

# **TENDER DOCUMENTS**

## **SUBSECTION 6.31 REINFORCING STEEL FOR CONCRETE**

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## SUBSECTION 6.31 REINFORCING STEEL FOR CONCRETE

### 6.31.1 GENERAL

- 6.31.1.1 This subsection 6.31 *Reinforcing Steel for Concrete* sets out the requirements relating to the reinforcing steel, wire mesh and anchor work under this Contract.
- 6.31.1.2 Unless otherwise indicated on the plans, new reinforcing bars to be supplied and placed by the Contractor which are referred to on the plans and specifications, are all in metric units. Existing bars identified on the plans may be identified in metric or imperial units.
- 6.31.1.3 Any specific requirements relating to the reinforcing steel, wire mesh and anchor work under this Contract are set out on the plans and in Section 4 *Special Technical Conditions*.
- 6.31.1.4 The requirements relating to formwork are described in subsection 6.32 *Formwork*.
- 6.31.1.5 The requirements relating to cast-in-place concrete are described in subsection 6.33 *Cast-in-Place Concrete*.
- 6.31.1.6 The requirements relating to dry-mix or wet-mix shotcrete are described in subsection 6.34 *Shotcrete*.

### 6.31.2 MEASUREMENT UNITS

- 6.31.2.1 The measurement units and respective symbols thereof used in this subsection are described as follows:

Measurement Unit	Designation	Symbol
length	meter	m
length	millimeter	mm
length	micrometer	µm
angle	degree	°
force	kilonewton	kN
temperature	Celsius degree	°C

### 6.31.3 REFERENCE STANDARDS

- 6.31.3.1 The Contractor shall carry out all reinforcing steel, wire mesh and anchor work in accordance with the requirements of the following standards and documents, to which the provisions of this Contract are added:
- 6.31.3.1.1 (ACI) American Concrete Institute:
- ACI SP-66 *ACI Detailing Manual*.

6.31.3.1.2 (ASTM) ASTM International:

- ASTM E1512 *Standard Test Methods for Testing Bond Performance of Bonded Anchors*;
- ASTM A123/A123M *Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products*;
- ASTM A276/A276M *Standard Specification for Stainless Steel Bars and Shapes*;
- ASTM A955/A955M *Standard Specification for Deformed and Plain Stainless-Steel Bars for Concrete Reinforcement*;
- ASTM A1064/A1064M *Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete*;
- ASTM D-520 type III *Standard Specification for Zinc Dust Pigment*.

6.31.3.1.3 CAN/CSA Group (Canadian Standards Association):

- CAN/CSA-A23.1/A23.2 *Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete*;
- CAN/CSA-A23.3 *Design of Concrete Structures*;
- CAN/CSA-G30.18 *Carbon Steel Bars for Concrete Reinforcement*;
- CAN/CSA S6 *Canadian Highway Bridge Design Code*;
- CAN/CSA-W186 *Welding of Reinforcing Bars in Reinforced Concrete Construction*.

6.31.3.1.4 RSIC (IAAC) Reinforcing Steel Institute of Canada:

- RSIC *Reinforcing Steel Manual of Standard Practice*.

6.31.3.1.5 (MTQ) Ministère des Transports du Québec:

- MTQ – *Cahier des charges et devis généraux (CCDG)*;
- MTQ – *Normes – Ouvrages routiers – Tome VII Matériaux, Chapitre 3 Béton de ciment et produits connexes, Norme 3402 Pavés*.

## 6.31.4 MATERIALS

### 6.31.4.1 REINFORCING STEEL

6.31.4.1.1 Unless otherwise indicated on the plans, all new reinforcing steel shall be 400W grade high-bond ribbed-surface steel compliant with standard CSA G30.18.

6.31.4.1.1.1 Where indicated on the plans, all stainless reinforcing steel shall be 420 grade and 316LN or 2205 Duplex type high-bond ribbed-surface steel compliant with standards ASTM A276/A276M and A955/A955M.

- 6.31.4.1.2 The Contractor shall provide proof of compliance of the physical and chemical properties through tests conducted by a laboratory member of Association des firmes de génie-conseil – Québec (AFG) in accordance with standard CSA G30.18, if the reinforcing steel is not from a Canadian or American steel mill. If the reinforcing steel is from an American steel mill, the latter shall hold a registration certificate compliant with standard ISO 9001 *Quality Management Systems – Requirements*.
- 6.31.4.1.2.1 The Contractor shall provide proof of compliance of the physical and chemical properties of the stainless steel bars through tests conducted by a laboratory member of the AFG, in accordance with standards CSA G30.18 and ASTM A955/A955M.
- 6.31.4.1.3 Unless otherwise indicated on the plans, all reinforcing steel provided for the construction and/or repairs indicated on the plans shall be hot dip galvanized in accordance with standard ASTM A123/A123M.
- 6.31.4.1.4 Steel reinforcing bars shall be cold mechanically bent after galvanizing and shall be free of veins, cracks or other defects that may affect their quality in accordance with the RSIC standard.
- 6.31.4.1.5 Steel reinforcing bars shall be bent after they are galvanized and before they are implemented, in the exact shapes indicated on the plans. The Contractor shall carefully check the bending measurements and ensure that the clearances between the formwork and the reinforcing steel are maintained in accordance with the RSIC standard.
- 6.31.4.1.6 Factory-cut straight galvanized reinforcing bars may be delivered to the site, provided that the cut ends have been covered, at the factory, with a zinc-rich coating using a brush.
- 6.31.4.1.7 After bending, the total spalling area at the bending radius shall not exceed the bent bar cross section. The bars having a spalling area greater than this value shall be rejected.
- 6.31.4.1.8 Galvanized surfaces damaged during shaping, transportation or installation shall be repaired by the Contractor, to the satisfaction of the Engineer, by means of a zinc-rich coating.
- 6.31.4.1.8.1 The zinc-rich coating products authorized under this Contract are the following:
- 6.31.4.1.8.1.1 *Sealtight Galvafruid Zinc-Rich Coating* manufactured by W.R. Meadows of Canada Limited;
- 6.31.4.1.8.1.2 *Z.R.C.* manufactured by Sealube, Quincy, Massachusetts;
- 6.31.4.1.8.1.3 *LPS-Instant Cold Galvanize*;

- 6.31.4.1.8.1.4 *Galvanox* manufactured by Carboline and distributed by Corrosion Service Company Limited;
- 6.31.4.1.8.1.5 An equivalent authorized by the Engineer.
- 6.31.4.1.9 The zinc-rich coating, cold galvanizing for corrections to hot dip galvanizing, shall be applied only to metal whose surface is clean and dry. The Contractor shall, using a solvent, remove the grease and oil before applying the coating in accordance with the manufacturer's recommendations. The Contractor shall apply two (2) coats of dry film of a minimum thickness of 100 µm or any other specification from the manufacturer, according to the most stringent one.
- 6.31.4.1.10 Reinforcing bars that are to receive a conical threaded coupler shall be threaded after galvanizing.
- 6.31.4.1.11 Stainless steel reinforcing bars shall be cut, bent and shaped in a factory authorized to that effect in accordance with the RSIC standard.
- 6.31.4.1.12 Stainless steel reinforcing bars shall be cold mechanically bent and shall be free of veins, cracks, contaminants or other defects that may affect their quality in accordance with the RSIC standard.
- 6.31.4.1.13 Ribbed-surface reinforcing bars shall be marked in accordance with standard CSA G30.18.
- 6.31.4.1.14 Reinforcing steel shall not be painted.
- 6.31.4.1.15 The Contractor shall provide the Engineer with four (4) copies of the bending lists, on which the reinforcing bars shall be numbered and itemized, as well as placement plans.
- 6.31.4.2 ANCHORS
- 6.31.4.2.1 Anchors shall be made of 400W grade high-bond reinforcing steel bars compliant with standard CSA G30.18 and shall be shaped in accordance with standard CAN/CSA-A23.1.
- 6.31.4.2.1.1 The anchors supporting the stainless steel reinforcing bars shall be made of 420 grade high-bond stainless steel reinforcing bars in accordance with standards CAN/CSA G30.18 and ASTM A955/A955M and shall be shaped in accordance with standard CAN/CSA-A23.1.
- 6.31.4.2.2 Unless otherwise indicated on the plans, the anchors indicated on the plans shall be hot dip galvanized in accordance with standard ASTM A123/A123M.
- 6.31.4.2.3 Anchors shall be long enough to take into account the different demolition depths.

6.31.4.2.4 Unless otherwise indicated on the plans, the anchors used for the wire mesh shall be *Gunite Hook*, fabricated by Hilti or an equivalent authorized by the Engineer, shall have a 6 mm diameter and be hot dip galvanized.

#### 6.31.4.3 WIRE MESH

6.31.4.3.1 The welded wire mesh shall comply with standard ASTM A1064/A1064M for mesh with unribbed-surface steel wire.

6.31.4.3.2 Unless otherwise indicated on the plans, wire mesh shall be 51 mm by 51 mm, MW9.1 x MW9.1 gauge and hot dip galvanized in accordance with standard ASTM A123/A123M.

6.31.4.3.3 The wire mesh shall not be painted.

6.31.4.3.4 The wire mesh shall be supplied in flat sheets only.

#### 6.31.4.4 TYING WIRE

6.31.4.4.1 The steel wire used to connect the reinforcing bars and the wire mesh shall be made of annealed steel of 1.6 mm in diameter (16 gauges) or bigger.

6.31.4.4.2 The steel wire used with galvanized reinforcing steel shall be galvanized.

6.31.4.4.3 The steel wire used with stainless reinforcing steel shall be made of stainless steel.

#### 6.31.4.5 BAR SPACERS AND BAR SUPPORTS

6.31.4.5.1 Bar spacers and bar supports shall be made of precast concrete, plastic or plastic-coated steel. The concrete shall contain entrained air and be chlorine free.

6.31.4.5.2 Continuous spacers with plastic-covered wires and plastic tabs shall be used to maintain horizontal the reinforcement layer which is located closest to the formwork, ground or existing concrete.

6.31.4.5.3 Circular plastic spacers whose center is fixed to the reinforcing steel shall be used to maintain upright reinforcement layers consisting of 15M and 20M bars.

6.31.4.5.4 Plastic spacers shall be used to maintain upright reinforcement layers consisting of bars whose diameter is equal to or greater than 25M.

6.31.4.5.5 Unless otherwise indicated on the plans, individual plastic spacers shall be used for the other horizontal reinforcement layers.

6.31.4.5.6 For footings and foundations, the bar spacers and bar supports shall be concrete paving stones compliant with MTQ standard 3402 *Pavés*, and of same composition and strength as the concrete used.

6.31.4.5.7 The use of wooden blocks, bricks or stones as bar spacers or bar supports is prohibited.

#### 6.31.4.6 COUPLERS

6.31.4.6.1 The couplers used for the mechanical joints of reinforcing bars shall be conical threaded couplers.

6.31.4.6.2 The couplers shall be hot dip galvanized in accordance with standard ASTM A123/A123M.

6.31.4.6.3 The threads shall be cleaned after galvanizing, so as to allow proper tightening of the reinforcing bars.

6.31.4.6.4 The couplers shall be delivered to the site with one end covered with a plastic cap. The cap shall have a seal and be screwed into the coupler.

#### 6.31.4.7 ANCHOR ADHESIVE

6.31.4.7.1 Unless otherwise indicated on the plans, the chemical adhesive system authorized under this Contract to secure anchors to concrete is the *HY-200* system manufactured by Hilti, or an equivalent authorized by the Engineer.

#### 6.31.4.8 CEMENTITIOUS CAPSULES

6.31.4.8.1 The cementitious capsules used to anchor reinforcing bars to hardened concrete shall be made of *Ambex* alumina cement manufactured by Ambex Concrete Technologies Inc. or an equivalent authorized by the Engineer.

#### 6.31.4.9 GALVANIZING

6.31.4.9.1 Where indicated on the plans, reinforcing bars shall be hot dip galvanized in accordance with standard ASTM A123/A123M.

### 6.31.5 INSPECTION AND STORAGE

6.31.5.1 The Engineer reserves the right to inspect the quality of the reinforcing steel and to conduct physical tests of samples.

6.31.5.2 The reinforcing steel delivered to the site shall be identified in accordance with the delivery slips.

6.31.5.3 The Contractor shall ensure that the reinforcing steel is stored so as to prevent rust, damage to the coating and deformation of the steels.

6.31.5.4 The Contractor shall repair, to the satisfaction of the Engineer, post-galvanizing damage to the coating. In such a case, the Contractor shall take corrective actions in accordance with standard ASTM D-520, at no additional cost to the Owner.



6.31.5.5 Stainless reinforcing steel bars that exhibit the following defects shall be rejected:

6.31.5.5.1 if a surface of contamination of the stainless steel by basic carbon steel, such as the presence of rust stains, is visible over a length of more than 100 mm on a reinforcing bar;

6.31.5.5.2 if two (2) or more surfaces of contamination of the stainless steel by basic carbon steel, such as the presence of rust stains, of a length of at least 25 mm are visible on the same reinforcing bar;

6.31.5.5.3 if small rust stains are visible over the entire length of reinforcing bar.

6.31.5.6 After placement of the reinforcing steel and before installation of the formwork, the Contractor shall submit to the Engineer a written notice, signed by an engineer who is a member of the *Ordre de ingénieurs du Québec* (OIQ), indicating that the reinforcing steel is placed and the anchor rods are installed in accordance with the plans and specifications relating to the origin (steel mill), grade, type of steel protection, diameter, length, location, coating of each bar as well as to the location of ligatures. This notice shall also state the date and time the inspection was carried out by the Engineer.

## **6.31.6 EXECUTION OF WORK**

### **6.31.6.1 PLANNING**

6.31.6.1.1 At least fourteen (14) days prior to the installation work, the Contractor shall submit to the Engineer, for review, the plans indicating the proposed placement of the reinforcing steel and installation of anchors.

6.31.6.1.1.1 The plans referred to in paragraph 6.31.6.1.1 above shall be prepared in accordance with the RSIC standard.

### **6.31.6.2 REINFORCING STEEL**

6.31.6.2.1 The reinforcing steel shall be free of mud, oil, coating or any other substance likely to reduce the bond with the concrete.

6.31.6.2.2 The reinforcing steel shall be placed in accordance with standard CAN/CSA-A23.1.

6.31.6.2.3 The bending of reinforcing bars on site is prohibited.

6.31.6.2.4 At the request of the Engineer, the Contractor shall add extra reinforcing bars.

6.31.6.2.5 Unless otherwise indicated on the plans, the minimum overlap length of the bars shall be 600 mm and compliant with standard CAN/CSA S6.

- 6.31.6.2.6 The reinforcing steel shall be connected to anchors, formwork brackets and tie rods previously placed by the Contractor or to the existing reinforcing steel by means of tying wires, as prescribed in Article 6.31.4.4 *Tying wire* and supported so as to avoid any shifting during the concrete placement.
- 6.31.6.2.7 The welding of reinforcing bars to existing or new reinforcing bars or anchors is prohibited, except with written authorization from the Engineer.
- 6.31.6.2.8 In congested areas or where the bars are greater than or equal to 25 mm in diameter, the Contractor shall avoid splices by using welded connections authorized by the Engineer, or mechanical coupler connections.
- 6.31.6.2.9 The electrodes used for welding shall comply with standard CAN/CSA W48 and be of classification E480XX.
- 6.31.6.2.10 Intersecting reinforcing bars shall be securely connected to one another at every intersection if the intersections are more than 300 mm apart and at every other intersection if the intersections are closer.
- 6.31.6.2.11 All tying wires used to connect the reinforcing bars to one another shall be bent inward so as not to reduce the thickness of the concrete cover.
- 6.31.6.2.12 Unless otherwise indicated on the plans, reinforcing bars shall be placed so as to ensure a minimum coverage compliant with standard CAN/CSA-A23.1.
- 6.31.6.2.13 Unless otherwise indicated on the plans, the minimum gap between the new reinforcing steel and the existing concrete shall be 30 mm.
- 6.31.6.2.14 Reinforcing bars shall be supported by support blocks placed no farther apart than 1 m from centre to centre. The dimensions of the support blocks shall be such that the required clearances between the reinforcing steel and the formwork are met.
- 6.31.6.2.15 The Contractor shall secure non-adherent or exposed reinforcing steel with anchors. Reinforcing steel considered as “exposed” are those whose ends are free over a length of more than 1 m and the reinforcing steel that is anchored at its ends but also loose over a length of more than 2 m.
- 6.31.6.2.16 During the concrete placement, all vertically placed reinforcing bars shall be held in place by the top.
- 6.31.6.2.17 Reinforcing bars fitted with conical threaded couplers shall be placed so that the plastic caps are pressed firmly against the formwork.
- 6.31.6.2.18 Unless otherwise indicated on the plans, the minimum concrete cover required on the reinforcing steel shall comply with standard CAN/CSA S6.

### 6.31.6.3 ANCHORS

- 6.31.6.3.1 The anchors indicated on the plans are required in order to anchor the new concrete to the existing substrate and to connect the new reinforcing steel. Anchors shall be long enough to permit the securing of the reinforcing bars in their final position, as indicated on the plans, while taking into account the different demolition depths.
- 6.31.6.3.2 The 6 mm diameter anchors used to secure the wire mesh shall develop their mechanical anchoring capacity with a minimum penetration of 30 mm into sound concrete.
- 6.31.6.3.3 10M and 15M anchors may be installed using cementitious capsules or an adhesive chemical resin in accordance with the manufacturer's recommendations. Anchor bars, drilled holes and resin cartridges shall have the diameters recommended by the manufacturer.
- 6.31.6.3.3.1 The cementitious capsules or resin mix shall completely fill the anchor holes. For overhanging anchors, the appropriate precautions shall be taken in order to avoid the loss of material due to gravity.
- 6.31.6.3.3.2 The technical data sheets pertaining to the cementitious capsules and resins, as well as the placement method, including the equipment used, shall be submitted to the Engineer for review at least fourteen (14) days before the installation of anchors begins.
- 6.31.6.3.4 The location of bore holes and length of anchor rods shall be as indicated on the plans.
- 6.31.6.3.5 Where the ambient temperature is below 5°C or below the minimum temperature specified by the manufacturer, the cementitious capsules or epoxy resin cartridges shall be stored in a heated area so that they can be placed at a temperature between 10°C and 25°C, and the anchor bars shall be preheated according to the manufacturer's recommendations.
- 6.31.6.3.6 Anchor holes on vertical surfaces shall be inclined 15° relative to the horizontal with the opening of the hole at the top.
- 6.31.6.3.7 Anchor hole shall be drilled using hammer-drill or rotary drills, and their diameter shall correspond to the dimensions specified by the anchor manufacturer. Compressed air and a brush shall be used to clean drilling debris from the holes.
- 6.31.6.3.7.1 Unless otherwise indicated by the Engineer, diamond drilling and pneumatic drilling are prohibited.
- 6.31.6.3.7.2 The Contractor shall take all precautions when drilling anchor holes in order not to damage the prestressing elements including the existing post-tensioning sheaths, cables and strands.

- 6.31.6.3.8 Anchor holes shall be protected from obstructions or clogging using plugs or other means authorized by the Engineer. Holes that become obstructed or clogged before completion of the work shall be cleaned or replaced with other holes.
- 6.31.6.3.9 Threaded anchors shall be provided for the purpose of conducting pull tests in accordance with standard ASTM E1512.
- 6.31.6.3.10 Unless otherwise indicated on the plans, the cementitious or chemical anchors shall withstand a theoretical pull force of 40 kN for the 10M and 15M bars. The Owner's Laboratory will test a minimum of 5 % of the randomly selected anchors in the proportion specified by the Engineer in order to check the bond-strength. If one or more anchors fail to withstand the minimum bond value specified above, the Contractor shall take corrective actions at its expense at no additional cost to the Owner and to the satisfaction of the Engineer.
- 6.31.6.3.11 Anchors shall not be subjected to any force within the first twenty-four (24) hours following their installation and shall not be touched or moved during the initial setting period of the resin or grout.
- 6.31.6.3.12 Unless otherwise indicated on the plans, the anchors that support the mesh shall withstand a pull force of 5 kN.
- 6.31.6.4 WIRE MESH FOR CONCRETE
- 6.31.6.4.1 Wire mesh shall be placed in accordance with standard CAN/CSA-A23.1.
- 6.31.6.4.2 Unless otherwise indicated on the plans, adjacent wire mesh shall overlap at least one and a half square.
- 6.31.6.4.3 Unless otherwise indicated on the plans, the addition of wire mesh and anchors is required for all surfaces to be repaired with shotcrete and such wire mesh and anchors shall comply with subsection 6.34 *Shotcrete*.
- 6.31.6.4.4 The Contractor shall secure the galvanized wire mesh to the anchors with galvanized steel wire.
- 6.31.6.4.5 Unless otherwise indicated on the plans, the wire mesh shall be positioned so as to ensure a minimum concrete cover of 40 mm.

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**END OF SUBSECTION**