

Part 1 General**1.1 DESCRIPTION**

- .1 The works contained in this section include the provision of all materials, equipment, supplies and services, labour and transportation necessary for the complete execution of the following tasks:
 - .1 Design, manufacture, supply, assembly, dismantling and maintenance of all formwork, scaffolding and temporary works required for the construction of all the works shown on the plans specified.
 - .2 Installation of sleeves, anchor bolts, anchor elements, bearing plates, parts buried, slots, sockets, brackets, accessory parts, drains and of all parts embedded in concrete shown on plans of all disciplines or described in the tender document.

1.2 REFERENCE STANDARDS

- .1 The following standards and publications are mentioned in this section of the specifications. They are an integral part of this specification and their requirements apply, but not in a limitative fashion with respect to the other prescriptions of the present section.
- .2 CSA Group (CSA)
 - .1 CSA-A23.1-14/A23.2-14, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
 - .2 CAN/CSA-O86-14, Engineering Design in Wood.
 - .3 CSA O121-08(R2013), Douglas Fir Plywood.
 - .4 CSA O151-09(R2014), Canadian Softwood Plywood.
 - .5 CSA O153-13, Poplar Plywood.
 - .6 CAN/CSA-O325.0-16, Construction Sheathing.
 - .7 CSA O437 Series-93(R2011), Standards for OSB and Waferboard.
 - .8 CSA S269.1-16, Falsework and Formwork.
 - .9 CAN/CSA-S269.3-M92(R2003), Concrete Formwork.
- .3 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S701-11, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00- Submittal Procedures.

1.4 RESPONSIBILITY

- .1 Assume responsibility for formwork and temporary shoring works. Examination of the formwork and temporary works drawings by the Departmental Representative does not relieve the Contractor of its responsibility for providing work fully compliant to the plans and specifications.
- .2 Be sure to know all the laws and regulations applicable to the design and on of formwork and falsework and ensure compliance.

- .3 Before the use of formwork and falsework, provide the Departmental Representative with a statement signed and sealed by an engineer registered or licensed in Nunavut, Canada, attesting that the formwork and falsework conform to the signed and sealed plans and that they can be used for the purposes for which they are intended.

1.5 SHOP DRAWINGS AND TECHNICAL SHEETS

- .1 Shop drawings for formwork and falsework:
 - .1 Before performing formwork or falsework, submit to the Departmental Representative for review and comment 10 days prior to the commencement of the work the shop formwork and falsework drawings depicting all the elements necessary to run the work according to plans and specifications.
 - .2 Shop drawings shall indicate, show or understand: the construction method, the works' schedule, the procedures for shoring, the stripping of formwork, the replacement of shoring, materials and the architectural features of finished exposed surfaces, the arrangement of joints, fasteners, anchors and interior linings, as well as the location of temporary embedded parts. Comply with CSA 269.1 with respect to drawings of temporary shoring works. Comply with the standard CAN/CSA-S269.3 with respect to formwork drawings.
 - .3 Shop drawings shall indicate, show or understand the data from the calculation sheets: i.e. the allowable speed and temperature for concrete pouring into the formwork.
 - .4 In addition to the details required in 1.8.1.2: at each location where falsework cling or rely on an existing structure or structure under construction, indicate on the shop drawings the intensity and direction of the maximum transmitted loads to the structure withholding the loads, while considering construction surcharges.
 - .5 Specify the order of assembly and dismantling of formwork and temporary shoring works.
 - .6 The formwork shoring plans must be signed and sealed by an engineer registered or licensed in Nunavut, Canada. The services of this engineer, hereinafter called the Contractor subcontractor's engineer, shall be selected and paid by the Contractor.
- .2 Shop drawings for sleeves, embedded parts and other
 - .1 Submit for approval 10 days prior to pouring concrete, a coordinated shop plan. This plan must be coordinated with all the embedded elements, niches and reservations (including their location and size) provided for structural, mechanical, electrical and architectural documents.
- .3 Technical sheets
 - .1 Submit for approval 10 days prior to the commencement of work all the concrete's accessories' technical sheets, as specified in Section 2.
 - .2 The Contractor may submit a request for equivalence to the products specified in Section 2. The Contractor shall, however, demonstrate that the proposed product meets the requirements of the product specified in the context used.

1.6 DESIGN CRITERIA OF FORMS AND TEMPORARY STRUCTURES

- .1 Design falsework according to the rules of Art, paying particular attention not to refer to the structure under construction solicitations beyond those eligible.

- .2 Consider construction sequences during the design of falsework. Describe in the shop drawings or in a footnote: the order and the instructions about the formwork, the position of the construction joints and the principle of reuse of falsework and formwork. Submit to the Departmental Representative, for examination, the explanatory notes and the relevant shop drawings.
- .3 The calculation, layout and construction of formwork are the sole responsibility of the specialized contractor.
- .4 The forms are designed for the loads and lateral pressures outlined in section 102 of the U.S. publication "Recommended Practice for Concrete Form Work" (ACI 347). The wind loads are those specified by the National Building Code, latest edition.
- .5 The calculation considerations and efforts allowed are in accordance with section 103 of the abovementioned U.S. publication.
- .6 Comply at all times, and at any point of execution, to the different governmental standards (provincial and federal) governing the specialized Contractor's duties with respect to the protection of workers on construction sites.

1.7 AUTHORISATION/APPROVAL OF DEPARTMENTAL REPRESENTATIVE

- .1 When required, in accordance to the requirements of this section of the specifications, the authorization or approval of the Departmental Representative shall be deemed to be obtained only when it has been notified in writing or recorded in the minutes ratified by all those present at a site meeting at which the which said Departmental Representative attended.

1.8 SLEEVE, EMBEDDED PARTS AND NICHES

- .1 Provide and implement the formwork required to achieve the openings shown on the structural drawings and drawings from other disciplines (mechanical, electrics, plumbing, and architecture) including all sleeves.
- .2 Provide and implement the necessary formwork elements for embedded elements, niches and the reservations shown on the structural drawings and those from other disciplines (mechanical, electrics, plumbing, architectural), including all sleeves.
- .3 The contractor is responsible for coordinating sleeves, embedded pieces and niches shown on the structural drawings and those from other disciplines (mechanical, electrics, plumbing, architectural).

1.9 DELIVERY, STORAGE AND HANDLING

- .1 Store and manage hazardous materials in accordance with Section 01 47 15- Sustainable Requirements: Construction.
- .2 Waste Management and Disposal:
 - .1 Separate waste materials for disposal, reuse and recycling in accordance with Section 01 74 21- Construction/Demolition Waste Management and Disposal.

Part 2 Products**2.1 MATERIALS**

- .1 Formwork materials:
 - .1 For concrete not representing any specific architectural feature, use formwork material such as plywood, wood, steel, aluminum, etc. Conform to the specifications of the latest CSA standards governing the manufacture of these materials.
 - .2 Rigid insulation board: to CAN/ULC-S701.
- .2 Form ties:
 - .1 Metal pulleys with instantaneous tripping ("snap-off") must not leave holes with diameters greater than 25 mm at the surface of the concrete. These are designed so that they can be cut to a depth of at least 15 mm inside the concrete during stripping.
 - .2 For exposed surfaces, the tie must not leave metal at less than 35 mm from the surface and leave a clean hole done with the help of a nylon cone or otherwise.
- .3 Form release agent: biodegradable, non-toxic, low VOC.
- .4 Form stripping agent: Inert oil that will not stain the concrete and will not reduce the adhesion of coatings or coverings. Colourless mineral oil, non-toxic, biodegradable, low VOC, free of kerosene, with viscosity between 15 to 24 mm²/s at 40 degrees C, flashpoint minimum 150 degrees C, open cup. Submit a technical sheet for the examination of the Departmental Representative.
- .5 Temporary Shoring Works: Conform to CSA S269-1 standard. Identify materials by a quality index or accompany them with a certificate, test data or other evidence of compliance.
- .6 Shoring: Steel telescopic jacks.

Part 3 Execution**3.1 FABRICATION AND ERECTION**

- .1 Prior to under taking the construction of the formwork and temporary shoring, check the alignments, levels and spacings and ensure that the dimensions correspond to those indicated on the drawings.
- .2 Obtain written approval from the Departmental Representative prior to pouring concrete directly on the ground or to placing openings in the formwork which were not indicated on the plans, but that may be required for construction purposes.
- .3 Before pouring directly on the ground, level the walls and the bottom of the excavated area, removing detached soil.
- .4 Fabricate and erect falsework in accordance with CSA S269.1.
- .5 Unless otherwise indicated, make and use forms in accordance with the standard CAN/CSA-A23.1/A23.2.
- .6 Before use, clean and treat the formwork's surfaces with stripping oil, in accordance to section 6.5.3.3 of CAN/CSA-A23.1/A23.2.
- .7 Do not place shores and mud sills on frozen ground.
- .8 Provide site drainage to prevent washout of soil supporting mud sills and shores.
- .9 Build and install the forms in accordance to CAN/CSA-S269.3 to obtain finished concrete works of form, dimension and level consistent with the indications and locations specified in the plans and specifications. Properly brace the formwork and bind them together to keep the position and the desired shape during the pouring. This should allow stripping without causing shock or damage to the concrete. Keep them in place until the concrete has reached the compressive strength shown on the plans or this specification, or if the Departmental Representative authorizes the stripping.
- .10 Align joints and make watertight formwork to prevent loss of cement. Minimize the number of joints in the formwork. Adequate reinforcements are placed on the back of the joints between the panels of plywood, to ensure that the plywood panels form a continuous flat surface capable of withstanding the weight without deformation or displacement at all stages of the pouring.
- .11 Use 25 mm chamfer strips on external corners and/or 25 mm fillets at interior corners, joints, unless specified otherwise.
- .12 Location and geometric configuration tolerances of the concrete elements after stripping to the drawings must conform to the tolerances specified in the standard CAN/CSA-A23.1/A23.2 section 6.4.
- .13 Make and build structures and temporary shoring in accordance with CSA S269.1-1975 and the "Exterior Plywood for Concrete Formwork" guide of the COFL.
- .14 Build the grooves, dovetails, moldings, openings, mortises, drips, entrants, expansion and construction joints as indicated on the plans and specifications.
- .15 Formwork can be reused after being cleaned sufficiently, provided that their surfaces are not cracked or rough.

- .16 Equip formwork with openings or other devices that allow inspection and cleaning of formwork, the pouring and its consolidation.
- .17 Before closing formwork, notify the Departmental Representative beforehand 48 hours in advance to allow him to make the required inspections. The pour of the concrete in the forms cannot take place until you have received written permission from the Departmental Representative.
- .18 Unless otherwise specified, supply sleeves, fasteners, anchors and other embedded items required by the plans and/or specifications. Install the forms in accordance with section 6.7 of standard CAN/CSA-A23.1/A23.2. Immediately prior to the concrete pouring, ensure through surveying verifications, that the dimensions required by the plans and specifications are respected and that the tolerances required by these elements are respected.

3.2 REMOVAL AND RESHORING

- .1 Leave formwork in place for following minimum periods of time after placing concrete.
 - .1 24 hours for footings and abutments.
 - .2 The times specified above represent cumulative number of hours, days or parts of days, not necessarily consecutive, during which the temperature is maintained at least 10°C.
- .2 Remove formwork when concrete has reached 80 % of its design strength or minimum period noted above, whichever comes later, and replace immediately with adequate reshoring.
- .3 Provide necessary reshoring of members where early removal of forms may be required or where members may be subjected to additional loads during construction as required.
- .4 Re-use formwork and falsework subject to requirements of CSA-A23.1/A23.2.
- .5 Notwithstanding the provisions of sub-article .1 above, proceed to formwork stripping only once the Departmental Representative, satisfied with the measures taken to ensure the concrete curing and protection against cold, heat and weather, has given authorization.
- .6 Even when authorized by the Departmental Representative to carry out the stripping and/or the removal of the shoring, the sub-contractor is solely responsible for any damage caused to parts of the concrete structure due to the premature implementation of these works.

3.3 LINES AND LEVELS

- .1 Place and secure on site all bench marks required to erect formwork in strict accordance with the lines and grades shown on the plans. The Contractor is solely responsible for the accuracy of these bench marks. He must check them regularly and each time the Departmental Representative deems that it is necessary.
- .2 Replace or rectify immediately any terminal landmark that has been removed or moved before the concrete work for which it is required is completed and approved by the Departmental Representative.

3.4 CONSTRUCTION JOINTS

- .1 The vertical boards placed in the forms to delineate the construction joints in the concrete structure must be rigid, straight and perfectly level. They must also be perforated so that the reinforcements installed perpendicular to them may be placed at the specified height and spacing as indicated on the plans.

3.5 ANCHORS, SLEEVES AND EMBEDDED PARTS

- .1 In accordance with section 6.7 of CSA-A23.1/A23.2, supply and install in the formwork sleeves, fasteners, anchors and other embedded items required on the plans and specifications. The works must be in accordance to Section 03 25 00.
- .2 In accordance with section 6.7 of CSA-A23.1/A23.2, supply and install in the formwork anchor bolts and fasteners for machinery, as shown and detailed on the plans.
- .3 In all cases, comply with installation tolerances specified in clause 6.7.3 of CSA A23.1/A23.2.
- .4 Install sleeves, ducts or pipes according to the following requirements:
 - .1 The outer diameter of the sleeve, duct or pipe must not exceed one third of the thickness of the beam, the slab or the wall in which they are embedded;
 - .2 The distance between two adjacent elements must be greater than or equal to three diameters;
 - .3 These parts should not be located so as to reduce the resistance of the structure;
 - .4 These parts must not be embedded in the floor slabs exposed to the weather.
- .5 If the requirements cannot be met, notify the Departmental Representative and wait for instructions on how to proceed.
- .6 Make sure the sleeves, ducts or pipes embedded in the concrete or aluminum are covered or adequately coated to prevent reactions causing aluminum corrosion.
- .7 It is forbidden to place in the formwork accessory parts not listed on the plans, or not required in the specifications or on the drawings referred to in sub-article .2 above, unless the Departmental Representative has given permission.
- .8 Ensure that anchors and inserts will not protrude beyond surfaces designated to receive applied finishes, including painting.

3.6 CONSTRUCTION SURCHARGE

- .1 It is forbidden to place heavy objects on the floor slabs of the building under construction before the concrete of the slab has cured under normal conditions for a period of at least 28 days. It is prohibited to accumulate thereafter on said slabs and material screeds, mechanical or electrical appliances and equipment whose weight exceeds the operating loads indicated on the plans.

3.7 FILLING OF TIE HOLES

- .1 Fill all conical cavities left after removal of the plastic cones on the ends of the ties with an approved mortar. Moisten beforehand, as requested by manufacturer. Smooth out the surface after the placement of mortar so as to merge all of the surrounding concrete surfaces. Ensure ripening.

END OF SECTION

Part 1 General**1.1 DESCRIPTION**

- .1 The works contained in this section include the provision of all materials, equipment, supplies and services, labour and transportation necessary for the complete execution of the following tasks:
 - .1 Design, manufacture, supply and assembly of all concrete reinforcement required for the construction of all the works shown on the plans specified.

1.2 REFERENCE STANDARDS

- .1 CSA Group (CSA)
 - .1 CSA-A23.1-14/A23.2-14, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.
 - .2 CAN/CSA-A23.3-14, Design of Concrete Structures.
 - .3 CSA-G30.18-09(R2014), Carbon Steel Bars for Concrete Reinforcement.
 - .4 CSA-G40.20/G40.21-13(R2014), General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
 - .5 CAN/CSA-G164-M92(R2003), Hot Dip Galvanizing of Irregularly Shaped Articles.
 - .6 CSA W186-M1990(R2016), Welding of Reinforcing Bars in Reinforced Concrete Construction.
- .2 Reinforcing Steel Institute of Canada (RSIC)
 - .1 RSIC-2004, Reinforcing Steel Manual of Standard Practice.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00- Submittal Procedures.
- .2 Prepare reinforcement drawings in accordance with RSIC Manual of Standard Practice.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Nunavut, Canada.
 - .1 Indicate placing of reinforcement and:
 - .1 Bar bending details.
 - .2 Lists.
 - .3 Quantities of reinforcement.
 - .4 Sizes, spacings, locations of reinforcement and mechanical splices if approved by the Departmental Representative, with identifying code marks to permit correct placement without reference to structural drawings.
 - .5 Indicate sizes, spacings and locations of chairs, spacers and hangers.
- .4 When Chromate solution is used as replacement for galvanizing non-prestressed reinforcement, provide product description for review by the Departmental Representative prior to its use.

1.4 QUALITY ASSURANCE

- .1 Submit in accordance with Section 01 45 00- Quality Control.
 - .1 Mill Test Report: provide the Departmental Representative with certified copy of mill test report of reinforcing steel, minimum 4 weeks prior to beginning reinforcing work.
 - .2 Submit in writing to the Departmental Representative proposed source of reinforcement material to be supplied.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with 01 61 00- Common Product Requirements.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Replace defective or damaged materials with new.

Part 2 Products**2.1 MATERIALS**

- .1 Substitute different size bars only if permitted in writing by the Departmental Representative.
- .2 Reinforcing steel: billet steel, grade 400, deformed bars to CSA-G30.18, unless indicated otherwise.
- .3 Reinforcing steel: weldable low alloy steel deformed bars to CSA-G30.18.
- .4 Cold-drawn annealed steel wire ties: to ASTM A82/A82M.
- .5 Deformed steel wire for concrete reinforcement: to ASTM A82/A82M.
- .6 Welded steel wire fabric: to ASTM A185/A185M.
- .7 Welded deformed steel wire fabric: to ASTM A82/A82M.
- .8 Galvanizing of non-prestressed reinforcement: to CAN/CSA-G164, minimum zinc coating 610 g/m².
 - .1 Protect galvanized reinforcing steel with chromate treatment to prevent reaction with Portland cement paste.
 - .2 If chromate treatment is carried out immediately after galvanizing, soak steel in aqueous solution containing minimum 0.2% by weight sodium dichromate or 0.2% chromic acid.
 - .1 Temperature of solution equal to or greater than 32 degrees and galvanized steels immersed for minimum 20 seconds.
 - .3 If galvanized steels are at ambient temperature, add sulphuric acid as bonding agent at concentration of 0.5% to 1%.
 - .1 In this case, no restriction applies to temperature of solution.
 - .4 Chromate solution sold for this purpose may replace solution described above, provided it is of equivalent effectiveness.
 - .1 Provide product description as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
- .9 Chairs, bolsters, bar supports, spacers: to CSA-A23.1/A23.2.
- .10 Mechanical splices: subject to approval of the Departmental Representative.
- .11 Plain round bars: to CSA-G40.20/G40.21.

2.2 FABRICATION

- .1 Fabricate reinforcing steel in accordance with CSA-A23.1/A23.2 and Reinforcing Steel Manual of Standard Practice by the Reinforcing Steel Institute of Canada.
- .2 Obtain Departmental Representative's written approval for locations of reinforcement splices other than those shown on placing drawings.
- .3 Upon approval of the Departmental Representative, weld reinforcement in accordance with CSA W186.
- .4 Ship bundles of bar reinforcement, clearly identified in accordance with bar bending details and lists.

2.3 SOURCE QUALITY CONTROL

- .1 Upon request, provide the Departmental Representative with certified copy of mill test report of reinforcing steel, showing physical and chemical analysis, minimum 4 weeks prior to beginning reinforcing work.
- .2 Upon request inform the Departmental Representative of proposed source of material to be supplied.

Part 3 Execution

3.1 PREPARATION

- .1 Galvanizing to include chromate treatment.
 - .1 Duration of treatment to be 1 hour per 25 mm of bar diameter.
- .2 Conduct bending tests to verify galvanized bar fragility in accordance with ASTM A143/A143M.

3.2 FIELD BENDING

- .1 Do not field bend or field weld reinforcement except where indicated.
- .2 When field bending is authorized, bend without heat, applying slow and steady pressure.
- .3 Replace bars, which develop cracks or splits.

3.3 PLACING REINFORCEMENT

- .1 Place reinforcing steel as indicated on placing drawings in accordance with CSA-A23.1/A23.2.
- .2 Use plain round bars as slip dowels in concrete.
 - .1 Paint portion of dowel intended to move within hardened concrete with one coat of asphalt paint.
 - .2 When paint is dry, apply thick even film of mineral lubricating grease.
- .3 Prior to placing concrete, obtain the Departmental Representative's approval of reinforcing material and placement.
- .4 Ensure cover to reinforcement is maintained during concrete pour.

3.4 FIELD TOUCH-UP

- .1 Touch up damaged and cut ends of epoxy coated or galvanized reinforcing steel with compatible finish to provide continuous coating.

3.5 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11- Cleaning.
- .2 Waste Management: in accordance with Section 01 74 21- Construction/Demolition Waste Management and Disposal.

END OF SECTION

Part 1 General**1.1 DESCRIPTION**

- .1 This section specifies the requirements for the expertise, supply, installation, finishing, curing protection of concrete cast in place according to the plans, present specifications and contractual documents.

1.2 DEFINITIONS

- .1 The following definitions apply to the present section of the specifications:
 - .1 The Laboratory: the expert in quality control of the placement of materials and concrete mandated by the contractor.
 - .2 The plans: the signed & sealed drawings issued by the Department Representative to be used for the proposed project.

1.3 REFERENCE STANDARDS

- .1 The instructions of the following publications & standards mentioned below form an integral part of the specifications, without limiting the instructions of this document itself.
- .2 ASTM International
 - .1 ASTM C939-10, Test Method for Flow of Grout for Preplaced Aggregate Concrete.
 - .2 ASTM C260/C260M-10a(2016), Standard Specification for Air-Entraining Admixtures for Concrete.
 - .3 ASTM C309-11, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
 - .4 ASTM C494/C494M-16, Standard Specification for Chemical Admixtures for Concrete.
 - .5 ASTM C1017/C1017M-13e1, Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
 - .6 ASTM D624-2012, Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomer.
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-37.2-M88, Emulsified Asphalt, Mineral Colloid-Type, Unfilled, for Dampproofing and Waterproofing and for Roof Coatings.
 - .2 CAN/CGSB-51.34-M86, Vapour Barrier, Polyethylene Sheet for Use in Building Construction.
- .4 CSA Group
 - .1 CSA A23.1/A23.2-14, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
 - .2 CSA A283-06(R2016), Qualification Code for Concrete Testing Laboratories.
 - .3 CSA A3000-13, Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005).

1.4 ABBREVIATIONS AND ACRONYMS

- .1 Portland Cement: hydraulic cement, blended hydraulic cement (XXb - b denotes blended) and Portland-limestone cement.
 - .1 Type GU, GUb and GUL - General use cement.
 - .2 Type MS and MSb - Moderate sulphate-resistant cement.
 - .3 Type MH, MHb and MHL - Moderate heat of hydration cement.
 - .4 Type HE, HEb and HEL - High early-strength cement.
 - .5 Type LH, LHb and LHL - Low heat of hydration cement.
 - .6 Type HS and HSb - High sulphate-resistant cement.
- .2 Fly ash:
 - .1 Type F - with CaO content less than 15%.
 - .2 Type CI - with CaO content ranging from 15 to 20%.
 - .3 Type CH - with CaO greater than 20%.
- .3 GGBFS - Ground, granulated blast-furnace slag.

1.5 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-installation Meetings: in accordance with convene pre-installation meeting one week prior to beginning of the concrete works.

1.6 DOCUMENTS/SAMPLES TO BE SUBMITTED

- .1 Provide submittals in accordance with Section 01 33 00- Submittal Procedures.
- .2 At least 4 weeks prior to commencing work, the laboratory must submit to the Departmental Representative all the documents necessary to certify that the materials listed below conform to the specified requirements.
 - .1 Portland cement
 - .2 Blended hydraulic cement
 - .3 Supplementary cementing materials
 - .4 Grout
 - .5 Additives
 - .6 Aggregates (provide granulometry study)
 - .7 Water
- .3 The laboratory must also provide to the Departmental Representative a mixing formula, stamped by a NAPEG Engineer, certifying that the chosen formula will produce quality concrete with the strength, performance and requirements according to CSA A23.1/A23.2. This formula must be based on the granulometry of the local aggregates.
- .4 Concrete pours: provide accurate records of poured concrete items indicating date and location of pour, quality, air temperature and test samples taken as described in PART 3 - FIELD QUALITY CONTROL.
- .5 The laboratory must provide a certificate stating that the mixing plant, equipment and materials to be used for the manufacture of concrete conform to the requirements of CSA A23.1/A23.2.

- .6 The acceptance by the Departmental Representative does not absolve the responsibility of the Contractor to provide specialized concrete with plastic as well as hardened properties that meet the requirements of the specifications.
- .7 Minimum 4 weeks prior to starting concrete work, provide proposed quality control procedures for review by the Department Representative on following items:
 - .1 Concrete pours in hot-weather
 - .2 Concrete pours in cold-weather
 - .3 Curing
 - .4 Finishing
 - .5 Grouting
- .8 All documents are to be submitted in two (2) copies. One annotated copy will be returned to the Contractor. The Contractor remains responsible to make additional copies and distribute them.

1.7 AUTHORIZATION / APPROVAL FROM DEPARTMENT REPRESENTATIVE

- .1 Where required in accordance with the obligations of this specification section, authorization or approval of the Department Representative shall be deemed to have been obtained when it has been notified in writing or verbally recognized by all present at a site meeting at which the said Department Representative has attended.
- .2 All concrete test results, from the laboratory, must be submitted to the Department Representative for consideration purposes, and in the case of any deviations from the concrete formula, do not continue work without a prior written authorization.
- .3 Submit two (2) copies of material safety data sheets required under SIMDU I, in accordance with Section 01 35 29.06.

Part 2 Products**2.1 MATERIALS**

- .1 Cement: Portland cement GU type and / or GUb- SF, depending on the type of concrete conforming to CSA A3001. Use one recognized brand of cement, per type of concrete for the entire contract.
- .2 Hydraulic slag cement: conforming to CAN/CSA-A362.
- .3 Supplementary cementing materials: conform to CSA A3001.
- .4 Mixing water: conforming to section 4.2.2 of CSA-A23.1/A23.2.
- .5 Fine aggregate: normal mass, according to Article 4.2.3 of CSA-A23.1/A23.2. It may be natural sand or sand manufactured with a proportion of at least 20% natural sand.
- .6 Coarse Aggregate: normal density, conforming to Article 4.2.3 of CSA-A23.1/A23.2 particles will be crushed, durable, free of dust and harmful materials. The particle size will have a maximum of 20 mm, unless otherwise specified. With the approval of the Department Representative, a maximum of 10 mm may be used in some hard to reach places. The coarse aggregates are to have a normal density. The amount of flat and elongated particles shall conform to Table 12 CSA-A23.1/A23.2.
- .7 Air entraining admixture: to ASTM C260.
- .8 Chemical admixtures and pozzolanic mineral admixtures: meeting the specifications of ASTM C494/C494M and ASTM standards C1017/C1017M respectively. The use of calcium chloride or adjuvants that may contain it are not permitted. The Department Representative must approve accelerators or retarders used during the concrete pour in cold weather or hot weather.
- .9 Superplasticizer: conforms to specifications at ASTM C494/C494M.
- .10 Non-shrinking mortar for concrete repairs: premixed Portland cement based product containing a non-metallic aggregate and plasticizer, and able to reach a compressive strength of at least 35 MPa at 7 days.
- .11 Setting retarder: conforming to ASTM C494/C494M water based, low VOC, solvent free. The film retarder shall not be exposed to moisture at any time.

2.2 CONCRETE FORMULA

- .1 The contractor's laboratory is responsible for the concrete mix and must at his own expense take all necessary steps to ensure the quality and consistency of the product.
- .2 The concrete must be prepared in a plant with a stationary mixer.
- .3 Straight out of the mixer, the slump of the concrete must be within 60 mm to 100 mm. In all cases where the addition of a superplasticizer is required, the minimums and maximums will be checked before the superplasticizer is added to the concrete. After the addition of the superplasticizer, the slump must be at a maximum of 150 mm.
- .4 Air Content %: as specified in table below.
- .5 Adding superplasticizer: As indicated in the plans, other sections of the specifications or to facilitate the casting of concrete with the approval of the Department Representative. Using a superplasticizer is expected where there is a high concentration of steel reinforcement, confined spaces or difficult to access places.

- .6 Ensure that the adjuvants used are compatible and that they are thoroughly mixed into the concrete following the manufacturer's instructions. If an adjuvant proves to be harmful or ineffective, replace it immediately with one approved by the Department Representative, while assuming all costs.
- .7 Produce and provide normal density concrete as specified in the following table and in accordance with the requirements of the specifications and plans. Base mixtures do not contain entrained air or coarse aggregates up to a maximum nominal size of 20 mm.

	Exposure type	Resistance at X days (MPa)	Cement	Maximum ratio E/L	Aggregates	Entrained air	Remark
Exterior foundations for lighting and flagpoles	S-3	30 @ 56d*	MS or GU**	0.50	20	-	Note 1
Exterior concrete slab	C-1	35 @ 28d	GU	0.40	20	5% to 8%	Note 1
Slab on decking	N	25 @ 28d	GU	Aa per formula	20	-	Note 1

Note 1: Limit temperature of pour to 4°C.

* : if GU cement is used, the resistance shall be 30 @ 28d

** : if GU cement is used, a concrete additive must be added such as silica fume to improve sulphate resistance

- .8 No change in the composition of concrete mixtures originally submitted for consideration by the Department Representative may be made without the written consent of the Department Representative.
- .9 The slump and entrained air content of concrete are affected when cast by a pump.

Part 3 Execution**3.1 PREPARATION**

- .1 Ensure that the formwork is completed as well as clean, free of ice, snow and water. Ensure that the reinforcements and any other units have been placed in accordance with the requirements of Sections 03 10 00 and 03 20 00 of the specifications. Thoroughly clean and remove all rubbish and debris of any kind in the formwork right before the casting of concrete.
- .2 If it is necessary to melt ice that adheres to the reinforcement or inner walls of the forms, the use of a steam jet or another method may be approved by the Department Representative. The use of de-icing agents is never allowed.
- .3 It is forbidden to pour concrete slabs when the formwork is sitting on frozen soil. In periods of frost, take the necessary steps to prevent freezing of the soil.
- .4 When concrete is pumped, the concrete formulas should be adjusted accordingly. The concrete must retain its characteristics when exiting the pipe of the pump.
- .5 Submit for approval to the Department Representative 5 days prior to casting a plan showing the location and dimensions of all sleeves and parts embedded in the concrete. This plan must make clear all elements embedded in the concrete of all subcontractors.
- .6 Ensure that the reinforcing bars and embedded pieces are not moved during the casting of concrete.
- .7 During concreting operations:
 - .1 Development of cold joints not allowed. Concrete pourage must be continuous to authorized construction joints.
 - .2 Ensure concrete delivery and handling facilitates placing with minimum of re-handling, and without damage to existing structure or Work.
- .8 Pumping of concrete is permitted only after approval of equipment and mix
- .9 Ensure reinforcement and inserts are not disturbed during concrete placement.
- .10 Prior to placing of concrete obtain the Department Representative's approval of proposed method for protection of concrete during placing and curing in adverse weather.
- .11 Protect previous Work from staining.
- .12 Maintain accurate records of poured concrete items to indicate date, location of pour, characteristics of concrete, truck numbers, quality, air temperature, test samples taken and any other additional and relevant information.
- .13 In locations where new concrete is dowelled to existing work, drill holes in existing concrete, clean them out properly and insert steel rebars using a high adhesion to epoxy grout to anchor and maintain the structures.
- .14 Do not place load upon new concrete until authorized by the Department Representative.

3.2 AUTHORIZATION TO CAST CONCRETE

- .1 Before any work begins, get approval from the Department Representative on the methods of casting concrete that must conform to Section 7.2 of the standard CAN/CSA-A23.1/A23.2.

- .2 Notify the Department Representative at least 96 hours in advance whenever a concrete pour of any volume is foreseen. A form entitled "Concrete Notice" must be used and completed by the Contractor.
- .3 No concrete pour shall be undertaken without the authorization of Department Representative.
- .4 Permission to cast concrete shall be granted when the Department Representative has made an inspection of the formwork and is satisfied that the requirements of Article 3.1 have been met.
- .5 It is forbidden to cast concrete when it is raining or snowing, unless the Department Representative is satisfied with the steps taken to accommodate the concrete during transport and casting.
- .6 The authorization granted by the Department Representative to cast concrete when the outside temperature is below 5°C or above 25°C in no way relieves the Contractor of his responsibility to produce the necessary strength and durability of concrete.

3.3 BATCHING & DELIVERY OF CONCRETE

- .1 All concrete is to be made in the plant. The equipment used for measuring, mixing and the transport to the job site must comply with the specifications of the National Ready Mixed Concrete Association.
- .2 Ensure that the temperature of concrete delivered to the site complies with upper and lower limits specified in Tables 14 and 21 of the CSA A23.1/A23.2.
- .3 Plan the batching of concrete and schedule deliveries to the site so that each casting takes place without interruption. Each batch of concrete must be entirely poured into the forms within two (2) hours after mixing. Follow the recommendations of section 5.2.4.3.1 of CSA A23.1/A23.2 for delivery times.
- .4 It is never allowed to add water to the concrete during delivery from the factory to the site. Similarly, it is not allowed to add water to the concrete prior to pouring from the concrete trucks, unless the Department Representative gives authorization. If so, the amount of water added is to be listed on the delivery bill and signed and certified by the representative of the Department Representative.
- .5 The Contractor has the responsibility to manufacture and deliver concrete mixes, required for the work at hand as to the conditions required by CSA-A23.1/A23.2.
- .6 The Contractor shall include costs for all means and precautions that must be used to allow the manufacture and delivery of concrete mixes while respecting the requirements of CSA-A23.1/A23.2. This includes the addition of superplasticizer to adjust the workability of mixes in heavily reinforced or difficult to access areas, the adding of ice or nitrogen to ensure temperature control during delivery and casting during hot weather, the adding of hot water and heating of aggregates during delivery and casting in cold periods, or any other situations where the Contractor is obligated to act in order to meet the requirements of CSA-A23.1/A23.2.
- .7 The use of aluminum is prohibited for all materials intended for mixing, transport or installation of concrete.

3.4 CASTING

- .1 Perform the casting of concrete in accordance with the requirements of CSA-A23.1/A23.2.

- .2 Use internal mechanical vibrators in accordance with Section 7.2.5 of CSA A23.1/A23.2 and entrust handling to qualified operators. The diameter and frequency of these vibrators are subject to the approval of the Department Representative.
- .3 Adjoin fresh concrete with bedrock or hardened concrete in accordance with section 7.2.2 of CSA-A23.1/A23.2.
- .4 Saturate hardened concrete surfaces with water immediately before casting concrete on these surfaces.
- .5 Place concrete continuously or in layers where the thickness of each new layer integrates with the underlying layers before the concrete hardens so as to cause the formation of cold joints.
- .6 If difficulties arise during casting, change the concrete formula following the directives of the Laboratory and use the proposed adjutant whilst assuming all costs.
- .7 Use an appropriate conduit or vertical tube whenever the concrete must be cast from a vertical drop of 1.5 meters or more.
- .8 The addition of a superplasticizer to concrete is required before it is placed in forms when walls have a height of 2 meters (including retaining walls) or more, and for columns and beams containing high concentrations of reinforcement.
- .9 Maintain accurate records of poured concrete items to indicate date, location of pour, quality, air temperature and test samples taken.

3.5 CURING & PROTECTION OF CONCRETE

- .1 Concrete curing is carried out according to the requirements of CSA-A23.1/A23.2 Section 7.4.
- .2 Except for the items mentioned in the paragraph below, the use of curing compounds is permitted provided that the products comply with the specifications of ASTM C309 03 type 1 or 1-D, and that they do not affect the adhesion or placement of finishes and sealants. Attach a written declaration that the various products to be used are compatible. In the case of floor slabs, the treatment must be carried out with water in accordance with Article 7.4.2.1 by either of the methods (a) and (b) described in section 7.4. 2.2.1 CSA A23.1/A23.2 (wet cure).
- .3 The curing of concrete in a humid atmosphere must be carried out for a minimum period of 7 days.
- .4 Ensure that, throughout the duration of the curing process, the concrete will not be subject to any overloading and will be adequately protected against shocks, excessive vibrations, bad weather and other disturbances.
- .5 If the outdoor temperature is 27°C or more, comply with the requirements of Article 7.4.1.4 CSA A23.1. Follow the recommendations of ACI 305R "Hot Weather Concreting", of the American Concrete Institute.
- .6 If the outdoor temperature is 5°C or less, or if it is possible that it descends to this level or lower within the 24 hours following the casting of concrete, comply with the requirements of section 7.4.1.5 CSA A23.1. Follow the recommendations of ACI 306R "Cold Weather Concreting", American Concrete Institute; however, avoid overheating the cast concrete.
- .7 During the curing process, protect the cast sections from bad weather and wind.
- .8 The costs of supplying, installing, powering and maintaining temporary structures and equipment that are required to protect the concrete during the curing process in either hot or cold weather are all included in the contractual work.

- .9 The Contractor must take the necessary measures to control plastic cracking, flaking and scaling due to shrinkage.
- .10 The costs of supplying, installing, powering and maintaining structures and equipment that are required to protect the concrete during the curing process in either hot or cold weather are all included in the contractual work.

3.6 CONSTRUCTION JOINTS

- .1 The location of construction joints for each concrete pour must be approved by the Department Representative. The Department Representative may require that these joints be moved or arranged differently for reasons of structural continuity and/or appearance.
- .2 No construction joint shown on the plans shall be removed or moved without the permission of the Department Representative.
- .3 Leave a minimum curing time of 7 days prior to pouring of another section adjacent to an already cast section.
- .4 Submit for approval to the Department Representative details of all splices required for overlapping rebars crossing construction joints that are not indicated on the plans or steel reinforcement drawings.
- .5 Placing construction joints is included within the regular contract of the Contractor. The Contractor is not entitled to charge extra even if joints are added following directives issued by the Department Representative.

3.7 FINISHING OF CONCRETE WITHIN FORMWORK

- .1 Clean and finish the formwork surfaces in accordance with section 7.7.3 of CSA-A23.1/A23.2. A smooth finished formwork surface is required in accordance with Article 7.7.3.6 of CSA-A23.1/A23.2 for surfaces that will be visually exposed in completed buildings. A rough finished formwork surface is required for all other surfaces according to Article 7.7.3.5 of CSA-A23.1/A23.2.
- .2 Fill holes left by formwork ties in accordance with Section 03 10 00 of the specifications.

3.8 REPAIRING OF CONCRETE

- .1 Remove and replace any damaged or defective concrete with new concrete meeting the specifications and demands of the plans.
- .2 After removing the formwork, any voids or other defects found on the surface of concrete should not be repaired before the Department Representative has examined them. Submit the proposed repair methods for the defects if any are found to the Department Representative for approval. Do not make any surface corrections before receiving permission from the Department Representative. Where it is possible and acceptable, complete the repairs as soon as possible after the removal of formwork.
- .3 Any marks, streaks or other irregularities on the surfaces that are to be waterproofed with a membrane or surfaces that remain exposed must be removed within a period of 24 hours after the removal of the formwork. Holes left by tie rods must be sealed within the same time period.

3.9 CUTTING, PIERCING & NOTCHING CURED CONCRETE

- .1 It is never permissible for any reason whatsoever to cut, drill or notch elements already that have already been cast, unless the Department Representative gives permission.
- .2 Any part of hardened concrete that is cut, drilled or notched must be authorized by the Department Representative at a specific location and according to the exact approved dimensions. Use rotary tools that prevent spalling the concrete.

3.10 SLEEVES AND INSERTS

- .1 Do not permit penetrations, sleeves, ducts, pipes or other openings to pass through joists, beams, column capitals or columns, except where indicated or approved by the Department Representative.
- .2 Where approved by the Department Representative, set sleeves, ties, pipe hangers and other inserts and openings as indicated or specified elsewhere.
- .3 Sleeves and openings greater than 100 x 100 mm not indicated, must be reviewed by the Department Representative.
- .4 Do not eliminate or displace reinforcement to accommodate hardware. If inserts cannot be located as specified, obtain written approval of modifications from the Department Representative before placing of concrete.
- .5 Confirm locations and sizes of sleeves and openings shown on drawings.
- .6 Set special inserts for strength testing as indicated and as required by non-destructive method of testing concrete.

3.11 GROUT

- .1 Grout under base plates and machinery using procedures in accordance with manufacturer's recommendations which result in 100% contact over grouted area.

3.12 TOLERANCES / DEFECTIVE CONCRETE

- .1 If the tolerances specified in Section 6.4 of CSA-A23.1/A23.2 were not observed during the construction of an element shown on the plans, the Department Representative may require that this element be demolished and rebuilt according to the tolerances of the Article with the Contractor assuming all costs.
- .2 If the concrete of an already built structure shown on the plans does not have the required compressive strength, and may compromise its structural efficiency, the Department Representative may require that it be strengthened or demolished and rebuilt; all costs will be assumed by the Contractor.
- .3 If the concrete of an already built structure shown on the plans does not meet the minimum compressive strength specified in the plans, but the Department Representative calculates that there is no need to replace or enhance the concrete, the Contractor will bear all costs of the verification and provide a discount based on the difference between the requested and obtained values of the defective concrete

3.13 FIELD QUALITY CONTROL

- .1 The Laboratory is to be mandated by the Contractor.
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- .2 The quality control of the concrete is to be performed in accordance with CSA-A23.1/A23.2. The Contractor is responsible for monitoring the quality of his work and must provide the Department Representative with a quality control program.
- .3 Submit for approval to the Departmental Representative the proposed formulas, prepared by the Laboratory, of each class of concrete. Specify the type and brand of all additives used.
- .4 The Laboratory must monitor the concrete pour and take the required samples for quality control tests during each concrete pour.
- .5 For every 50 m³ of cast concrete, the Laboratory will take one (1) sample of concrete and cast four (4) standard cylinders used for strength tests at 7 and 28 days respectively. The Laboratory will never take less than one (1) sample per day of each type of concrete cast, and for each type of particular structural element cast.
- .6 The cylinders should be numbered consecutively. The laboratory report must indicate the exact location of the concrete sampled along with the number of the original truck.
- .7 The laboratory will measure the slump and air content of the concrete whenever samples for resistance testing are taken and as often as necessary in regard to the nature of the work at hand.
- .8 Find a place on site protected from the weather elements where the concrete cylinders can be stored safely at an ambient temperature of 10 ° C - 25 ° C before their delivery to the testing laboratory.
- .9 The Laboratory will collect additional cylindrical specimens when casting in cold weather. The curing of these samples should be on the site, under the same conditions as the concrete elements from which they are taken.
- .10 The Testing Laboratory shall provide a complete inspection report to the Departmental Representative. This report will be necessary before acceptance of work.
- .11 If tests conducted by the Department Representative indicate that the concrete of an already built element shown on the plans does not meet the minimum specified compressive strength, all costs incurred by the provisions of Article 4.4.6.7 of CSA A23.1-A23.2, on the Non-compliance with the results of tests on cylinders subjected to a standardized treatment, CSA A23.1 A23.2 will be assumed by the Contractor.
- .12 The Contractor is solely responsible for the completion of all required concrete work as shown on the plans and specifications. All work that does not meet the specification requirements for any reason whatsoever (quality of materials, mixing, casting, resistance, impermeability, etc.) must be modified in accordance with the requirements of the Department Representative or shall be demolished in whole or in part and rebuilt in accordance with the plans and specifications at the Contractor's expense.

3.14 CLEANING

- .1 Clean in accordance with Section 01 74 11- Cleaning.
- .2 Waste Management: in accordance with Section 01 74 21- Construction/Demolition Waste Management and Disposal.

END OF SECTION