/or supplied by other trades which will affect the work of this division.

3. Prior to placing concrete, request review of formwork and reinforcing steel by the Engineer. Concrete shall not be placed until the Engineer has completed the review.

4. Before placement, all equipment for mixing and transporting the concrete shall be cleaned, and all debris and ice shall be removed from the places to be occupied by concrete. Reinforcement shall be thoroughly cleaned of ice, dirt, scale or other coatings.

1.11 COOPERATION WITH OTHER TRADES

1. Set sleeves, ties, anchor bolts, pipe hangers and other inserts, openings and sleeves in concrete work, as required by other Sections.

2. Read the specifications and examine the drawings covering the work of other interfacing trades. Consult with the trades concerned to give them all necessary facilities and directions and information to complete the work of their trade.

3. Confine operations to the immediate vicinity of the item's final location in the Work, and co-operate fully in order to permit work adjacent to or appurtenant to the work to be carried out with a minimum of interference.

1.12 ENVIRONMENTAL CONDITIONS

1. Cold Weather Requirements:

1. When the air temperature is at or below 5 degrees Celsius or when there is a probability of it falling to that limit within 24 hours of placing, the

concrete temperature shall be maintained in accordance with CAN/CSA-A23.1.

2. Ensure that the surface on which finished slabs and toppings are placed, including soil, is at a temperature of at least +13 degrees Celsius (e.g. finished concrete). Ensure that any surface against which concrete is placed, including soil, is at a temperature of at least +5 degrees Celsius (e.g. footings).

3. In cold weather, concrete shall be delivered to the Work having a temperature of not less than 18 degrees Celsius and not more than 32 degrees Celsius.

4. Provide temporary heating equipment as necessary. Exhaust heaters producing carbon dioxide shall be vented directly to the outside. Protect concrete surfaces from direct exposure to the combustion gases of heaters.

5. Provide protection for concrete such that all sections of the concrete and
surrounding air will remain continuously at a temperature of between +10 degrees Celsius and +27 degrees Celsius for 5 days after placing.

6. The housing, covering or other protection used in connection with curing shall remain in place and intact at least twenty-four hours and until the air temperature in the enclosure has reached the outside air temperature after the artificial heating is discontinued. No dependence shall be placed on salt or other chemicals for the prevention of freezing.

2. Hot Weather Requirements:

1. When the air temperature is at or above 27 degrees Celsius or when there is a probability of it rising to 27 degrees Celsius during the placing period, special effort shall be made to maintain the concrete temperature in accordance with CAN/CSA-A23.1 Curing and Protection.

2. Water down all formwork, steel deck, reinforcing, sub-grade and general area around the Work just before placing concrete to reduce the temperature and increase the humidity. Do no permit water to puddle.

3. In hot weather concrete shall be delivered to the Work having a temperature of not less than 10 degrees Celsius and not more than 27 degrees Celsius.

4. Take suitable precautions to avoid drying of the concrete prior to finishing operations. Provide windbreaks, sunshades, fog sprays or other devices.

5. Do not place concrete which has a temperature of 27 degrees Celsius or above.

1.13 QUALITY CONTROL

1. Defective materials or quality of work whenever found at any time shall be rejected, regardless of previous inspection. Inspection is not to relieve the Contractor from responsibility, but is a precaution against oversight and errors. Defective materials shall be removed and replaced by the Contractor at their own expense, and without change to the Contract Time.

Part 2 Products

2.1 CONCRETE MATERIALS

1. Hydraulic Cement: CSA-A3001, Type GUL; Grey colour.
2. Blended Hydraulic Cement: CSA-A3001, Type GUb; Grey colour.
3. Fine Aggregates: Normal density aggregates, graded to CSA-A23.1/A23.2
4. Coarse Aggregates: Normal density aggregates, graded to CSA-A23.1/A23.2
5. Water: CSA-A23.1/A23.2, clean and not detrimental to concrete.

2.2 ACCESSORIES

1. Non-Premixed Dry Pack Grout: Composition of non metallic aggregate, Portland cement with sufficient water for mixture to retain its shape when made into a ball by hand and capable of developing compressive strength of 50 MPa when measured at 28 days.
2. Non-Shrink Grout: Premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents; capable of developing minimum compressive strength of 17 MPa in 48 hours and 48 MPa in 28 days.
3. Premoulded joint filler:
    1. Bituminous impregnated fibreboard: to ASTM D1751.
4. Other concrete materials: to CSA-A23.1/A23.2.

2.3 CONCRETE MIX

1. Performance Method for specifying concrete: to meet Engineers performance criteria in accordance with CAN/CSA-A23.1/A23.2.
    1. Ensure concrete supplier meets performance criteria.
    2. Provide concrete mix per Structural Notes on Structural Drawings.
    3. If requested, provide concrete supplier's certification.
    4. Provide quality management plan to ensure verification of concrete quality to specified performance.

2.4 CONCRETE CLASS

1. Classes of concrete shall be placed in the locations noted:

Class of Concrete	Location
C-1	Exterior structurally reinforced slabs
C-2	Exterior unreinforced slab on grade, curbs
F-2	Exterior walls, columns and piers
N-CF	Interior concrete floor slabs that are not subjected to freezing or chlorides
N-1	Interior piers and foundation walls not exposed to freezing
N-1	Interior concrete on composite floor deck
N-2	Footings

2. Classes of concrete shall have the following mix requirements:

Class of Concrete	Strength	W/C Ratio	Air Entrainment	Chloride Ion
C-1	35 MPa (56 days)	0.40	5%-8%	<1500 Coulombs at 91d
C-2	32 MPa	0.45	5%-8%	
F-2	25 MPa	0.55	4%-7%	
N-CF	25 MPa	0.55		
N-1	25 MPa	0.55		
N-1	25 MPa	0.55		
N-2	20 MPa			

3. Use accelerating admixtures in cold weather only when approved by Consultant. Use of admixtures will not relax cold weather placement requirements.
4. Use calcium chloride only when approved by Engineer.
5. Use set retarding admixtures during hot weather only when approved by Engineer.
6. Add air entraining agent to normal weight concrete mix for work exposed to exterior.

Part 3 Execution

3.1 EXAMINATION

1. Verify existing conditions before starting work.
2. Verify all dimensions and locations required on drawings.
3. Verify requirements for concrete cover over reinforcement.
4. Verify that anchors, seats, plates, reinforcement and other items to be cast into concrete are accurately placed, positioned securely, and will not impede concrete placement.
5. Verify locations of all openings and embedments required for other structural, architectural, mechanical and electrical work.

3.2 PREPARATION

1. Prepare previously placed concrete and apply bonding agent to manufacturer's written instructions.
2. In locations where new concrete is dowelled to existing work, drill holes in existing concrete, with size as shown on Drawings.
3. Coordinate the placement of joint devices with erection of concrete formwork and placement of form accessories.
4. During concreting operation:
    1. Development of cold joints not allowed.
    2. Ensure concrete delivery and handling facilitates placing with minimum of re-handling, and without damage to existing structure or Work.
    3. Protect previous Work from staining.
    4. Clean and remove stains prior to application of concrete finishes.

3.3 PLACING CONCRETE

1. Place concrete in accordance with CSA-A23.1/A23.2 and CSA A23.3.
2. Notify Consultant minimum forty eight (48) hours prior to commencement of operations.
3. Ensure reinforcement and embedded parts are not disturbed during concrete placement.
4. Refer to Architectural for requirement for below slab membranes or vapour retarders.
5. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.
6. Place concrete continuously between predetermined expansion, control, and construction joints.
7. Do not interrupt successive placement; do not permit cold joints to occur.
8. Where required, saw cut joints to a minimum 1/4 depth of slab thickness within twenty-four (24) hours after placing. The maximum center/center spacing for saw-cut shall be 24 times the depth.
9. Fill sawcuts and construction joints with semi-rigid, flexible epoxy joint filler, to the manufacturer's specifications.
    1. Acceptable fillers for interior joints : W.R. Meadows Rezi-Weld Flex, Sika Loadflex or Approved Alternate.
    2. Acceptable fillers for exterior joints: Formex Canseal Clear NS or Approved Alternate
10. Do not add water to concrete on site.
11. Do not hard trowel or machine trowel air entrained concrete slabs.
12. Use high frequency vibration to place all concrete.

3.4 SEPARATE FLOOR TOPPINGS

1. Place required reinforcing and other items to be cast into concrete.
2. Place concrete floor toppings to required lines and levels.

3.5 TOLERANCES

1. Slab and Floor Tolerances: To CSA-A23.1/A23.2, to tolerance schedule as indicated.
2. Slab and Floor Tolerances: To CSA-A23.1/A23.2, using F-number method in accordance with ASTM E1155M. Tolerance measurement shall be made a maximum of 72 hours after completion of each floor placement.

3.6 CONCRETE FINISHING

1. Finish concrete floor surfaces to requirements of Section 03 35 00 and architectural drawings.

3.7 CURING AND PROTECTION

1. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical damage.

1. Hot weather protection is required for all concrete placed where it is forecasted that the temperature will be at or above 27C at the time of placement.
2. Take adequate measures to protect concrete from exposure to freezing temperatures at least seven days after concrete placement. Cold weather protection is required for all concrete placed where it is forecasted that the temperature will drop below 5C within 24 hours of placement.

2. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
3. Cure floor surfaces in accordance with CSA-A23.1/A23.2.
4. All concrete shall be kept moist during the first three days of curing. Concrete floors shall be covered in plastic for the first three days of curing.

3.8 FIELD QUALITY CONTROL

1. Inspection and Testing:
   1. Provide free access to Work and cooperate with appointed firm.
   2. All concrete to be tested by a CSA certified concrete testing laboratory. Contractor to provide copies of testing report to consultant for review.
   3. Submit proposed mix design of each class of concrete to testing firm for review prior to commencement of Work.
   4. Tests of cement and aggregates may be performed to ensure conformance with specified requirements.
   5. Minimum Three (3) concrete test cylinders will be taken. Not less than one strength test shall be made for each 100 m^3 of concrete with at least three (3) tests for each class of concrete used, per day.
   6. One additional test cylinder will be taken during cold weather concreting, cured on job site under same conditions as concrete it represents.
   7. Provide one concrete air entrainment test for each pour of air entrained concrete.

3.9 PATCHING

1. Allow Consultant to inspect concrete surfaces immediately upon removal of forms.
2. Excessive honeycomb or embedded debris in concrete is not acceptable. Notify Consultant upon discovery.

3.10 DEFECTIVE CONCRETE

1. Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements.
2. Repair or replacement of defective concrete will be determined by the Consultant.
3. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Consultant for each individual area.

End of Section