

**Part 1 General**

**1.1 RELATED REQUIREMENTS**

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 03 20 00 - Concrete Reinforcing.
- .3 Section 03 30 00 - Cast-In-Place Concrete.

**1.2 REFERENCES**

- .1 Canadian Standards Association (CSA International)
  - .1 CSA-A23.1-2009/A23.2-2009, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
  - .2 CSA-O86S1-2005, Supplement No. 1 to CAN/CSA-O86-2001, Engineering Design in Wood.
  - .3 CSA O121-2008, Douglas Fir Plywood.
  - .4 CSA O151-2009, Canadian Softwood Plywood.
  - .5 CSA O153-2008, Poplar Plywood.
  - .6 CSA S269.1-2003, Falsework for Construction Purposes.
  - .7 CAN/CSA-S269.3-2008, Concrete Formwork, National Standard of Canada.
- .2 American Concrete Institute (ACI)
  - .1 ACI 347 - Recommended Practice for Concrete Formwork.
  - .2 ACI SP-4 - Formwork for Concrete.
  - .3 ACI 117 - Specification for Tolerances for Concrete Construction.
- .3 Underwriters' Laboratories of Canada (ULC)
  - .1 CAN/ULC-S701-2011, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.

**1.3 SUBMITTALS**

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit shop drawings for formwork and falsework.
  - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
- .3 Indicate method and schedule of construction, shoring, stripping and reshoring procedures, materials, arrangement of joints, ties, liners, and locations of temporary embedded parts. Comply with CSA S269.1/S269.3 for falsework drawings and formwork drawings.
- .4 Indicate formwork design data: permissible rate of concrete placement, and temperature of concrete, in forms.
- .5 Indicate sequence of erection and removal of formwork/falsework as directed by Departmental Representative.

- .6 When slip forming/flying forms are used, submit details of equipment and procedures for review by Departmental Representative.

#### **1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Waste Management and Disposal: 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 without special architectural features, use wood and wood product formwork materials to CSA-O121CAN/CSA-O86 and CSA-O153.
- .2 Form Ties:
  - .1 For concrete not designated 'Architectural', use removable or snap-off metal ties, fixed or adjustable length, free of devices leaving holes larger than 25-mm diameter in concrete surface.
- .3 Form Release Agent: chemically active release agents containing compounds that react with free lime in concrete resulting in water insoluble soaps.
- .4 Form Stripping Agent: colourless mineral oil, nontoxic, free of kerosene, with viscosity between 70 and 110s Saybolt Universal, 15 to 24 mm<sup>2</sup>/s at 40°C, flashpoint minimum 150°C, open cup.
- .5 Falsework Materials: to CSA-S269.1.

### **Part 3 Execution**

#### **3.1 FABRICATION AND ERECTION**

- .1 Verify lines, levels and centers before proceeding with formwork/falsework and ensure dimensions agree with drawings.
- .2 Fabricate and erect falsework in accordance with CSA S269.1.
- .3 Do not place shores and mud sills on frozen ground.
- .4 Provide site drainage to prevent washout of soil supporting mud sills and shores.
- .5 Fabricate and erect formwork in accordance with CAN/CSA-S269.3 to produce finished concrete conforming to shape, dimensions, locations and levels indicated within tolerances required by CSA-A23.1/A23.2.
- .6 Align form joints and make watertight.
- .7 Keep form joints to minimum.
- .8 Locate the lift joints maximum 2400 mm or as shown on the drawings or suggested by the Contractor with the approval of the Departmental Representative.

- .9 Use 25-mm chamfer strips on external corners and/or 25-mm fillets at interior corners and joints, unless specified otherwise.
- .10 Form chases, slots, openings, drips, recesses, expansion and control joints as indicated.
- .11 Build in anchors, sleeves, and other inserts required to accommodate Work specified in other sections.
  - .1 Ensure that anchors and inserts will not protrude beyond surfaces designated to receive applied finishes, including painting.
- .12 Clean formwork in accordance with CSA-A23.1/A23.2, before placing concrete.

### **3.2 REMOVAL AND RESHORING**

- .1 Leave formwork in place for the minimum period of 7 days after placing concrete.
- .2 Remove formwork when concrete has reached 70% 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 Space reshoring in each principal direction at not more than 3000 mm apart.
- .5 Reuse formwork and falsework subject to requirements of CSA-A23.1/A23.2.

**END OF SECTION**

**Part 1            General**

**1.1               RELATED REQUIREMENTS**

- .1       Section 03 10 00 - Concrete Forming and Accessories.
- .2       Section 03 30 00 - Cast-In-Place Concrete.

**1.2               REFERENCES**

- .1       National Building Code of Canada (NBCC).
- .2       American Society for Testing Materials (ASTM)
  - .1       ASTM D412-2006 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension.
  - .2       ASTM D570-2010 - Standard Test Method for Water Absorption of Plastics.
  - .3       ASTM D624-2012 - Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.
  - .4       ASTM D638-2010 - Standard Test Method for Tensile Properties of Plastics.
  - .5       ASTM D746-2007 - Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
  - .6       ASTM D747-2010 - Standard Test Method for Apparent Bending Modulus of Plastics by Means of a Cantilever Beam.
  - .7       ASTM D792-2008 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
  - .8       ASTM D2240-2010 - Standard Test Method for Rubber Property – Durometer Hardness.
- .3       Corps of Engineers
  - .1       CRD-C 572 - Corps of Engineers Specifications for Polyvinylchloride Waterstops.

**1.3               SUBMITTALS**

- .1       Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2       Provide after Contract award documentation to the Departmental Representative demonstrating that the manufacturer has 5 years (minimum) continuous, successful experience in the production of waterstops.
- .3       Supply Departmental Representative with review and approval and samples of proposed waterstops at least 120 days before the date of its intended use.
  - .1       Samples of the material to be used, in sheet form, in 3000-mm lengths, having a uniform thickness between 1.5 and 3 mm and having a total area of not less than 0.2 m<sup>2</sup>, will be sent to a competent independent testing laboratory by the Contractor.
  - .2       Accompany the samples supplied to the Departmental Representative by an affidavit from the Purchaser to the effect that the samples are of the same material in all respects as that to be used in the manufacture of the finished

waterstop and an affidavit from a laboratory, approved by the Departmental Representative to certify that the waterstop material has been tested and conforms with the requirements of the respective specifications noted above.

- .3 All test reports to be mailed simultaneously to the Contractor and the Departmental Representative.
- .4 Waterstops not be ordered without the Departmental Representative's approval.

#### **1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .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 dry location and in accordance with manufacturer's recommendations in clean and dry area.
  - .2 Protect from oil, dirt, and sunlight while in storage on site prior to use.
  - .3 Replace defective or damaged materials with new.

### **Part 2 Products**

#### **2.1 PVC WATERSTOPS**

- .1 Extruded from a high-grade elastomeric plastic compound, of which the basic resin is prime virgin polyvinyl chloride (PVC).
- .2 Contain additional resins, plasticizers, stabilizers, inhibitors and other additives such that when compounded will meet the specified performance requirements.
- .3 Homogeneous, free from porosity or other imperfections, and does not contain any scrapped or reclaimed material or pigments.
- .4 Damaged waterstops will not be used in the Works.
- .5 To conform to the shapes and sizes shown on the Drawings.
- .6 Accepted Waterstops:
  - .1 Arctic grade, capable of resisting a head pressure of 45 m, remain workable throughout a temperature range of -50°C to +80°C.
  - .2 Ribbed type with center bulb conforming to CGSB 41-GP 35 M, Type 2.
    - .1 Type 1: 150 mm - install at all horizontal construction joints.
    - .2 Type 2: 225 mm - install at all vertical construction joints.
    - .3 Type 3: 225 mm - install at all vertical contraction joints.
- .7 Capable of accommodating a movement of 20 mm across the center bulb in contraction joints.
- .8 Come complete with hog rings or grommets spaced along the length of the waterstop according to manufacturer's requirements.

- .9 Meet the following requirements:

Requirement	Method of Test
Tensile strength using die “C”: not less than 13.78 MPa	ASTM D412
Water absorption: 0.15% maximum	ASTM D570
Tear resistance: not less than 35 kN/m	ASTM D624
Ultimate elongation: not less than 350%	ASTM D638
Low temperature brittleness: no failure at -50°C	ASTM D746
Stiffness in flexure: not less than 4.1 MPa	ASTM D747
Specific gravity: not less than 1.20; 1.45 maximum	ASTM D792
Tensile strength after accelerated extraction: 11.0 MPa	CRD C-572
Elongation after accelerated extraction: 300% minimum	CRD C-572

### Part 3 Execution

#### 3.1 INSTALLATION

- .1 Furnish all materials and equipment for cutting and end butt splicing waterstops. All waterstop intersections or changes in direction such as tees, 90° angles, Y-pieces, crosses, transitions or special interconnections will be factory fabricated off site and as approved by the Departmental Representative, such that only butt joint splices are required in the field.
- .2 Make all necessary cuts and end butt splices in the waterstops by means of a suitable accepted portable teflon-coated thermostatically controlled waterstop splicing iron, or by another generally recognized method, provided the equipment and procedure is in strict accordance with the manufacturer's specifications. Lapping of waterstop, use of adhesives or solvents is not allowed.
- .3 Take suitable precautions and provide means to support and protect waterstops during the progress of the work.
- .4 Repair or replace any damaged waterstops. Supply all necessary supports and ties required for placing the waterstops.
- .5 Install waterstops located at contraction joints as shown/detailed on the Drawings.
- .6 Install waterstops such that the bulb is centered across the contraction joint. Do not install waterstops in formed keys that are offset from the face of the form/contraction joint.
- .7 Install waterstops at all construction joints that could be subjected to hydrostatic pressure, as shown on the Drawings and as directed by the Departmental Representative.
- .8 Install waterstops at all intermediate joints not shown on the Drawings, those that have been caused by the setting of underlying concrete.
- .9 Install waterstops at joints between the foundation working slab and concrete pours above where seepage cutoff is required.
- .10 Install waterstops with equal widths of the material embedded in the concrete on each side of the joint and make sure that they are held rigidly in place.

- .11 Carefully place and vibrate around waterstops to ensure complete filling of the forms in the areas around waterstops and a complete bond between the concrete and all embedded areas of the waterstops.
- .12 Do not deposit concrete directly onto the waterstops.
- .13 Seal waterstops against rock and extend it 300 mm into the rock in a drilled slot or similar neat excavation, as approved by the Departmental Representative.
- .14 Fill the space around the waterstops in the slot with flowable nonshrink grout as shown on the Drawings.
- .15 Protect waterstops by timber enclosures or by other means as approved by the Departmental Representative wherever waterstops project from completed sections and complete embedment is to be delayed.
- .16 Perform all splicing, bending, sealing and joining to PVC waterstops as directed by the manufacturer, and as approved by the Departmental Representative.

### **3.2 FIELD QUALITY CONTROL**

- .1 Unacceptable waterstop splicing defects requiring replacements to the approval of the Departmental Representative include, but are not limited to, the following:
  - .1 Tensile strength less than 80% of parent section.
  - .2 Misalignment of center bulb, ribs and end bulbs greater than 1.5 mm.
  - .3 Bond failure at joint deeper than 1.5 mm or 15% of material thickness.
  - .4 Misalignment that reduces waterstop cross section more than 15%.
  - .5 Visible porosity in the weld.
  - .6 Bubbles or inadequate bonding.
  - .7 Visible signs of splice separation when cooled splice is bent by hand at a sharp angle.
  - .8 Charred or burnt material.

**END OF SECTION**

**Part 1 General**

**1.1 UNIT PRICES**

- .1 The quantities of additional concrete and reinforcement beyond the limits shown on the drawings, that are over and above as specified in the Contract Documents, and have been authorized in writing by Departmental Representative will be paid based on the actual quantities measured on site and the unit prices stated in the Bid and Acceptance Form.

**1.2 RELATED REQUIREMENTS**

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 03 10 00 - Concrete Forming and Accessories.
- .3 Section 03 30 00 - Cast-In-Place Concrete.

**1.3 REFERENCES**

- .1 National Building Code of Canada, 2010.
- .2 Canadian Standards Association (CSA)
  - .1 CSA A23.1 - Concrete Materials and Methods of Concrete Construction.
  - .2 CSA A23.3 - Design of Concrete Structures.
  - .3 CSA G30.18 - Carbon Steel Bars for Concrete Reinforcement.
  - .4 CSA W186 - Welding of Reinforcing Bars in Reinforced Concrete Construction.
- .3 American Society for Testing Materials (ASTM)
  - .1 ASTM A185 - Steel Welded Wire Reinforcement - Plain - for Concrete.
  - .2 ASTM A497 - Steel Welded Wire Reinforcement - Deformed - for Concrete.
  - .3 ASTM A767/A767M - Zinc-coated (Galvanized) Steel Bars for Concrete Reinforcement.
- .4 American National Standards Institute/American Concrete Institute
  - .1 ACI SP-66 - ACI Detailing Manual.
- .5 Reinforcing Steel Institute of Ontario
  - .1 Reinforcing Steel - Manual of Standard Practice.

**1.4 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 Province of Ontario.
    - .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 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.
- .2 Detail lap lengths and bar development lengths to CAN/CSA-A23.3.
  - .3 Detail length of the standard hooks to CAN/CSA A23.3 or as shown on the drawings.

## **1.5 QUALITY ASSURANCE**

- .1 Submit in accordance with Section 01 45 00 - Quality Control and as described in PART 2 - SOURCE QUALITY CONTROL.
  - .1 Mill Test Report: provide 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 Departmental Representative proposed source of reinforcement material to be supplied.

## **1.6 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 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 dry location and 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 Departmental Representative.
- .2 Reinforcing steel: billet steel, grade 400, deformed bars to CSA-G30.18, unless indicated otherwise and 400R for nonweldable and 400W for weldable rebars.
- .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 Chairs, bolsters, bar supports, spacers: to CSA-A23.1/A23.2.
- .8 Mechanical splices: subject to approval of Departmental Representative.
- .9 Plain round bars: to CSA-G40.20/G40.21.
- .10 Hot-dipped galvanized dowels: to CSA-G30.18

## **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 All the splices will be tension splice class B unless noted otherwise on the drawings.
- .3 Obtain Departmental Representative's written approval for locations of reinforcement splices other than those shown on placing drawings.
- .4 Welding of reinforcing is not permitted. However if permitted by the Departmental Representative, weld reinforcement in accordance with CSA W186.
- .5 Ship bundles of bar reinforcement, clearly identified in accordance with bar bending details and lists.

## **2.3 SOURCE QUALITY CONTROL**

- .1 Provide 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 Inform Departmental Representative of proposed source of material to be supplied.

## **Part 3 Execution**

### **3.1 PREPARATION**

- .1 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 or authorized by Departmental Representative.
- .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 and in accordance with CSA-A23.1/A23.2.
- .2 Dowels embedded in the bedrock will be hot-dipped galvanized meeting the requirements of CSA G146. Use nonshrink, nonmetallic cementitious grout having 30 MPa as 28 days compressive strength or prepackaged equal with the approval of the Departmental Representative.

- .3 Prior to placing concrete, obtain Departmental Representative's approval of reinforcing material and placement.
- .4 Ensure cover to reinforcement is maintained during concrete pour.

### **3.4 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

**END OF SECTION**

**Part 1 General**

**1.1 UNIT PRICES**

- .1 The quantities of additional concrete and reinforcement beyond the limits shown on the drawings, that are over and above as specified in the Contract Documents, and have been authorized in writing by Departmental Representative will be paid based on the actual quantities measured on site and the unit prices stated in the Bid and Acceptance Form.

**1.2 RELATED REQUIREMENTS**

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 03 10 00 - Concrete Forming and Accessories.
- .3 Section 03 20 00 - Concrete Reinforcing.
- .4 Section 05 50 00 - Metal Fabrications.

**1.3 REFERENCES**

- .1 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.
- .2 Reference Standards:
  - .1 National Building Code of Canada (NBCC), 2010.
  - .2 National Fire Code of Canada (NFCC), 2010.
  - .3 Canadian Standards Association (CSA)
    - .1 CSA A23.1-2009 - Concrete Materials and Methods of Concrete Construction.
    - .2 CSA A23.1-2009 Annex B - Alkali-Aggregate Reaction.
    - .3 CSA A23.2-2009 - Test Methods and Standard Practices for Concrete.
    - .4 CSA A23.3-2010 - Design of Concrete Structures.
    - .5 CSA A23.4-2009 - Precast Concrete - Materials and Construction.

- .6 CSA A3000-2008 - Cementitious Materials Compendium (which consists of A3001, A3002, A3003, A3004 and A3005).
- .7 CSA A283-2011 - Qualification Code for Concrete Testing Laboratories.
- .4 Canadian General Standards Board (CGSC).
- .5 Reinforcing Steel Institute of Ontario (RSIO)
  - .1 Reinforcing Steel - Manual of Standard Practice.
- .6 American Society of Testing and Materials (ASTM)
  - .1 ASTM C31/C31M-2012 - Making and Curing Concrete Test Specimens in the Field.
  - .2 ASTM C33/C33M-2013 - Standard Specification for Concrete Aggregates.
  - .3 ASTM C39/C39M-2012 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
  - .4 ASTM C40/C40M-2011 - Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.
  - .5 ASTM C70 -2013 - Standard Test Method for Surface Moisture in Fine Aggregate.
  - .6 ASTM C88-2005 - Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
  - .7 ASTM C94/C94M-2012 - Standard Specification for Ready-Mixed Concrete.
  - .8 ASTM C127-2012 - Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate.
  - .9 ASTM C128-2008 - Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate.
  - .10 ASTM C131-2006 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
  - .11 ASTM C136-2006 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
  - .12 ASTM C143/C143M -2012 - Standard Test Method for Slump of Hydraulic Cement Concrete.
  - .13 ASTM C150/C150M-2012 - Standard Specification for Portland Cement.
  - .14 ASTM C192/192M-2012 - Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
  - .15 ASTM C260/260M-2010 - Standard Specification for Air-Entraining Admixtures for Concrete.
  - .16 ASTM C309-2011 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
  - .17 ASTM C451-2008 - Standard Test Method for Early Stiffening of Hydraulic Cement (Paste Method).
  - .18 ASTM C457/C457M-2012 - Standard Test Method for Microscopical Determination of Parameters of the Air-Void System in Hardened Concrete.

- .19 ASTM C494/C494M -2012- Standard Specification for Chemical Admixtures for Concrete.
- .20 ASTM C666/C666M-2008 - Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing.
- .21 ASTM C1017/C1017M-2007 - Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
- .7 Cement Association of Canada (CAC)
  - .1 Design and Control of Concrete Mixtures.
- .8 American Concrete Institute (ACI)
  - .1 ACI 207.1R-2005 - Guide to Mass Concrete.
  - .2 ACI 211.1-1991 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
  - .3 ACI 214R-2002 - Guide to Evaluation of Strength Test Results of Concrete.
  - .4 ACI 301M-2010 - Specifications for Structural Concrete.
  - .5 ACI 304R-2000 - Guide for Measuring, Mixing, Transporting, and Placing Concrete.
  - .6 ACI 305R-2010 - Guide to Hot Weather Concreting.
  - .7 ACI 306R-2010 - Guide to Cold Weather Concreting.
  - .8 ACI 308R-2001 - Guide to Curing Concrete.
  - .9 ACI 309R-2005 - Guide for Consolidation of Concrete.
  - .10 ACI 318M-2008 - Building Code Requirements for Structural Concrete.

#### **1.4 ADMINISTRATIVE REQUIREMENTS**

- .1 Pre-Installation Meetings: convene pre-installation meeting one week prior to beginning concrete works.
  - .1 Ensure key personnel attend.
  - .1 Verify project requirements.

#### **1.5 SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Provide testing results for review by Departmental Representative and do not proceed without written approval when deviations from mix design or parameters are found.
- .3 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 Section 3.4 - FIELD QUALITY CONTROL.
- .4 Provide two copies of Workplace Hazardous Materials Information System (WHMIS) material safety data sheets (MSDS) in accordance with Section 01 35 29.06 - Health and Safety Requirements.

#### **1.6 QUALITY ASSURANCE**

- .1 Quality Assurance: in accordance with Section 01 45 00 - Quality Control.

- .2 Provide Departmental Representative, minimum 4 weeks prior to starting concrete work, with valid and recognized certificate from plant delivering concrete.
  - .1 Provide test data and certification by qualified independent inspection and testing laboratory that materials and mix designs used in concrete mixture will meet specified requirements.
- .3 Minimum 4 weeks prior to starting concrete work, provide proposed quality control procedures for review by Departmental Representative on following items:
  - .1 Falsework erection.
  - .2 Hot weather concrete.
  - .3 Cold weather concrete.
  - .4 Curing.
  - .5 Finishes.
  - .6 Formwork removal.
- .4 Quality Control Plan: provide written report to Departmental Representative verifying compliance that concrete in place meets performance requirements of concrete as established in PART 2 - PRODUCTS.
- .5 Sustainability Standards Certification:
  - .1 Construction Waste Management: provide copy of plan.

## **1.7 DELIVERY, STORAGE AND HANDLING**

- .1 Delivery and Acceptance Requirements:
  - .1 Concrete hauling time: deliver to site of Work and discharged within 120 minutes maximum after batching as described in CSA A23.1/A23.2.
    - .1 Do not modify maximum time limit without receipt of prior written agreement from Departmental Representative and concrete producer as described in CSA A23.1/A23.2.
    - .2 Deviations to be submitted for review by Departmental Representative.
  - .2 Concrete delivery: ensure continuous concrete delivery from plant meets CSA A23.1/A23.2.
- .2 Packaging Waste Management: in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

## **Part 2 Products**

### **2.1 DESIGN CRITERIA**

- .1 To CSA A23.1/A23.2, and as described in Section 2.3 - MIXES below.

### **2.2 MATERIALS**

- .1 Cement: to CSA A3001, Type GU. Total alkali content contributed by the cement less than 0.6% Na<sub>2</sub>O.

- .2 Supplementary Cementing Materials: Fly Ash Class F or CI to CSA A3000 with maximum of 40% replacement, by mass of total cementitious materials to CSA A3001.
- .3 Water: to CSA-A23.1/A23.2.
- .4 Aggregates: to CSA A23.1/A23.2.
- .5 Admixtures:
  - .1 Air-entraining admixture: to ASTM C260.
  - .2 Chemical admixture: to CSA A23.1 and ASTM C494/C494M and C1017/C1017M. Departmental Representative to approve accelerating or set retarding admixtures during cold and hot weather placing.
- .6 The use of calcium chloride is not permitted.
- .7 Curing Compound: to CSA A23.1/A23.2.

## **2.3 MIXES**

- .1 According to CSA A23.1/A23.2:
  - .1 Ensure concrete supplier meets performance criteria as established below and provide verification of compliance as in Quality Control Plan.
  - .2 Provide concrete mix to meet the following plastic state requirements:
    - .1 Uniformity: as per CSA A23.1.
    - .2 Workability: as per CSA A23.1, free of surface blemishes, loss of mortar, colour variations and segregation.
    - .3 Finishability: as per CSA A23.1.
    - .4 Set time: as per CSA A23.1.
  - .3 Provide concrete mix to meet the following hard state requirements:
    - .1 Cast in place concrete including the lean concrete slab (under the control structure) except the deck slab:
      - .1 Durability and “F1” class of exposure to CSA-A23.1 Tables 10, 11 and 14.
      - .2 Compressive strength at 28 days: 30 MPa minimum.
    - .2 Concrete deck slab:
      - .1 Durability and “C1” class of exposure to CSA-A23.1 Tables 10, 11 and 14.
      - .2 Compressive strength at 28 days: 35 MPa minimum.
  - .4 Maximum nominal size of coarse aggregate: 20 mm for sections having minimum dimension less than 1 m and 20 mm to 40 mm for sections having least dimension more than 1 m.
  - .5 Test aggregate for alkali reactivity as per CSAA23.2 and as approved by the Departmental Representative.
  - .6 Provide quality management plan to ensure verification of concrete quality to specified performance.
  - .7 Concrete supplier’s certification: both batch plant and materials meet CSA A23.1 requirements.



**Part 3            Execution**

**3.1               PREPARATION**

- .1 Obtain Departmental Representative's written approval before placing concrete.
  - .1 Provide 24 hours minimum notice prior to placing of concrete.
- .2 Place concrete reinforcing in accordance with Section 03 20 00 - Concrete Reinforcing.
- .3 During concreting operations:
  - .1 Development of cold joints not allowed.
  - .2 Ensure concrete delivery and handling facilitates placing with minimum of rehandling, and without damage to existing structure or Work.
- .4 Pumping of concrete is permitted only after approval of equipment and mix.
- .5 Ensure reinforcement and inserts are not disturbed during concrete placement.
- .6 Prior to placing of concrete, obtain Departmental Representative's approval of proposed method for protection of concrete during placing and curing in adverse weather.
- .7 Protect previous Work from staining.
- .8 Clean and remove stains prior to application for concrete finishes.
- .9 Maintain accurate records of poured concrete items to indicate date, location of pour, quality, air temperature and test samples taken.
- .10 Do not place load upon new concrete until authorized by Departmental Representative.

**3.2               INSTALLATION/APPLICATION**

- .1 Do cast-in-place concrete work to CSA A23.1/A23.2.
- .2 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 Departmental Representative.
  - .2 Where approved by the Departmental 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 Departmental 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 Departmental Representative.
  - .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 nondestructive method of testing concrete.
- .3 Anchor Bolts:
  - .1 Set anchor bolts to templates in coordination with appropriate trade prior to placing concrete.

- .2 Grout anchor bolts in preformed holes or holes drilled after concrete has set only after receipt of written approval from Departmental Representative.
  - .1 Formed holes: 100-mm minimum diameter.
  - .2 Drilled holes: to manufacturers' recommendations.
- .3 Protect anchor bolt holes from water accumulations, snow and ice build-ups.
- .4 Set bolts and fill holes with shrinkage compensating grout.
- .5 Locate anchor bolts used in connection with expansion shoes, rollers and rockers with due regard to ambient temperature at time of erection.
- .4 Concrete Cover: clear cover will be as follows and as shown in the drawings:
  - .1 Surfaces exposed to water: 100 mm.
  - .2 Surfaces exposed to earth/rock : 75 mm.
  - .3 Surfaces exposed to weather: 60 mm.
  - .4 Top surface of the deck slab minimum cover: 60 mm.
  - .5 In no case concrete cover will be less than 1.5 times the reinforcing bar diameter.
- .5 Finishing and Curing:
  - .1 Finish concrete to CSA A23.1/A23.2.
  - .2 Use procedures as reviewed by the Departmental Representative and those noted in CSA A23.1/A23.2 to remove excess bleed water. Ensure surface is not damaged.
  - .3 Rub exposed sharp edges of concrete with carborundum to produce 3-mm minimum radius edges unless otherwise indicated.
  - .4 For buried concrete the finish surface will be "F1", and for exposed concrete the surface finish will be "F2".
  - .5 The finish surface for the concrete exposed to water will be "F3" except the pier nose and abutment upstream faces where it will be "F4".
- .6 Waterstops:
  - .1 Install waterstops to provide continuous water seal.
  - .2 Do not distort or pierce waterstop in way as to hamper performance.
  - .3 Do not displace reinforcement when installing waterstops.
  - .4 Use equipment to manufacturer's requirements to field splice waterstops.
  - .5 Tie waterstops rigidly in place.
  - .6 Use only straight heat-sealed butt joints in field.
  - .7 Use factory-welded corners and intersections unless otherwise approved by the Institution or the Departmental Representative.

### **3.3 SURFACE TOLERANCE**

- .1 Concrete tolerance to CSA A23.1.

### **3.4 FIELD QUALITY CONTROL**

- .1 Site Tests: conduct tests in accordance with Section 01 45 00 - Quality Control and submit report as described in Section 1.4 - SUBMITTALS.

- .1 Concrete pours.
- .2 Slump.
- .3 Air content.
- .4 Compressive strength at 7, 28 and 56 days.
- .5 Air and concrete temperature.
- .2 Inspection and testing of concrete and concrete materials will be carried out by testing laboratory designated by Departmental Representative for review to CSA A23.1/A23.2.
  - .1 Ensure testing laboratory is certified to CSA A283.
- .3 Ensure slump tests are according to CSA A23.1.
- .4 Ensure test results are distributed for discussion at prepouring concrete meeting between testing laboratory and Departmental Representative.
- .5 Departmental Representative may take additional test cylinders during cold weather concreting. Cure cylinders on job site under same conditions as concrete which they represent.
- .6 Nondestructive Methods for Testing Concrete: to CSA A23.1/A23.2.
- .7 Inspection or testing by Departmental Representative will not augment or replace Contractor quality control nor relieve Contractor of his contractual responsibility.

### **3.5 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**